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Federal Communications Commission Radio Frequency Interference Statement

Warning: The equipment described herein has been certified to comply with the limits for a Class B computing device, pursuant to Subpart J of Part 15 of the FCC rules. Only peripherals (computer input/output devices, terminals, printers, etc.) certified to comply with the Class B limits may be attached to the computer. Operation with non-certified peripherals is likely to result in interference to radio and TV reception. If peripherals not offered by IBM are used with the equipment, it is suggested to use shielded grounded cables with in-line filters if necessary.

CAUTION
This product described herein is equipped with a grounded plug for the user's safety. It is to be used in conjunction with a properly grounded receptacle to avoid electrical shock.

Notes:

Preface

This manual describes the various units of the IBM Personal Computer AT and how they interact. It also has information about the basic input/output system (BIOS) and about programming support.

The information in this publication is for reference, and is intended for hardware and program designers, programmers, engineers, and anyone else who needs to understand the design and operation of the IBM Personal Computer AT.

This manual consists of nine sections:

- The first three sections describe the hardware aspects of the IBM Personal Computer AT including signal charts and register information.
- Section 4 describes keyboard operation, the commands to and from the system, and the various keyboard layouts.
- Section 5 contains information about the usage of BIOS and a system BIOS listing.
- Section 6 contains instruction sets for the 80286 microprocessor and the 80287 math coprocessor.
- Section 7 provides information about characters, keystrokes, and colors.
- Section 8 has general communications information.
- Section 9 contains information about the compatibility of the IBM Personal Computer AT and the rest of the IBM Personal Computer family.

A glossary of terms and a bibliography of related publications are included.

Prerequisite Publications

Guide to Operations for the IBM Personal Computer AT

Suggested Reading

- *BASIC* for the IBM Personal Computer
- *Disk Operating System (DOS)*
- *MACRO Assembler* for the IBM Personal Computer

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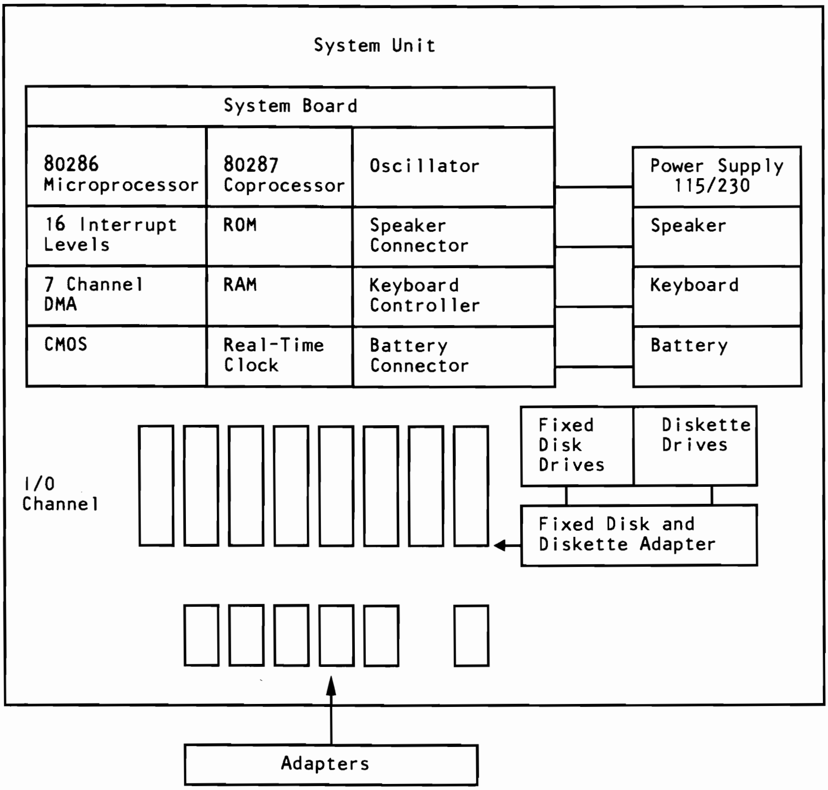


SECTION 1. SYSTEM BOARD

Contents

The type 1 system board is approximately 30.5 by 35 centimeters (12 by 13.8 inches). The type 2 system board is approximately 23.8 by 35 centimeters (9.3 by 13.8 inches). Both types of system boards use very large scale integration (VLSI) technology and have the following components:

- Intel 80286 Microprocessor
- System support function:
  - Seven-Channel Direct Memory Access (DMA)
  - Sixteen-level interrupt
  - Three programmable timers
  - System clock
- 64K read-only memory (ROM) subsystem, expandable to 128K
- A 512K random-access memory (RAM) Subsystem
- Eight input/output (I/O) slots:
  - Six with a 36-pin and a 62-pin card-edge socket
  - Two with only the 62-pin card-edge socket
- Speaker attachment
- Keyboard attachment
- Complementary metal oxide semiconductor (CMOS) memory RAM to maintain system configuration
- Real-Time Clock
- Battery backup for CMOS configuration table and Real-Time Clock

Memory

The type 1 system board has four banks of memory sockets, each supporting 9 128K-by-1-bit modules for a total memory size of 512K, with parity checking.

The type 2 system board has two banks of memory sockets, each supporting 9 256K-by-1-bit modules for a total memory size of 512K, with parity checking.

Microprocessor

The Intel 80286 microprocessor has a 24-bit address, 16-bit memory interface[1], an extensive instruction set, DMA and interrupt support capabilities, a hardware fixed-point multiply and divide, integrated memory management, four-level memory protection, 1G (1,073,741,824 bytes) of virtual address space for each task, and two operating modes: the 8086-compatible real address mode and the protected or virtual address mode. More detailed descriptions of the microprocessor may be found in the publications listed in the Bibliography of this manual.

Real Address Mode

In the real address mode, the microprocessor's physical memory is a contiguous array of up to one megabyte. The microprocessor addresses memory by generating 20-bit physical addresses.

The selector portion of the pointer is interpreted as the upper 16 bits of a 20-bit segment address. The lower 4 bits of the 20-bit segment address are always zero. Therefore, segment addresses begin on multiples of 16 bytes.

1 In this manual, the term interface refers to a device that carries signals between functional units.

All segments in the real address mode are 64K in size and may be read, written, or executed. An exception or interrupt can occur if data operands or instructions attempt to wrap around the end of a segment. For example, a word with its low-order byte at offset FFFF and its high-order byte at 0000. If, in the real address mode, the information contained in the segment does not use the full 64K, the unused end of the segment may be overlayed by another segment to reduce physical memory requirements.

Protected (Virtual Address) Mode

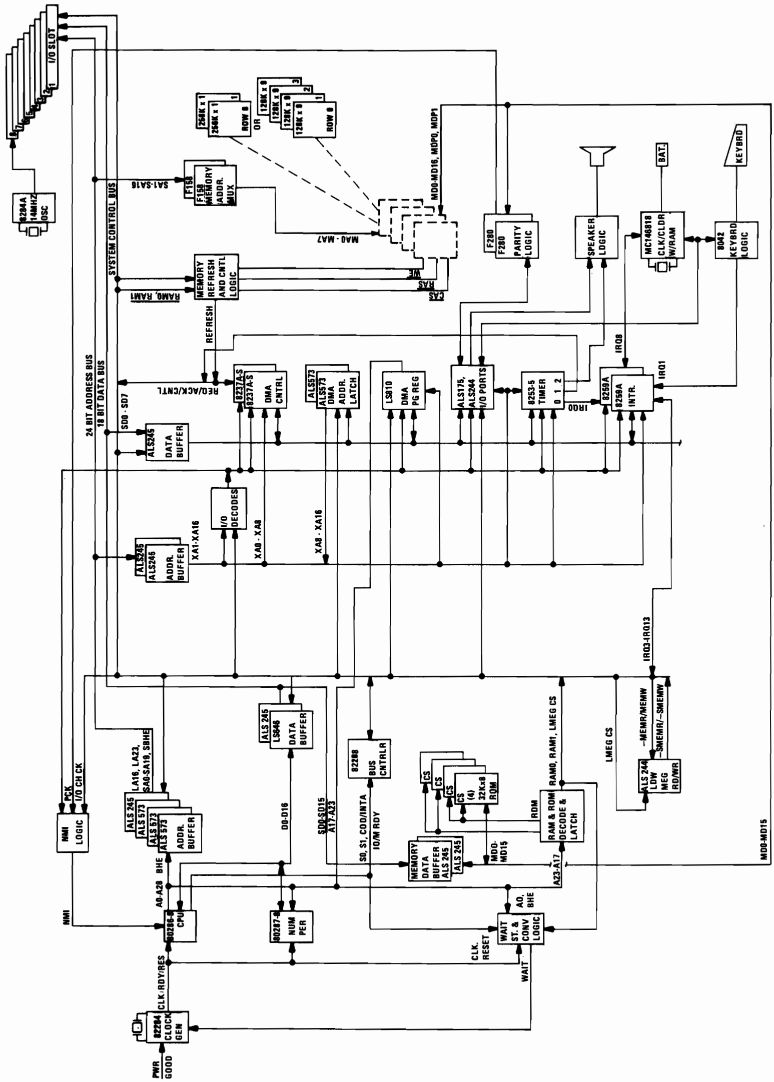
The protected mode offers extended physical and virtual memory address space, memory protection mechanisms, and new operations to support operating systems and virtual memory.

> **Note:** See "BIOS Programming Hints" in Section 5 for special cautions while operating in the protected mode.

The protected mode provides a 1G virtual address space for each task mapped into a 16M physical address space. The virtual address space may be larger than the physical address space, because any use of an address that does not map to a physical memory location will cause a restartable exception.

As in the real address mode, the protected mode uses 32-bit pointers, consisting of 16-bit selector and offset components. The selector, however, specifies an index into a memory resident table rather than the upper 16 bits of a real memory address. The 24-bit base address of the desired segment is obtained from the tables in memory. The 16-bit offset is added to the segment base address to form the physical address. The microprocessor automatically refers to the tables whenever a segment register is loaded with a selector. All instructions that load a segment register will refer to the memory-based tables without additional program support. The memory-based tables contain 8-byte values called *descriptors*.

Following is a block diagram of the system board.



System Performance

The 80286 microprocessor operates at 6 MHz, resulting in a clock cycle time of 167 nanoseconds.

A bus cycle requires 3 clock cycles (which includes 1 wait state) so that a 500-nanosecond, 16-bit, microprocessor cycle time is achieved. Eight-bit bus operations to 8-bit devices take 6 clock cycles (which include 4 wait states), resulting in a 1000-nanosecond microprocessor cycle. Sixteen-bit bus operations to 8-bit devices take 12 clock cycles (which include 10 wait states) resulting in a 2-microsecond microprocessor cycle.

The refresh controller steps one refresh address every 15 microseconds. Each refresh cycle requires 5 clock cycles to refresh all of the system's dynamic memory; 256 refresh cycles are required every 4 milliseconds. The following formula determines the percentage of bandwidth used for refresh.

```
% Bandwidth used    5 cycles X 256   1280
   for Refresh    = -------------- = ----- = 5.3%
                     4 ms/167 ns     24000
```

The DMA controller operates at 3 MHz, which results in a clock cycle time of 333 nanoseconds. All DMA data-transfer bus cycles are 5 clock cycles or 1.66 microseconds. Cycles spent in the transfer of bus control are not included.

DMA channels 0, 1, 2, and 3 are used for 8-bit data transfers, and channels 5, 6, and 7 process 16-bit transfers. Channel 4 is used to cascade channels 0 through 3 to the microprocessor.

The following figure is a system memory map.

Address	Name	Function
000000 to 07FFFF	512K system board	System board memory
080000 to 09FFFF	128K	I/O channel memory - IBM Personal Computer AT 128K Memory Expansion Option
0A0000 to 0BFFFF	128K video RAM	Reserved for graphics display buffer
0C0000 to 0DFFFF	128K I/O expansion ROM	Reserved for ROM on I/O adapters
0E0000 to 0EFFFF	64K reserved on system board	Duplicated code assignment at address FE0000
0F0000 to 0FFFFF	64K ROM on the system board	Duplicated code assignment at address FF0000
100000 to FDFFFF	Maximum memory 15M	I/O channel memory - 512K to 15M installed on memory expansion options
FE0000 to FEFFFF	64K reserved on system board	Duplicated code assignment at address 0E0000
FF0000 to FFFFFF	64K ROM on the system board	Duplicated code assignment at address 0F0000

System Memory Map

Direct Memory Access

The system supports seven direct memory access (DMA) channels. Two Intel 8237A-5 DMA Controller chips are used, with four channels for each chip. The DMA channels are assigned as follows:

Controller 1	Controller 2
Ch 0 - Reserved Ch 1 - SDLC Ch 2 - Diskette (IBM Personal Computer) Ch 3 - Reserved	Ch 4 - Cascade for Ctlr 1 Ch 5 - Reserved Ch 6 - Reserved Ch 7 - Reserved

DMA Channels

DMA controller 1 contains channels 0 through 3. These channels support 8-bit data transfers between 8-bit I/O adapters and 8- or 16-bit system memory. Each channel can transfer data throughout the 16M system-address space in 64K blocks.

The following figures show address generation for the DMA channels.

Source	DMA Page Registers	Controller
Address	A23<---------->A16	A15<---------->A0

Address Generation for DMA Channels 0 through 3

> **Note:** The addressing signal, 'byte high enable' (BHE), is generated by inverting address line A0.

DMA controller 2 contains channels 4 through 7. Channel 4 is used to cascade channels 0 through 3 to the microprocessor. Channels 5, 6, and 7 support 16-bit data transfers between 16-bit I/O adapters and 16-bit system memory. These DMA channels can transfer data throughout the 16M system-address space in 128K blocks. Channels 5, 6, and 7 cannot transfer data on odd-byte boundaries.

Source	DMA Page Registers	Controller
Address	A23<---------->A17	A16<---------->A1

Address Generation for DMA Channels 5 through 7

> **Note:** The addressing signals, BHE and A0, are forced to a logical 0.

The following figure shows the addresses for the page register.

Page Register	I/O Hex Address
DMA Channel 0	0087
DMA Channel 1	0083
DMA Channel 2	0081
DMA Channel 3	0082
DMA Channel 5	008B
DMA Channel 6	0089
DMA Channel 7	008A
Refresh	008F

Page Register Addresses

Addresses for all DMA channels do not increase or decrease through page boundaries (64K for channels 0 through 3, and 128K for channels 5 through 7).

DMA channels 5 through 7 perform 16-bit data transfers. Access can be gained only to 16-bit devices (I/O or memory) during the DMA cycles of channels 5 through 7. Access to the DMA controller, which controls these channels, is through I/O addresses hex 0C0 through 0DF.

The DMA controller command code addresses follow.

Hex Address	Register Function
0C0	CH0 base and current address
0C2	CH0 base and current word count
0C4	CH1 base and current address
0C6	CH1 base and current word count
0C8	CH2 base and current address
0CA	CH2 base and current word count
0CC	CH3 base and current address
0CE	CH3 base and current word count
0D0	Read Status Register/Write Command Register
0D2	Write Request Register
0D4	Write Single Mask Register Bit
0D6	Write Mode Register
0D8	Clear Byte Pointer Flip-Flop
0DA	Read Temporary Register/Write Master Clear
0DC	Clear Mask Register
0DE	Write All Mask Register Bits

DMA Controller

All DMA memory transfers made with channels 5 through 7 must occur on even-byte boundaries. When the base address for these channels is programmed, the real address divided by 2 is the data written to the base address register. Also, when the base word count for channels 5 through 7 is programmed, the count is the number of 16-bit words to be transferred. Therefore, DMA channels 5 through 7 can transfer 65,536 words, or 128Kb maximum, for any selected page of memory. These DMA channels divide the 16M memory space into 128K pages. When the DMA page registers for channels 5 through 7 are programmed, data bits D7 through D1 contain the high-order seven address bits (A23 through A17) of the desired memory space. Data bit D0 of the page registers for channels 5 through 7 is not used in the generation of the DMA memory address.

At power-on time, all internal locations, especially the mode registers, should be loaded with some valid value. This is done even if some channels are unused.

System Interrupts

The 80286 microprocessor's non-maskable interrupt (NMI) and two 8259A Controller chips provide 16 levels of system interrupts.

> **Note:** Any or all interrupts may be masked (including the microprocessor's NMI).

Hardware Interrupt Listing

The following shows the interrupt-level assignments in decreasing priority.

Level		Function
Microprocessor NMI		Parity or I/O Channel Check
Interrupt Controllers CTRL 1	CTRL 2	
IRQ 0		Timer Output 0
IRQ 1		Keyboard (Output Buffer Full)
IRQ 2		Interrupt from CTRL 2
	IRQ 8	Realtime Clock Interrupt
	IRQ 9	Software Redirected to INT 0AH PC Network * PC Network(Alt.) *
	IRQ 10	Reserved
	IRQ 11	Reserved
	IRQ 12	Reserved
	IRQ 13	Coprocessor
	IRQ 14	Fixed Disk Controller
	IRQ 15	Reserved
IRQ 3		Serial Port 2 BSC BSC (Alt.) Cluster (Primary) PC Network * PC Network (Alt.) * SDLC
IRQ 4		Serial Port 1 BSC BSC (Alt.) SDLC
IRQ 5		Parallel Port 2
IRQ 6		Diskette Controller Fixed Disk and Diskette Drive
IRQ 7		Parallel Port 1 Data Aquisition and Control *** GPIB ** Cluster (Secondary)

* The PC Network is jumper selectable.
** The GPIB Adapter can be set to interrupts 2 through 7.
*** The Data Acquisition Adapter can be set to interrupts 3 through 7. The default interrupt is 7.

Hardware Interrupt Listing

Interrupt Sharing

A definition for standardized hardware design has been established that enables multiple adapters to share an interrupt level. This section describes this design and discusses the programming support required.

> **Note:** Since interrupt routines do not exist in ROM for protected mode operations, this design is intended to run only in the microprocessor's real address mode.

Design Overview

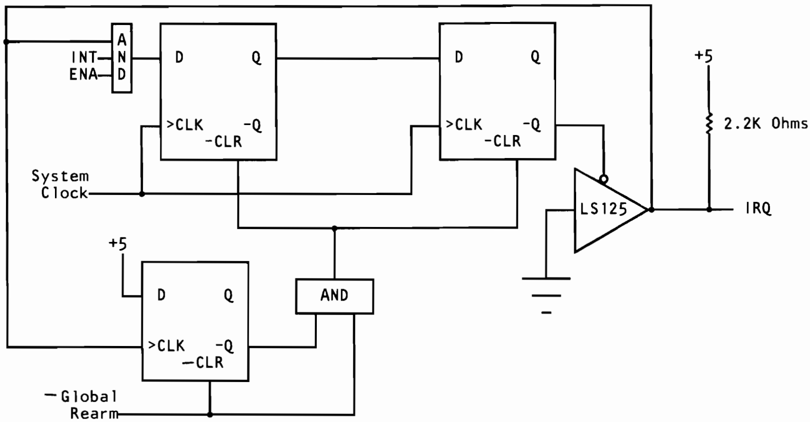
Most interrupt-supporting adapters hold the 'interrupt request' line (IRQ) at a low level and then drive the line high to cause an interrupt. In contrast, the shared-interrupt hardware design allows IRQ to float high through pull-up resistors on each adapter. Each adapter on the line may cause an interrupt by pulsing the line to a low level. The leading edge of the pulse arms the 8259A Interrupt Controller; the trailing edge signals the interrupt controller to cause the interrupt. The duration of this pulse must be between 125 and 1,000 nanoseconds.

The adapters must have an 'interrupt' status bit (INT) and a 'interrupt enable' bit (ENA) that can be controlled and monitored by its software.

Each adapter sharing an interrupt level must monitor the IRQ line. When any adapter drives the line low, all other adapters on that line must be prevented from issuing an interrupt request until they are rearmed.

If an adapter's INT status bit is at a high level when the interrupt sharing logic is rearmed, the adapter must reissue the interrupt. This prevents lost interrupts if two adapters issue an interrupt at the same time and an interrupt handler issues a Global Rearm after servicing one of the adapters.

The following diagram is an example of the shared interrupt hardware logic.



Shared Interrupt Logic Diagram

Program Support

During multitasking, tasks are constantly being activated and deactivated in no particular order. The interrupt-sharing program support described in this section provides for an orderly means to:

- Link a task's interrupt handler to a chain of interrupt handlers
- Share the interrupt level while the task is active
- Unlink the interrupt handler from the chain when the task is deactivated.

Linking to a Chain

Each newly activated task replaces the interrupt vector in low memory with a pointer to its own interrupt handler. The old interrupt vector is used as a forward pointer (FPTR) and is stored at a fixed offset from the new task's interrupt handler.

Sharing the Interrupt Level

When the new task's handler gains control as a result of an interrupt, the handler reads the contents of the adapter's interrupt status register to determine if its adapter caused the interrupt. If it did, the handler services the interrupt, disables the interrupts (CLI), issues a non-specific End of Interrupt (EOI), and then, to rearm the interrupt hardware, writes to address 02F*X*, where *X* corresponds to interrupt levels 3 through 7, and 9 (IRQ9 is 02F2). A write to address 06F*X*, where *X* may be 2 through 7, is required for interrupt levels 10 through 15, respectively. Each adapter in the chain decodes the address which results in a Global Rearm. An adapter is required to decode the least significant 11 bits for this Global Rearm command. The handler then issues a Return From Interrupt (IRET).

If its adapter did not cause the interrupt, the handler passes control to the next interrupt handler in the chain.

Unlinking from the Chain

To unlink from the chain, a task must first locate its handler's position within the chain. By starting at the interrupt vector in low memory, and using the offset of each handler's FPTR to find the entry point of each handler, the chain can be methodically searched until the task finds its own handler. The FPTR of the previous handler in the chain is replaced by the task's FPTR, thus removing the handler from the chain.

Error Recovery

Should the unlinking routine discover that the interrupt chain has been corrupted (an interrupt handler is linked but does not have a valid SIGNATURE), an unlinking error-recovery procedure must be in place. Each application can incorporate its own unlinking error procedure into the unlinking routine. One application may choose to display an error message requiring the operator to either correct the situation or power down the system. Another application may choose an error recovery procedure that restores the original interrupt vector in low memory, and bypasses the corrupt portion of the interrupt chain. This error recovery procedure may not be suitable when adapters that are being serviced by the corrupt handler are actively generating interrupts, since unserviced interrupts lock up that interrupt level.

ROS Considerations

Adapters with their handlers residing in ROS may choose to implement chaining by storing the 4 byte FPTR (plus the FIRST flag if it is sharing interrupt 7 or 15) in on-adapter latches or ports. Adapter ROS without this feature must first test to see that it is the first in the chain. If it is the first in the chain, the adapter can complete the link; if not, the adapter must exit its routine without linking.

Precautions

The following precautions must be taken when designing hardware or programs using shared interrupts:

- Hardware designers should ensure the adapters:
  - Do not power up with the ENA line active or an interrupt pending.
  - Do not generate interrupts that are not serviced by a handler. Generating interrupts when a handler is not active to service the adapter causes the interrupt level to lock up. The design relies on the handler to clear its adapter's interrupt and issue the Global Rearm.
  - Can be disabled so that they do not remain active after their application has terminated.
- Programmers should:
  - Ensure that their programs have a short routine that can be executed with the AUTOEXEC.BAT to disable their adapter's interrupts. This precaution ensures that the adapters are deactivated if the user reboots the system.

- Treat words as words, not bytes. Remember that data is stored in memory using the Intel format (word 424B is stored as 4B42).

Interrupt Chaining Structure

```
ENTRY:  JMP         SHORT PAST          ; Jump around structure
        FPTR        DD    0             ; Forward Pointer
        SIGNATURE   DW    424BH         ; Used when unlinking to identify
                                        ;  compatible interrupt handlers
        FLAGS       DB                  ; Flags
        FIRST       EQU   80H           ; Flag for being first in chain
        JMP         SHORT RESET
        RES_BYTES   DB    DUP 7 (0)     ; Future expansion
PAST:   ...                             ; Actual start of code
```

The interrupt chaining structure is a 16-byte format containing FPTR, SIGNATURE, and RES__BYTES. It begins at the third byte from the interrupt handler's entry point. The first instruction of every handler is a short jump around the structure to the start of the routine. Since the position of each interrupt handler's chaining structure is known (except for the handlers on adapter ROS), the FPTRs can be updated when unlinking.

The FIRST flag is used to determine the handler's position in the chain when unlinking when sharing interrupts 7 and 15. The RESET routine, an entry point for the operating system, must disable the adapter's interrupt and RETURN FAR to the operating system.

Note: All handlers designed for interrupt sharing must use 424B as the signature to avoid corrupting the chain.

Examples

In the following examples, notice that interrupts are disabled before control is passed to the next handler on the chain. The next handler receives control as if a hardware interrupt had caused it to receive control. Also, notice that the interrupts are disabled before the non-specific EOI is issued, and not reenabled in the interrupt handler. This ensures that the IRET is executed (at which point the flags are restored and the interrupts reenabled) before another interrupt is serviced, protecting the stack from excessive build up.

Example of an Interrupt Handler

```
YOUR_CARD  EQU      xxxx                 ; Location of your card's interrupt
                                         ;  control/status register
ISB        EQU      xx                   ; Interrupt bit in your card's interrupt
                                         ;  control status register
REARM      EQU      2F7H                 ; Global Rearm location for interrupt
                                         ;  level 7
SPC_EOI    EQU      67H                  ; Specific EOI for 8259's interrupt
                                         ;  level 7
EOI        EQU      20H                  ; Non-specific EOI
OCR        EQU      20H                  ; Location of 8259 operational control
                                         ;  register
IMR        EQU      21H                  ; Location of 8259 interrupt mask
                                         ;  register

MYCSEG     SEGMENT  PARA
           ASSUME   CS:MYCSEG,DS:DSEG
ENTRY      PROC     FAR
           JMP      SHORT PAST           ; Entry point of handler
FPTR       DD       0                    ; Forward Pointer
SIGNATURE  DW       424BH                ; Used when unlinking to identify
                                         ;  compatible interrupt handlers
FLAGS      DB       0                    ; Flags
FIRST      EQU      80H
JMP        SHORT    RESET
RES_BYTES  DB       DUP 7 (0)            ; Future expansion
PAST:      STI                           ; Actual start of handler code
           PUSH     ...                  ; Save needed registers
           MOV      DX,YOUR_CARD         ; Select your status register
           IN       AL,DX                ; Read the status register
           TEST     AL,ISB               ; Your card caused the interrupt?
           JNZ      SERVICE              ; Yes, branch to service logic
           TEST     CS:FLAGS,FIRST       ; Are we the first ones in?
           JNZ      EXIT                 ; If yes, branch for EOI and Rearm
           POP      ...                  ; Restore registers
           CLI                           ; Disable interrupts
           JMP      DWORD PTR CS:FPTR    ; Pass control to next guy on chain

SERVICE:   ...                           ; Service the interrupt
EXIT:
           CLI                           ; Disable the interrupts
           MOV      AL,EOI
           OUT      OCR,AL               ; Issue non-specific EOI to 8259
           MOV      DX,REARM             ; Rearm the cards
           OUT      DX,AL
           POP      ...                  ; Restore registers
           IRET
RESET:     ...                           ; Disable your card
           RET                           ; Return FAR to operating system
ENTRY      ENDP
           MYCSEG   ENDS
           END      ENTRY
```

Linking Code Example

```
        PUSH     ES
        CLI                           ; Disable interrupts
; Set forward pointer to value of interrupt vector in low memory
        ASSUME   CS:CODESEG,DS:CODESEG
        PUSH     ES
        MOV      AX,350FH             ; DOS get interrupt vector
        INT      21H
        MOV      SI,OFFSET CS:FPTR    ; Get offset of your forward pointer
                                      ;  in an indexable register
        MOV      CS:[SI],BX           ; Store the old interrupt vector
        MOV      CS:[SI+2],ES         ;  in your forward pointer for chaining
        CMP      ES:BYTE PTR[BX],CFH  ; Test for IRET
        JNZ      SETVECTR
        MOV      CS:FLAGS,FIRST       ; Set up first in chain flag
SETVECTR: POP    ES
        PUSH     DS
; Make interrupt vector in low memory point to your handler
        MOV      DX,OFFSET ENTRY      ; Make interrupt vector point to your handler
        MOV      AX,SEG ENTRY         ; If DS not = CS, get it
        MOV      DS,AX                ;  and put it in DS
        MOV      AX,250FH             ; DOS set interrupt vector
        INT      21H
        POP      DS
; Unmask (enable) interrupts for your level
        IN       AL,IMR               ; Read interrupt mask register
        JMP      $+2                  ; IO delay
        AND      AL,07FH              ; Unmask interrupt level 7
        OUT      IMR,AL               ; Write new interrupt mask
        MOV      AL,SPC_EOI           ; Issue specific EOI for level 7
        JMP      $+Z             ;  to allow pending level 7 interrupts
        OUT      OCR,AL               ;  (if any) to be serviced
        STI                           ; Enable interrupts
        POP      ES                   ;
```

Unlinking Code Example

```
          PUSH     DS
          PUSH     ES
          CLI                             ; Disable interrupts
          MOV      AX,350FH               ; DOS get interrupt vector
          INT      21H                    ; ES:BX points to first of chain
          MOV      CX,ES                  ; Pickup segment part of interrupt vector
; Are we the first handler in the chain?
          MOV      AX,CS                  ; Get code seg into comparable register
          CMP      BX,OFFSET ENTRY        ; Interrupt vector in low memory
                                          ;  pointing to your handler's offset?
          JNE      UNCHAIN_A              ; No, branch
          CMP      AX,CX                  ; Vector pointing to your
                                          ;  handler's segment?
          JNE      UNCHAIN_A              ; No, branch
; Set interrupt vector in low memory to point to the handler
;  pointed to by your pointer

          PUSH     DS
          MOV      DX,WORD PTR CS:FPTR
          MOV      DS,WORD PTR CS FPTR[2]
          MOV      AX,250FH               ; DOS set interrupt vector
          INT      21H
          POP      DS
          JMP      UNCHAIN_X
UNCHAIN_A:     ; BX = FPTR offset, ES = FPTR segment, CX = CS
          CMP      ES:[BX+6],4B42H        ; Is handler using the appropriate
                                          ;  conventions (is SIGNATURE present in
                                          ;   the interrupt chaining structure)?
          JNE      exception              ; No, invoke error exception handler
          LDS      SI,ES:[BX+2]           ; Get FPTR's segment and offset
          CMP      SI,OFFSET ENTRY        ; Is this forward pointer pointing to
                                          ;  your handler's offset?
          JNE      UNCHAIN_B              ; No, branch
          MOV      CX,DS                  ; Move to compare
          CMP      AX,CX                  ; Is this forward pointer pointing to
                                          ;  your handler's segment?
          JNE      UNCHAIN_B              ; No, branch
; Located your handler in the chain
          MOV      AX,WORD PTR CS:FPTR ; Get your FPTR's offset
          MOV      ES:[BX+2],AX           ; Replace offset of FPTR of handler
                                          ;  that points to you
          MOV      AX,WORD PTR CS:FPTR[2] ; Get your FPTR's segment
          MOV      ES:[BX+4],AX           ; Replace segment of FPTR of handler
                                          ;  that points to you
          MOV      AL,CS:FLAGS            ; Get your flags
          AND      AL,FIRST               ; Isolate FIRST flag
          OR       ES:[BX + 6],AL         ; Set your first flag into prior routine
          JMP      UNCHAIN_X
UNCHAIN_B: MOV     BX,SI                  ; Move new offset to BX
          PUSH     DS
          PUSH     ES
          JMP      UNCHAIN_A              ; Examine next handler in chain
UNCHAIN_X: STI                            ; Enable interrupts
          POP      ES
          POP      DS
```

System Timers

The system has three programmable timer/counters, Channels 0 through 2. They are controlled by an Intel 8254-2 Timer/Counter chip, and are defined as follows:

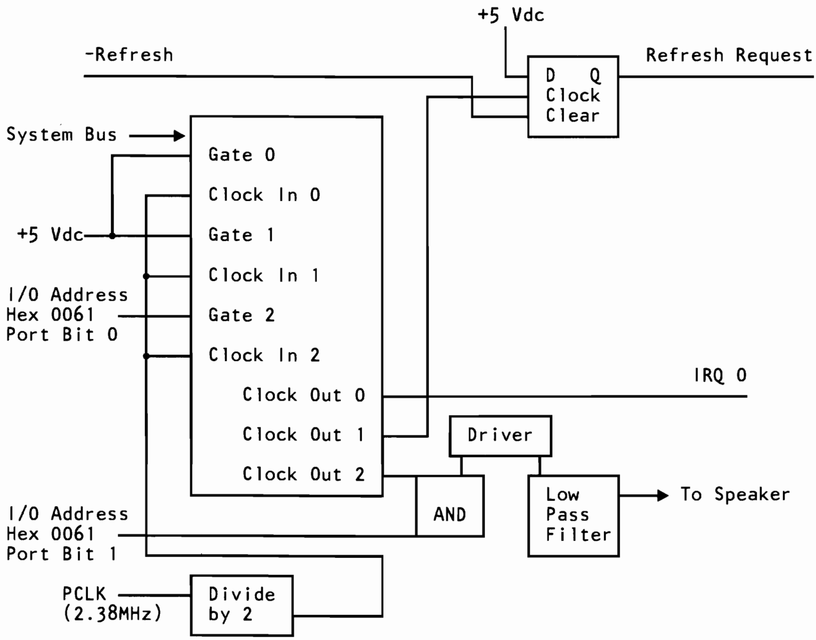
Channel 0	**System Timer**
GATE 0	Tied on
CLK IN 0	1.190 MHz OSC
CLK OUT 0	8259A IRQ 0

Channel 1	**Refresh Request Generator**
GATE 1	Tied on
CLK IN 1	1.190 MHz OSC
CLK OUT 1	Request refresh cycle

Note: Channel 1 is programmed as a rate generator to produce a 15-microsecond period signal.

Channel 2	**Tone Generation for Speaker**
GATE 2	Controlled by bit 0 of port hex 61, PPI bit
CLK IN 2	1.190 MHz OSC
CLK OUT 2	Used to drive the speaker

The 8254-2 Timer/Counter is a programmable interval timer/counter that system programs treat as an arrangement of four external I/O ports. Three ports are treated as counters; the fourth is a control register for mode programming. The following is a system-timer block diagram.



System-Timer Block Diagram

System Clock

The 82284 System Clock Generator is driven by a 12-MHz crystal. Its output 'clock' signal (CLK) is the input to the system microprocessor, the coprocessor, and I/O channel.

ROM Subsystem

The system board's ROM subsystem consists of two 32K by 8-bit ROM/EPROM modules in a 32K-by-16-bit arrangement. The code for odd and even addresses resides in separate modules. ROM is assigned at the top of the first and last 1M address space (0F0000 and FF0000). ROM is not parity-checked. Its access time is 150 nanoseconds and its cycle time is 230 nanoseconds.

RAM Subsystem

The system board's RAM subsystem starts at address 000000 of the 16M address space. It is 512K of 128K-by-1-bit RAM modules (type 1 system board) or 512K of 256K-by-1-bit RAM modules (type 2 system board). Memory access time is 150 nanoseconds and the cycle time is 275 nanoseconds.

Memory refresh requests one memory cycle every 15 microseconds through the timer/counter (channel 1). The RAM initialization program performs the following functions:

- Initializes channel 1 of the timer/counter to the rate generation mode, with a period of 15 microseconds.

- Performs a memory write operation to any memory location.

  Note: The memory must be accessed or refreshed eight times before it can be used.

I/O Channel

The I/O channel supports:

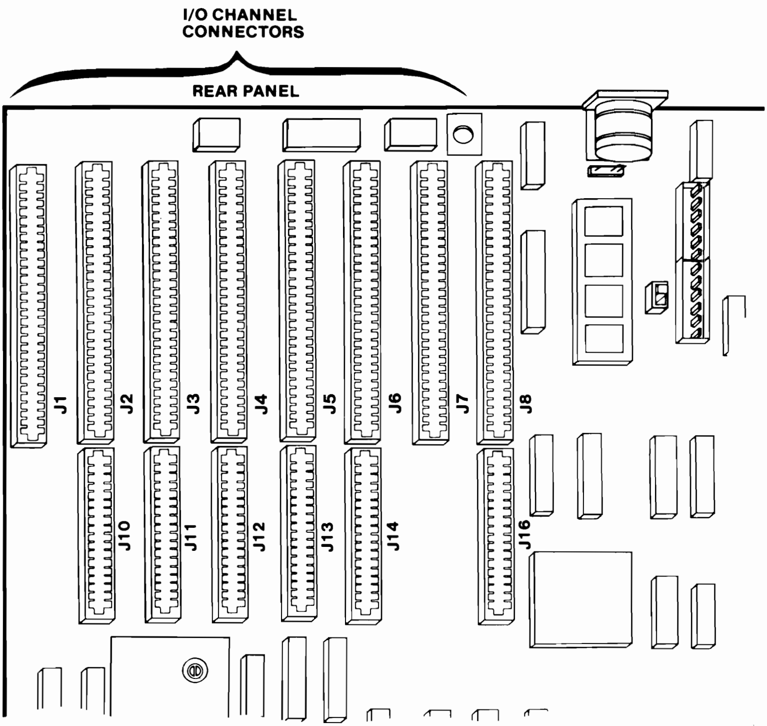
- I/O address space hex 100 to hex 3FF
- 24-bit memory addresses (16M)
- Selection of data accesses (either 8- or 16-bit)
- Interrupts
- DMA channels
- I/O wait-state generation

- Open-bus structure (allowing multiple microprocessors to share the system's resources, including memory)
- Refresh of system memory from channel microprocessors.

Connectors

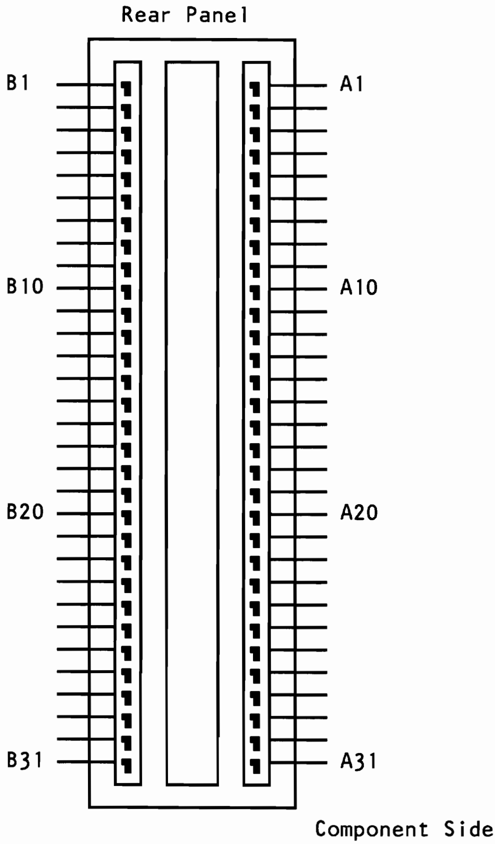
The following figure shows the location and the numbering of the I/O channel connectors. These connectors consist of six 36-pin and eight 62-pin edge connector sockets.

> **Note:** The 36-pin connector is not present in two positions on the I/O channel. These positions can support only 62-pin I/O bus adapters.



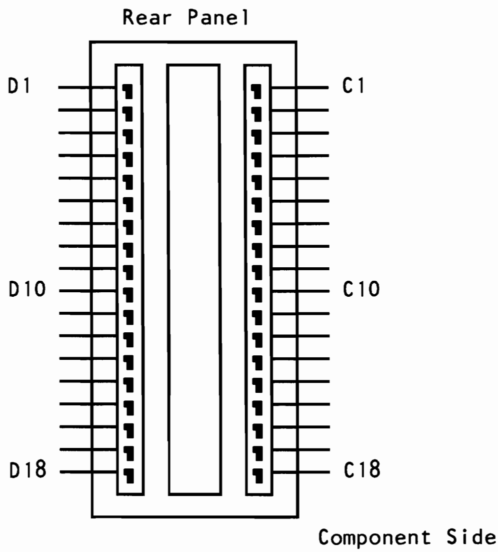
I/O Channel Connector Location

The following figure shows the pin numbering for I/O channel connectors J1 through J8.



I/O Channel Pin Numbering (J1-J8)

The following figure shows the pin numbering for I/O channel connectors J10 through J14 and J16.



I/O Channel Pin Numbering (J10-J14 and J16)

The following figures summarize pin assignments for the I/O channel connectors.

I/O Pin	Signal Name	I/O
A1	-I/O CH CK	I
A2	SD7	I/O
A3	SD6	I/O
A4	SD5	I/O
A5	SD4	I/O
A6	SD3	I/O
A7	SD2	I/O
A8	SD1	I/O
A9	SD0	I/O
A10	-I/O CH RDY	I
A11	AEN	O
A12	SA19	I/O
A13	SA18	I/O
A14	SA17	I/O
A15	SA16	I/O
A16	SA15	I/O
A17	SA14	I/O
A18	SA13	I/O
A19	SA12	I/O
A20	SA11	I/O
A21	SA10	I/O
A22	SA9	I/O
A23	SA8	I/O
A24	SA7	I/O
A25	SA6	I/O
A26	SA5	I/O
A27	SA4	I/O
A28	SA3	I/O
A29	SA2	I/O
A30	SA1	I/O
A31	SA0	I/O

I/O Channel (A-Side, J1 through J8)

I/O Pin	Signal Name	I/O
B1	GND	Ground
B2	RESET DRV	O
B3	+5 Vdc	Power
B4	IRQ 9	I
B5	-5 Vdc	Power
B6	DRQ2	I
B7	-12 Vdc	Power
B8	OWS	I
B9	+12 Vdc	Power
B10	GND	Ground
B11	-SMEMW	O
B12	-SMEMR	O
B13	-IOW	I/O
B14	-IOR	I/O
B15	-DACK3	O
B16	DRQ3	I
B17	-DACK1	O
B18	DRQ1	I
B19	-REFRESH	I/O
B20	CLK	O
B21	IRQ7	I
B22	IRQ6	I
B23	IRQ5	I
B24	IRQ4	I
B25	IRQ3	I
B26	-DACK2	O
B27	T/C	O
B28	BALE	O
B29	+5Vdc	Power
B30	OSC	O
B31	GND	Ground

I/O Channel (B-Side, J1 through J8)

SECTION 1

I/O Pin	Signal Name	I/O
C1	SBHE	I/O
C2	LA23	I/O
C3	LA22	I/O
C4	LA21	I/O
C5	LA20	I/O
C6	LA19	I/O
C7	LA18	I/O
C8	LA17	I/O
C9	-MEMR	I/O
C10	-MEMW	I/O
C11	SD08	I/O
C12	SD09	I/O
C13	SD10	I/O
C14	SD11	I/O
C15	SD12	I/O
C16	SD13	I/O
C17	SD14	I/O
C18	SD15	I/O

I/O Channel (C-Side, J10 through J14 and 16)

I/O Pin	Signal Name	I/O
D1	-MEM CS16	I
D2	-I/O CS16	I
D3	IRQ10	I
D4	IRQ11	I
D5	IRQ12	I
D6	IRQ15	I
D7	IRQ14	I
D8	-DACK0	O
D9	DRQ0	I
D10	-DACK5	O
D11	DRQ5	I
D12	-DACK6	O
D13	DRQ6	I
D14	-DACK7	O
D15	DRQ7	I
D16	+5 Vdc	POWER
D17	-MASTER	I
D18	GND	GROUND

I/O Channel (D-Side, J10 through J14 and 16)

I/O Channel Signal Description

The following is a description of the system board's I/O channel signals. All signal lines are TTL compatible. I/O adapters should be designed with a maximum of two low-power Shottky (LS) loads per line.

SA0 through SA19 (I/O)

Address signals 0 through 19 are used to address memory and I/O devices within the system. These 20 address lines, in addition to LA17 through LA23, allow access of up to 16M of memory. SA0 through SA19 are gated on the system bus when 'buffered address latch enable' signal (BALE) is high and are latched on the falling edge of BALE. These signals are generated by the microprocessor or DMA Controller. They also may be driven by other microprocessors or DMA controllers that reside on the I/O channel.

LA17 through LA23 (I/O)

These signals (unlatched) are used to address memory and I/O devices within the system. They give the system up to 16M of addressability. These signals are valid when BALE is high. LA17 through LA23 are not latched during microprocessor cycles and therefore do not stay valid for the whole cycle. Their purpose is to generate memory decodes for 16-bit, 1 wait-state, memory cycles. These decodes should be latched by I/O adapters on the falling edge of BALE.

These signals also may be driven by other microprocessors or DMA controllers that reside on the I/O channel.

CLK (O)

This is the 6-MHz system 'clock' signal. It is a synchronous microprocessor cycle clock with a cycle time of 167 nanoseconds. The clock has a 50% duty cycle. This signal should be used only for synchronization. It is not intended for uses requiring a fixed frequency.

RESET DRV (O)

The 'reset drive' signal is used to reset or initialize system logic at power-up time or during a low voltage condition. This signal is active high.

SD0 through SD15 (I/O)

These signals provide bus bits 0 through 15 for the microprocessor, memory, and I/O devices. D0 is the least-significant bit and D15 is the most-significant bit. All 8-bit devices on the I/O channel should use D0 through D7 for communications to the microprocessor. The 16-bit devices will use D0 through D15. To support 8-bit devices, the data on D8 through D15 will be gated to D0 through D7 during 8-bit transfers to these devices; 16-bit microprocessor transfers to 8-bit devices will be converted to two 8-bit transfers.

BALE (O) (buffered)

The 'buffered address latch enable' signal is provided by the 82288 Bus Controller and is used on the system board to latch valid addresses and memory decodes from the microprocessor. It is available to the I/O channel as an indicator of a valid microprocessor or DMA address (when used with 'address enable' signal, AEN). Microprocessor addresses SA0 through SA19 are latched with the falling edge of BALE. BALE is forced high (active) during DMA cycles.

-I/O CH CK (I)

The '-I/O channel check' signal provides the system board with parity (error) information about memory or devices on the I/O channel. When this signal is active (low), it indicates a non-correctable system error.

I/O CH RDY (I)

The 'I/O channel ready' signal is pulled low (not ready) by a memory or I/O device to lengthen I/O or memory cycles. Any slow device using this line should drive it low immediately upon detecting its valid address and a Read or Write command. Machine cycles are extended by an integral number of clock cycles (167 nanoseconds). This signal should be held low for no more than 2.5 microseconds.

IRQ3-IRQ7, IRQ9-IRQ12, IRQ14, and IRQ15 (I)

Interrupt requests 3 through 7, 9 through 12, 14, and 15 are used to signal the microprocessor that an I/O device needs attention. The interrupt requests are prioritized, with IRQ9 through IRQ12, IRQ14, and IRQ15 having the highest priority (IRQ9 is the highest), and IRQ3 through IRQ7 having the lowest priority (IRQ7 is the lowest). An interrupt request is generated when an IRQ line is raised from low to high. The line is high until the microprocessor acknowledges the interrupt request (Interrupt Service routine).

> **Note:** Interrupt 13 is used on the system board and is not available on the I/O channel. IRQ 8 is used for the real-time clock.

-IOR (I/O)

The '-I/O read' signal instructs an I/O device to drive its data onto the data bus. This signal may be driven by the system microprocessor or DMA controller, or by a microprocessor or DMA controller resident on the I/O channel. This signal is active low.

-IOW (I/O)

The '-I/O write' signal instructs an I/O device to read the data off the data bus. It may be driven by any microprocessor or DMA controller in the system. This signal is active low.

-SMEMR (O) -MEMR (I/O)

These signals instruct the memory devices to drive data onto the data bus. -SMEMR is active only when the memory decode is within the low 1M of memory space. -MEMR is active on all memory read cycles. -MEMR may be driven by any microprocessor or DMA controller in the system. -SMEMR is derived from -MEMR and the decode of the low 1M of memory. When a microprocessor on the I/O channel wishes to drive -MEMR, it must have the address lines valid on the bus for one clock cycle before driving -MEMR active. Both signals are active low.

-SMEMW (O) -MEMW (I/O)

These signals instruct the memory devices to store the data present on the data bus. -SMEMW is active only when the memory decode is within the low 1M of the memory space. -MEMW is active on all memory write cycles. -MEMW may be driven by any microprocessor or DMA controller in the system. -SMEMW is derived from -MEMW and the decode of the low 1M of memory. When a microprocessor on the I/O channel wishes to drive -MEMW, it must have the address lines valid on the bus for one clock cycle before driving -MEMW active. Both signals are active low.

DRQ0-DRQ3 and DRQ5-DRQ7 (I)

The 'DMA request' signals 0 through 3 and 5 through 7 are asynchronous channel requests used by peripheral devices and a microprocessor to gain DMA service (or control of the system). They are prioritized, with DRQ0 having the highest priority and DRQ7 the lowest. A request is generated by bringing a DRQ line to an active (high) level. A DRQ line is held high until the corresponding 'DMA acknowledge' (DACK) line goes active. DRQ0 through DRQ3 perform 8-bit DMA transfers; DRQ5 through DRQ7 perform 16-bit transfers. DRQ4 is used on the system board and is not available on the I/O channel.

-DACK0 to -DACK3 and -DACK5 to -DACK7 (O)

-DMA acknowledge 0 through 3 and 5 through 7 are used to acknowledge DMA requests. These signals are active low.

AEN (O)

The 'address enable' signal is used to degate the microprocessor and other devices from the I/O channel to allow DMA transfers to take place. When this line is active, the DMA controller has control of the address bus, the data-bus Read command lines (memory and I/O), and the Write command lines (memory and I/O). This signal is active high.

-REFRESH (I/O)

This signal is used to indicate a refresh cycle and can be driven by a microprocessor on the I/O channel. This signal is active low.

T/C (O)

The 'terminal count' signal provides a high pulse when the terminal count for any DMA channel is reached.

SBHE (I/O)

The 'system bus high enable' signal indicates a transfer of data on the upper byte of the data bus, SD8 through SD15. Sixteen-bit devices use SBHE to condition data bus buffers tied to SD8 through SD15. This signal is active high.

-MASTER (I)

This signal is used with a DRQ line to gain control of the system. A processor or DMA controller on the I/O channel may issue a DRQ to a DMA channel in cascade mode and receive a -DACK. Upon receiving the -DACK, a microprocessor may pull

-MASTER active (low), which will allow it to control the system address, data, and control lines (a condition known as *tri-state*). After -MASTER is low, the microprocessor must wait one clock cycle before driving the address and data lines, and two clock cycles before issuing a Read or Write command. If this signal is held low for more than 15 microseconds, the system memory may be lost because of a lack of refresh.

-MEM CS16 (I)

The '-memory 16-bit chip select' signal indicates to the system that the present data transfer is a 1 wait-state, 16-bit, memory cycle. It must be derived from the decode of LA17 through LA23. -MEM CS16 is active low and should be driven with an open collector or tri-state driver capable of sinking 20 mA.

-I/O CS16 (I)

The '-I/O 16-bit chip select' signal indicates to the system that the present data transfer is a 16-bit, 1 wait-state, I/O cycle. It is derived from an address decode. -I/O CS16 is active low and should be driven with an open collector or tri-state driver capable of sinking 20 mA.

OSC (O)

The 'oscillator' signal is a high-speed clock with a 70-nanosecond period (14.31818 MHz). This signal is not synchronous with the system clock. It has a 50% duty cycle.

0WS (I)

The 'zero wait state' signal tells the microprocessor that it can complete the present bus cycle without inserting any additional wait cycles. In order to run a memory cycle to a 16-bit device without wait cycles, 0WS is derived from an address decode gated with a Read or Write command. In order to run a memory cycle to an 8-bit device with a minimum of two wait states, 0WS should be driven active one clock cycle after the Read or Write command is active, and gated with the address decode for the device. Memory Read and Write commands to an 8-bit device are active on the falling edge of CLK. 0WS is active low and should be driven with an open collector or tri-state driver capable of sinking 20 mA.

The following figure is an I/O address map.

Hex Range	Device
000-01F	DMA controller 1, 8237A-5
020-03F	Interrupt controller 1, 8259A, Master
040-05F	Timer, 8254-2
060-06F	8042 (Keyboard)
070-07F	Real-time clock, NMI (non-maskable interrupt) mask
080-09F	DMA page register , 74LS612
0A0-0BF	Interrupt Controller 2, 8259A
0C0-0DF	DMA controller 2, 8237A-5
0F0	Clear Math Coprocessor Busy
0F1	Reset Math Coprocessor
0F8-0FF	Math Coprocessor
Note: I/O Addresses, hex 000 to 0FF, are reserved for the system board I/O. Hex 100 to 3FF are available on the I/O channel.	

I/O Address Map (Part 1 of 2)

Hex Range	Device
1F0-1F8	Fixed Disk
200-207	Game I/O
20C-20D	Reserved
21F	Reserved
278-27F	Parallel printer port 2
2B0-2DF	Alternate Enhanced Graphics Adapter
2E1	GPIB (Adapter 0)
2E2 & 2E3	Data Acquisition (Adapter 0)
2F8-2FF	Serial port 2
300-31F	Prototype card
360-363	PC Network (low address)
364-367	Reserved
368-36B	PC Network (high address)
36C-36F	Reserved
378-37F	Parallel printer port 1
380-38F	SDLC, bisynchronous 2
390-393	Cluster
3A0-3AF	Bisynchronous 1
3B0-3BF	Monochrome Display and Printer Adapter
3C0-3CF	Enhanced Graphics Adapter
3D0-3DF	Color/Graphics Monitor Adapter
3F0-3F7	Diskette controller
3F8-3FF	Serial port 1
6E2 & 6E3	Data Acquisition (Adapter 1)
790-793	Cluster (Adapter 1)
AE2 & AE3	Data Acquisition (Adapter 2)
B90-B93	Cluster (Adapter 2)
EE2 & EE3	Data Acquisition (Adapter 3)
1390-1393	Cluster (Adapter 3)
22E1	GPIB (Adapter 1)
2390-2393	Cluster (Adapter 4)
42E1	GPIB (Adapter 2)
62E1	GPIB (Adapter 3)
82E1	GPIB (Adapter 4)
A2E1	GPIB (Adapter 5)
C2E1	GPIB (Adapter 6)
E2E1	GPIB (Adapter 7)
Note: I/O Addresses, hex 000 to 0FF, are reserved for the system board I/O. Hex 100 to 3FF are available on the I/O channel.	

I/O Address Map (Part 2 of 2)

NMI and Coprocessor Controls

At power-on time, the non-maskable interrupt (NMI) into the 80286 is masked off. The mask bit can be set and reset with system programs as follows:

Mask On Write to I/O address hex 070, with data bit 7 equal to a logic 0.

Mask Off Write to I/O address hex 070, with data bit 7 equal to a logic 1.

Note: At the end of POST, the system sets the NMI mask on (NMI enabled).

The following is a description of the Math Coprocessor controls.

0F0 An 8-bit Out command to port F0 will clear the latched Math Coprocessor '-busy' signal. The '-busy' signal will be latched if the coprocessor asserts its '-error' signal while it is busy. The data output should be zero.

0F1 An 8-bit Out command to port F1 will reset the Math Coprocessor. The data output should be zero.

I/O address hex 080 is used as a diagnostic-checkpoint port or register. This port corresponds to a read/write register in the DMA page register (74LS612).

The '-I/O channel check' signal (-I/O CH CK) is used to report non-correctable errors on RAM adapters on the I/O channel. This check will create an NMI if the NMI is enabled. At power-on time, the NMI is masked off and -I/O CH CK is disabled. Follow these steps when enabling -I/O CH CK and the NMI.

1. Write data in all I/O RAM-adapter memory locations; this will establish good parity at all locations.

2. Enable -I/O CH CK.

3. Enable the NMI.

Note: All three of these functions are performed by POST.

When a check occurs, an interrupt (NMI) will result. Read the status bits to determine the source of the NMI (see the figure, "I/O Address Map", on page 1-37). To determine the location of the failing adapter, write to any memory location within a given adapter. If the parity check was from that adapter, -I/O CH CK will be reset to inactive.

Other Circuits

Speaker

The system unit has a 2-1/4 inch permanent-magnet speaker, which can be driven from:

- The I/O-port output bit
- The timer/counter's CLK OUT 2
- Both of the above

RAM Jumpers

The system board has a 3-pin, Berg-strip connector (J18). Starting at the front of the system, the pins are numbered 1 through 3. Jumper placement across these pins determines how much system board RAM is enabled. Pin assignments follow.

Pin	Assignments
1	No Connection
2	- RAM SEL
3	Ground

RAM Jumper Connector (J18)

The following shows how the jumpers affect RAM.

Jumper Positions	Function
1 and 2 2 and 3	Enable 2nd 256K of system board RAM Disable 2nd 256K of system board RAM

RAM Jumper

> **Note:** The normal mode is the enable mode. The other mode permits the additional RAM to reside on adapters plugged into the I/O bus.

Display Switch

Set the slide switch on the system board to select the primary display adapter. Its positions are assigned as follows:

On (toward the front of the system unit): The primary display is attached to the Color/Graphics Monitor Adapter or Professional Graphics Controller.

Off (toward the rear of the system unit): The primary display is attached to the Monochrome Display and Printer Adapter.

The switch may be set to either position if the primary display is attached to an Enhanced Graphics Adapter.

> **Note:** The primary display is activated when the system is powered on.

Variable Capacitor

The system board has a variable capacitor. Its purpose is to adjust the 14.31818 MHz oscillator signal (OSC), used to obtain the color-burst signal required for color televisions.

Keyboard Controller

The keyboard controller is a single-chip microcomputer (Intel 8042) that is programmed to support the keyboard serial interface. The keyboard controller receives serial data from the keyboard, checks the parity of the data, translates scan codes, and presents the data to the system as a byte of data in its output buffer. The controller can interrupt the system when data is placed in its output buffer, or wait for the system to poll its status register to determine when data is available.

Data is sent the keyboard by first polling the controller's status register to determine when the input buffer is ready to accept data and then writing to the input buffer. Each byte of data is sent to the keyboard serially with an odd parity bit automatically inserted. The keyboard is required to acknowledge all data transmissions, another byte of data should not be sent to the keyboard until acknowledgement is received for the previous byte sent. The output-buffer-full interrupt may be used for both send and receive routines.

Keyboard Controller Initialization

At power on, the keyboard controller set the system flag bit to 0. After a power-on reset or the execution of the Self Test command, the keyboard controller disables the keyboard interface by forcing the 'keyboard clock' line low. The keyboard interface parameters are specified at this time by writing to locations within the 8042 RAM. The keyboard-inhibit function is then disabled by setting the inhibit-override bit in the command byte. A hex 55 is then placed in the output buffer if no errors are detected during the self test. Any value other than hex 55 indicates that the 8042 is defective. The keyboard interface is now enabled by lifting the 'keyboard data' and 'keyboard clock' signal lines, and the system flag is set to 1. The keyboard controller is then ready to accept commands from the system unit microprocessor or receive keyboard data.

Receiving Data from the Keyboard

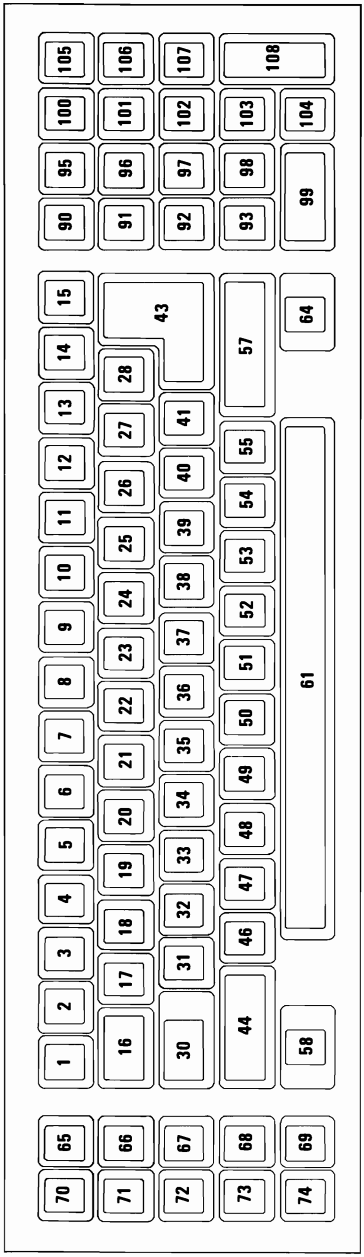
The keyboard sends data in a serial format using an 11-bit frame. The first bit is a start bit, and is followed by eight data bits, an odd parity bit, and a stop bit. Data sent is synchronized by a clock supplied by the keyboard. At the end of a transmission, the keyboard controller disables the interface until the system accepts the byte. If the byte of data is received with a parity error, a Resend command is automatically sent to the keyboard. If the keyboard controller is unable to receive the data correctly after a set number of retries, a hex FF is placed in its output buffer, and the parity bit in the status register is set to 1, indicating a receive parity error. The keyboard controller will also time a byte of data from the keyboard. If a keyboard transmission does not end within two milliseconds, a hex FF is placed in the keyboard controller's output buffer, and the receive time-out bit in the status register is set. No retries will be attempted on a receive time-out error.

> **Note:** When a receive error occurs in the default mode (bits 5, 6, and 7 of the command byte set to 0), hex 00 is placed in the output buffer instead of hex FF. See "Commands (I/O Address Hex 64)" on page 1-51 for a detailed description of the command byte.

Scan Code Translation

Scan codes received from the keyboard are converted by the keyboard controller before being placed into the controller's output buffer. The following figure shows the keyboard layout. Each key position is numbered for reference.

Keyboard



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The following figure is the scan-code translation table.

System Scan Code	Keyboard Scan Code	Key
01	76	90
02	16	2
03	1E	3
04	26	4
05	25	5
06	2E	6
07	36	7
08	3D	8
09	3E	9
0A	46	10
0B	45	11
0C	4E	12
0D	55	13
0E	66	15
0F	0D	16
10	15	17
11	1D	18
12	24	19
13	2D	20
14	2C	21
15	35	22
16	3C	23
17	43	24
18	44	25
19	4D	26
1A	54	27
1B	5B	28
1C	5A	43
1D	14	30
1E	1C	31
1F	1B	32
20	23	33
21	2B	34
22	34	35
23	33	36
24	3B	37
25	42	38
26	4B	39
27	4C	40
28	52	41
29	0E	1
2A	12	44
2B	5D	14
2C	1A	46
2D	22	47
2E	21	48
2F	2A	49

Scan-Code Translation Table (Part 1 of 2)

System Scan Code	Keyboard Scan Code	Key
30	32	50
31	31	51
32	3A	52
33	41	53
34	49	54
35	4A	55
36	59	57
38	11	58
39	29	61
3A	58	64
3B	05	70
3C	06	65
3D	04	71
3E	0C	66
3F	03	72
40	0B	67
41	02 or 83	73
42	0A	68
43	01	74
44	09	69
45	77	95
46	7E	100
47	6C	91
48	75	96
49	7D	101
4A	7B	107
4B	6B	92
4C	73	97
4D	74	102
4E	79	108
4F	69	93
50	72	98
51	7A	103
52	70	99
53	71	104
54	7F or 84	105

Scan-Code Translation Table (Part 2 of 2)

The following scan codes are reserved.

Key	System Scan Code	Keyboard Scan Code
Reserved	55	60
Reserved	56	61
Reserved	57	78
Reserved	58	07
Reserved	59	0F
Reserved	5A	17
Reserved	5B	1F
Reserved	5C	27
Reserved	5D	2F
Reserved	5E	37
Reserved	5F	3F
Reserved	60	47
Reserved	61	4F
Reserved	62	56
Reserved	63	5E
Reserved	64	08
Reserved	65	10
Reserved	66	18
Reserved	67	20
Reserved	68	28
Reserved	69	30
Reserved	6A	38
Reserved	6B	40
Reserved	6C	48
Reserved	6D	50
Reserved	6E	57
Reserved	6F	6F
Reserved	70	13
Reserved	71	19
Reserved	72	39
Reserved	73	51
Reserved	74	53
Reserved	75	5C
Reserved	76	5F
Reserved	77	62
Reserved	78	63
Reserved	79	64
Reserved	7A	65
Reserved	7B	67
Reserved	7C	68
Reserved	7D	6A
Reserved	7E	6D
Reserved	7F	6E

Reserved Scan-Code Translation Table

Sending Data to the Keyboard

The keyboard sends data in the same serial format used to receive data from the keyboard. A parity bit is automatically inserted by the keyboard controller. If the keyboard does not start clocking the data from the keyboard controller within 15 milliseconds, or complete that clocking within 2 milliseconds, a hex FE is placed in the keyboard controller's output buffer, and the transmit time-out error bit is set in the status register.

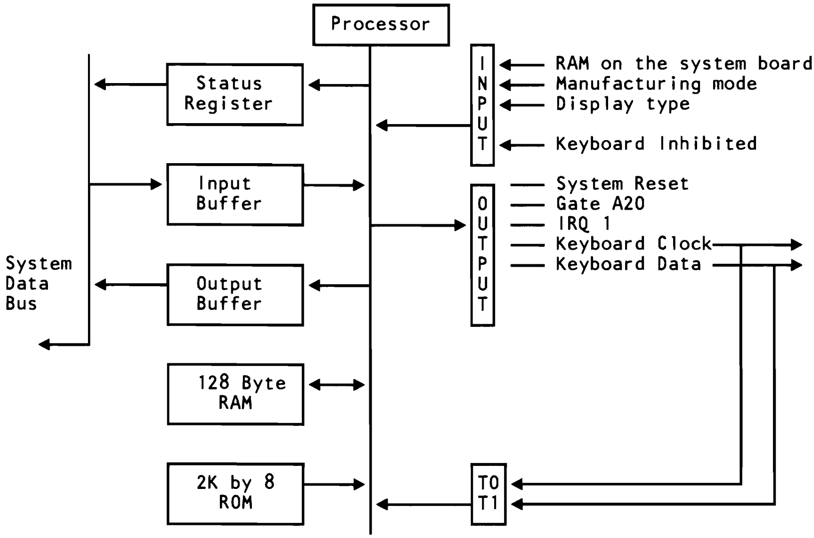
The keyboard is required to respond to all transmissions. The keyboard responds to any valid command and parameter, other than Echo and Resend, with an Acknowledge (ACK) response, hex FA. If the response contains a parity error, the keyboard controller places a hex FE in its output buffer, and the transmit time-out and parity error bits are set in the status register. The keyboard controller is programmed to set a 25-millisecond time limit for the keyboard to respond. If this time limit is exceeded, the keyboard controller places a hex FE in its output buffer and sets the transmit time-out and receive time-out error bits in the status register. No retries are attempted by the keyboard controller for any transmission error.

Inhibit

The keyboard interface may be inhibited by setting input port bit 7 (keyboard inhibit switch) to 0. All transmissions to the keyboard will be allowed regardless of the state of this bit. The keyboard controller tests data received from the keyboard to determine if the byte received is a command response or a scan code. If the byte is a command response, it is placed in the keyboard controller's output buffer. If the byte is a scan code, it is ignored.

Keyboard Controller System Interface

The keyboard controller communicates with the system through a status register, an output buffer, and an input buffer. The following figure is a block diagram of the keyboard interface.



Keyboard Controller Interface Block Diagram

Status Register

The status register is an 8-bit read-only register at I/O address hex 64. It has information about the state of the keyboard controller (8042) and interface. It may be read at any time.

Status-Register Bit Definition

Bit 7 Parity Error—A 0 indicates the last byte of data received from the keyboard had odd parity. A 1 indicates the last byte had even parity. The keyboard should send data with odd parity.

Bit 6 Receive Time-Out—A 1 indicates that a transmission was started by the keyboard but did not finish within the programmed receive time-out delay.

Bit 5 Transmit Time-Out—A 1 indicates that a transmission started by the keyboard controller was not properly completed. If the transmit byte was not clocked out within the specified time limit, this will be the only error.

If the transmit byte was clocked out but a response was not received within the programmed time limit, the transmit time-out and receive time-out error bits are set to 1. If the transmit byte was clocked out but the response was received with a parity error, the transmit time-out and parity error bits are set to 1.

Bit 4 Inhibit Switch—This bit is updated whenever data is placed in the keyboard controller's output buffer. It reflects the state of the keyboard-inhibit switch. A 0 indicates the keyboard is inhibited.

Bit 3 Command/Data—The keyboard controller's input buffer may be addressed as either I/O address hex 60 or 64. Address hex 60 is defined as the data port, and address hex 64 is defined as the command port. Writing to address hex 64 sets this bit to 1; writing to address hex 60 sets this bit to 0. The controller uses this bit to determine if the byte in its input buffer should be interpreted as a command byte or a data byte.

Bit 2 System Flag—This bit is monitored by the system during the reset routine. If it is a 0, the reset was caused by a power on. The controller sets this bit to 0 at power on and it is set to 1 after a successful self test. This bit can be changed by writing to the system flag bit in the command byte (hex 64).

Bit 1 Input Buffer Full—A 0 indicates that the keyboard controller's input buffer (I/O address hex 60 or 64) is empty. A 1 indicates that data has been written into the buffer but the controller has not read the data. When the controller reads the input buffer, this bit will return to 0.

Bit 0 Output Buffer Full—A 0 indicates that the keyboard controller's output buffer has no data. A 1 indicates that the controller has placed data into its output buffer but the system has not yet read the data. When the system reads the output buffer (I/O address hex 60), this bit will return to a 0.

Output Buffer

The output buffer is an 8-bit read-only register at I/O address hex 60. The keyboard controller uses the output buffer to send scan codes received from the keyboard, and data bytes requested by command, to the system. The output buffer should be read only when the output-buffer-full bit in the status register is 1.

Input Buffer

The input buffer is an 8-bit write-only register at I/O address hex 60 or 64. Writing to address hex 60 sets a flag, which indicates a data write; writing to address hex 64 sets a flag, indicating a command write. Data written to I/O address hex 60 is sent to the keyboard, unless the keyboard controller is expecting a data byte following a controller command. Data should be written to the controller's input buffer only if the input buffer's full bit in the status register is 0. The following are valid keyboard controller commands.

Commands (I/O Address Hex 64)

20 Read Keyboard Controller's Command Byte—The controller sends its current command byte to its output buffer.

60 Write Keyboard Controller's Command Byte—The next byte of data written to I/O address hex 60 is placed in the controller's command byte. Bit definitions of the command byte are as follows:

Bit 7 Reserved—Should be written as a 0.

Bit 6 IBM Personal Computer Compatibility Mode—Writing a 1 to this bit causes the controller to convert the scan codes received from the keyboard to those used by the IBM Personal Computer. This includes converting a 2-byte break sequence to the 1-byte IBM Personal Computer format.

Bit 5 IBM Personal Computer Mode—Writing a 1 to this bit programs the keyboard to support the IBM Personal Computer keyboard interface. In this mode the controller does not check parity or convert scan codes.

Bit 4 Disable Keyboard—Writing a 1 to this bit disables the keyboard interface by driving the 'clock' line low. Data is not sent or received.

Bit 3 Inhibit Override—Writing a 1 to this bit disables the keyboard inhibit function.

Bit 2 System Flag—The value written to this bit is placed in the system flag bit of the controller's status register.

Bit 1 Reserved—Should be written as a 0.

Bit 0 Enable Output-Buffer-Full Interrupt—Writing a 1 to this bit causes the controller to generate an interrupt when it places data into its output buffer.

AA Self-Test—This commands the controller to perform internal diagnostic tests. A hex 55 is placed in the output buffer if no errors are detected.

AB Interface Test—This commands the controller to test the 'keyboard clock' and 'keyboard data' lines. The test result is placed in the output buffer as follows:

00 No error detected.
01 The 'keyboard clock' line is stuck low.
02 The 'keyboard clock' line is stuck high.
03 The 'keyboard data' line is stuck low.
04 The 'keyboard data' line is stuck high.

AC Diagnostic Dump—Sends 16 bytes of the controller's RAM, the current state of the input port, the current state of the output port, and the controller's program status word to the system. All items are sent in scan-code format.

AD Disable Keyboard Feature—This command sets bit 4 of the controller's command byte. This disables the keyboard interface by driving the clock line low. Data will not be sent or received.

AE Enable Keyboard Interface—This command clears bit 4 of the command byte, which releases the keyboard interface.

C0 Read Input Port—This commands the controller to read its input port and place the data in its output buffer. This command should be used only if the output buffer is empty.

D0 Read Output Port—This command causes the controller to read its output port and place the data in its output buffer. This command should be issued only if the output buffer is empty.

D1 Write Output Port—The next byte of data written to I/O address hex 60 is placed in the controller's output port.

> **Note:** Bit 0 of the controller's output port is connected to System Reset. This bit should not be written low as it will reset the microprocessor.

E0 Read Test Inputs—This command causes the controller to read its T0 and T1 inputs. This data is placed in the output buffer. Data bit 0 represents T0, and data bit 1 represents T1.

F0–FF Pulse Output Port—Bits 0 through 3 of the controller's output port may be pulsed low for approximately 6 microseconds. Bits 0 through 3 of this command indicate which bits are to be pulsed. A 0 indicates that the bit should be pulsed, and a 1 indicates the bit should not be modified.

> **Note:** Bit 0 of the controller's output port is connected to System Reset. Pulsing this bit resets the microprocessor.

I/O Ports

The keyboard controller has two I/O ports, one assigned for input and the other for output. Two test inputs are used by the controller to read the state of the keyboard's 'clock' (T0) and 'data' (T1) lines.

The following figures show bit definitions for the input and output ports, and the test-inputs.

Bit 7	Keyboard inhibit switch 0 = Keyboard inhibited 1 = Keyboard not inhibited
Bit 6	Display switch - Primary display attached to: 0 = Color/Graphics adapter 1 = Monochrome adapter
Bit 5	Manufacturing Jumper 0 = Manufacturing jumper installed 1 = Jumper not installed
Bit 4	RAM on the system board 0 = Enable 512K of system board RAM 1 = Enable 256K of system board RAM
Bit 3	Reserved
Bit 2	Reserved
Bit 1	Reserved
Bit 0	Reserved

Input-Port Bit Definitions

Bit 7	Keyboard data (output)
Bit 6	Keyboard clock (output)
Bit 5	Input buffer empty
Bit 4	Output buffer full
Bit 3	Reserved
Bit 2	Reserved
Bit 1	Gate A20
Bit 0	System reset

Output-Port Bit Definitions

T1	Keyboard data (input)
T0	Keyboard clock (input)

Test-Input Bit Definitions

Real-Time Clock/CMOS RAM Information

The RT/CMOS RAM chip (Motorola MC146818) contains the real-time clock and 64 bytes of CMOS RAM. The internal clock circuitry uses 14 bytes of this RAM, and the rest is allocated to configuration information. The following figure shows the CMOS RAM addresses.

Addresses	Description
00 - 0D	* Real-time clock information
0E	* Diagnostic status byte
0F	* Shutdown status byte
10	Diskette drive type byte - drives A and B
11	Reserved
12	Fixed disk type byte - types 1-14
13	Reserved
14	Equipment byte
15	Low base memory byte
16	High base memory byte
17	Low expansion memory byte
18	High expansion memory byte
19	Disk C extended byte
1A	Disk D extended byte
1B - 2D	Reserved
2E - 2F	2-byte CMOS checksum
30	* Low expansion memory byte
31	* High expansion memory byte
32	* Date century byte
33	* Information flags (set during power on)
34 - 3F	Reserved

CMOS RAM Address Map

* These bytes are not included in the checksum calculation and are not part of the configuration record.

Real-Time Clock Information

The following figure describes real-time clock bytes and specifies their addresses.

Byte	Function	Address
0	Seconds	00
1	Second Alarm	01
2	Minutes	02
3	Minute Alarm	03
4	Hours	04
5	Hour Alarm	05
6	Day of Week	06
7	Date of Month	07
8	Month	08
9	Year	09
10	Status Register A	0A
11	Status Register B	0B
12	Status Register C	0C
13	Status Register D	0D

Real-Time Clock Information (Addresses 00 - 0D)

Note: The setup program initializes registers A, B, C, and D when the time and date are set. Also Interrupt 1A is the BIOS interface to read/set the time and date. It initializes the status bytes the same as the Setup program.

Status Register A

Bit 7 Update in Progress (UIP)—A 1 indicates the time update cycle is in progress. A 0 indicates the current date and time are available to read.

Bit 6–Bit 4 22-Stage Divider (DV2 through DV0)—These three divider-selection bits identify which time-base frequency is being used. The system initializes the stage divider to 010, which selects a 32.768-kHz time base.

Bit 3–Bit 0 Rate Selection Bits (RS3 through RS0)—These bits allow the selection of a divider output frequency. The system initializes the rate selection bits to 0110, which selects a 1.024-kHz square wave output frequency and a 976.562-microsecond periodic interrupt rate.

Status Register B

Bit 7 Set—A 0 updates the cycle normally by advancing the counts at one-per-second. A 1 aborts any update cycle in progress and the program can initialize the 14 time-bytes without any further updates occurring until a 0 is written to this bit.

Bit 6 Periodic Interrupt Enable (PIE)—This bit is a read/write bit that allows an interrupt to occur at a rate specified by the rate and divider bits in register A. A 1 enables an interrupt, and a 0 disables it. The system initializes this bit to 0.

Bit 5 Alarm Interrupt Enable (AIE)—A 1 enables the alarm interrupt, and a 0 disables it. The system initializes this bit to 0.

Bit 4 Update-Ended Interrupt Enabled (UIE)—A 1 enables the update-ended interrupt, and a 0 disables it. The system initializes this bit to 0.

Bit 3 Square Wave Enabled (SQWE)—A 1 enables the the square-wave frequency as set by the rate selection bits in register A, and a 0 disables the square wave. The system initializes this bit to 0.

Bit 2 Date Mode (DM)—This bit indicates whether the time and date calendar updates are to use binary or binary coded decimal (BCD) formats. A 1 indicates binary, and a 0 indicates BCD. The system initializes this bit to 0.

Bit 1	24/12—This bit indicates whether the hours byte is in the 24-hour or 12-hour mode. A 1 indicates the 24-hour mode and a 0 indicates the 12-hour mode. The system initializes this bit to 1.
Bit 0	Daylight Savings Enabled (DSE)—A 1 enables daylight savings and a 0 disables daylight savings (standard time). The system initializes this bit to 0.

Status Register C

Bit 7–Bit 4	IRQF, PF, AF, UF—These flag bits are read-only and are affected when the AIE, PIE, and UIE bits in register B are set to 1.
Bit 3–Bit 0	Reserved—Should be written as a 0.

Status Register D

Bit 7	Valid RAM Bit (VRB)—This bit is read-only and indicates the status of the power-sense pin (battery level). A 1 indicates battery power to the real-time clock is good. A 0 indicates the battery is dead, so RAM is not valid.
Bits 6–Bit 0	Reserved—Should be written as a 0.

CMOS RAM Configuration Information

The following lists show bit definitions for the CMOS configuration bytes (addresses hex 0E – 3F).

Diagnostic Status Byte (Hex 0E)

Bit 7	Power status of the real-time clock chip—A 0 indicates that the chip has not lost power, and a 1 indicates that the chip lost power.

Bit 6	Configuration Record (Checksum Status Indicator)—A 0 indicates that checksum is good, and a 1 indicates it is bad.
Bit 5	Incorrect Configuration Information—This is a check, at power-on time, of the equipment byte of the configuration record. A 0 indicates that the configuration information is valid, and a 1 indicates it is invalid. Power-on checks require: • At least one diskette drive to be installed (bit 0 of the equipment byte set to 1). • The primary display adapter setting in configuration matches the system board's display switch setting and the actual display adapter hardware in the system.
Bit 4	Memory Size Comparison—A 0 indicates that the power-on check determined the same memory size as in the configuration record, and a 1 indicates the memory size is different.
Bit 3	Fixed Disk Adapter/Drive C Initialization Status—A 0 indicates that the adapter and drive are functioning properly and the system can attempt "boot up." A 1 indicates that the adapter and/or drive C failed initialization, which prevents the system from attempting to "boot up."
Bit 2	Time Status Indicator (POST validity check)— A 0 indicates that the time is valid, and a 1 indicates that it is invalid.
Bit 1–Bit 0	Reserved

SECTION 1

Shutdown Status Byte (Hex 0F)

The bits in this byte are defined by the power on diagnostics. For more information about this byte, see "BIOS Listing."

Diskette Drive Type Byte (Hex 10)

Bit 7–Bit 4 Type of first diskette drive installed:

0000 No drive is present.
0001 Double Sided Diskette Drive (48 TPI).
0010 High Capacity Diskette Drive (96 TPI).

Note: 0011 through 1111 are reserved.

Bit 3–Bit 0 Type of second diskette drive installed:

0000 No drive is present.
0001 Double Sided Diskette Drive (48 TPI).
0010 High Capacity Diskette Drive (96 TPI).

Note: 0011 through 1111 are reserved.

Hex address 11 contains a reserved byte.

Fixed Disk Type Byte (Hex 12)

Bit 7–Bit 4	Defines the type of first fixed disk drive installed (drive C):
	0000 No fixed disk drive is present.
	0001 to 1110 Define type 1 through type 14 as shown in the following table (also see BIOS listing at label FD_TBL)
	1111 Type 16 through 255. See "Drive C Extended Byte (Hex 19)" on page 1-65 .
Bit 3–Bit 0	Defines the type of second fixed disk drive installed (drive D):
	0000 No fixed disk drive is present.
	0001 to 1110 Define type 1 through type 14 as shown in the following table (also see BIOS listing at label FD_TBL)
	1111 Type 16 through 255. See "Drive D Extended Byte (Hex 1A)" on page 1-65 .

The following figure shows the BIOS fixed disk parameters.

Type	Cylinders	Heads	Write Pre-Comp	Landing Zone
1	306	4	128	305
2	615	4	300	615
3	615	6	300	615
4	940	8	512	940
5	940	6	512	940
6	615	4	None	615
7	462	8	256	511
8	733	5	None	733
9	900	15	None	901
10	820	3	None	820
11	855	5	None	855
12	855	7	None	855
13	306	8	128	319
14	733	7	None	733
15	Extended Parameters (hex 19 and 1A)			

BIOS Fixed Disk Parameters

Hex address 13 contains a reserved byte.

Equipment Byte (Hex 14)

Bit 7–Bit 6 Indicates the number of diskette drives installed:

00 1 drive
01 2 drives
10 Reserved
11 Reserved

Bit 5–Bit 4 Primary display

00 Primary display is attached to an adapter that has its own BIOS, such as one of the following:

- the Enhanced Graphics Adapter
- the Professional Graphics Controller.

01	Primary display is in the 40-column mode and attached to the Color/Graphics Monitor Adapter.
10	Primary display is in the 80-column mode and attached to the Color/Graphics Monitor Adapter.
11	Primary display is attached to the Monochrome Display and Printer Adapter.

Bit 3–Bit 2 Not used.

Bit 1 Math Coprocessor presence bit:

- **0** Math Coprocessor not installed
- **1** Math Coprocessor installed

Bit 0 Diskette drive presence bit:

- **0** Diskette drive not installed
- **1** Diskette drive installed

Note: The equipment byte defines basic equipment in the system for power-on diagnostics.

Low and High Base Memory Bytes (Hex 15 and 16)

Bit 7–Bit 0 Address hex 15—Low-byte base size

Bit 7–Bit 0 Address hex 16—High-byte base size

Valid Sizes:

0100H	256K–system board RAM
0200H	512K–system board RAM
0280H	640K–512K system board RAM and the IBM Personal Computer AT 128KB Memory Expansion Option

Low and High Expansion Memory Bytes (Hex 17 and 18)

Bit 7–Bit 0 Address hex 17—Low-byte expansion size

Bit 7-Bit 0 Address hex 18—High-byte expansion size

Valid Sizes:

0200H 512K–I/O adapter
0400H 1024K–I/O adapter (2 adapters)
0600H 1536K–I/O adapter (3 adapters)
through
3C00H 15360K I/O adapter (15M maximum).

Drive C Extended Byte (Hex 19)

Bit 7–Bit 0 Defines the type of first fixed disk drive installed (drive C):

00000000 through 00001111 are reserved.

00010000 to 11111111 define type 16 through 255 as shown in the following table (see BIOS listing at label FD_TBL).

Drive D Extended Byte (Hex 1A)

Bit 7–Bit 0 Defines the type of second fixed disk drive installed (drive D):

00000000 through 00001111 are reserved.

00010000 to 11111111 define type 16 through 255 as shown in the following table (see BIOS listing at label FD_TBL).

The following figure shows the BIOS fixed disk parameters for fixed disk drive types 16 through 22.

Note: Types 23 through 255 are reserved.

Type	Cylinders	Heads	Write Pre-Comp	Landing Zone
16	612	4	All Cyl	663
17	977	5	300	977
18	977	7	None	977
19	1024	7	512	1023
20	733	5	300	732
21	733	7	300	732
22	733	7	300	733
23	Reserved			
.	.			
.	.			
255	Reserved			

BIOS Fixed Disk Parameters (Extended)

Hex addresses 1B through 2D are reserved.

Checksum (Hex 2E and 2F)

Bit 7–Bit 0 Address hex 2E—High byte of checksum

Bit 7–Bit 0 Address hex 2F—Low byte of checksum

Note: Checksum is calculated on addresses hex 10-2D.

Low and High Expansion Memory Bytes (Hex 30 and 31)

Bit 7–Bit 0	Address hex 30—Low-byte expansion size
Bit 7–Bit 0	Address hex 31—High-byte expansion size

Valid Sizes:

0200H	512K–I/O adapter
0400H	1024K–I/O adapter
0600H	1536K–I/O adapter through
3C00H	15360K I/O adapter (15M maximum).

Note: This word reflects the total expansion memory above the 1M address space as determined at power-on time. This expansion memory size can be determined through system interrupt 15 (see the BIOS listing). The base memory at power-on time is determined through the system memory-size-determine interrupt (hex 12).

Date Century Byte (Hex 32)

Bit 7–Bit 0	BCD value for the century (BIOS interface to read and set).

Information Flag (Hex 33)

Bit 7	When set, this bit indicates that the top 128K of base memory is installed.
Bit 6	This bit is set to instruct the Setup utility to put out a first user message after initial setup.
Bit 5–Bit 0	Reserved

Hex addresses 34 through 3F are reserved.

I/O Operations

Writing to CMOS RAM involves two steps:

1. OUT to port hex 70 with the CMOS address that will be written to.

2. OUT to port hex 71 with the data to be written.

Reading CMOS RAM also requires two steps:

1. OUT to port hex 70 with the CMOS address that is to be read from.

2. IN from port hex 71, and the data read is returned in the AL register.

Specifications

System Unit

Size

- Length: 540 millimeters (21.3 inches)
- Depth: 439 millimeters (17.3 inches)
- Height: 162 millimeters (6.8 inches)

Weight

- 20.0 kilograms (44 pounds)

Power Cables

- Length: 1.8 meters (6 feet)

Environment

- Air Temperature
  - System On: 15.6 to 32.2 degrees C (60 to 90 degrees F)
  - System Off: 10 to 43 degrees C (50 to 110 degrees F)
- Wet Bulb Temperature
  - System On: 22.8 degrees C (73 degrees F)
  - System Off: 26.7 degrees C (80 degrees F)

- Humidity
  - System On: 8% to 80%
  - System Off: 20% to 80%
- Altitude
  - Maximum altitude: 2133.6 meters (7000 feet)

Heat Output

- 1229 British Thermal Units (BTU) per hour

Noise Level

- Meets Class 3; 59 decibels average-noise rating (without printer)

Electrical

- Power: 450 VA
- Range 1
  - Nominal: 115 Vac
  - Minimum: 100 Vac
  - Maximum: 125 Vac
- Range 2
  - Nominal: 230 Vac
  - Minimum: 200 Vac
  - Maximum: 240 Vac

Connectors

The system board has the following additional connectors:

- Two power-supply connectors (PS8 and PS9)
- Speaker connector (J19)
- Power LED and key lock connector (J20)
- Battery connector (J21)
- Keyboard connector (J22)

The pin assignments for the power-supply connectors, PS8 and PS9, are as follows. The pins are numbered 1 through 6 from the rear of the system.

Connector	Pin	Assignments
PS8	1	Power Good
	2	+5 Vdc
	3	+12 Vdc
	4	-12 Vdc
	5	Ground
	6	Ground
PS9	1	Ground
	2	Ground
	3	-5 Vdc
	4	+5 Vdc
	5	+5 Vdc
	6	+5 Vdc

Power Supply Connectors (PS8, PS9)

The speaker connector, J19, is a 4-pin, keyed, Berg strip. The pins are numbered 1 through 4 from the front of the system. The pin assignments are as follows:

Pin	Function
1	Data out
2	Key
3	Ground
4	+5 Vdc

Speaker Connector (J19)

The power LED and key lock connector, J20, is a 5-pin Berg strip. The pins are numbered 1 through 5 from the front of the system. The pin assignments are as follows:

Pin	Assignments
1	LED Power
2	Key
3	Ground
4	Keyboard Inhibit
5	Ground

Power LED and Key Lock Connector (J20)

The battery connector, J21, is a 4-pin, keyed, Berg strip. The pins are numbered 1 through 4 from the right of the system. The pin assignments are as follows:

Pin	Assignments
1	Ground
2	Not Used
3	Key
4	6 Vdc

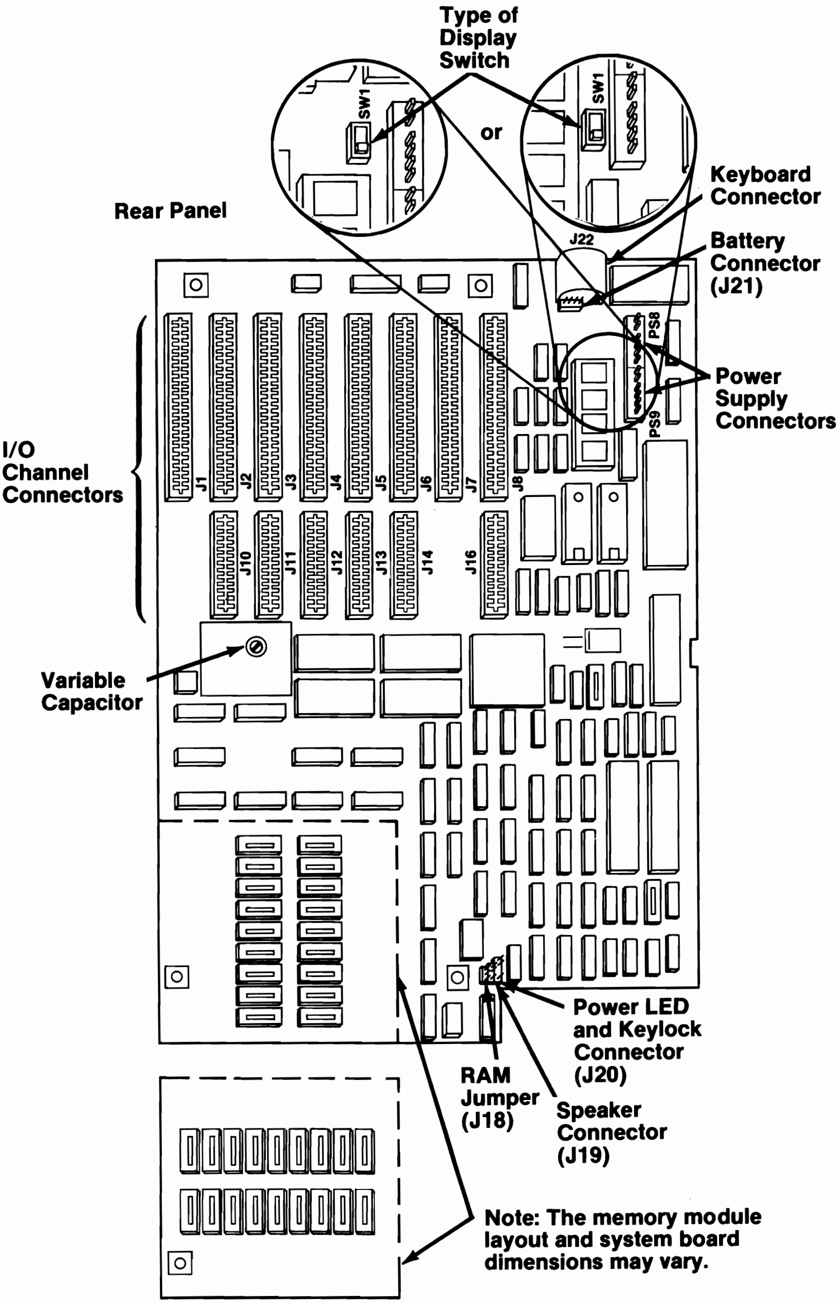
Battery Connector (J21)

The keyboard connector, J22, is a 5-pin, 90-degree Printed Circuit Board (PCB) mounting, DIN connector. For pin numbering, see the "Keyboard" Section. The pin assignments are as follows:

Pin	Assignments
1	Keyboard Clock
2	Keyboard Data
3	Reserved
4	Ground
5	+5 Vdc

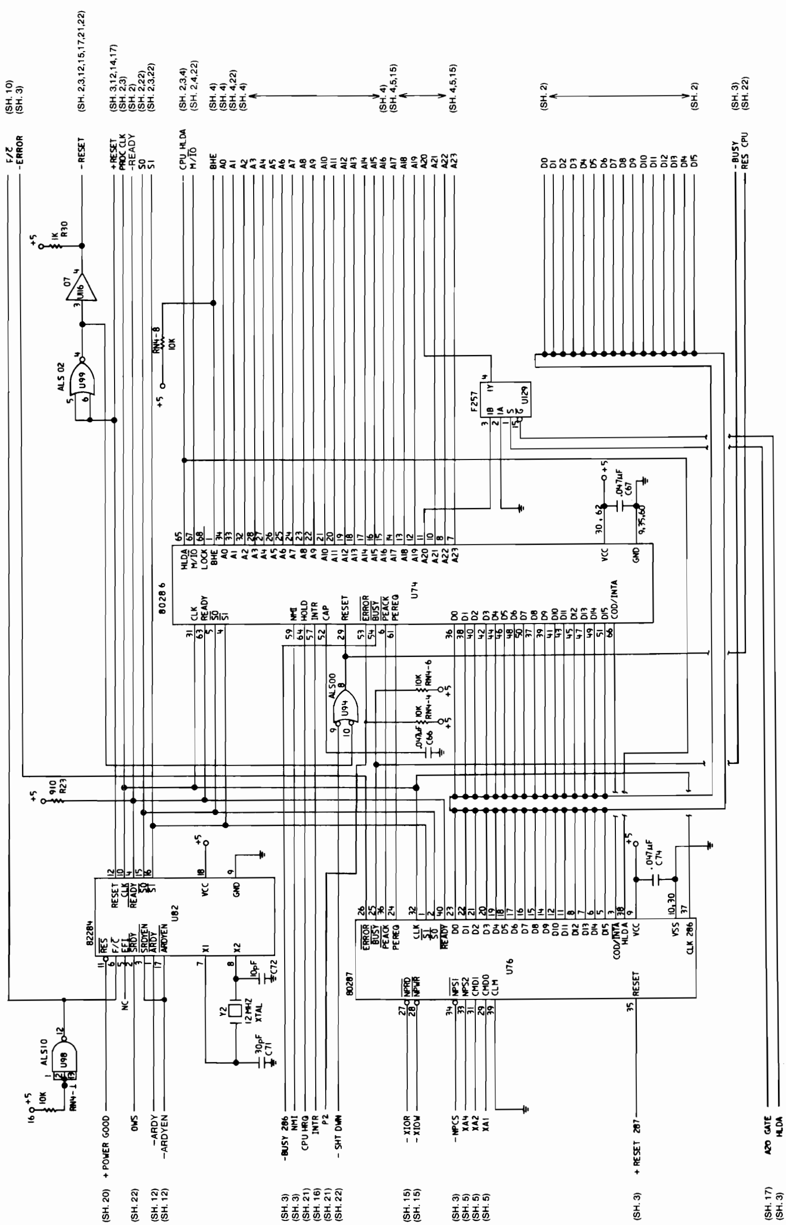
Keyboard Connector (J22)

The following figure shows the layout of the system board.

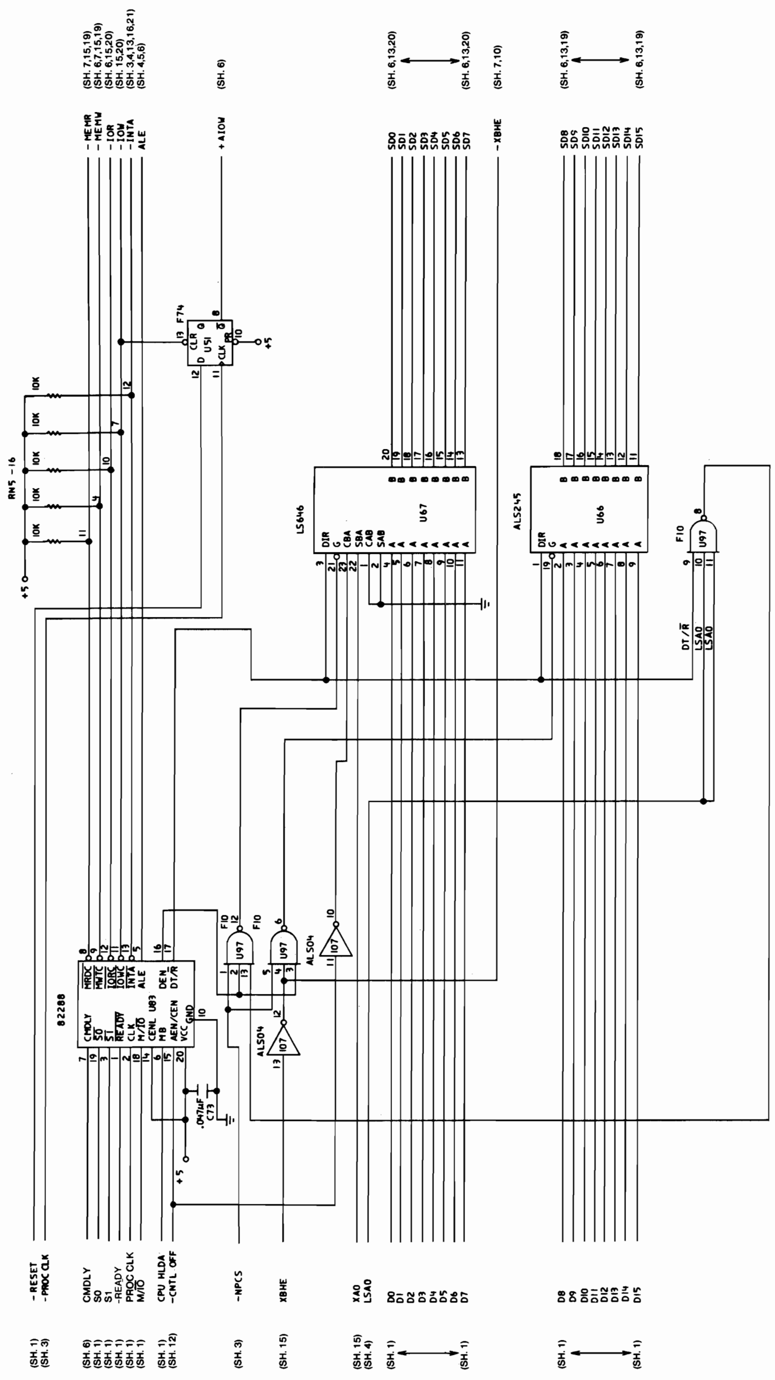


Notes:

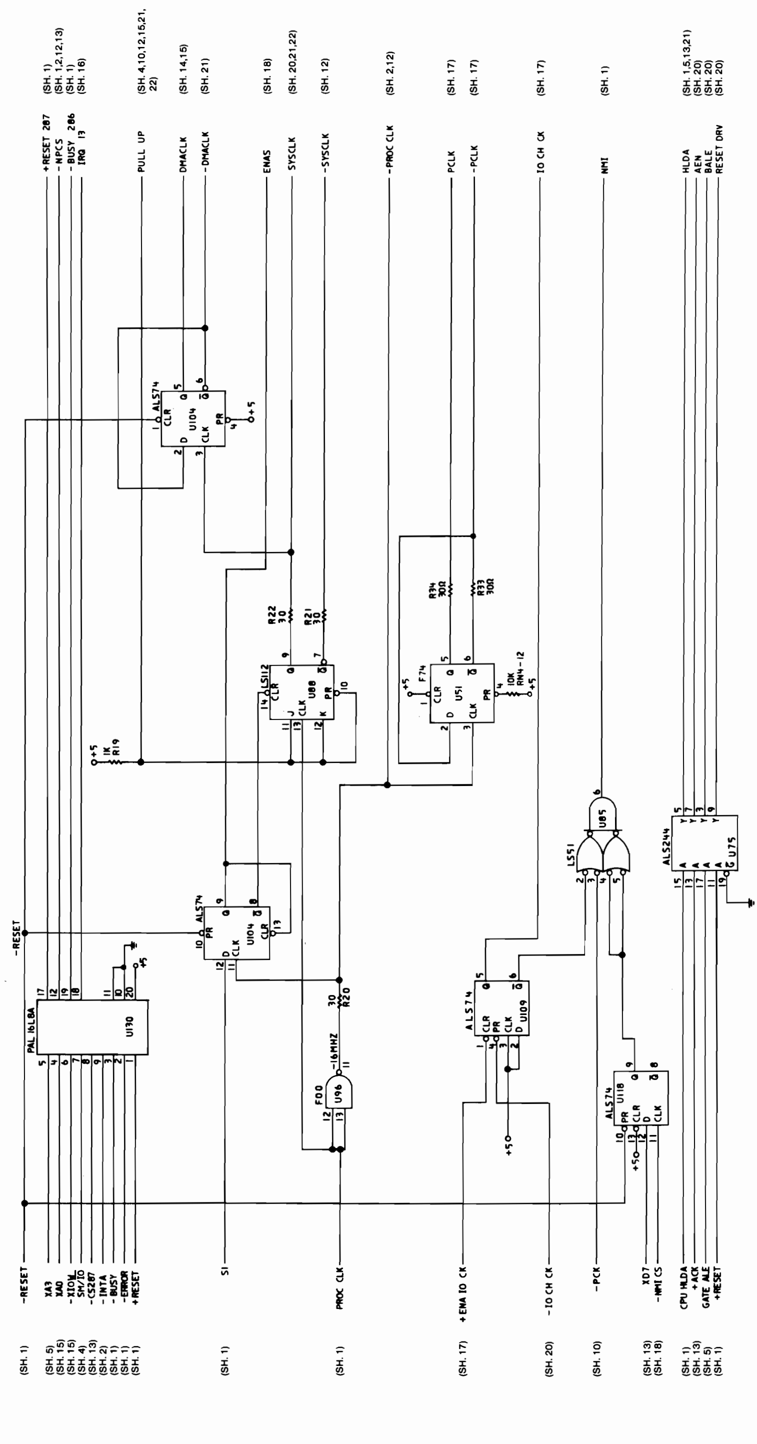
Logic Diagrams - Type 1



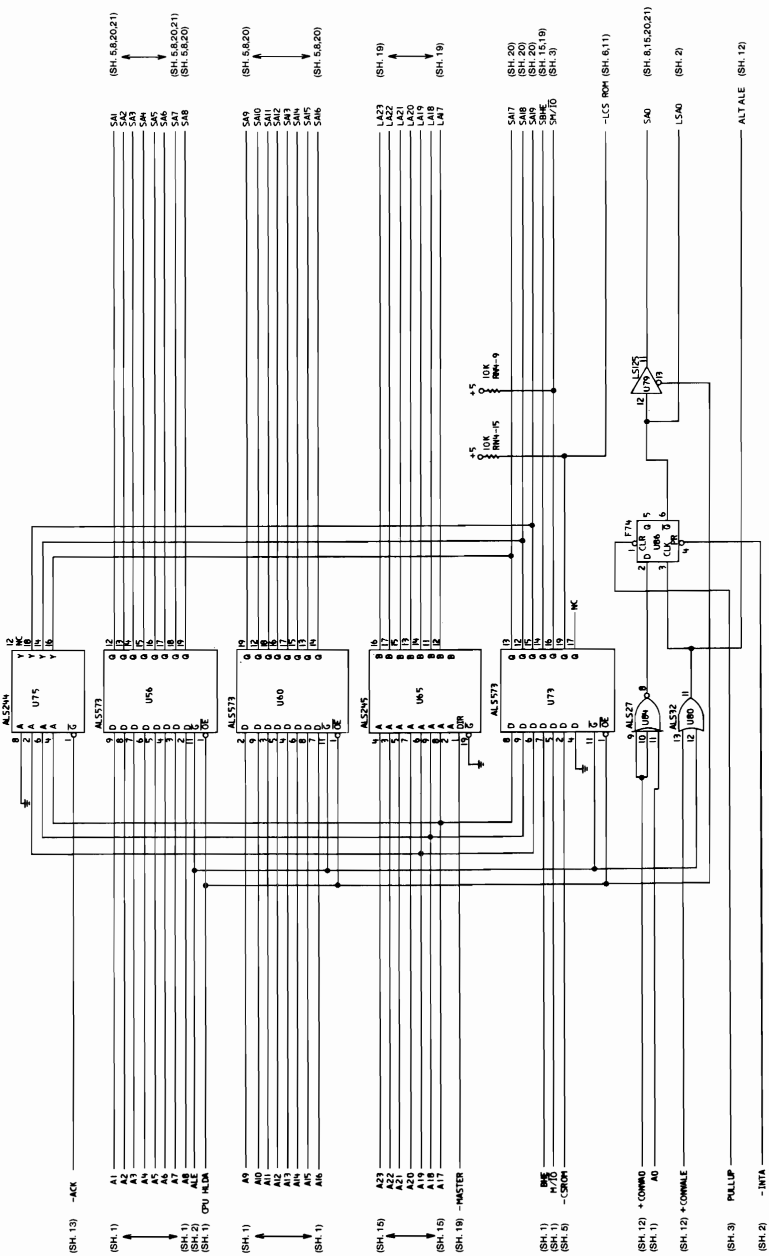
Type 1 512KB Planar (Sheet 1 of 22)



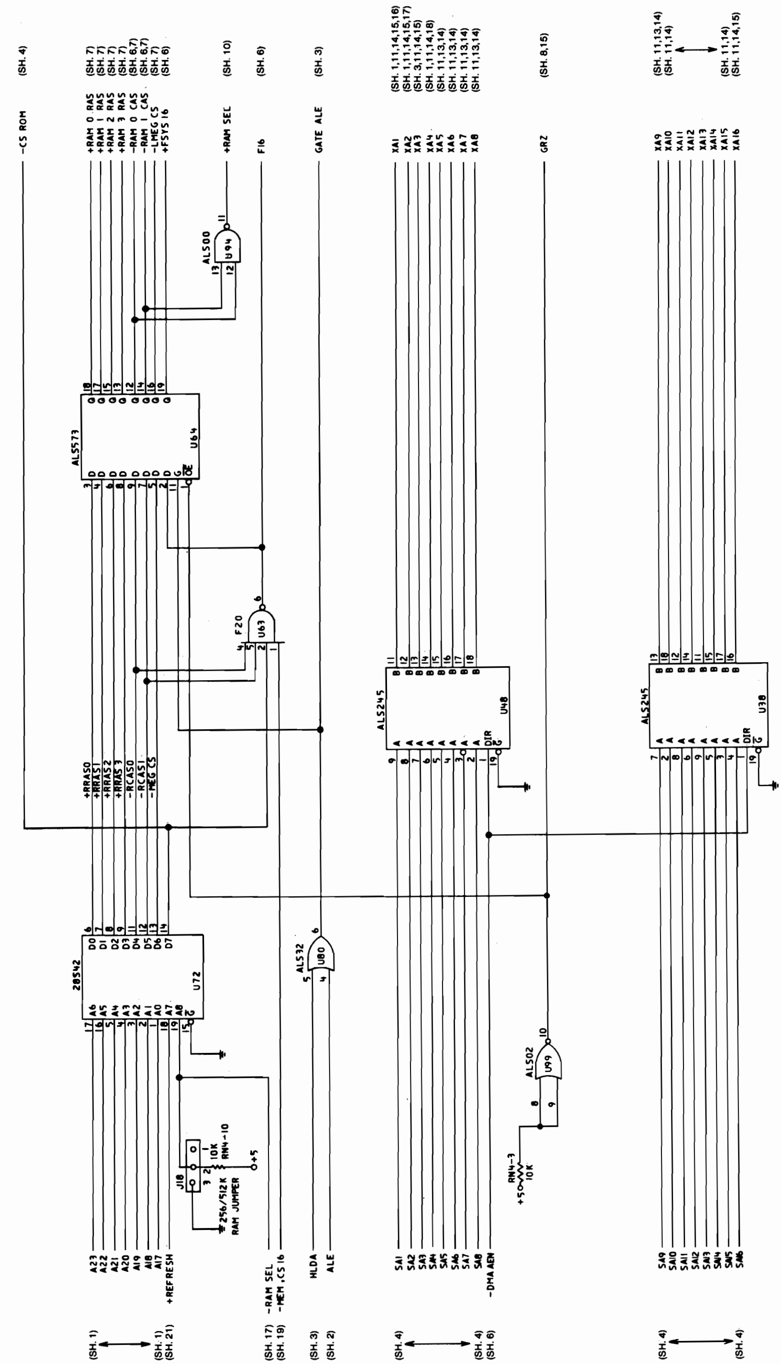
Type 1 512KB Planar (Sheet 2 of 22)



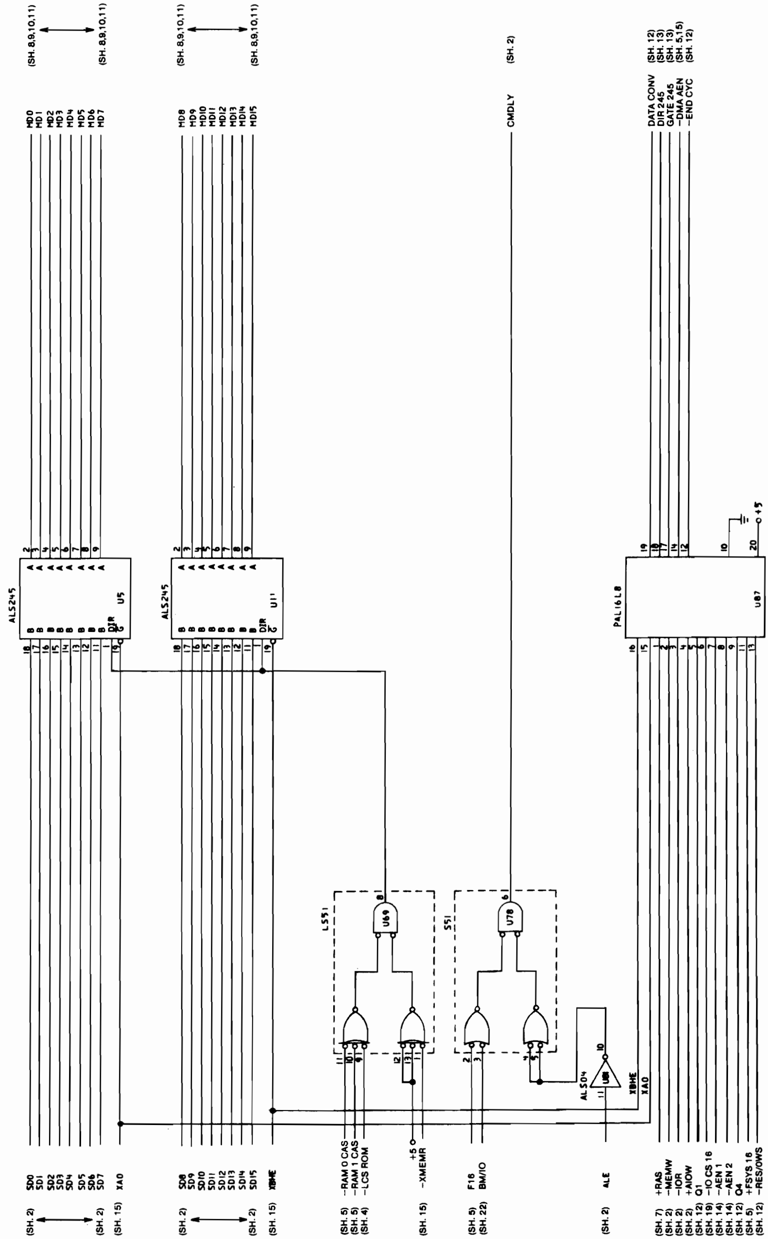
Type 1 512KB Planar (Sheet 3 of 22)



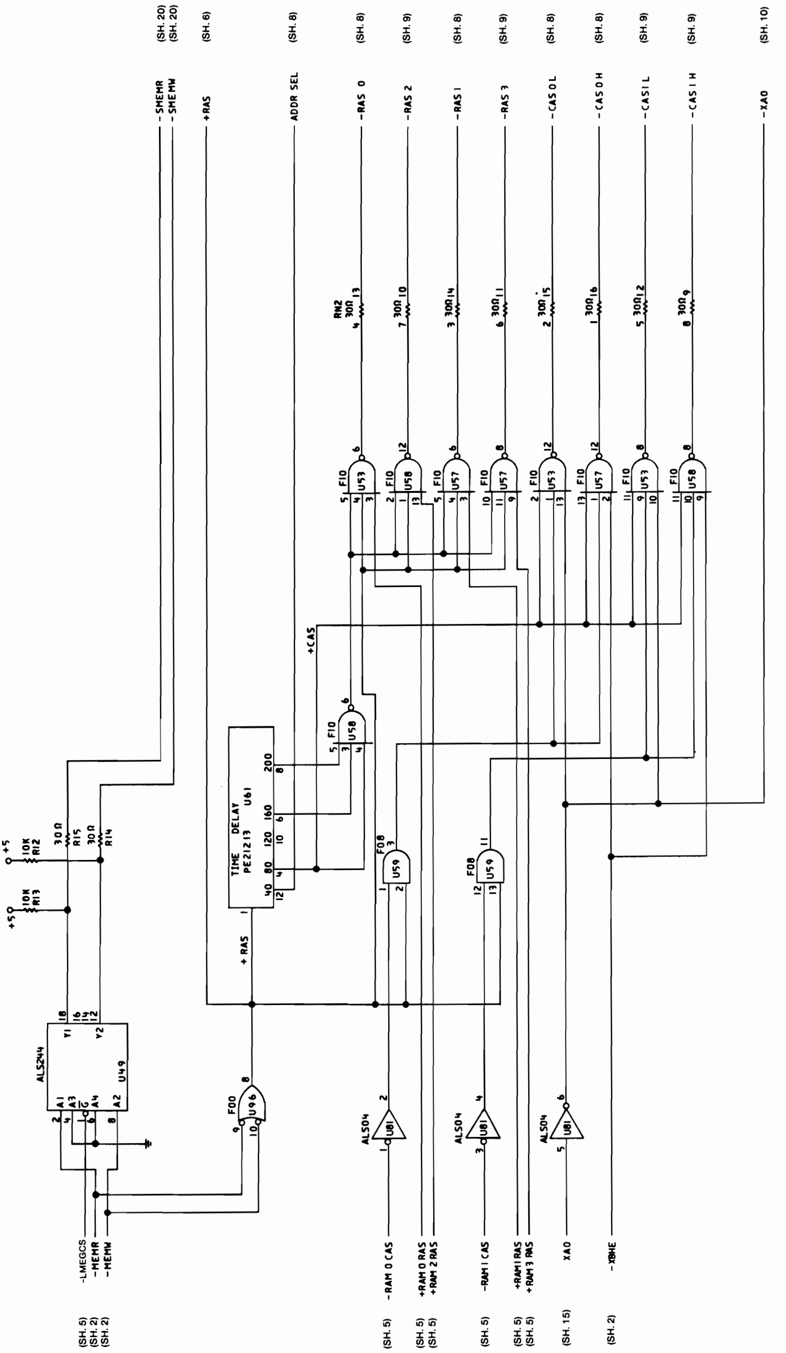
Type 1 512KB Planar (Sheet 4 of 22)



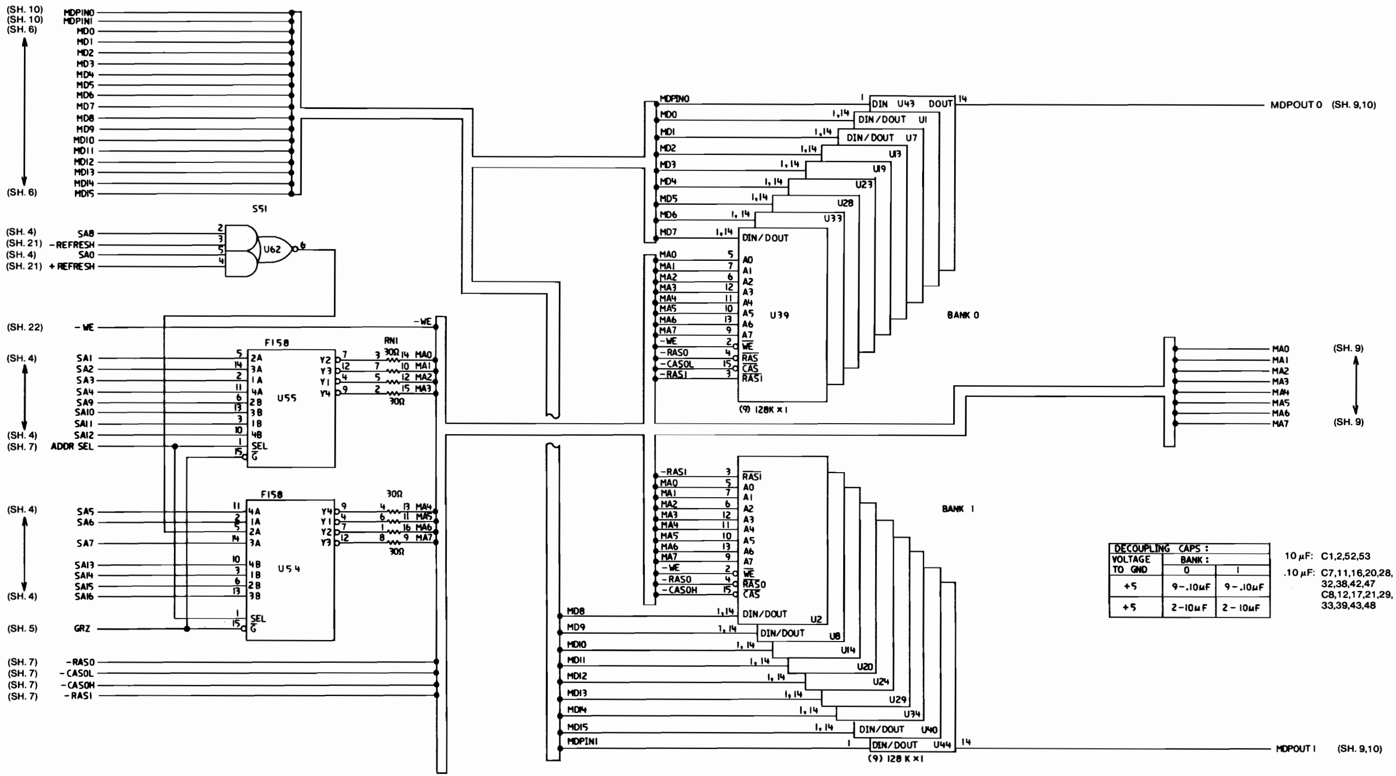
Type 1 512KB Planar (Sheet 5 of 22)



Type 1 512KB Planar (Sheet 6 of 22)



Type 1 512KB Planar (Sheet 7 of 22)



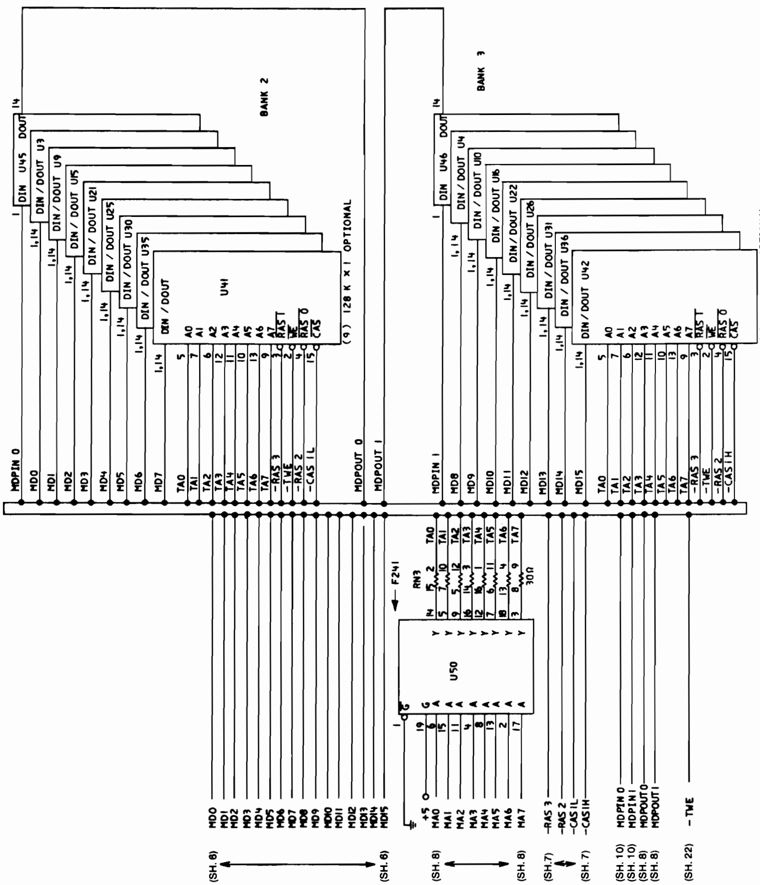
Type 1 512KB Planar (Sheet 8 of 22)

DECOUPLING CAP:		
VOLTAGE TO GND	BANK 2	BANK 3
+ 5	9 – .10µF	9 – .10µF
+ 5	2 – 10µF	2 – 10µF

10µF: C3,4,54,55

.10µF: C9,13,18,22,30,34,40,44,49

C10,14,19,23,31,35,41,45,50



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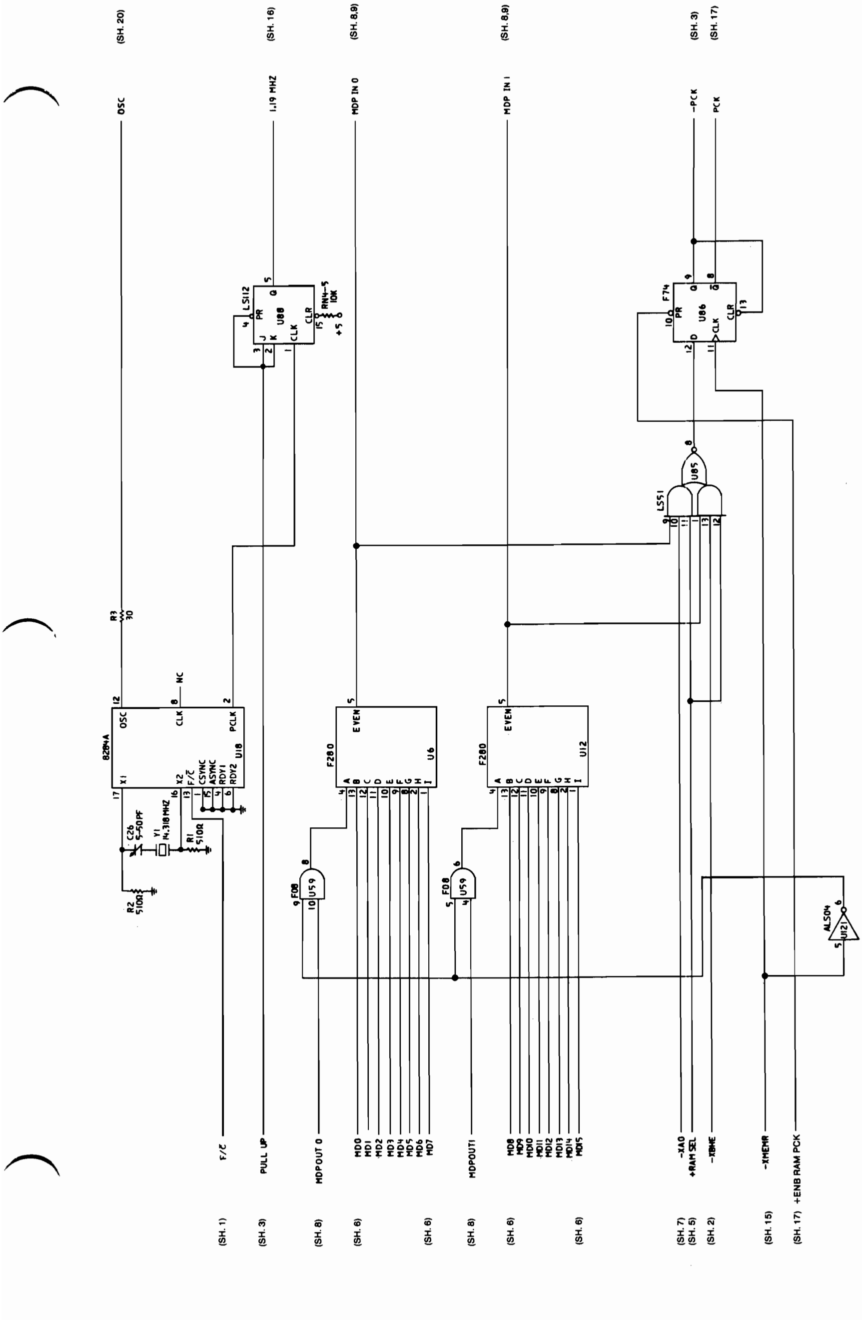

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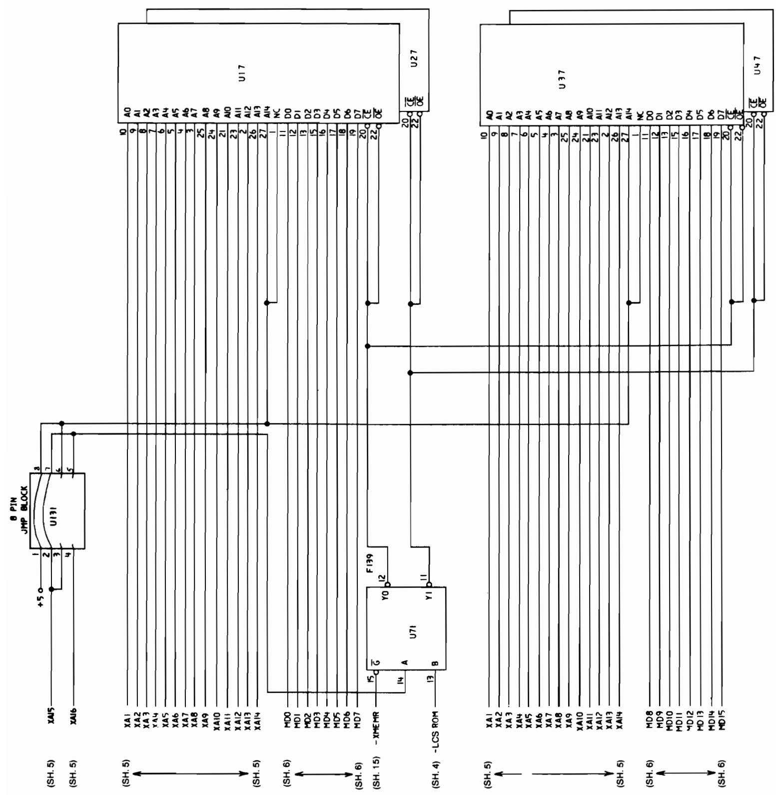

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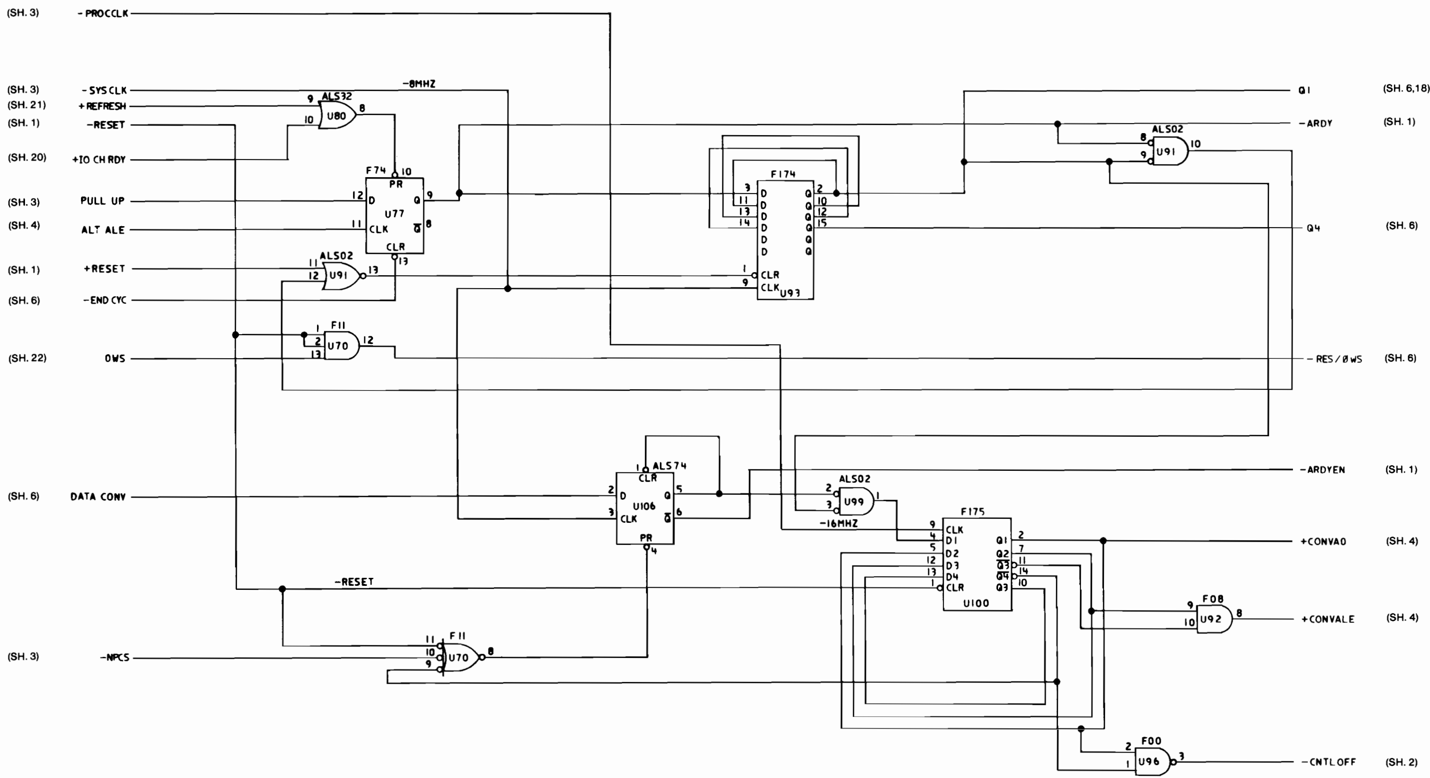

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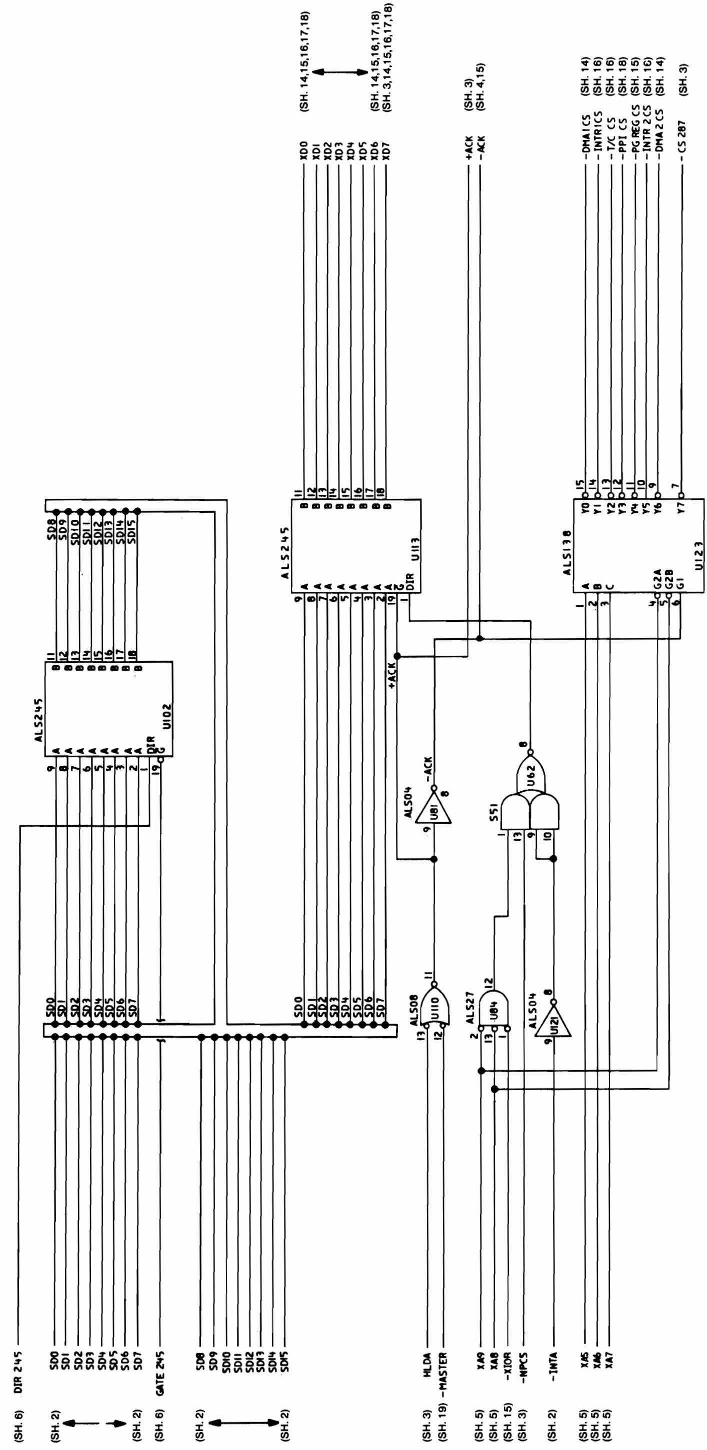

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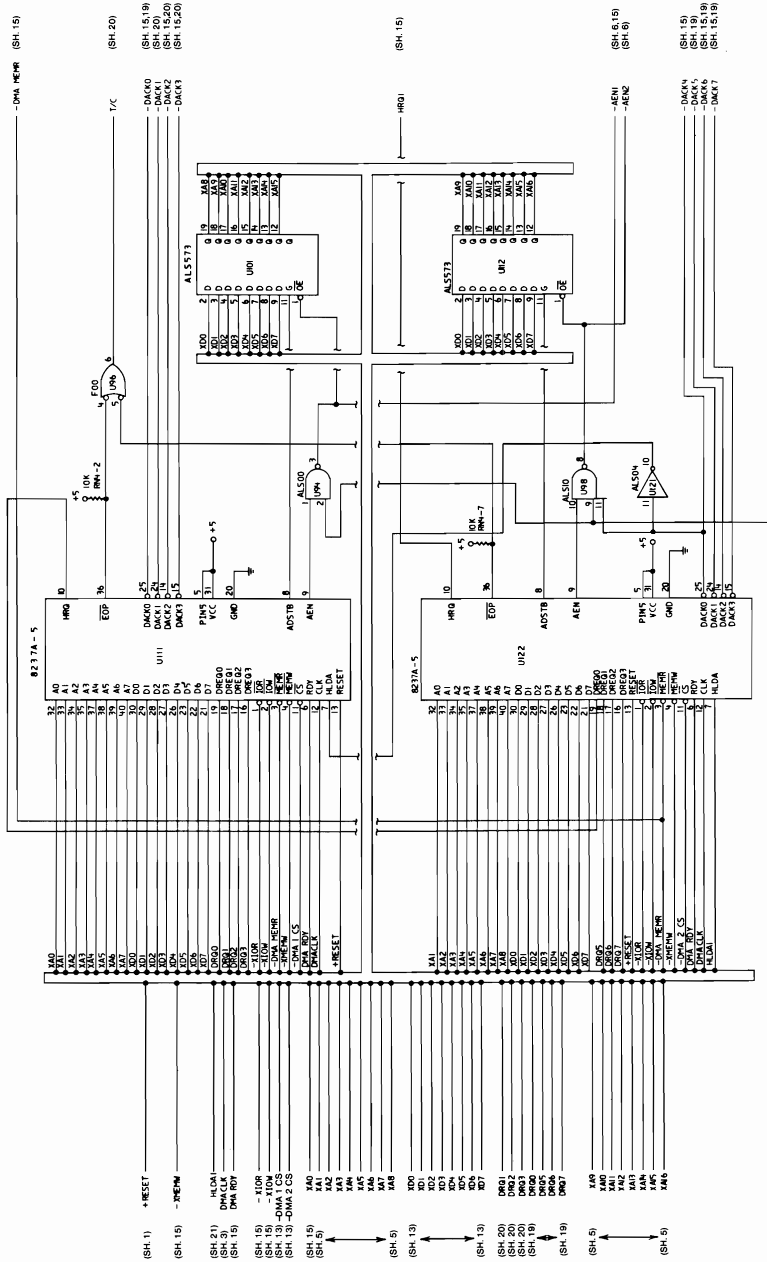

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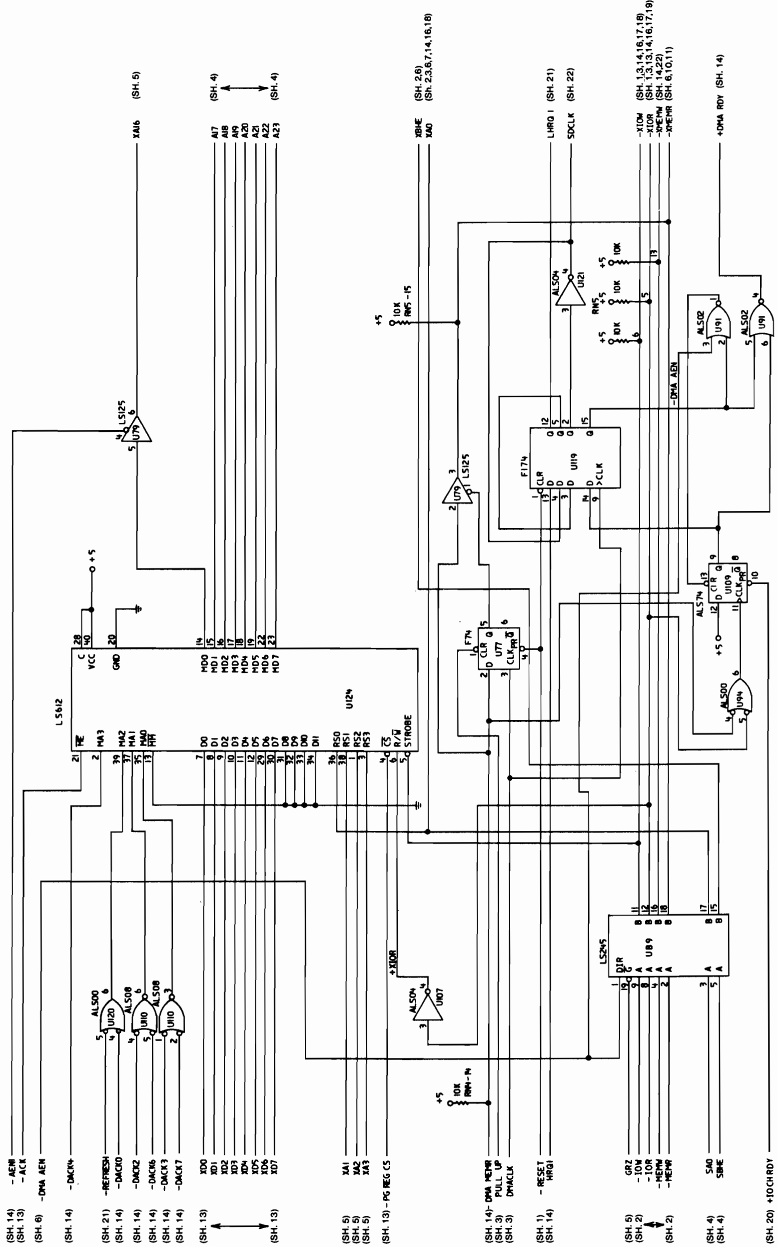

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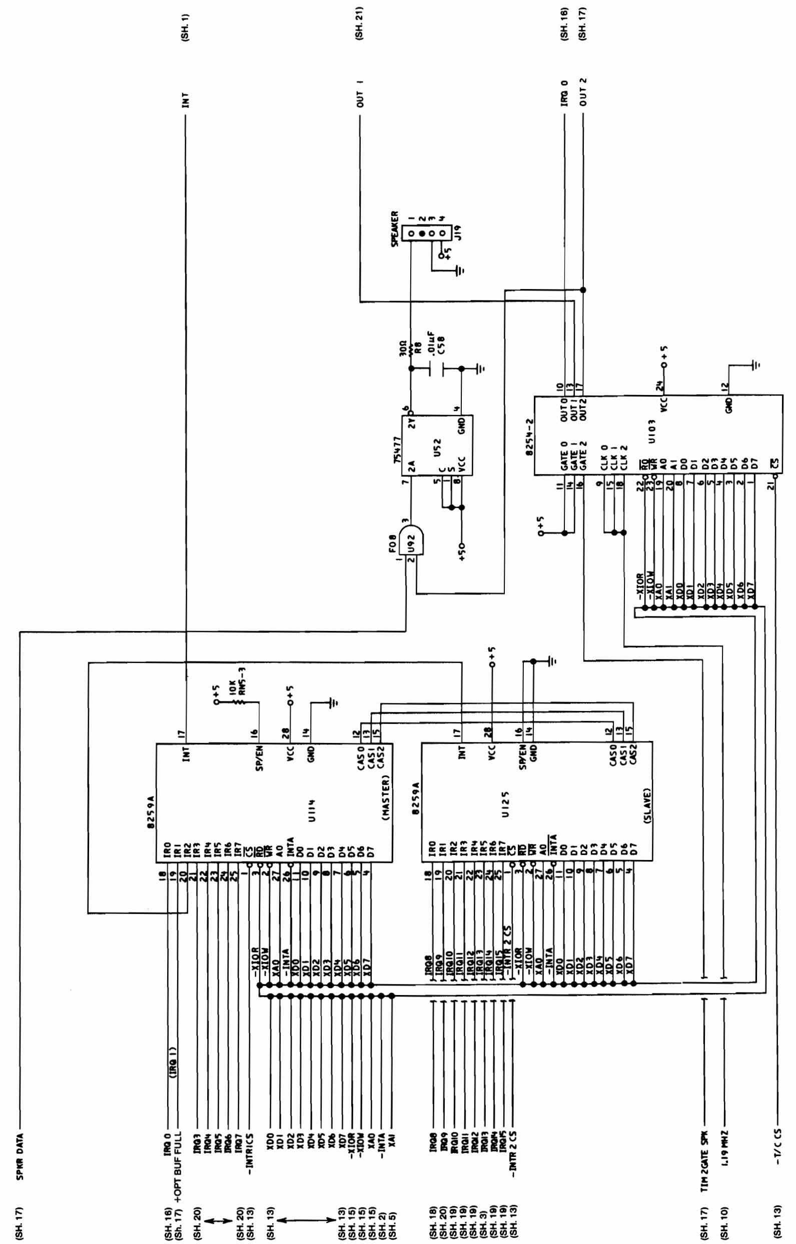

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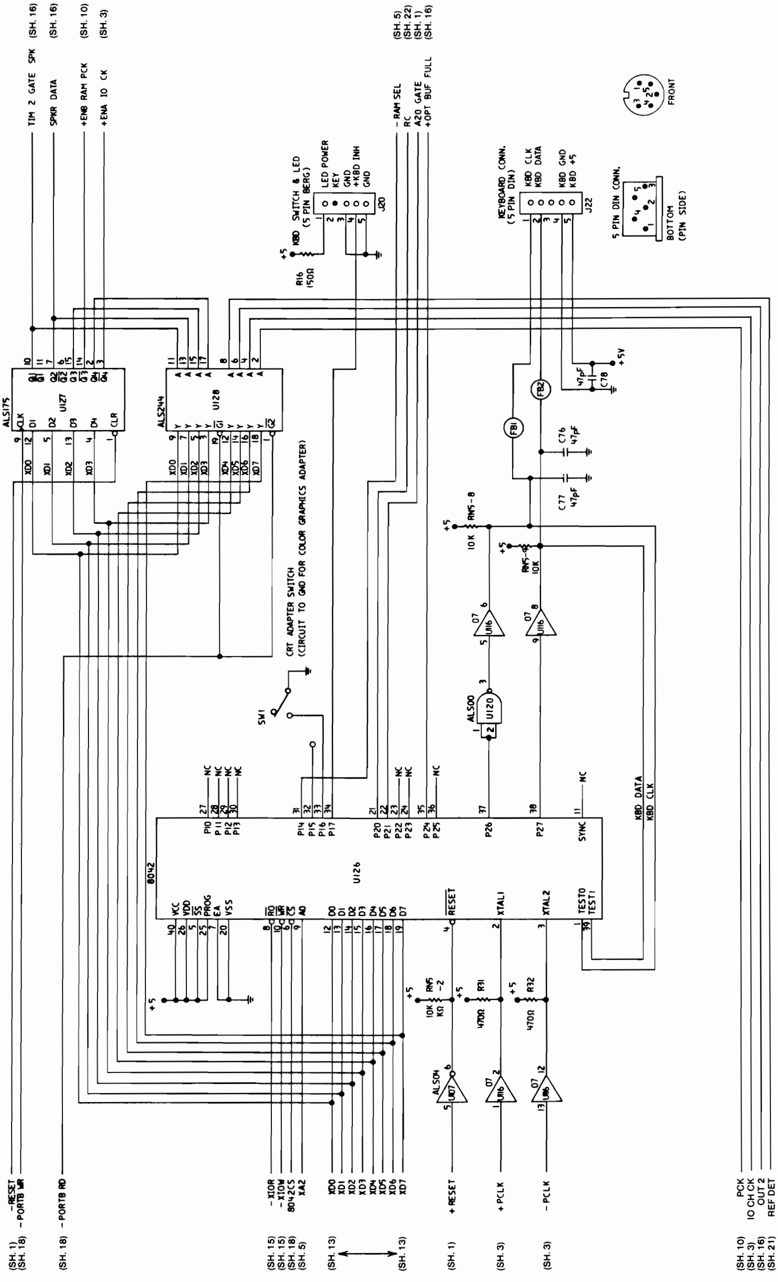

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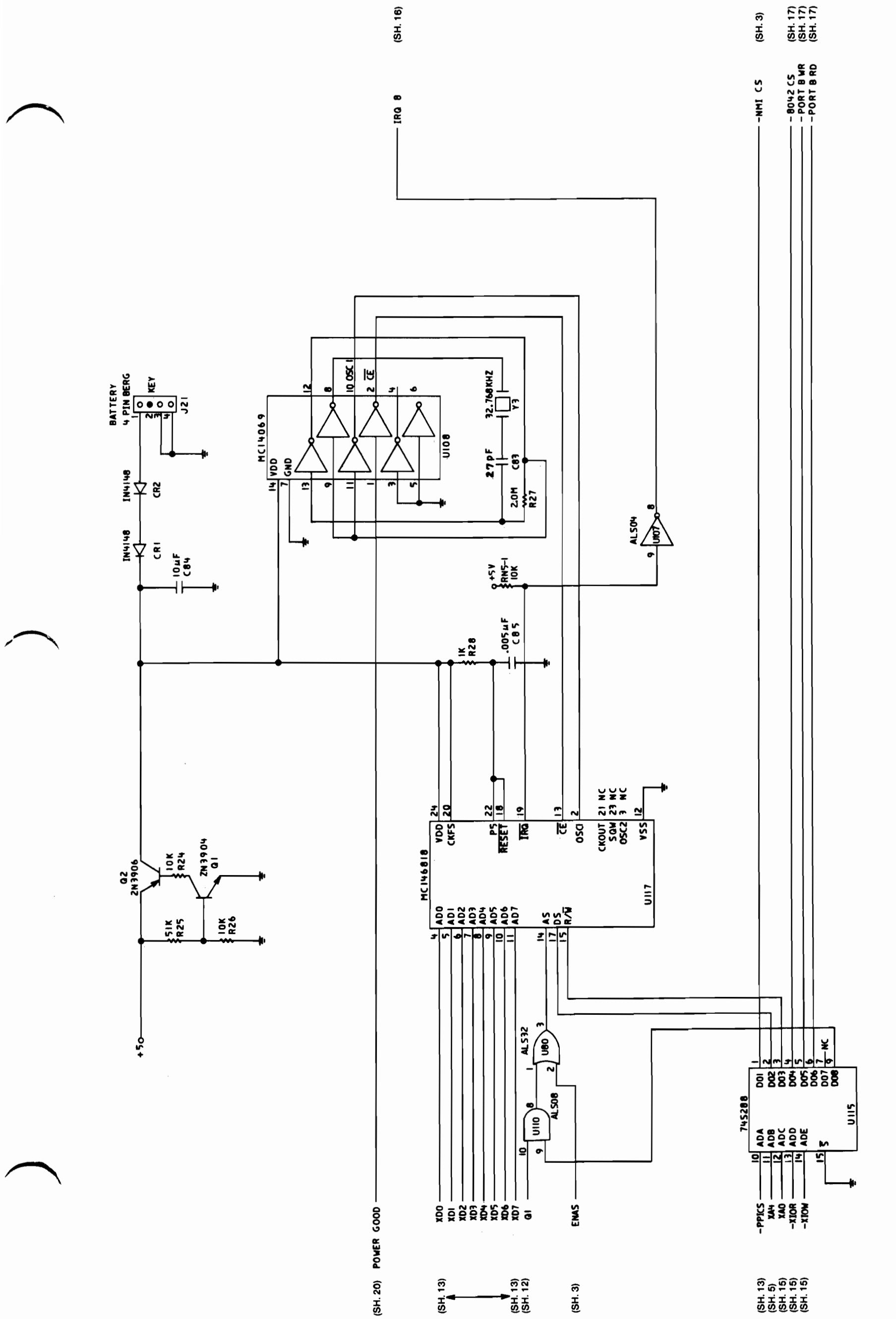

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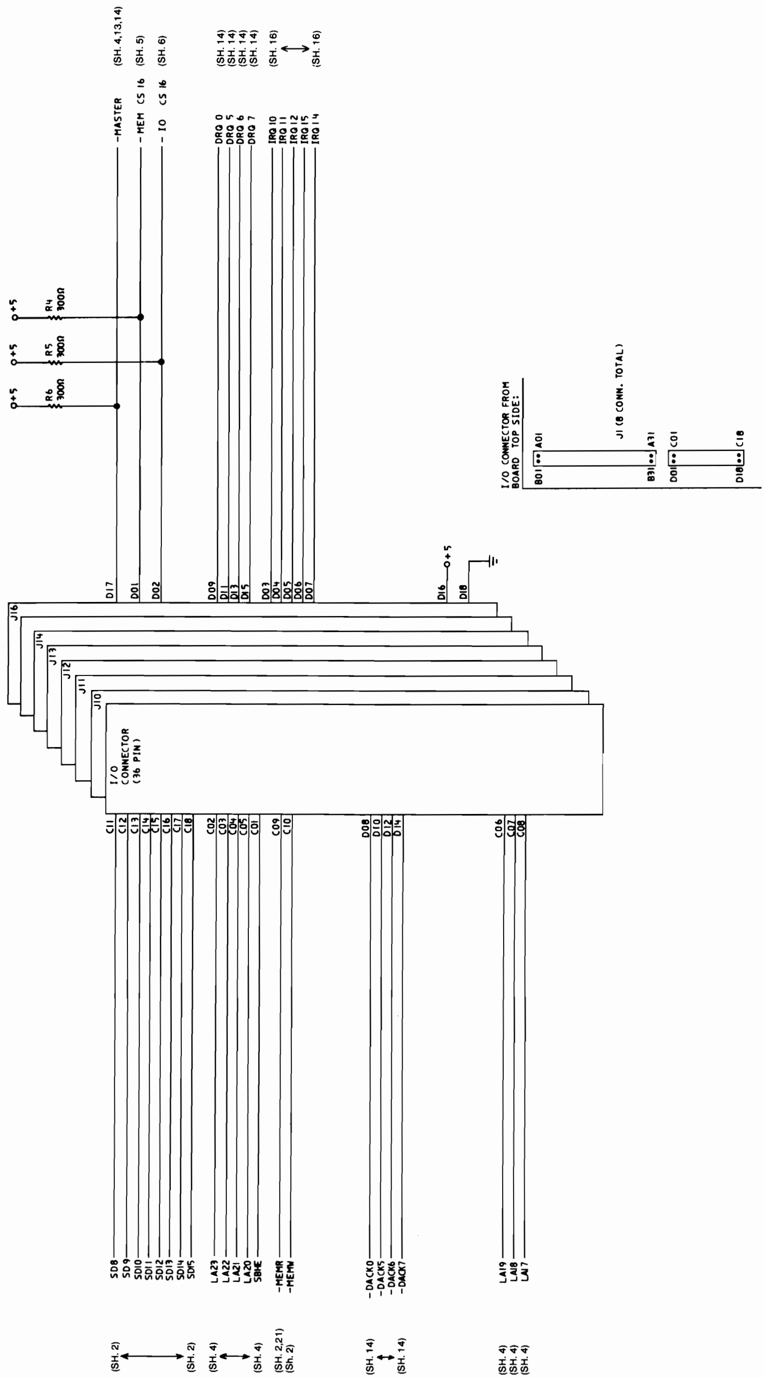

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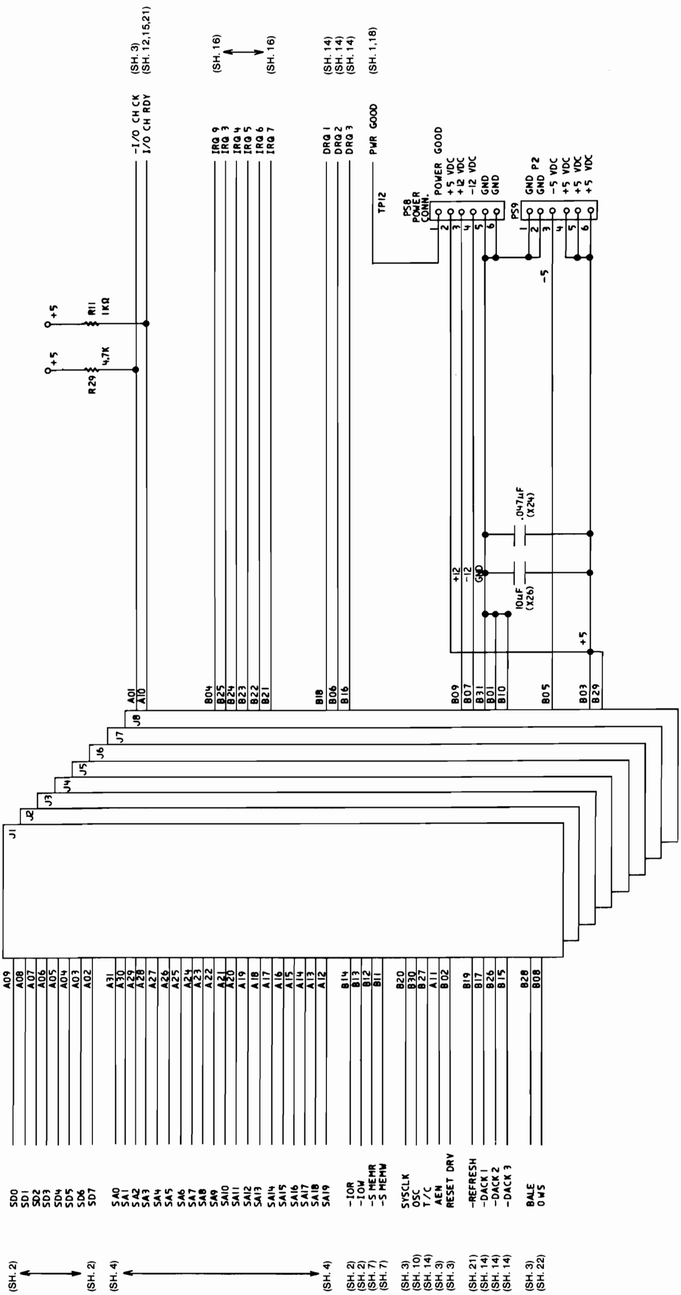

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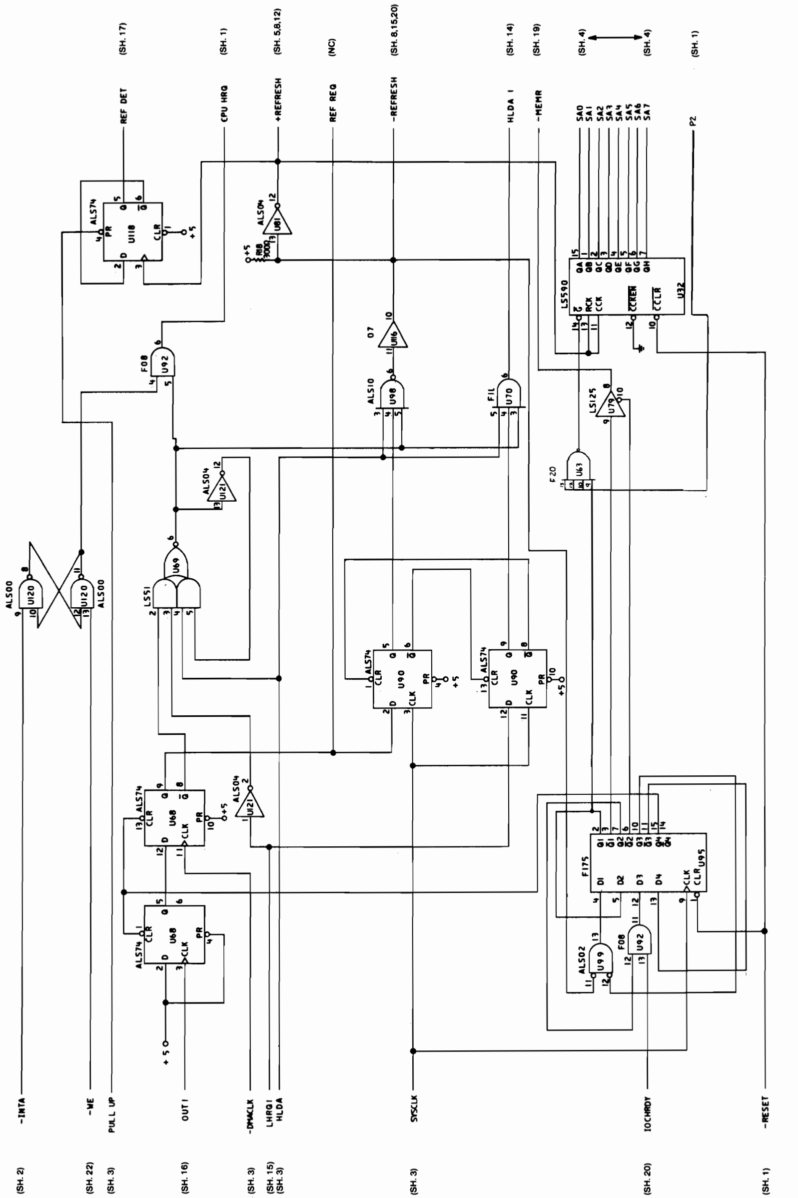

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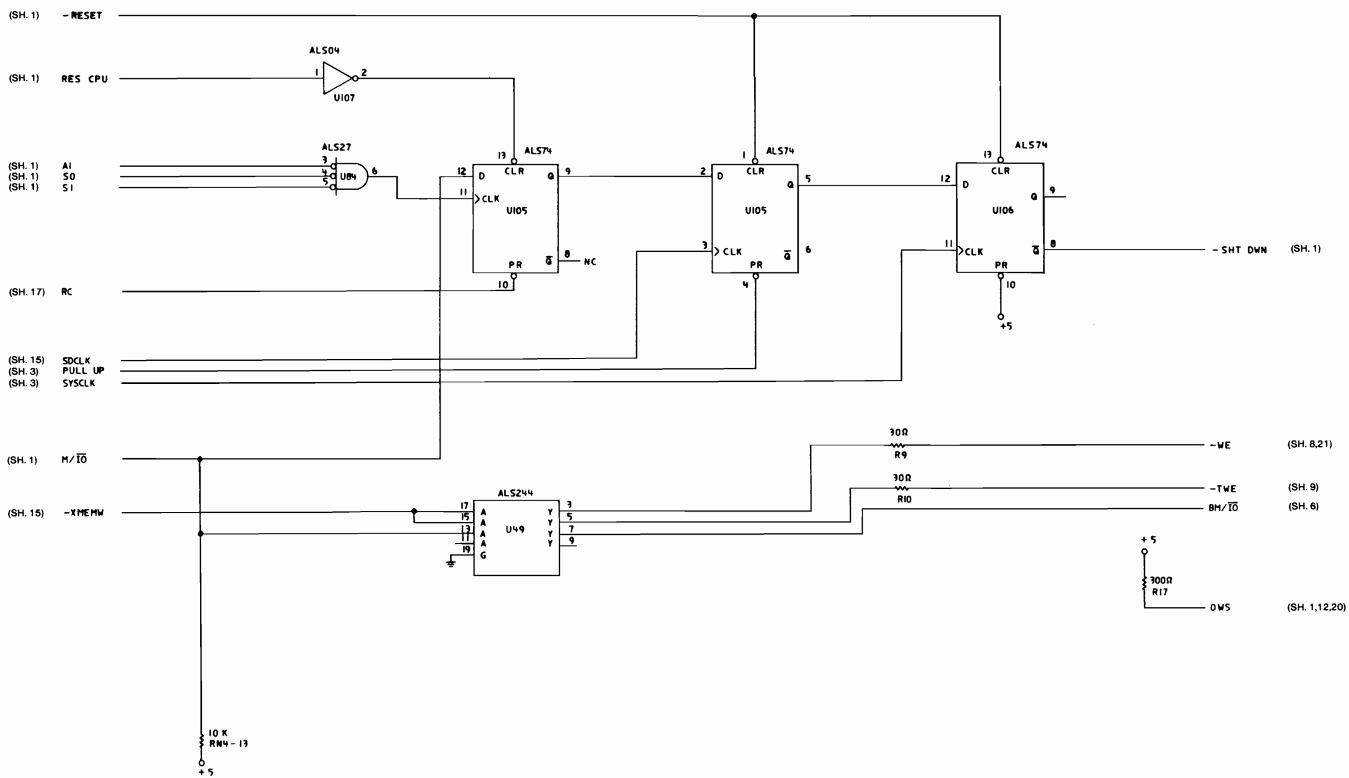

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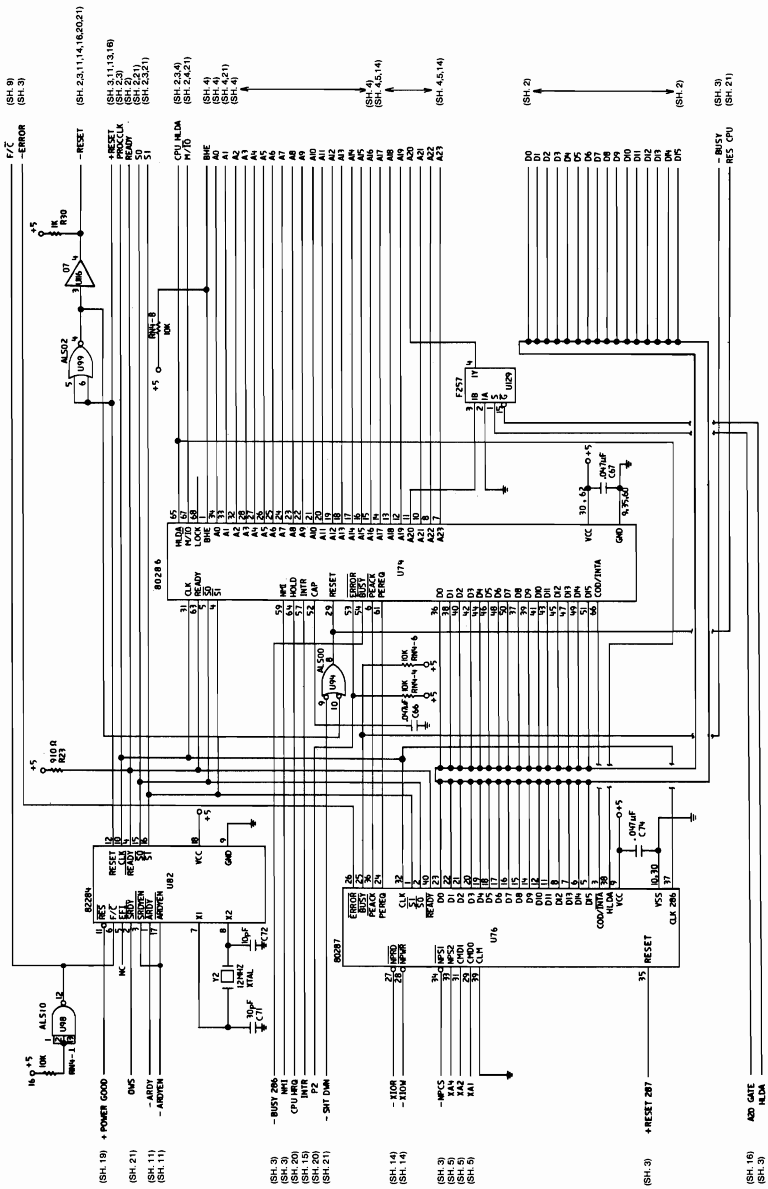

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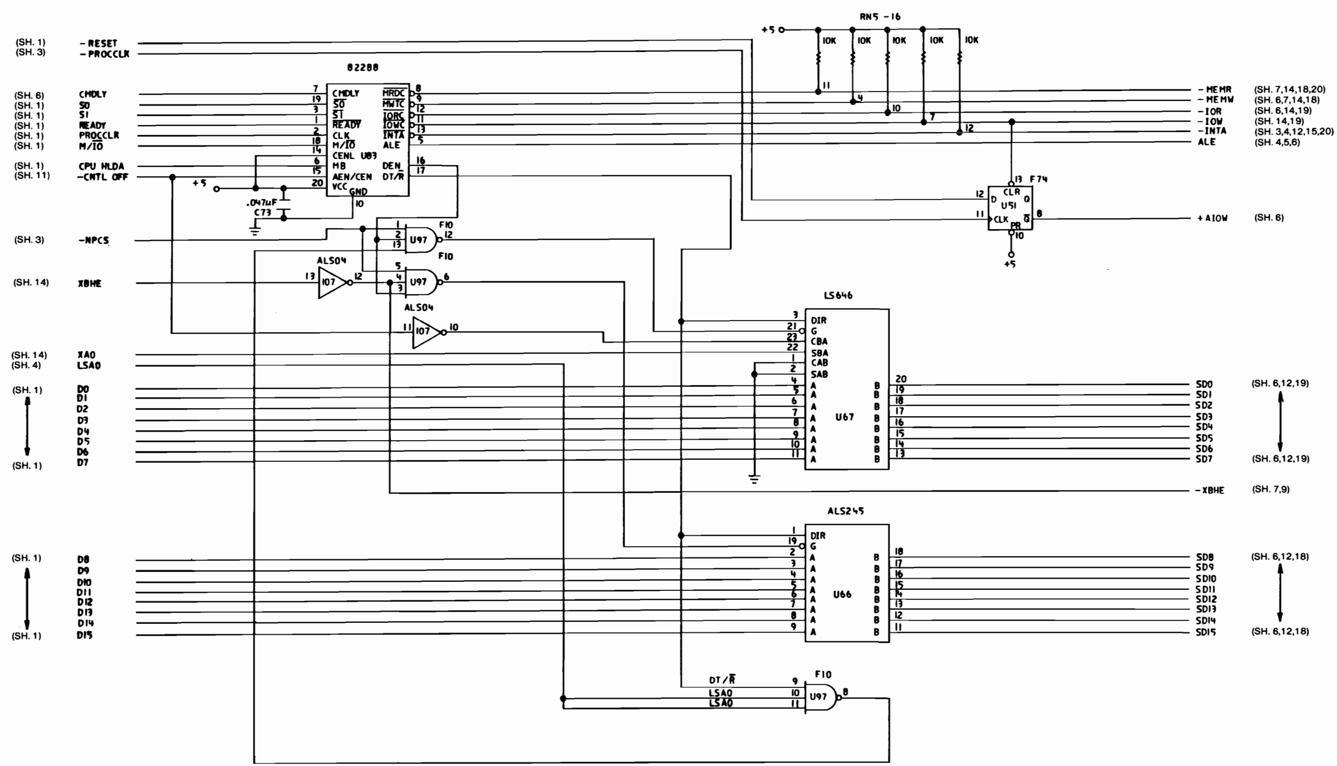

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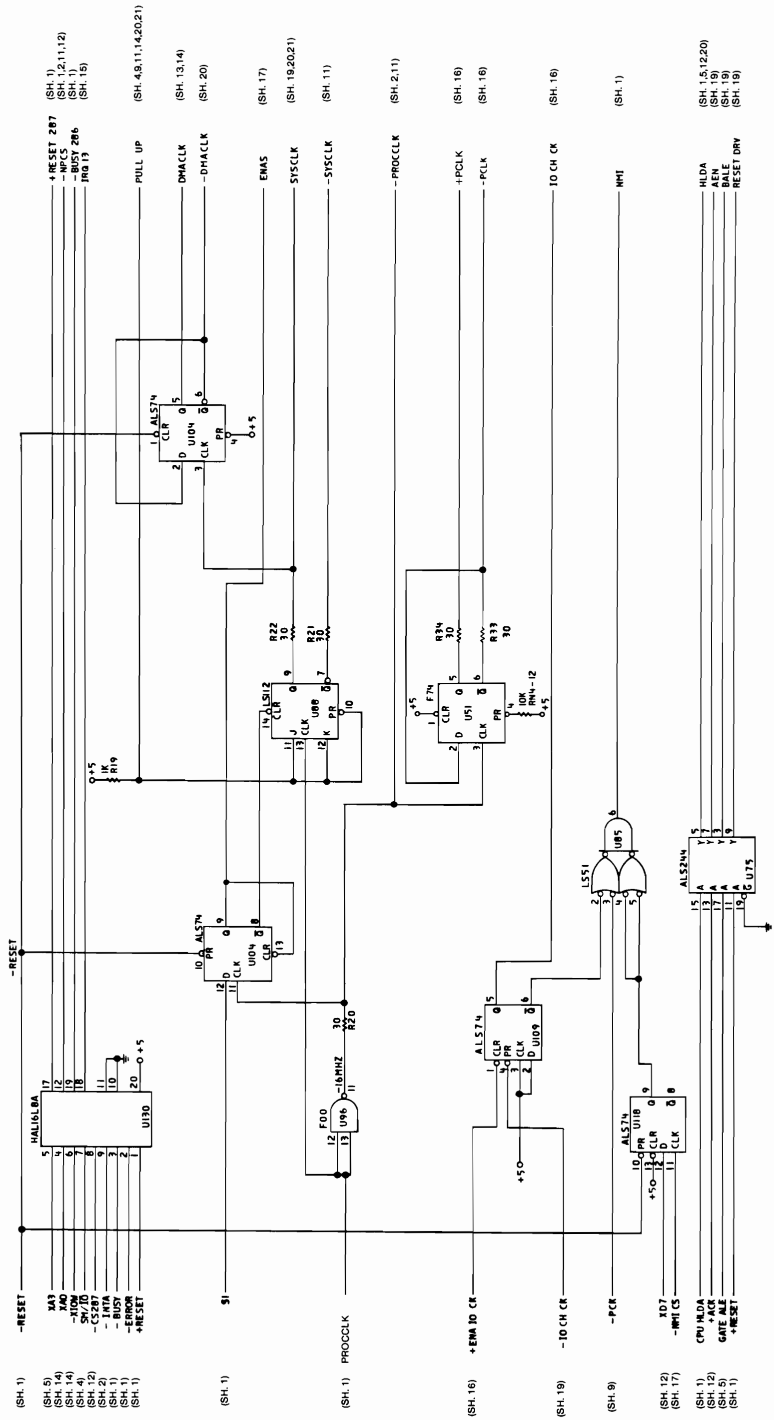

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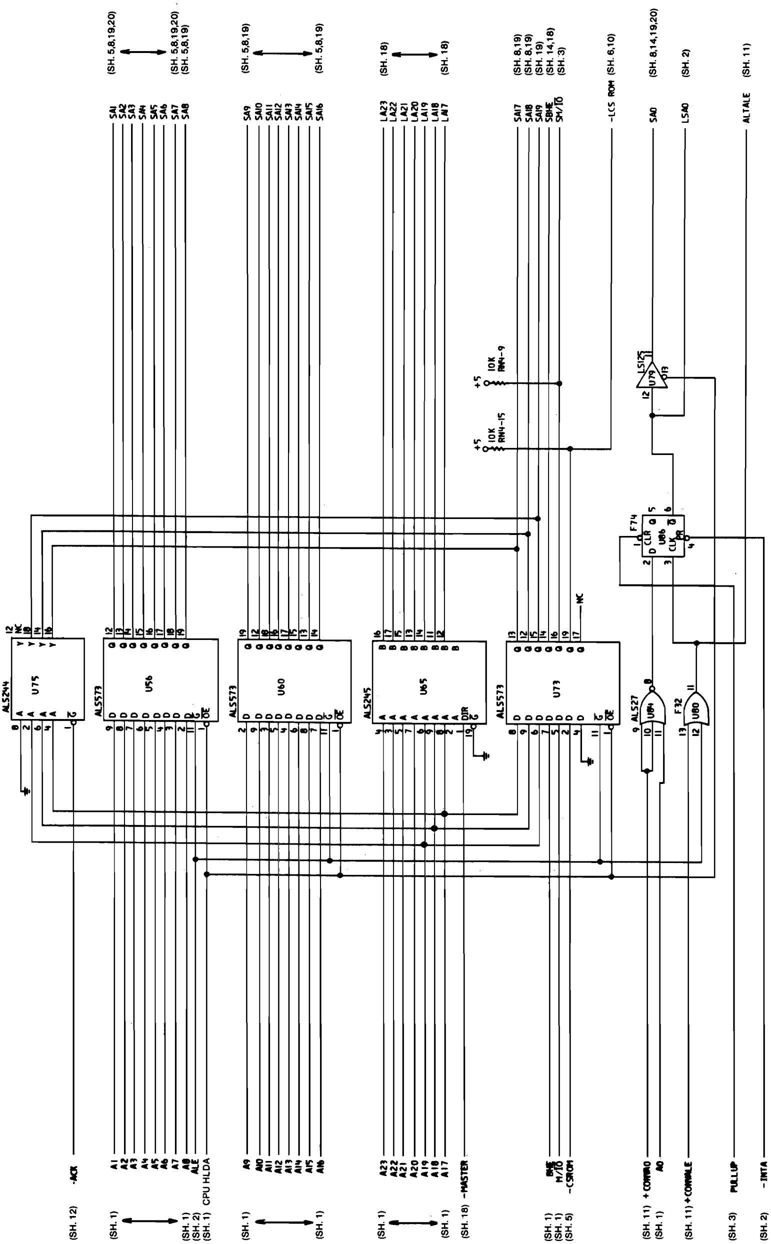

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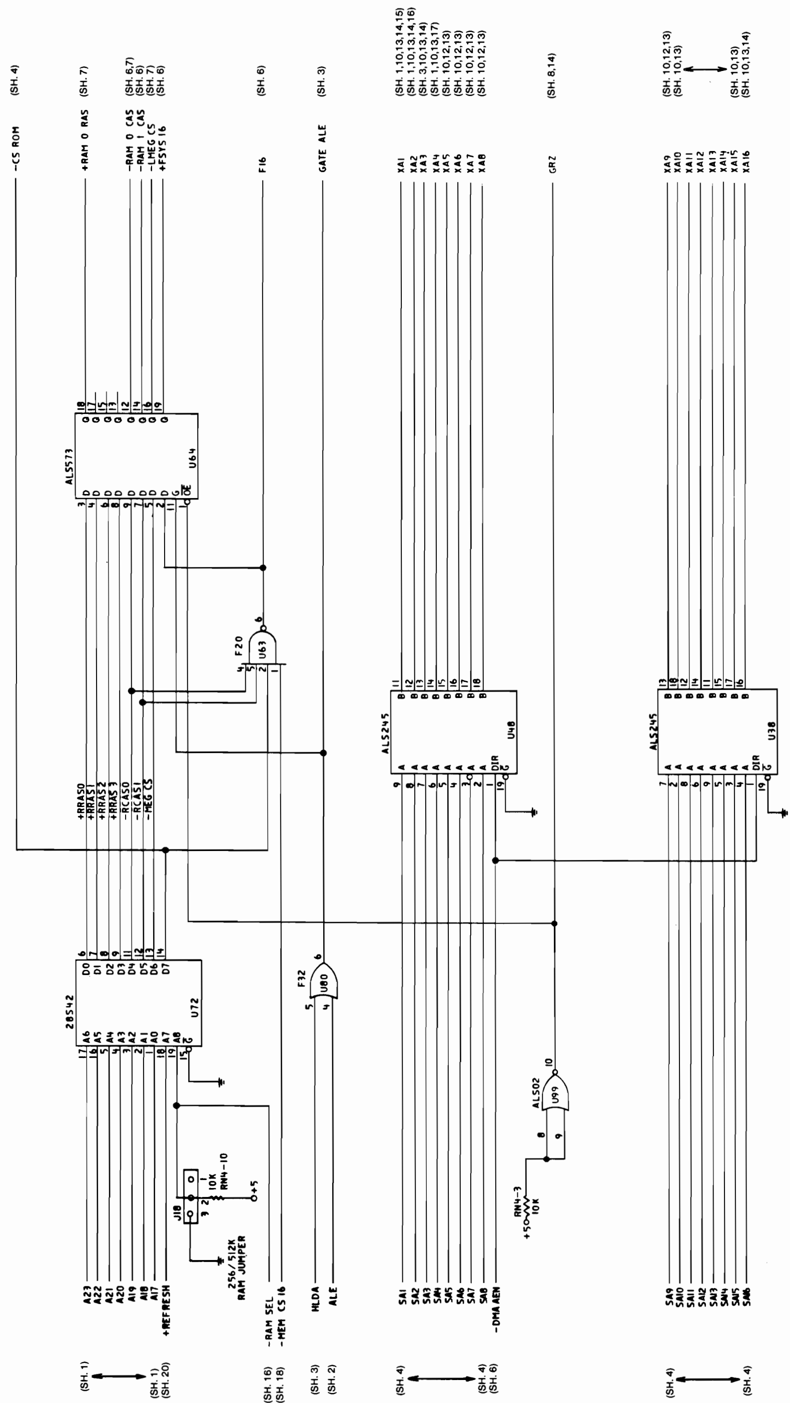

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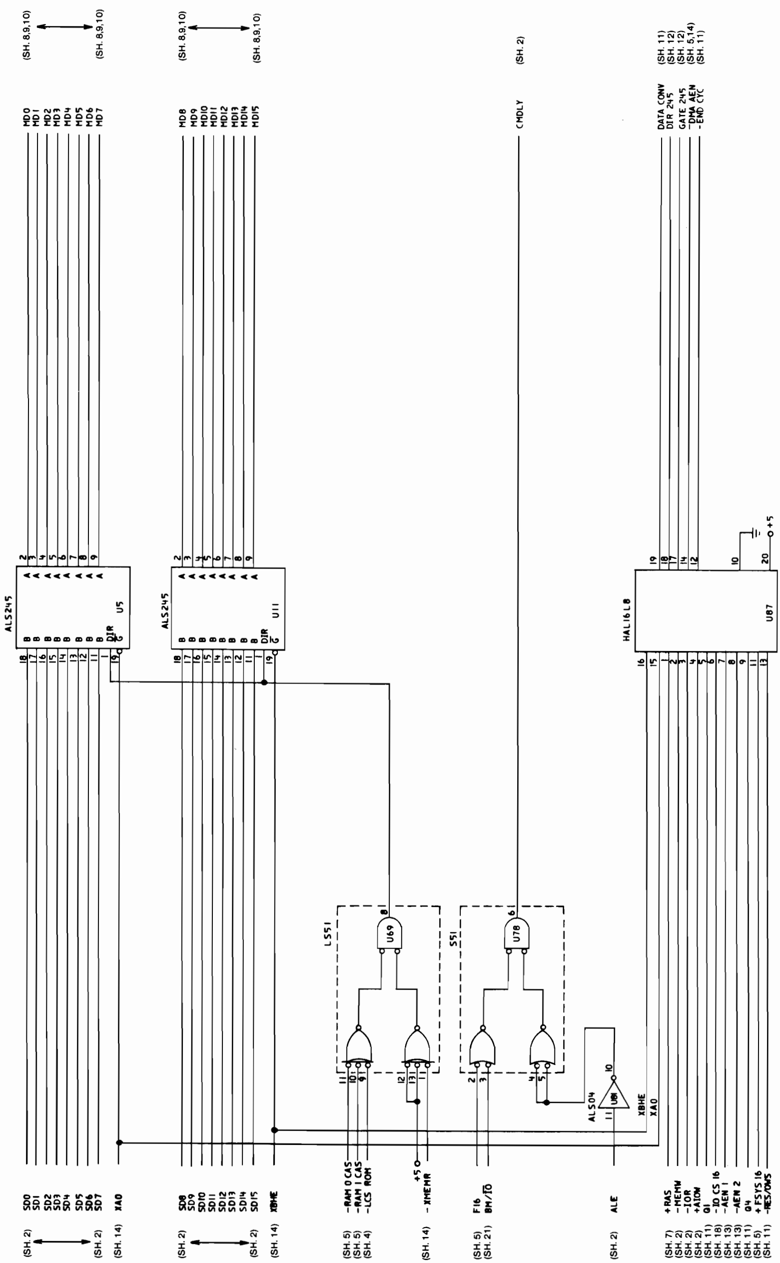

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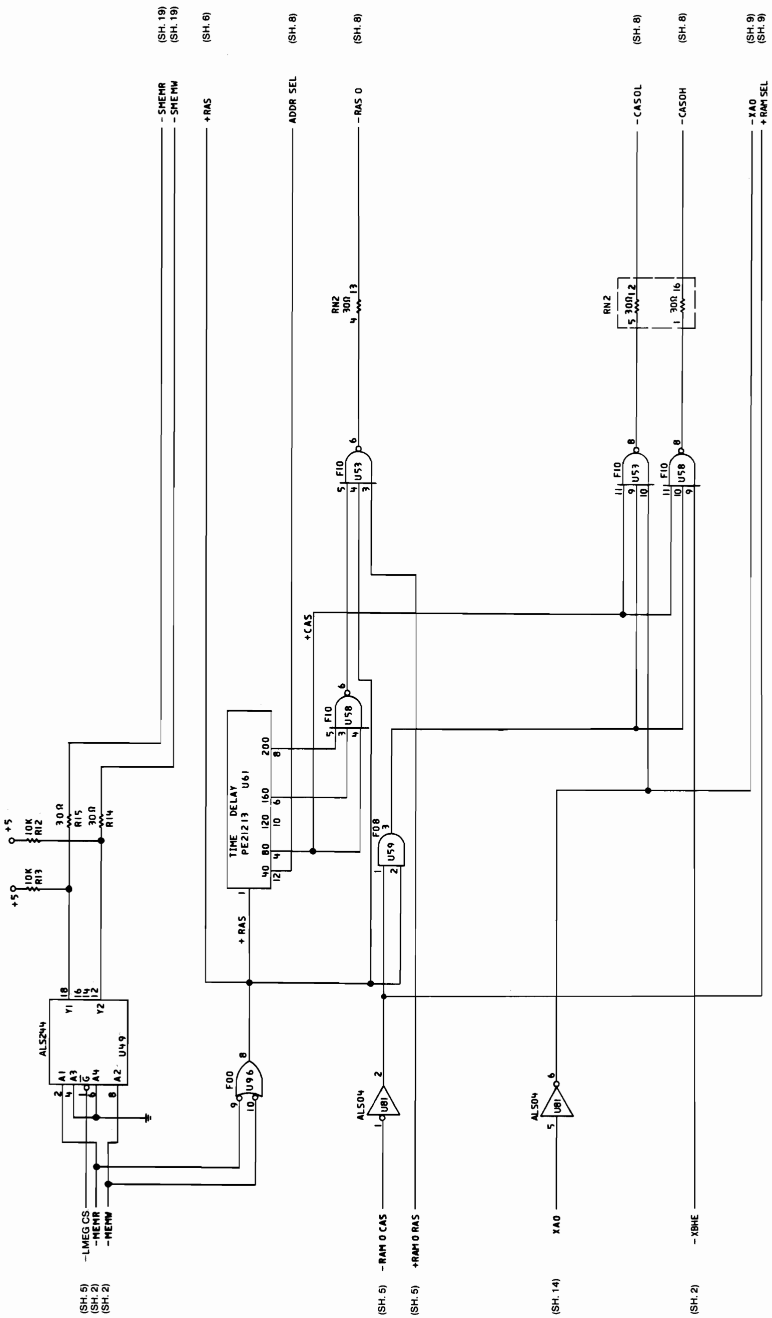

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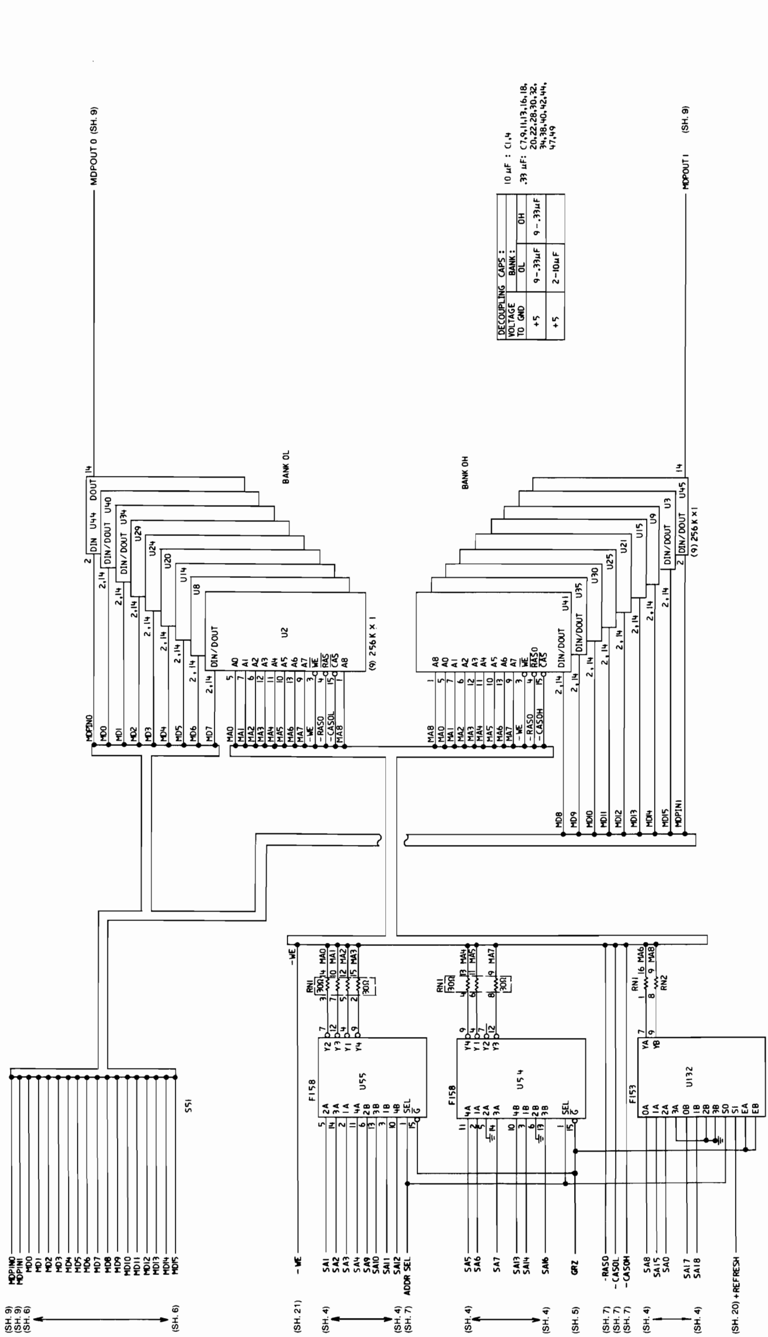

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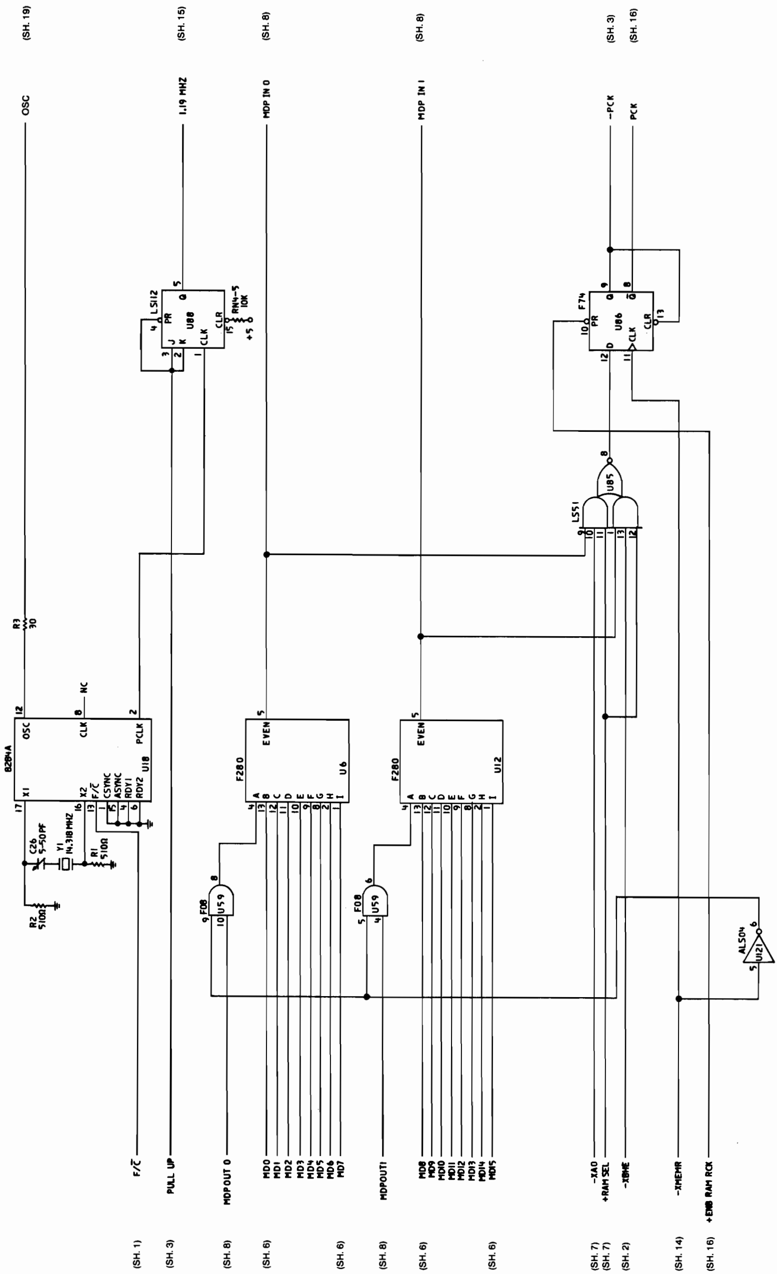

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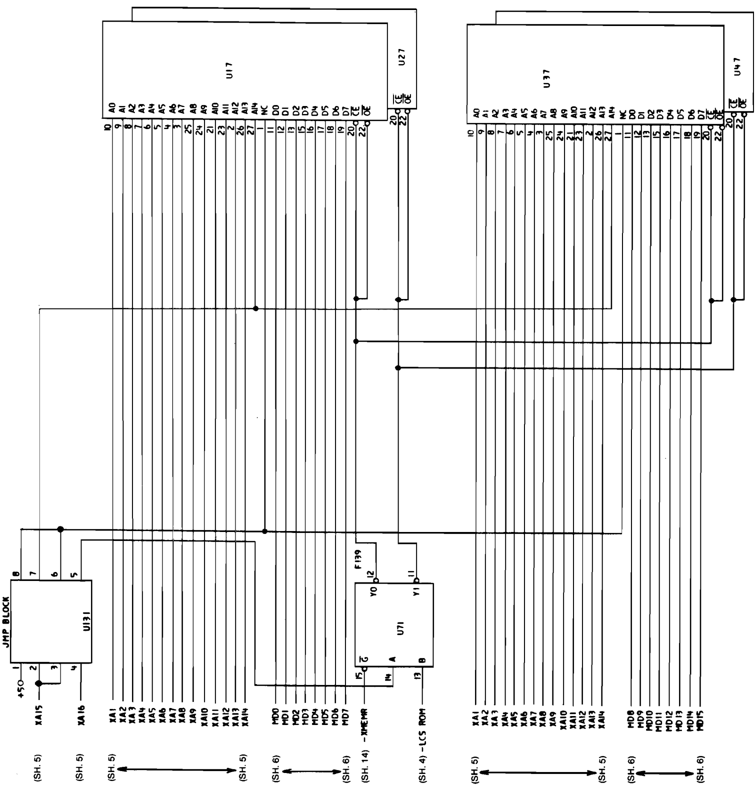

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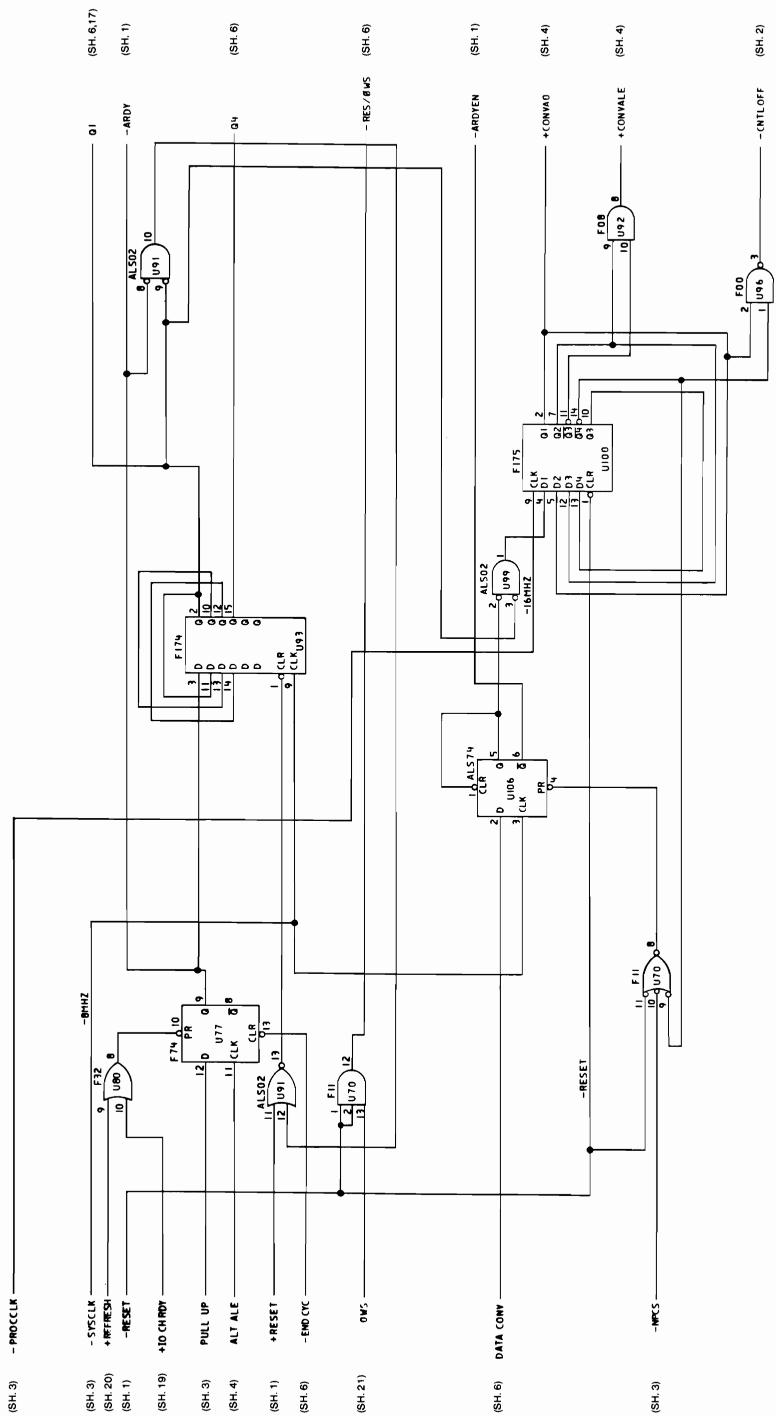

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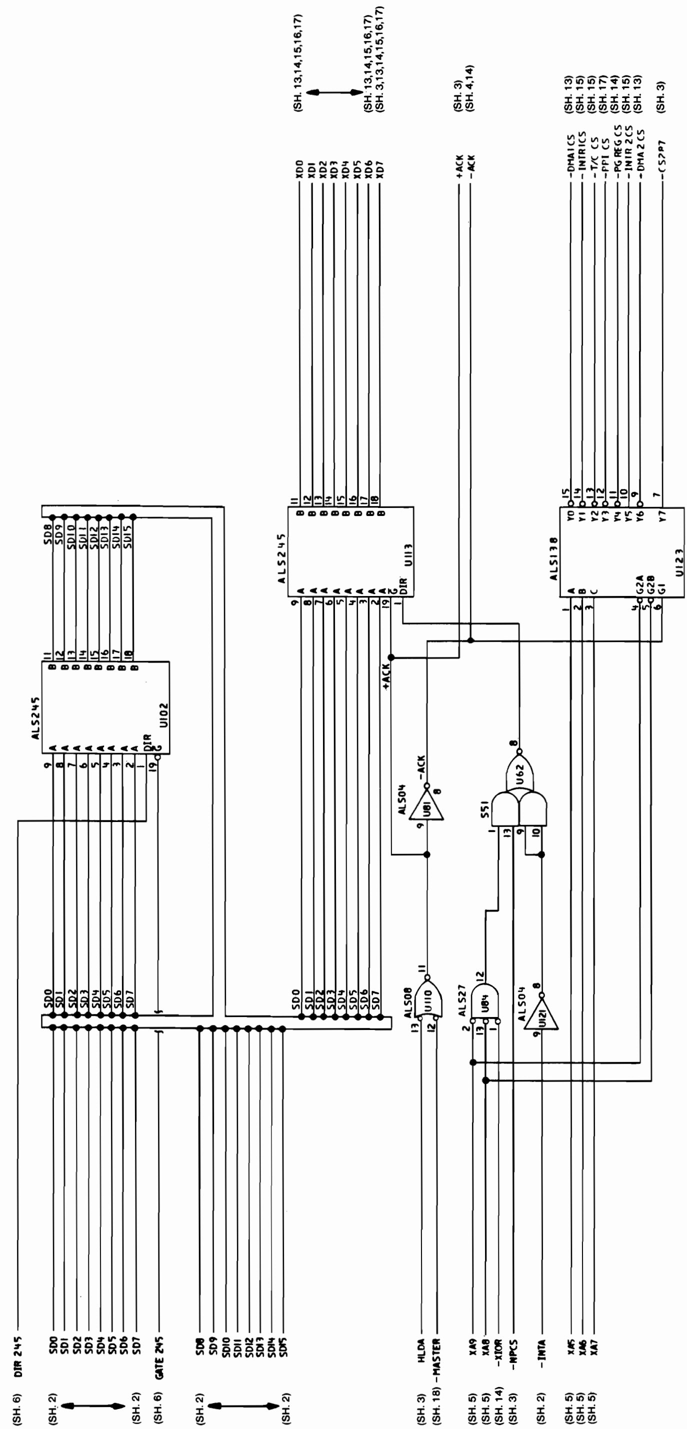

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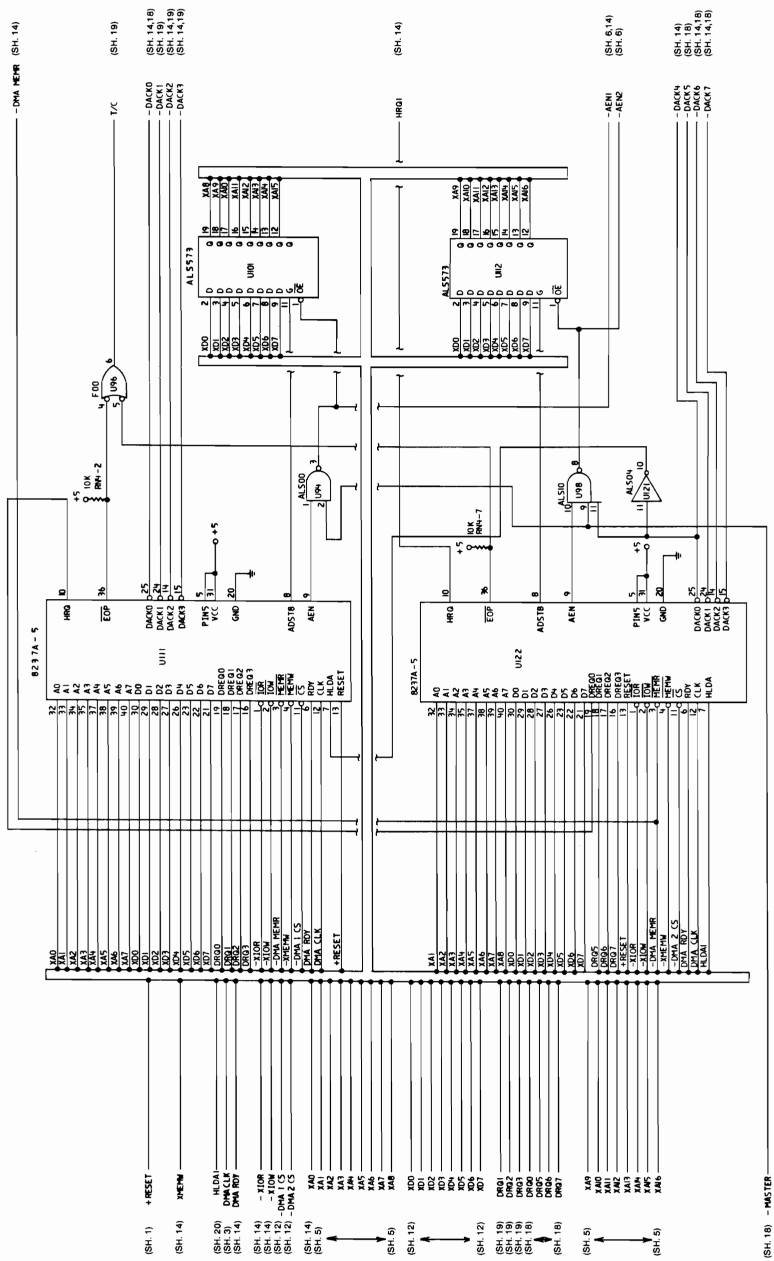

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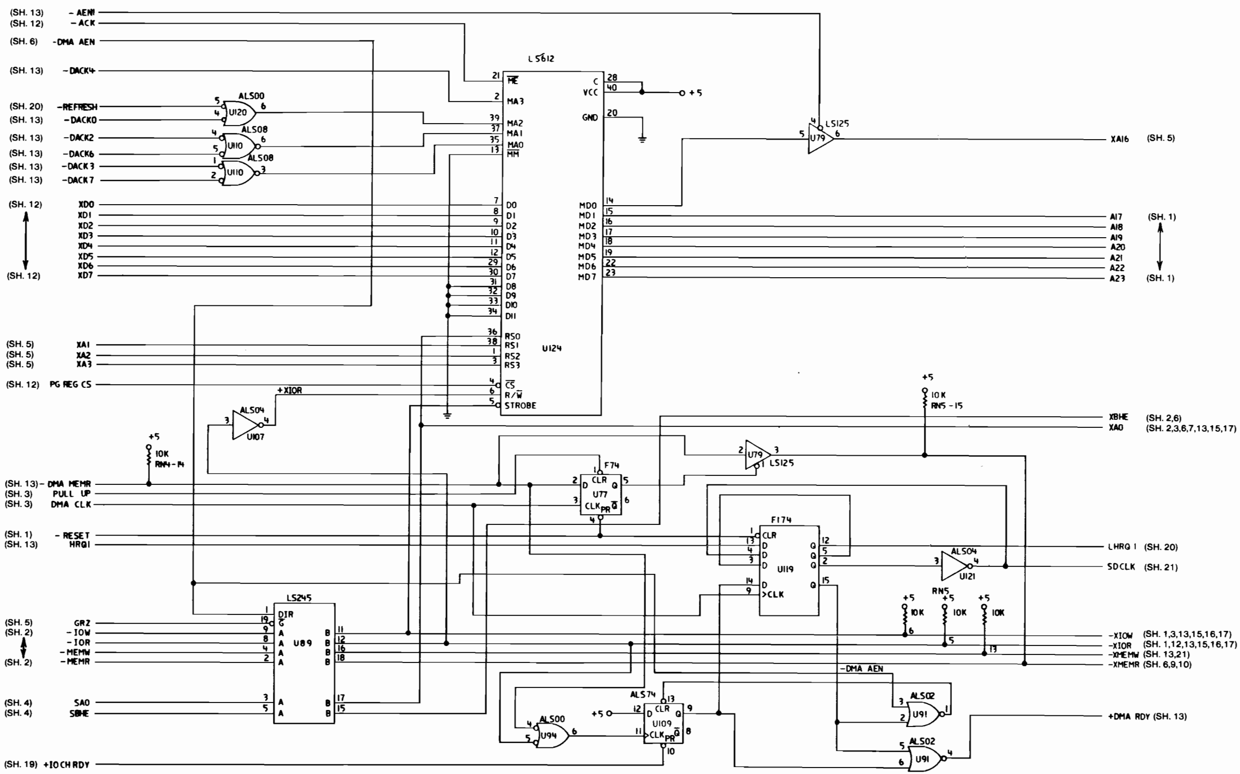

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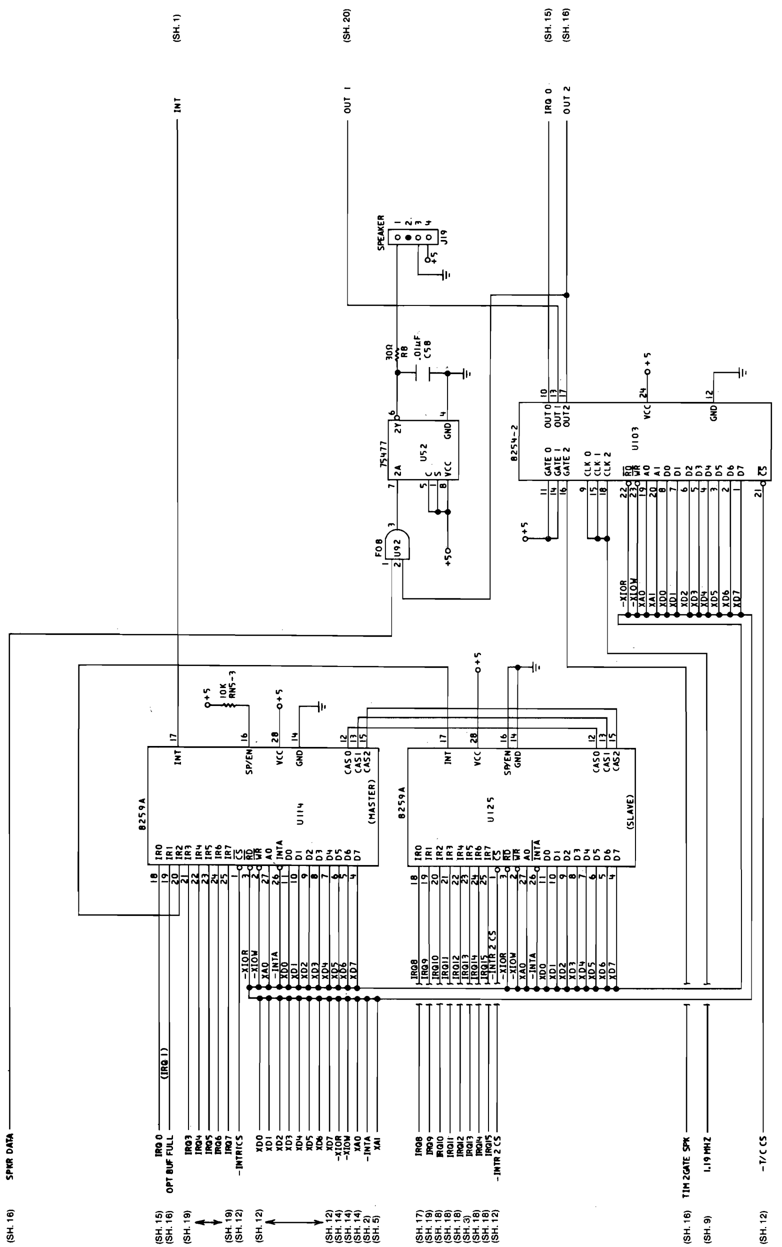

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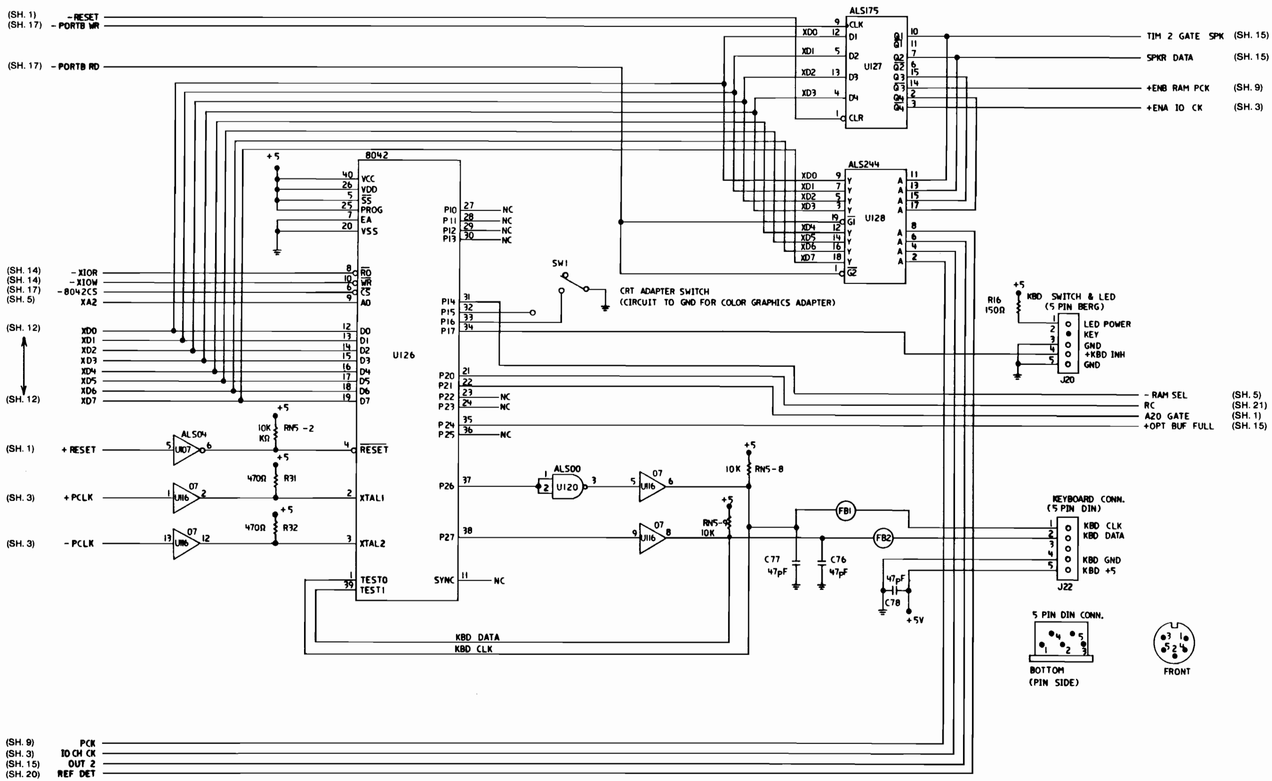

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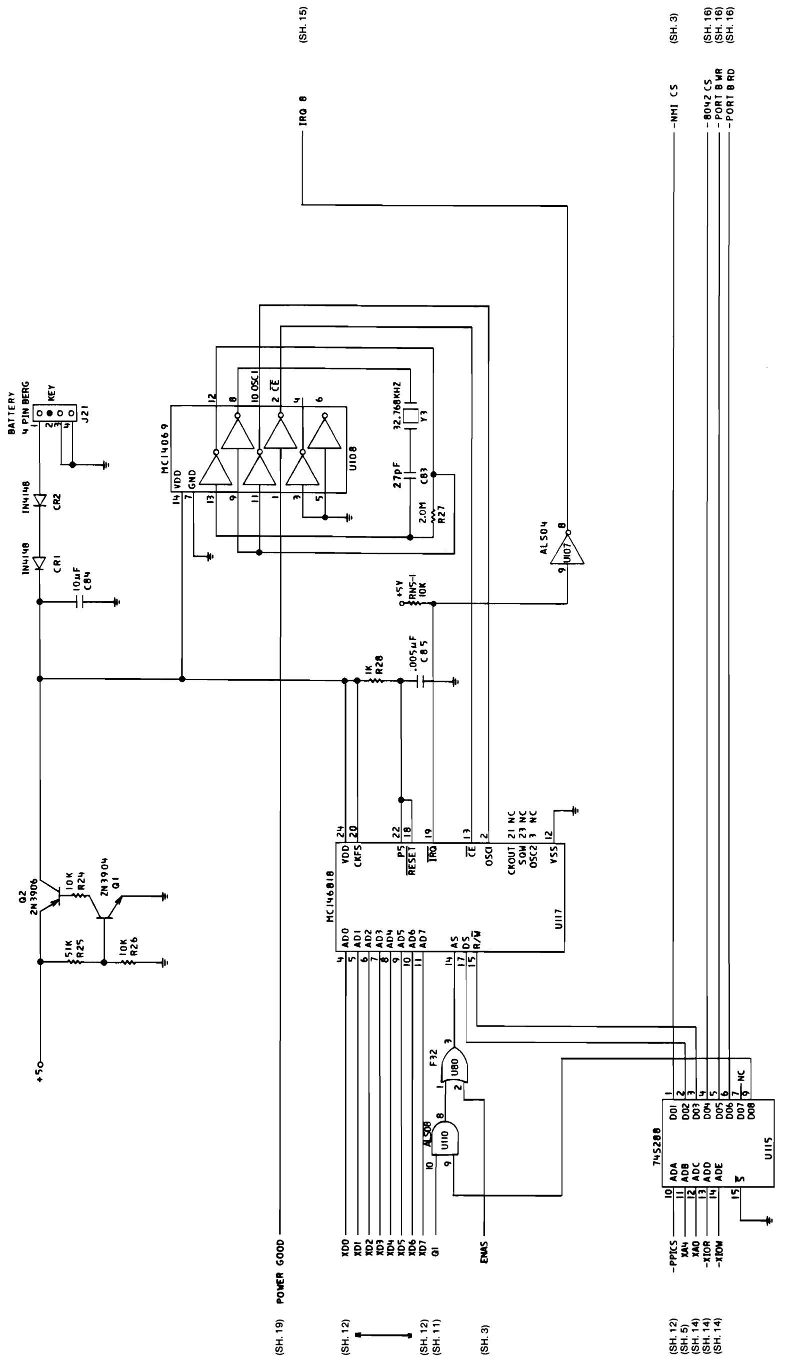

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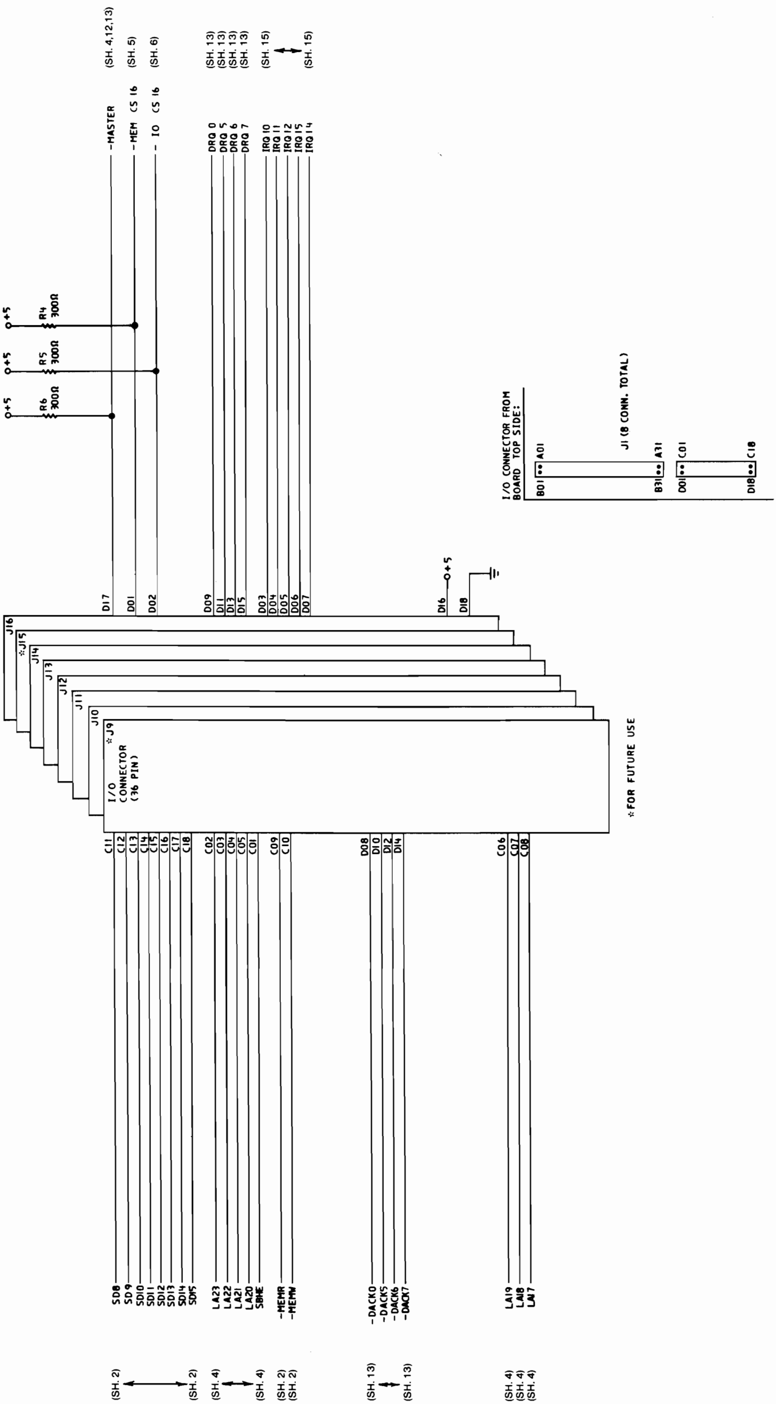

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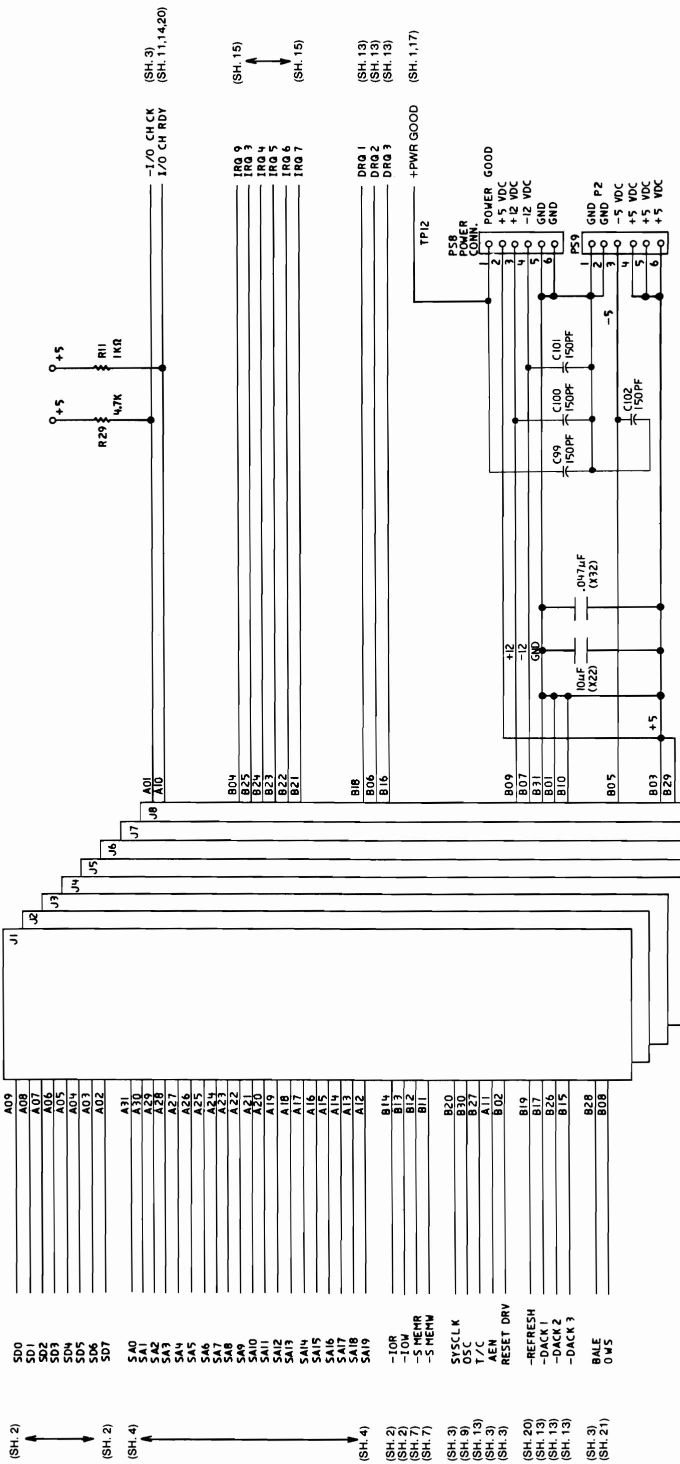

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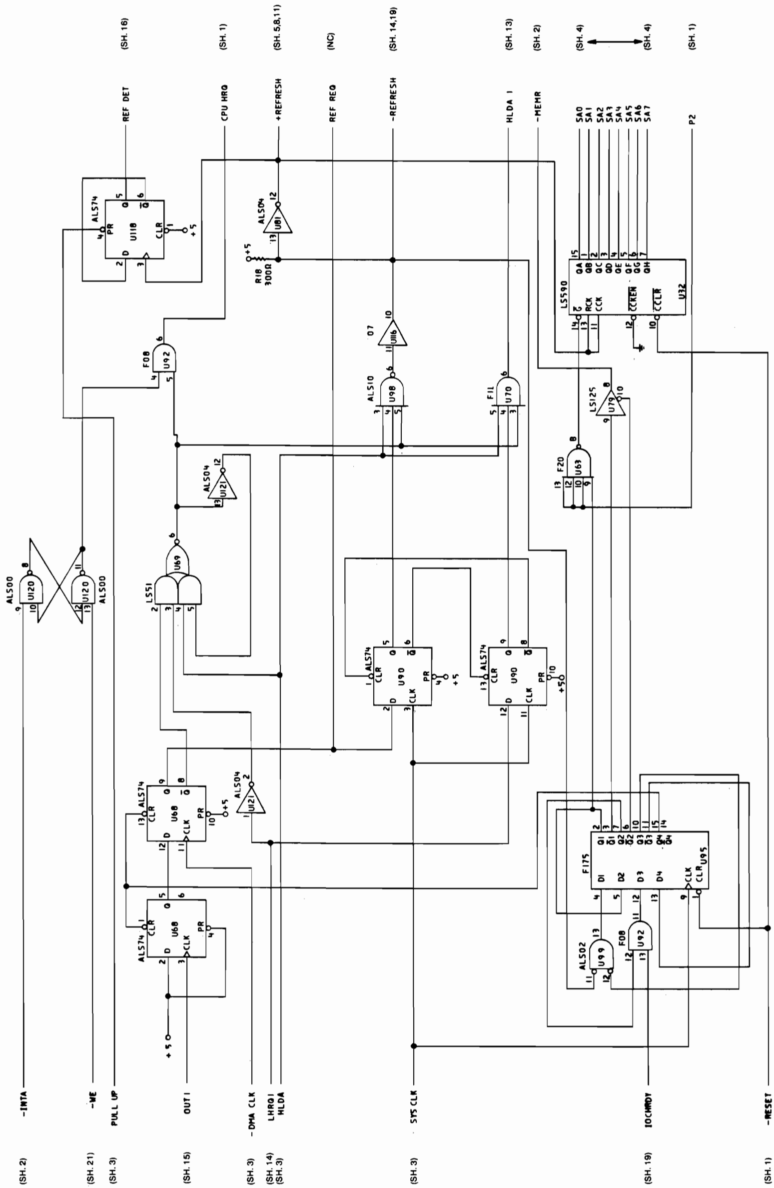

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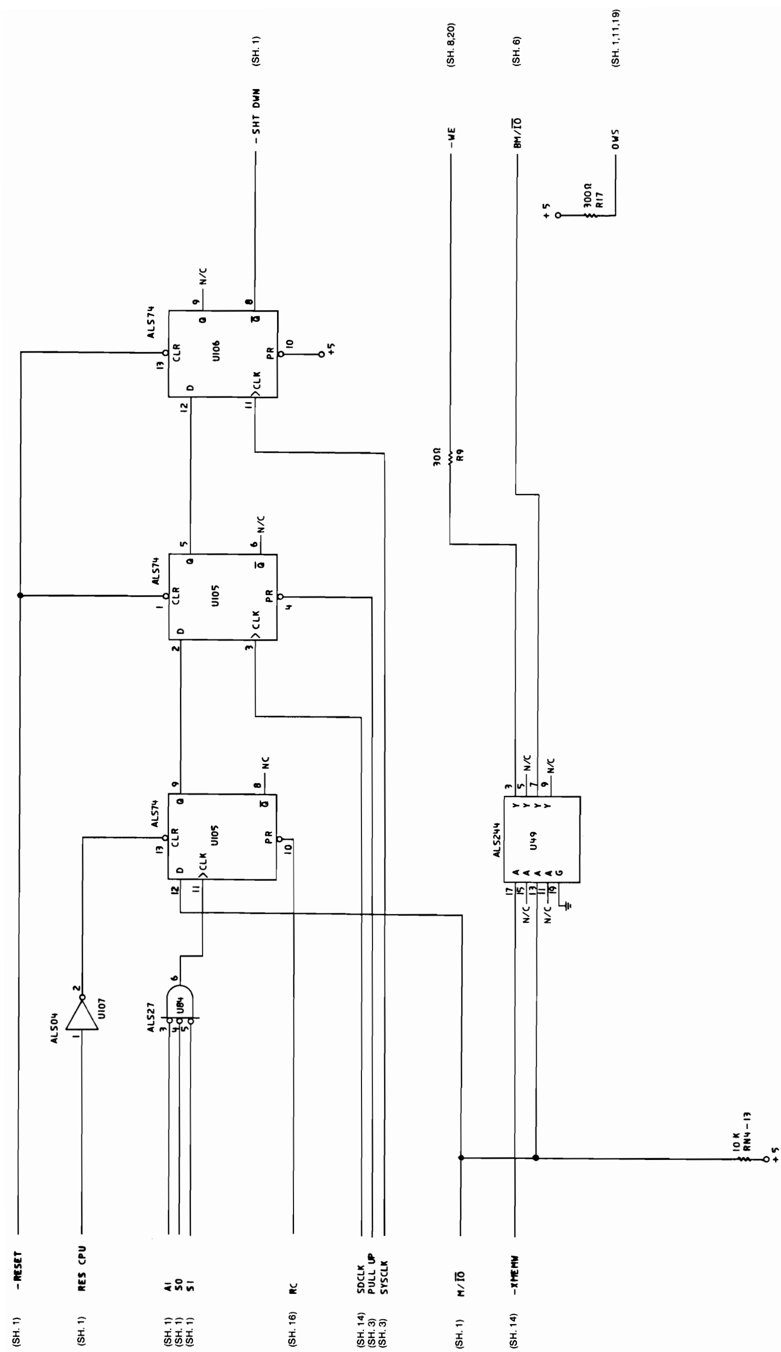

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SECTION 2. COPROCESSOR

Contents

SECTION 2

Notes:

Description

The IBM Personal Computer AT Math Coprocessor enables the IBM Personal Computer AT to perform high-speed arithmetic, logarithmic functions, and trigonometric operations.

The coprocessor works in parallel with the microprocessor. The parallel operation decreases operating time by allowing the coprocessor to do mathematical calculations while the microprocessor continues to do other functions.

The coprocessor works with seven numeric data types, which are divided into the following three classes:

- Binary integers (3 types)
- Decimal integers (1 type)
- Real numbers (3 types)

Programming Interface

The coprocessor offers extended data types, registers, and instructions to the microprocessor.

The coprocessor has eight 80–bit registers, which provides the equivalent capacity of forty 16–bit registers. This register space allows constants and temporary results to be held in registers during calculations, thus reducing memory access and improving speed as well as bus availability. The register space can be used as a stack or as a fixed register set. When used as a stack, only the top two stack elements are operated on.

The following figure shows representations of large and small numbers in each data type.

Data Type	Bits	Significant Digits (Decimal)	Approximate Range (Decimal)
Word Integer	16	4	$-32{,}768 \le x \le +32{,}767$
Short Integer	32	9	$-2\times10^{9} \le x \le +2\times10^{9}$
Long Integer	64	19	$-9\times10^{18} \le x \le +9\times10^{18}$
Packed Decimal	80	18	$-9..99 \le x \le +9..99$ (18 digits)
Short Real *	32	6-7	$8.43\times10^{-37} \le x \le 3.37\times10^{38}$
Long Real *	64	15-16	$4.19\times10^{-307} \le x \le 1.67\times10^{308}$
Temporary Real	80	19	$3.4\times10^{-4932} \le x \le 1.2\times10^{4932}$

Data Types

* The Short Real and Long Real data types correspond to the single and double precision data types.

Hardware Interface

The coprocessor uses the same clock generator as the microprocessor. It works at one-third the frequency of the system microprocessor (2.66 MHz). The coprocessor is wired so that it functions as an I/O device through I/O port addresses hex 00F8, 00FA, and 00FC. The microprocessor sends OP codes and operands through these I/O ports. The microprocessor also receives and stores results through the same I/O ports. The coprocessor's 'busy' signal informs the microprocessor that it is executing; the microprocessor's Wait instruction forces the microprocessor to wait until the coprocessor is finished executing.

The coprocessor detects six different exception conditions that can occur during instruction execution. If the appropriate exception mask within the coprocessor is not set, the coprocessor sets its error signal. This error signal generates a hardware interrupt (interrupt 13) and causes the 'busy' signal to the coprocessor to be held in the busy state. The 'busy' signal may be cleared by an 8-bit I/O Write command to address hex F0 with D0 through D7 equal to 0.

The power-on self-test code in the system ROM enables IRQ 13 and sets up its vector to point to a routine in ROM. The ROM routine clears the 'busy' signal's latch and then transfers control to the address pointed to by the NMI interrupt vector. This allows code written for any IBM Personal Computer to work on an IBM Personal Computer AT. The NMI interrupt handler should read the coprocessor's status to determine if the NMI was caused by the coprocessor. If the interrupt was not generated by the coprocessor, control should be passed to the original NMI interrupt handler.

The coprocessor has two operating modes similar to the two modes of the microprocessor. When reset by a power-on reset, system reset, or an I/O write operation to port hex 00F1, the coprocessor is in the real address mode. This mode is compatible with the 8087 Math Coprocessor used in other IBM Personal Computers. The coprocessor can be placed in the protected mode by executing the SETPM ESC instruction. It can be placed back in the real mode by an I/O write operation to port hex 00F1, with D7 through D0 equal to 0.

The coprocessor instruction extensions to the microprocessor can be found in Section 6 of this manual.

Detailed information for the internal functions of the Intel 80287 Coprocessor can be found in books listed in the bibliography.

Notes:

SECTION 3. POWER SUPPLY

Contents

Notes:

The system power supply is contained *inside* of the system unit and provides power for the system board, the adapters, the diskette drives, the fixed disk drives, the keyboard, and the IBM Monochrome Display.

Inputs

The power supply can operate at a frequency of either 60 ±3 Hz or 50 ±3 Hz and it can operate at 110 Vac, 5 A or 220/240 Vac, 2.5 A. The voltage is selected with the switch above the power-cord plug at the rear of the power supply. The following figure shows the input requirements.

Range	Voltage (Vac)	Current (Amperes)
115 Vac	Minimum 100 Maximum 125	Maximum 5
230 Vac	Minimum 200 Maximum 240	Maximum 3.0

Input Requirements

Note: The maximum in-rush current is 100 A.

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Outputs

The power supply provides +5, -5, +12, and -12 Vdc. The following figure shows the load current and regulation tolerance for these voltages. The power supply also supplies either 115 Vac or 230 Vac for the IBM Monochrome Display.

Nominal Output	Load Current (A) Min	Max	Regulation Tolerance
+5 Vdc	7.0	19.8	+5% to -4%
-5 Vdc	0.0	0.3	+10% to -8%
+12 Vdc	2.5	7.3	+5% to -4%
-12 Vdc	0.0	0.3	+10% to -9%

DC Load Requirements

DC Output Protection

If any output becomes overloaded, the power supply will switch off within 20 milliseconds. An overcurrent condition will not damage the power supply.

Output Voltage Sequencing

Under normal conditions, the output voltage levels track within 300 milliseconds of each other when power is applied to, or removed from the power supply, provided at least minimum loading is present.

No-Load Operation

No damage or hazardous conditions occur when primary power is applied with no load on any output level. In such cases, the power supply may switch off, and a power-on reset will be required. The power supply requires a minimum load for proper operation.

Power-Good Signal

The power supply provides a 'power-good' signal to indicate proper operation of the power supply.

When the supply is switched off for a minimum of one second and then switched on, the 'power-good' signal is generated, assuming there are no problems. This signal is a logical AND of the dc output-voltage sense signal and the ac input-voltage sense signal. The 'power-good' signal is also a TTL-compatible high level for normal operation, or a low level for fault conditions. The ac fail signal causes 'power-good' to go to a low level at least one millisecond before any output voltage falls below the regulation limits. The operating point used as a reference for measuring the one millisecond is normal operation at minimum line voltage and maximum load.

Load Resistor

If no fixed disk drive is connected to the power supply, the load resistor must be connected to P10. The load resistor is a 5 ohm, 50 watt resistor.

The dc output-voltage sense signal holds the 'power-good' signal at a low level when power is switched on until all output voltages have reached their minimum sense levels. The 'power-good' signal has a turn-on delay of at least 100 milliseconds but not longer than 500 milliseconds and can drive six standard TTL loads.

The following figure shows the minimum sense levels for the output voltages.

Level (Vdc)	Minimum (Vdc)
+5	+4.5
-5	-3.75
+12	+10.8
-12	-10.4

Sense Level

Connectors

The following figure shows the pin assignments for the power-supply output connectors.

Load Point	Voltage (Vdc)	Max. Current (A)
PS8-1	Power Good	See Note
PS8-2	+5	3.8
PS8-3	+12	0.7
PS8-4	-12	0.3
PS8-5	Ground	0.0
PS8-6	Ground	0.0
PS9-1	Ground	0.0
PS9-2	Ground	0.0
PS9-3	-5	0.3
PS9-4	+5	3.8
PS9-5	+5	3.8
PS9-6	+5	3.8
P10-1	+12	2.8
P10-2	Ground	0.0
P10-3	Ground	0.0
P10-4	+5	1.8
P11-1	+12	2.8
P11-2	Ground	0.0
P11-3	Ground	0.0
P11-4	+5	1.8
P12-1	+12	1.0
P12-2	Ground	0.0
P12-3	Ground	0.0
P12-4	+5	0.6

DC Load Distribution

Note: For more details, see "Power-Good Signal".

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Notes:

SECTION 4. KEYBOARD

Contents

SECTION 4

Description

The keyboard is a low-profile, 84-key, detachable unit. A bidirectional serial interface in the keyboard is used to carry signals between the keyboard and system unit.

Cabling

The keyboard cable connects to the system board through a 5-pin DIN connector. The following figure lists the connector pins and their signals.

DIN Connector Pins	Signal Name
1	+KBD CLK
2	+KBD DATA
3	Reserved
4	Ground
5	+5.0 Vdc

Sequencing Key Code Scanning

The keyboard is able to detect all keys that are pressed, and their scan codes will be sent to the interface in correct sequence, regardless of the number of keys held down. Keystrokes entered while the interface is inhibited (when the key lock is on) will be lost. Keystrokes are stored only when the keyboard is not serviced by the system.

Keyboard Buffer

The keyboard has a 16-character first-in-first-out (FIFO) buffer where data is stored until the interface is ready to receive it.

A buffer-overrun condition will occur if more than sixteen codes are placed in the buffer before the first keyed data is sent. The seventeenth code will be replaced with the overrun code, hex 00. (The 17th position is reserved for overrun codes). If more keys are pressed before the system allows a keyboard output, the data will be lost. When the keyboard is allowed to send data, the

SECTION 4

characters in the buffer will be sent as in normal operation, and new data entered will be detected and sent.

Keys

All keys are classified as *make/break*, which means when a key is pressed, the keyboard sends a make code for that key to the keyboard controller. When the key is released, its break code is sent (the break code for a key is its make code preceded by hex F0).

All keys are *typematic*. When a key is pressed and held down, the keyboard continues to send the make code for that key until the key is released. The rate at which the make code is sent is known as the *typematic rate* (The typematic rate is described under "Set Typematic Rate/Delay"). When two or more keys are held down, only the last key pressed repeats at the typematic rate. Typematic operation stops when the last key pressed is released, even if other keys are still held down. When a key is pressed and held down while the interface is inhibited, only the first make code is stored in the buffer. This prevents buffer overflow as a result of typematic action.

Power-On Routine

Power-On Reset

The keyboard logic generates a POR when power is applied to the keyboard. The POR lasts a minimum of 300 milliseconds and a maximum of 9 seconds.

> **Note:** The keyboard may issue a false return during the first 200 milliseconds after the +5 Vdc is established at the 90% level. Therefore, the keyboard interface is disabled for this period.

Basic Assurance Test

Immediately following the POR, the keyboard executes a basic assurance test (BAT). This test consists of a checksum of all read-only memory (ROM), and a stuck-bit and addressing test of all random-access memory (RAM) in the keyboard's microprocessor. The mode indicators—three light emitting diodes (LEDs) on the upper right-hand corner of the keyboard—are turned on then off, and must be observed to ensure they are operational.

Execution of the BAT will take from 600 to 900 milliseconds. (This is in addition to the time required for the POR.)

The BAT can also be started by a Reset command.

After the BAT, and when the interface is enabled ('clock' and 'data' lines are set high), the keyboard sends a completion code to the interface—either hex AA for satisfactory completion or hex FC (or any other code) for a failure. If the system issues a Resend command, the keyboard sends the BAT completion code again. Otherwise, the keyboard sets the keys to typematic and make/break.

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Commands from the System

The commands described below may be sent to the keyboard at any time. The keyboard will respond within 20 milliseconds.

> **Note:** The following commands are those sent by the system. They have a different meaning when issued by the keyboard.

Reset (Hex FF)

The system issues a Reset command to start a program reset and a keyboard internal self-test. The keyboard acknowledges the command with an 'acknowledge' signal (ACK) and ensures the system accepts the ACK before executing the command. The system signals acceptance of the ACK by raising the clock and data for a minimum of 500 microseconds. The keyboard is disabled from the time it receives the Reset command until the ACK is accepted or until another command overrides the previous one. Following acceptance of the ACK, the keyboard begins the reset operation, which is similar to a power-on reset. The keyboard clears the output buffer and sets up default values for typematic and delay rates.

Resend (Hex FE)

The system can send this command when it detects an error in any transmission from the keyboard. It can be sent only after a keyboard transmission and before the system enables the interface to allow the next keyboard output. Upon receipt of Resend, the keyboard sends the previous output again unless the previous output was Resend. In this case, the keyboard will resend the last byte before the Resend command.

No-Operation (NOP) (Hex FD through F7)

These commands are reserved and are effectively no-operation or NOP. The system does not use these codes. If sent, the keyboard will acknowledge the command and continue in its prior scanning state. No other operation will occur.

Set Default (Hex F6)

The Set Default command resets all conditions to the power-on default state. The keyboard responds with ACK, clears its output buffer, sets default conditions, and continues scanning (only if the keyboard was previously enabled).

Default Disable (Hex F5)

This command is similar to Set Default, except the keyboard stops scanning and awaits further instructions.

Enable (Hex F4)

Upon receipt of this command, the keyboard responds with ACK, clears its output buffer, and starts scanning.

Set Typematic Rate/Delay (Hex F3)

The system issues this command, followed by a parameter, to change the typematic rate and delay. The typematic rate and delay parameters are determined by the value of the byte following the command. Bits 6 and 5 serve as the delay parameter and bits 4, 3, 2, 1, and 0 (the least-significant bit) are the rate parameter. Bit 7, the most-significant bit, is always 0. The delay is equal to 1 plus the binary value of bits 6 and 5 multiplied by 250 milliseconds $\pm 20\%$. The period (interval from one typematic output to the next) is determined by the following equation:

Period = $(8 + A) \times (2^B) \times 0.00417$ seconds, where A = binary value of bits 2, 1, and 0 and B = binary value of bits 4 and 3.

The typematic rate (make code per second) is 1/period. The period is determined by the first equation above. The following table results.

Bit 4 - 0	Typematic Rate ± 20%	Bit 4 - 0	Typematic Rate ± 20%
00000	30.0	10000	7.5
00001	26.7	10001	6.7
00010	24.0	10010	6.0
00011	21.8	10011	5.5
00100	20.0	10100	5.0
00101	18.5	10101	4.6
00110	17.1	10110	4.3
00111	16.0	10111	4.0
01000	15.0	11000	3.7
01001	13.3	11001	3.3
01010	12.0	11010	3.0
01011	10.9	11011	2.7
01100	10.0	11100	2.5
01101	9.2	11101	2.3
01110	8.0	11110	2.1
01111	8.0	11111	2.0

The keyboard responds to the Set Typematic Rate Delay command with an ACK, stops scanning, and waits for the rate parameter. The keyboard responds to the rate parameter with another ACK, sets the rate and delay, and continues scanning (if the keyboard was previously enabled). If a command is received instead of the rate parameter, the set-typematic-rate function ends with no change to the existing rate, and the new command is processed. However, the keyboard will not resume scanning unless instructed to do so by an Enable command.

The default rate for the system keyboard is as follows:

The typematic rate = 10 characters per second ±20% and the delay = 500 ms ±20%.

No-Operation (NOP) (Hex F2 through EF)

These commands are reserved and are effectively no-operation (NOP). The system does not use these codes. If sent, the keyboard acknowledges the command and continues in its prior scanning state. No other operation will occur.

Echo (Hex EE)

Echo is a diagnostic aide. When the keyboard receives this command, it issues a hex EE response and continues scanning if the keyboard was previously enabled.

Set/Reset Mode Indicators (Hex ED)

Three mode indicators on the keyboard are accessible to the system. The keyboard activates or deactivates these indicators when it receives a valid command from the system. They can be activated or deactivated in any combination.

The system remembers the previous state of an indicator so that its setting does not change when a command sequence is issued to change the state of another indicator.

A Set/Reset Mode Indicators command consists of two bytes. The first is the command byte and has the following bit setup:

11101101 – hex ED

The second byte is an option byte. It has a list of the indicators to be acted upon. The bit assignments for this option byte are as follows:

Bit	Indicator
0	Scroll Lock Indicator
1	Num Lock Indicator
2	Caps Lock Indicator
3-7	Reserved (must be 0's)

Note: Bit 7 is the most-significant bit; bit 0 is the least-significant.

The keyboard will respond to the Set/Reset Mode Indicators command with an ACK, discontinue scanning, and wait for the option byte. The keyboard will respond to the option byte with an ACK, set the indicators, and continue scanning if the keyboard was previously enabled. If another command is received in place of the option byte, execution of the function of the Set/Reset Mode Indicators command is stopped with no change to the indicator states, and the new command is processed. Then scanning is resumed.

Commands to the System

The commands described here are those sent by the keyboard. They have a different meaning when issued by the system.

Resend (Hex FE)

The keyboard issues a Resend command following receipt of an invalid input, or any input with incorrect parity. If the system sends nothing to the keyboard, no response is required.

ACK (Hex FA)

The keyboard issues an ACK response to any valid input other than an Echo or Resend command. If the keyboard is interrupted while sending ACK, it will discard ACK and accept and respond to the new command.

Overrun (Hex 00)

An overrun character is placed in position 17 of the keyboard buffer, overlaying the last code if the buffer becomes full. The code is sent to the system as an overrun when it reaches the top of the buffer.

Diagnostic Failure (Hex FD)

The keyboard periodically tests the sense amplifier and sends a diagnostic failure code if it detects any problems. If a failure occurs during BAT, the keyboard stops scanning and waits for a system command or power-down to restart. If a failure is reported after scanning is enabled, scanning continues.

Break Code Prefix (Hex F0)

This code is sent as the first byte of a 2-byte sequence to indicate the release of a key.

BAT Completion Code (Hex AA)

Following satisfactory completion of the BAT, the keyboard sends hex AA. Hex FC (or any other code) means the keyboard microprocessor check failed.

ECHO Response (Hex EE)

This is sent in response to an Echo command from the system.

Keyboard Scan-Code Outputs

Each key is assigned a unique 8-bit, make scan code, which is sent when the key is pressed. Each key also sends a break code when the key is released. The break code consists of two bytes, the first of which is the break code prefix, hex F0; the second byte is the same as the make scan code for that key.

The typematic scan code for a key is the same as the key's make code. Refer to "Keyboard Layouts" beginning on page 4-15 to determine the character associated with each key number.

The following figure lists the positions of the keys and their make scan codes.

Key Number	Make Code	Key Number	Make Code	Key Number	Make Code
1	0E	31	1C	67	0B
2	16	32	1B	68	0A
3	1E	33	23	69	09
4	26	34	2B	70	05
5	25	35	34	71	04
6	2E	36	33	72	03
7	36	37	3B	73	83
8	3D	38	42	74	01
9	3E	39	4B	90	76
10	46	40	4C	91	6C
11	45	41	52	92	6B
12	4E	43	5A	93	69
13	55	44	12	95	77
14	5D	46	1A	96	75
15	66	47	22	97	73
16	0D	48	21	98	72
17	15	49	2A	99	70
18	1D	50	32	100	7E
19	24	51	31	101	7D
20	2D	52	3A	102	74
21	2C	53	3C	103	7A
22	35	54	49	104	71
23	3C	55	4A	105	84
24	43	57	59	106	7C
25	44	58	11	107	7B
26	4D	61	29	108	79
27	54	64	58		
28	5B	65	06		
30	14	66	0C		

Note: Break codes consists of two bytes; the first is hex F0, the second is the make scan code for that key.

Clock and Data Signals

The keyboard and system communicate over the 'clock' and 'data' lines. The source of each of these lines is an open-collector device on the keyboard that allows either the keyboard or the system to force a line to a negative level. When no communication is occurring, both the 'clock' and 'data' lines are at a positive level.

Data transmissions to and from the keyboard consist of 11-bit data streams that are sent serially over the 'data' line. The following figure shows the structure of the data stream.

Bit	Function
1	Start bit (always 1)
2	Data bit 0 (least-significant)
3	Data bit 1
4	Data bit 2
5	Data bit 3
6	Data bit 4
7	Data bit 5
8	Data bit 6
9	Data bit 7 (most-significant)
10	Parity bit (always odd)
11	Stop bit (always 1)

The parity bit is either 1 or 0, and the eight data bits plus the parity bit always equals an odd number.

When the system sends data to the keyboard, it forces the 'data' line to a negative level and allows the 'clock' line to go to a positive level.

When the keyboard sends data to, or receives data from the system, it generates the 'clock' signal to time the data. The system can prevent the keyboard from sending data by forcing the 'clock' line to a negative level; the 'data' line may go high or low during this time.

During the BAT, the keyboard allows the 'clock' and 'data' lines to go to a positive level.

Keyboard Data Output

When the keyboard is ready to send data, it first checks for a keyboard-inhibit or system request-to-send status on the 'clock' and 'data' lines. If the 'clock' line is low (inhibit status), data is stored in the keyboard buffer. If the 'clock' line is high and 'data' is low (request-to-send), data is stored in the keyboard buffer, and the keyboard receives system data.

If 'clock' and 'data' are both high, the keyboard sends the 0 start bit, 8 data bits, the parity bit and the stop bit. Data will be valid after the rising edge and before the falling edge of the 'clock' line. During transmission, the keyboard checks the 'clock' line for a positive level at least every 60 milliseconds. If the system lowers the 'clock' line from a positive level after the keyboard starts sending data, a condition known as *line contention* occurs, and the keyboard stops sending data. If line contention occurs before the rising edge of the tenth clock (parity bit), the keyboard buffer returns the 'data' and 'clock' lines to a positive level. If contention does not occur by the tenth clock, the keyboard completes the transmission.

Following a transmission, the system can inhibit the keyboard until the system processes the input or until it requests that a response be sent.

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Keyboard Data Input

When the system is ready to send data to the keyboard, it first checks if the keyboard is sending data. If the keyboard is sending but has not reached the tenth clock, the system can override the keyboard output by forcing the 'clock' line to a negative level. If the keyboard transmission is beyond the tenth clock, the system must receive the transmission.

If the keyboard is not sending, or if the system elects to override the keyboard's output, the system forces the 'clock' line to a negative level for more than 60 microseconds while preparing to send. When the system is ready to send the start bit ('data' line will be low), it allows the 'clock' line to go to a positive level.

The keyboard checks the state of the 'clock' line at intervals of no less than 60 milliseconds. If a request-to-send is detected, the keyboard counts 11 bits. After the tenth bit, the keyboard forces the 'data' line low and counts one more (the stop bit). This action signals the system that the keyboard has received its data. Upon receipt of this signal, the system returns to a ready state, in which it can accept keyboard output, or goes to the inhibited state until it is ready.

Each system command or data transmission to the keyboard requires a response from the keyboard before the system can send its next output. The keyboard will respond within 20 milliseconds unless the system prevents keyboard output. If the keyboard response is invalid or has a parity error, the system sends the command or data again. A Resend command **should** not be sent in this case.

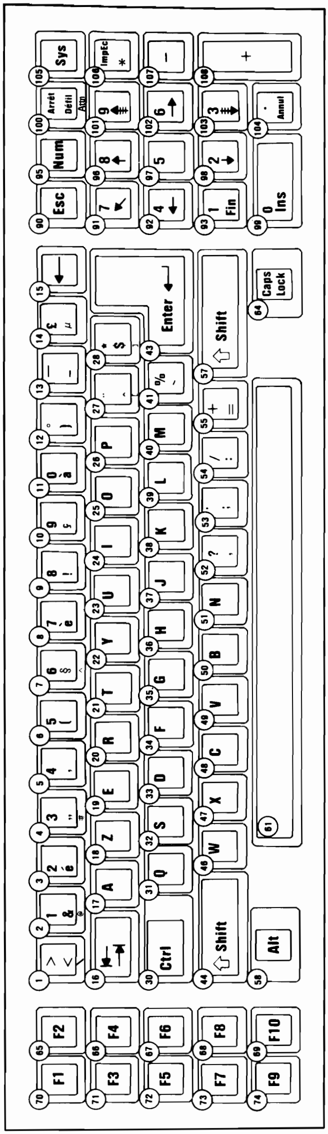
Keyboard Layouts

The keyboard has six different layouts:

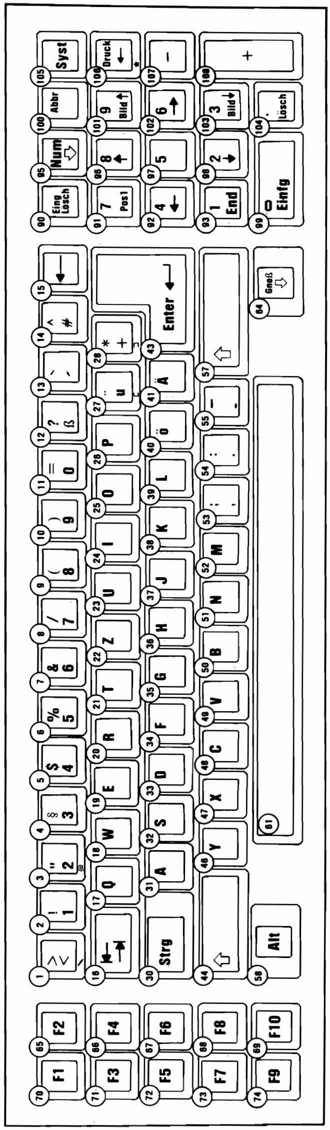
- French
- German
- Italian
- Spanish
- U.K. English
- U.S. English

The following pages show the six keyboard layouts.

French Keyboard



German Keyboard



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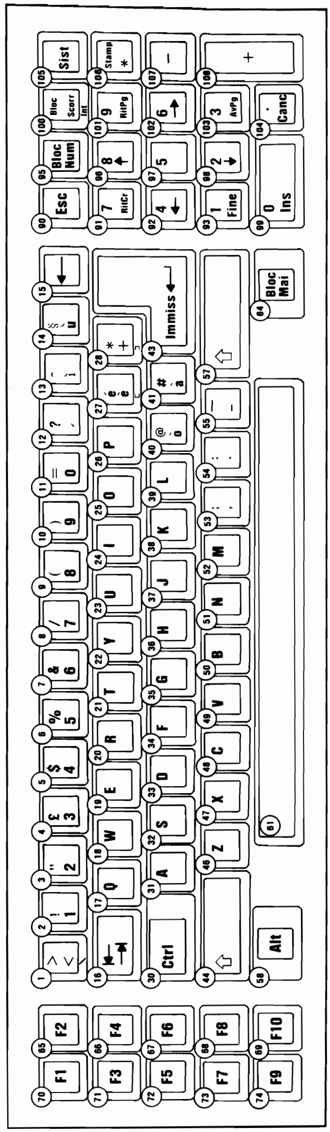
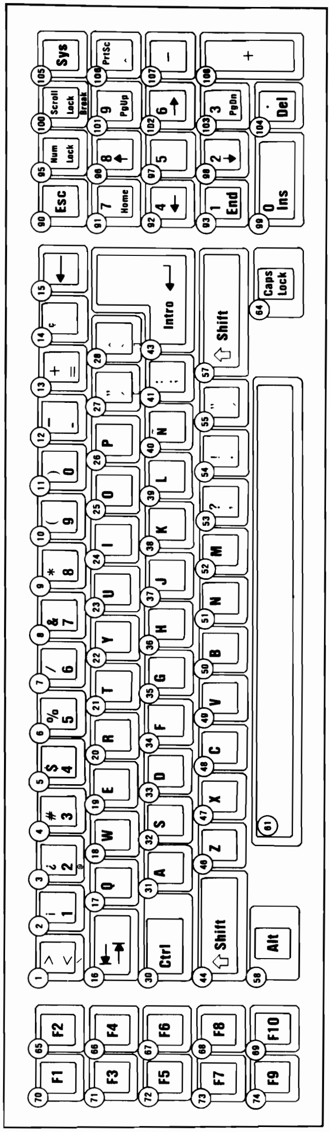
Italian Keyboard



Spanish Keyboard



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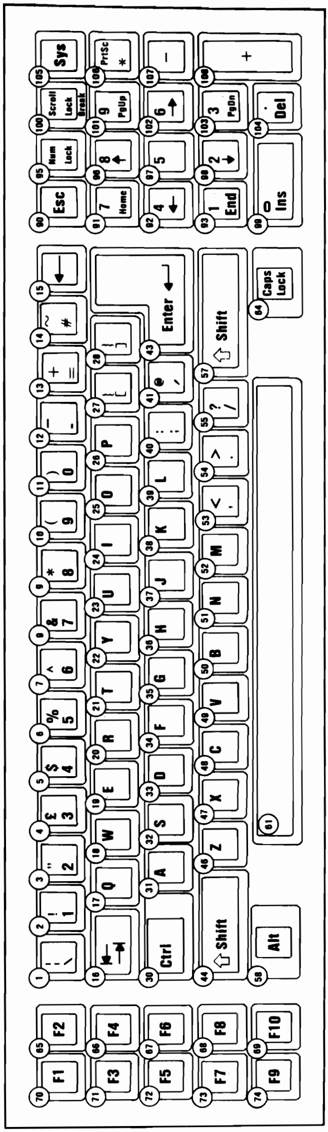
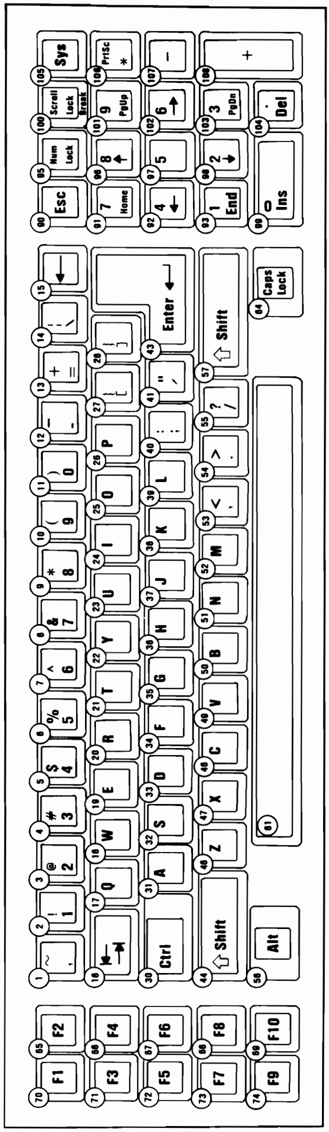
U.K. English Keyboard



U.S. English Keyboard



SECTION 4

Specifications

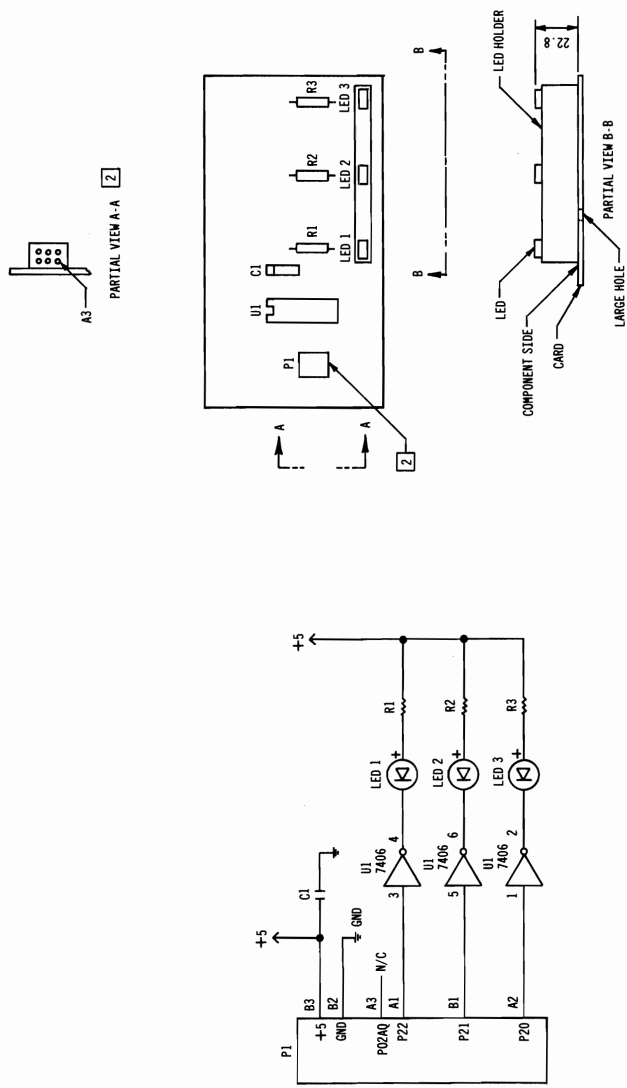
Size

- Length: 540 millimeters (21.6 inches)
- Depth: 100 millimeters (4 inches)
- Height: 225 millimeters (9 inches)

Weight

- 2.8 kilograms (6.2 pounds)

Logic Diagram



Enhancement Logic Card Assembly

SECTION 4

Notes:

SECTION 5. SYSTEM BIOS

Contents

SECTION 5

Notes:

The basic input/output system (BIOS) resides in ROM on the system board and provides level control for the major I/O devices in the system and provides system services, such as time-of-day and memory size determination. Additional ROM modules may be placed on option adapters to provide device-level control for that option adapter. BIOS routines enable the assembly language programmer to perform block (disk or diskette) or character-level I/O operations without concern for device address and characteristics.

If the sockets labeled U17 and U37 on the system board are empty, additional ROM modules may be installed in these sockets. During POST, a test is made for valid code at this location, starting at address hex E0000 and ending at hex EFFFF. More information about these sockets may be found under "Additional System Board ROM Modules" on page 5-13 .

The goal of the BIOS is to provide an operational interface to the system and relieve the programmer of concern about the characteristics of hardware devices. The BIOS interface isolates the user from the hardware, allowing new devices to be added to the system, yet retaining the BIOS level interface to the device. In this manner, hardware modifications and enhancements are not apparent to user programs.

The IBM Personal Computer *MACRO Assembler* manual and the IBM Personal Computer *Disk Operating System (DOS)* manual provide useful programming information related to this section. A complete listing of the BIOS is given later in this section.

System BIOS Usage

Access to the BIOS is through program interrupts of the microprocessor in the real mode. Each BIOS entry point is available through its own interrupt. For example, to determine the amount of base RAM available in the system with the microprocessor in the real mode, INT 12H invokes the BIOS routine for determining the memory size and returns the value to the caller.

Parameter Passing

All parameters passed to and from the BIOS routines go through the 80286 registers. The prolog of each BIOS function indicates the registers used on the call and return. For the memory size example, no parameters are passed. The memory size, in 1K increments, is returned in the AX register.

If a BIOS function has several possible operations, the AH register is used at input to indicate the desired operation. For example, to set the time of day, the following code is required:

```
MOV   AH,1              ; function is to set time-of-day
MOV   CX,HIGH_COUNT     ; establish the current time
MOV   DX,LOW_COUNT
INT   1AH               ; set the time
```

To read the time of day:

```
MOV   AH,0              ; function is to read time-of-day
INT   1AH               ; read the timer
```

The BIOS routines save all registers except for AX and the flags. Other registers are modified on return only if they are returning a value to the caller. The exact register usage can be seen in the prolog of each BIOS function.

The following figure shows the interrupts with their addresses and functions.

Int	Address	Name	BIOS Entry
0	0-3	Divide by Zero	D11
1	4-7	Single Step	D11
2	8-B	Nonmaskable	NMI INT
3	C-F	Breakpoint	D11
4	10-13	Overflow	D11
5	14-17	Print Screen	PRINT_SCREEN
6	18-1B	Reserved	D11
7	1C-1F	Reserved	D11
8	20-23	Time of Day	TIMER_INT
9	24-27	Keyboard	KB_INT
A	28-2B	Reserved	D11
B	2C-2F	Communications	D11
C	30-33	Communications	D11
D	34-37	Alternate Printer	D11
E	38-3B	Diskette	DISK_INT
F	3C-3F	Printer	D11
10	40-43	Video	VIDEO_IO
11	44-47	Equipment Check	EQUIPMENT
12	48-4B	Memory	MEMORY_SIZE_ DETERMINE
13	4C-4F	Diskette/Disk	DISKETTE_IO
14	50-53	Communications	RS232_IO
15	54-57	Cassette	CASSETTE IO/System Extensions
16	58-5B	Keyboard	KEYBOARD_IO
17	5C-5F	Printer	PRINTER_IO
18	60-63	Resident Basic	F600:0000
19	64-67	Bootstrap	BOOTSTRAP
1A	68-6B	Time of Day	TIME_OF_DAY
1B	6C-6F	Keyboard Break	DUMMY_RETURN
1C	70-73	Timer Tick	DUMMY_RETURN
1D	74-77	Video Initialization	VIDEO_PARMS
1E	78-7B	Diskette Parameters	DISK_BASE
1F	7C-7F	Video Graphics Chars	0

80286-2 Program Interrupt Listing (Real Mode Only)

Note: For BIOS index, see the BIOS Quick Reference on page 5-24 .

The following figure shows hardware, BASIC, and DOS reserved interrupts.

Interrupt	Address	Function
20	80-83	DOS program terminate
21	84-87	DOS function call
22	88-8B	DOS terminate address
23	8C-8F	DOS Ctrl Break exit address
24	90-93	DOS fatal error vector
25	94-97	DOS absolute disk read
26	98-9B	DOS absolute disk write
27	9C-9F	DOS terminate, fix in storage
28-3F	A0-FF	Reserved for DOS
40-5F	100-17F	Reserved for BIOS
60-67	180-19F	Reserved for user program interrupts
68-6F	1A0-1BF	Not used
70	1C0-1C3	IRQ 8 Realtime clock INT (BIOS entry RTC_INT)
71	1C4-1C7	IRQ 9 (BIOS entry RE_DIRECT)
72	1C8-1CB	IRQ 10 (BIOS entry D11)
73	1CC-1CF	IRQ 11 (BIOS entry D11)
74	1D0-1D3	IRQ 12 (BIOS entry D11)
75	1D4-1D7	IRQ 13 BIOS Redirect to NMI interrupt (BIOS entry INT_287)
76	1D8-1DB	IRQ 14 (BIOS entry D11)
77	1DC-1DF	IRQ 15 (BIOS entry D11)
78-7F	1E0-1FF	Not used
80-85	200-217	Reserved for BASIC
86-F0	218-3C3	Used by BASIC interpreter while BASIC is running
F1-FF	3C4-3FF	Not used

Hardware, Basic, and DOS Interrupts

Vectors with Special Meanings

Interrupt 15—Cassette I/O: This vector points to the following functions:

- Device open
- Device closed
- Program termination
- Event wait
- Joystick support

- System Request key pressed
- Wait
- Move block
- Extended memory size determination
- Processor to protected mode

Additional information about these functions may be found in the BIOS listing.

Interrupt 1B—Keyboard Break Address: This vector points to the code that is executed when the Ctrl and Break keys are pressed. The vector is invoked while responding to a keyboard interrupt, and control should be returned through an IRET instruction. The power-on routines initialize this vector to point to an IRET instruction so that nothing will occur when the Ctrl and Break keys are pressed unless the application program sets a different value.

This routine may retain control with the following considerations:

- The Break may have occurred during interrupt processing, so that one or more End of Interrupt commands must be sent to the 8259 controller.
- All I/O devices should be reset in case an operation was underway at the same time.

Interrupt 1C—Timer Tick: This vector points to the code that will be executed at every system-clock tick. This vector is invoked while responding to the timer interrupt, and control should be returned through an IRET instruction. The power-on routines initialize this vector to point to an IRET instruction, so that nothing will occur unless the application modifies the pointer. The application must save and restore all registers that will be modified.

Interrupt 1D—Video Parameters: This vector points to a data region containing the parameters required for the initialization of the 6845 on the video adapter. Notice that there are four separate tables, and all four must be reproduced if all modes of operation are to be supported. The power-on routines initialize this vector to point to the parameters contained in the ROM video routines.

Interrupt 1E—Diskette Parameters: This vector points to a data region containing the parameters required for the diskette drive. The power-on routines initialize this vector to point to the parameters contained in the ROM diskette routine. These default parameters represent the specified values for any IBM drives attached to the system. Changing this parameter block may be necessary to reflect the specifications of other drives attached.

Interrupt 1F—Graphics Character Extensions: When operating in graphics modes 320 x 200 or 640 x 200, the read/write character interface will form a character from the ASCII code point, using a set of dot patterns. ROM contains the dot patterns for the first 128 code points. For access to the second 128 code points, this vector must be established to point at a table of up to 1K, where each code point is represented by 8 bytes of graphic information. At power-on time, this vector is initialized to 000:0, and the user must change this vector if the additional code points are required.

Interrupt 40—Reserved: When a Fixed Disk and Diskette Drive Adapter is installed, the BIOS routines use interrupt 40 to revector the diskette pointer.

Interrupt 41 and 46—Fixed Disk Parameters: These vectors point to the parameters for the fixed disk drives, 41 for the first drive and 46 for the second. The power-on routines initialize the vectors to point to the appropriate parameters in the ROM disk routine if CMOS is valid. The drive type codes in CMOS are used to select which parameter set the vector points to. Changing this parameter hook may be necessary to reflect the specifications of other fixed drives attached.

Other Read/Write Memory Usage

The IBM BIOS routines use 256 bytes of memory from absolute hex 400 to hex 4FF. Locations hex 400 to 407 contain the base addresses of any RS-232C adapters installed in the system. Locations hex 408 to 40F contain the base addresses of any printer adapters.

Memory locations hex 300 to hex 3FF are used as a stack area during the power-on initialization and bootstrap, when control is passed to it from power-on. If the user desires the stack to be in a different area, that area must be set by the application.

The following figure shows the reserved memory locations.

Address	Mode	Function
400-4A1	ROM BIOS	See BIOS listing
4A2-4EF		Reserved
4F0-4FF		Reserved as intra-application communication area for any application
500-5FF		Reserved for DOS and BASIC
500	DOS	Print screen status flag store 0=Print screen not active or successful print screen operation 1=Print screen in progress 255=Error encountered during print screen operation
504	DOS	Single drive mode status byte
510-511	BASIC	BASIC's segment address store
512-515	BASIC	Clock interrupt vector segment:offset store
516-519	BASIC	Break key interrupt vector segment:offset store
51A-51D	BASIC	Disk error interrupt vector segment:offset store

Reserved Memory Locations

The following is the BASIC workspace for DEF SEG (default workspace).

Offset	Length	
2E	2	Line number of current line being executed
347	2	Line number of last error
30	2	Offset into segment of start of program text
358	2	Offset into segment of start of variables (end of program text 1-1)
6A	1	Keyboard buffer contents 0=No characters in buffer 1=Characters in buffer
4E	1	Character color in graphics mode*

Basic Workspace Variables

*Set to 1, 2, or 3 to get text in colors 1-3. Do not set to 0. The default is 3.

SECTION 5

Example
100 PRINT PEEK (&H2E) + 256 x PEEK (&H2F)

L	H
Hex 64	Hex 00

The following is a BIOS memory map.

Starting Address	
00000	BIOS interrupt vectors
001E0	Available interrupt vectors
00400	BIOS data area
00500	User read/write memory
E0000	Read only memory
F0000	BIOS program area

BIOS Memory Map

BIOS Programming Hints

The BIOS code is invoked through program interrupts. The programmer should not "hard code" BIOS addresses into applications. The internal workings and absolute addresses within BIOS are subject to change without notice.

If an error is reported by the disk or diskette code, reset the drive adapter and retry the operation. A specified number of retries should be required for diskette reads to ensure the problem is not due to motor startup.

When altering I/O-port bit values, the programmer should change only those bits necessary to the current task. Upon completion, the original environment should be restored. Failure to adhere to this practice may cause incompatibility with present and future applications.

Additional information for BIOS programming can be found in Section 9 of this manual.

Move Block BIOS

The Move Block BIOS was designed to make use of the memory above the 1M address boundary while operating with IBM DOS. The Block Move is done with the Intel 80286 Microprocessor operating in the protected mode.

Because the interrupts are disabled in the protected mode, Move Block BIOS may demonstrate a data overrun or lost interrupt situation in certain environments.

Communication devices, while receiving data, are sensitive to these interrupt routines; therefore, the timing of communication and the Block Move should be considered. The following table shows the interrupt servicing requirements for communication devices.

Baud Rate	11 Bit (ms)	9 bit (ms)
300	33.33	30.00
1200	8.33	7.50
2400	4.16	7.50
4800	2.08	1.87
9600	1.04	0.93
Times are approximate		

Communication Interrupt Intervals

The following table shows the time required to complete a Block Move.

Block Size	Buffer Addresses	Time in ms
Normal 512 Byte	Both even	0.98
	Even and odd	1.04
	Both odd	1.13
Maximum 64K	Both Even	37.0
	Even and odd	55.0
	Both odd	72.0
Time is approximate		

Move Block BIOS Timing

SECTION 5

Following are some ways to avoid data overrun errors and loss of interrupts:

- Do not use the Block Move while communicating, or
- Restrict the block size to 512 bytes or less while communicating, or
- Use even address buffers for both the source and the destination to keep the time for a Block Move to a minumum.

Adapters with System-Accessible ROM Modules

The ROM BIOS provides a way to integrate adapters with on-board ROM code into the system. During POST, interrupt vectors are established for the BIOS calls. After the default vectors are in place, a scan for additional ROM modules occurs. At this point, a ROM routine on an adapter may gain control and establish or intercept interrupt vectors to hook themselves into the system.

The absolute addresses hex C8000 through E0000 are scanned in 2K blocks in search of a valid adapter ROM. A valid ROM is defined as follows:

Byte 0 Hex 55

Byte 1 Hex AA

Byte 2 A length indicator representing the number of 512-byte blocks in the ROM

Byte 3 Entry by a CALL FAR

A checksum is also done to test the integrity of the ROM module. Each byte in the defined ROM module is summed modulo hex 100. This sum must be 0 for the module to be valid.

When the POST identifies a valid ROM, it does a CALL FAR to byte 3 of the ROM, which should be executable code. The adapter can now perform its power-on initialization tasks. The adapter's ROM should then return control to the BIOS routines by executing a RETURN FAR.

Additional System Board ROM Modules

The POST provides a way to integrate the code for additional ROM modules into the system. These modules are placed in the sockets marked U17 and U37. A test for additional ROM modules on the system board occurs. At this point, the additional ROM, if valid, will gain control.

The absolute addresses, E0000 through EFFFF, are scanned in 64K blocks for a valid checksum. Valid ROM is defined as follows:

Byte 0 Hex 55

Byte 1 Hex AA

Byte 2 Not used

Byte 3 Entry by a CALL FAR

A checksum is done to test the integrity of the ROM modules. Each byte in the ROM modules is summed modulo hex 100. This sum must be 0 for the modules to be valid. This checksum is located at address EFFFF.

When the POST identifies a valid ROM at this segment, it does a CALL FAR to byte 3 of the ROM, which should be executable code.

Keyboard Encoding and Usage

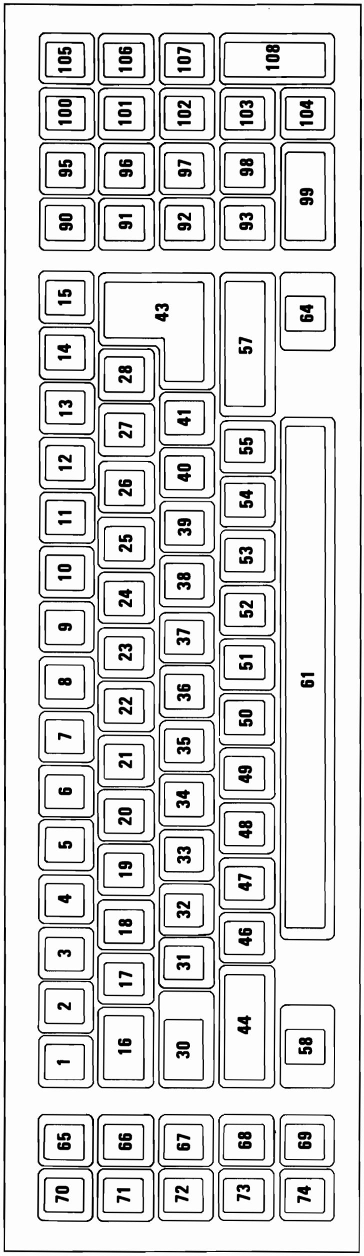
The keyboard routine, provided by IBM in the ROM BIOS, is responsible for converting the keyboard scan codes into what will be termed *Extended ASCII*. The extended ASCII codes returned by the ROM routine are mapped to the U.S. English keyboard layout. Some operating systems may make provisions for alternate keyboard layouts by providing an interrupt replacer, which resides in the read/write memory. This section discusses only the ROM routine.

Extended ASCII encompasses 1-byte character codes, with possible values of 0 to 255, an extended code for certain extended keyboard functions, and functions handled within the keyboard routine or through interrupts.

Character Codes

The character codes described later are passed through the BIOS keyboard routine to the system or application program. A "-1" means the combination is suppressed in the keyboard routine. The codes are returned in the AL register. See “Characters, Keystrokes, and Color” later in this manual for the exact codes.

The following figure shows the keyboard layout and key positions.



SECTION 5

Key	Base Case	Uppercase	Ctrl	Alt
1	'	~	-1	-1
2	1	!	-1	(*)
3	2	@	Nul(000) (*)	(*)
4	3	#	-1	(*)
5	4	$	-1	(*)
6	5	%	-1	(*)
7	6	^	RS(030)	(*)
8	7	&	-1	(*)
9	8	*	-1	(*)
10	9	(	-1	(*)
11	0	)	-1	(*)
12	-	_	US(031)	(*)
13	=	+	-1	(*)
14	\	|	FS(028)	-1
15	Backspace (008)	Backspace (008)	Del(127)	-1
16	→| (009)	|← (*)	-1	-1
17	q	Q	DC1(017)	(*)
18	w	W	ETB(023)	(*)
19	e	E	ENQ(005)	(*)
20	r	R	DC2(018)	(*)
21	t	T	DC4(020)	(*)
22	y	Y	EM(025)	(*)
23	u	U	NAK(021)	(*)
24	i	I	HT(009)	(*)
25	o	O	SI(015)	(*)
26	p	P	DLE(016)	(*)
27	[	{	Esc(027)	(*)
28	]	}	GS(029)	-1
30 Ctrl	-1	-1	-1	-1
31	a	A	SOH(001)	(*)
32	s	S	DC3(019)	(*)
33	d	D	EOT(004)	(*)
34	f	F	ACK(006)	(*)
35	g	G	BEL(007)	(*)
36	h	H	BS(008)	(*)
37	j	J	LF(010)	(*)
38	k	K	VT(011)	(*)
39	l	L	FF(012)	(*)
40	;	:	-1	-1
41	'	"	-1	-1
43	CR	CR	LF(010)	-1
44 Shift (Left)	-1	-1	-1	-1
46	z	Z	SUB(026)	(*)
47	x	X	CAN(024)	(*)
48	c	C	ETX(003)	(*)

Notes:
(*) Refer to "Extended Functions" in this section.
(**) Refer to "Special Handling" in this section.

Character Codes (Part 1 of 2)

Key	Base Case	Uppercase	Ctrl	Alt
49	v	V	SYN(022)	(*)
50	b	B	STX(002)	(*)
51	n	N	SO(014)	(*)
52	m	M	CR(013)	(*)
53	,	<	-1	-1
54	.	>	-1	-1
55	/	?	-1	-1
57 Shift (Right)	-1	-1	-1	-1
58 Alt	-1	-1	-1	-1
61	Space	Space	Space	Space
64 Caps Lock	-1	-1	-1	-1
90	Esc	Esc	Esc	-1
95 Num Lock	-1	-1 (*)	Pause (**)	-1
100 Scroll Lock	-1	-1	Break (**)	-1
107	-	-	(*)	(*)
108	Enter	Enter	-1	-1
112	Null (*)	Null (*)	Null (*)	Null(*)
113	Null (*)	Null (*)	Null (*)	Null(*)
114	Null (*)	Null (*)	Null (*)	Null(*)
115	Null (*)	Null (*)	Null (*)	Null(*)
116	Null (*)	Null (*)	Null (*)	Null(*)
117	Null (*)	Null (*)	Null (*)	Null(*)
118	Null (*)	Null (*)	Null (*)	Null(*)

Notes:
(*) Refer to "Extended Functions" in this section.
(**) Refer to "Special Handling" in this section.

Character Codes (Part 2 of 2)

SECTION 5

The following figure lists keys that have meaning only in Num Lock, Shift, or Ctrl states. The Shift key temporarily reverses the current Num Lock state.

Key	Num Lock	Base Case	Alt	Ctrl
91	7	Home (*)	-1	Clear Screen
92	4	← (*)	-1	Reverse Word (*)
93	1	End (*)	-1	Erase to EOL (*)
96	8	↑ (*)	-1	-1
97	5	-1	-1	-1
98	2	↓ (*)	-1	-1
99	0	Ins	-1	-1
101	9	Page Up (*)	-1	Top of Text and Home
102	6	→ (*)	-1	Advance Word (*)
103	3	Page Down (*)	-1	Erase to EOS (*)
104	.	Delete (*,**)	(**)	(**)
105	-	Sys Request	-1	-1
106	+	+ (*)	-1	-1

Notes:
(*) Refer to "Extended Functions" in this section.
(**) Refer to "Special Handling" in this section.

Special Character Codes

Extended Functions

For certain functions that cannot be represented by a standard ASCII code, an extended code is used. A character code of 000 (null) is returned in AL. This indicates that the system or application program should examine a second code, which will indicate the actual function. Usually, but not always, this second code is the scan code of the primary key that was pressed. This code is returned in AH.

The following is a list of the extended codes and their functions.

Second Code	Function
3	Nul Character
15	|← (Back-tab)
16-25	Alt Q, W, E, R, T, Y, U, I, O, P
30-38	Alt A, S, D, F, G, H, J, K, L
44-50	Alt Z, X, C, V, B, N, M
59-68	F1 to F10 Function Keys (Base Case)
71	Home
72	↑ (Cursor Up)
73	Page Up and Home Cursor
75	← (Cursor Left)
77	→ (Cursor Right)
79	End
80	↓ (Cursor Down)
81	Page Down and Home Cursor
82	Ins (Insert)
83	Del (Delete)
84-93	F11 to F20 (Shift-F1 through Shift-F10)
94-103	F21 to F30 (Ctrl-F1 through Ctrl-F10)
104-113	F31 to F40 (Alt-F1 through Alt-F10)
114	Ctrl PrtSc (Start/Stop Echo to Printer)
115	Ctrl ← (Reverse Word)
116	Ctrl → (Advance Word)
117	Ctrl End (Erase to End of Line-EOL)
118	Ctrl PgDn (Erase to End of Screen-EOS)
119	Ctrl Home (Clear Screen and Home)
120-131	Alt 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, -, = keys 2-13
132	Ctrl PgUp (Top 25 Lines of Text and Cursor Home)

Keyboard Extended Functions

Shift States

Most shift states are handled within the keyboard routine, and are not apparent to the system or application program. In any case, the current status of active shift states is available by calling an entry point in the BIOS keyboard routine. The following keys result in altered shift states:

Shift: This key temporarily shifts keys 1 through 13, 15 through 29, 31 through 41, and 46 through 55, to uppercase (base case if in Caps Lock state). Also, the Shift temporarily reverses the Num Lock or non-Num Lock state of keys 91 through 93, 96, 98, 99, and 101 through 104.

Ctrl: This key temporarily shifts keys 3, 7, 12, 15, 17 through 29, 31 through 39, 43, 46 through 52, 91 through 93, and 101 through 103 to the Ctrl state. The Ctrl key is also used with the Alt and Del keys to cause the system-reset function; with the Scroll Lock key to cause the break function; and with the Num Lock key to cause the pause function. The system-reset, break, and pause functions are described under "Special Handling" later in this section.

Alt: This key temporarily shifts keys 1 through 13, 17 through 26, 31 through 39, and 46 through 52 to the Alt state. The Alt key is also used with the Ctrl and Del keys to cause a system reset.

The Alt key also allows the user to enter any character code from 1 to 255.

> **Note:** Character codes 97-122 will display uppercase with Caps Lock activated.

The user holds down the Alt key and types the decimal value of the characters desired on the numeric keypad (keys 91 through 93, 96 through 99, and 101 through 103). The Alt key is then released. If the number is greater than 255, a modulo-256 value is used. This value is interpreted as a character code and is sent through the keyboard routine to the system or application program. Alt is handled internal to the keyboard routine.

Caps Lock: This key shifts keys 17 through 26, 31 through 39, and 46 through 52 to uppercase. When Caps Lock is pressed again, it reverses the action. Caps Lock is handled internal to the keyboard routine. When Caps Lock is pressed, it changes the Caps Lock Mode indicator. If the indicator was on, it will go off; and if it was off, it will go on.

Scroll Lock: When interpreted by appropriate application programs, this key indicates that the cursor-control keys will cause windowing over the text rather than moving the cursor. When the Scroll Lock key is pressed again, it reverses the action. The keyboard routine simply records the current shift state of the Scroll Lock key. It is the responsibility of the application program to perform the function. When Scroll Lock is pressed, it changes the Scroll Lock Mode indicator. If the indicator was on, it will go off; and if it was off, it will go on.

Num Lock: This key shifts keys 91 through 93, 96 through 99, and 101 through 104 to uppercase. When Num Lock is pressed again, it reverses the action. Num Lock is handled internal to the keyboard routine. When Num Lock is pressed, it changes the Num Lock Mode indicator. If the indicator was on, it will go off; if it was off, it will go on.

If the keyboard Num Lock Mode indicator and the system get out of synchronization, pressing the key combination of Shift and Num Lock will synchronize them. This key combination changes the Num Lock bit in the keyboard memory, but sends only the scan code for the Shift key to the system.

Shift Key Priorities and Combinations: If combinations of the Alt, Ctrl, and Shift keys are pressed and only one is valid, the priority is as follows: the Alt key is first, the Ctrl key is second, and the Shift key is third. The only valid combination is Alt and Ctrl, which is used in the system-reset function.

Special Handling

System Reset

The combination of the Alt, Ctrl, and Del keys results in the keyboard routine that starts a system reset or restart. System reset is handled by BIOS.

Break

The combination of the Ctrl and Break keys results in the keyboard routine signaling interrupt hex 1B. The extended characters AL=hex 00, and AH=hex 00 are also returned.

Pause

The Pause key (Ctrl and Num Lock) causes the keyboard interrupt routine to loop, waiting for any key except Num Lock to be pressed. This provides a method of temporarily suspending an operation, such as listing or printing, and then resuming the operation. The method is not apparent to either the system or the application program. The key stroke used to resume operation is discarded. Pause is handled internal to the keyboard routine.

Print Screen

The PrtSc key results in an interrupt invoking the print-screen routine. This routine works in the alphanumeric or graphics mode, with unrecognizable characters printing as blanks.

System Request

When the System Request (Sys) key is pressed, a hex 8500 is placed in AX, and an interrupt hex 15 is executed. When the Sys key is released, a hex 8501 is placed in AX, and another interrupt hex 15 is executed. If an application is to use System Request, the following rules must be observed:

Save the previous address.

Overlay interrupt vector hex 15.

Check AH for a value of hex 85:

If yes, process may begin.
If no, go to previous address.

The application program must preserve the value in all registers, except AX, upon return. System Request is handled internal to the keyboard routine.

Other Characteristics

The keyboard routine does its own buffering, and the keyboard buffer is large enough to support entries by a fast typist. However, if a key is pressed when the buffer is full, the key will be ignored and the "alarm" will sound.

The keyboard routine also suppresses the typematic action of the following keys: Ctrl, Shift, Alt, Num Lock, Scroll Lock, Caps Lock, and Ins.

During each interrupt 09H from the keyboard, an interrupt 15H, function (AH)=4FH is generated by the BIOS after the scan code is read from the keyboard adapter. The scan code is passed in the (AL) register with the carry flag set. This is to allow an operating system to intercept each scan code prior to its being handled by the interrupt 09H routine, and have a chance to change or act on the scan code. If the carry flag is changed to 0 on return from interrupt 15H, the scan code will be ignored by the interrupt handler.

SECTION 5

Quick Reference

SECTION 5

Address		Publics by Name	Address		Publics by Value
F000:E729		A1	F000:0000		POST1
F000:3A23		ACT_DISP_PAGE	F000:0008	Abs	K6L
F000:6000		BASIC	F000:0010	Abs	M4
F000:19F0		BEEP	F000:0050		START_1
F000:1B1A		BLINK_INT	F000:0396		C8042
F000:2022		BOOT_STRAP_1	F000:03A2		OBF_42
F000:0C96		C21	F000:0C96		POST2
F000:0396		C8042	F000:0C96		C21
F000:4135		CASSETTE_IO_1	F000:1052		SHUT3
F000:1941		CMOS_READ	F000:10B6		SHUT2
F000:195B		CMOS_WRITE	F000:10B9		SHUT7
F000:1A45		CONFIG_BAD	F000:10DA		SHUT6
F000:E6F5		CONF_TBL	F000:1613		SHUT4
F000:FA6E		CRT_CHAR_GEN	F000:1671		POST3
F000:E020		D1	F000:1941		CMOS_READ
F000:1BCA		D11	F000:1941		POST4
F000:E030		D2	F000:195B		CMOS_WRITE
F000:E040		D2A	F000:1975		DDS
F000:1975		DDS	F000:197D		E_MSG
F000:20E3		DISKETTE_IO_1	F000:19A4		P_MSG
F000:EFC7		DISK_BASE	F000:19B2		ERR_BEEP
F000:2A17		DISK_INT_1	F000:19F0		BEEP
F000:2C2B		DISK_IO	F000:1A36		WAITF
F000:2A82		DISK_SETUP	F000:1A45		CONFIG_BAD
F000:2A2E		DSKETTE_SETUP	F000:1A59		XPC_BYTE
F000:FF53		DUMMY_RETURN	F000:1A69		PRT_HEX
F000:1C18		DUMMY_RETURN_1	F000:1A70		PRT_SEG
F000:E05E		E101	F000:1A85		PROT_PRT_HEX
F000:E077		E102	F000:1AB1		ROM_CHECKSUM
F000:E090		E103	F000:1ABD		ROM_CHECK
F000:E0A9		E104	F000:1AEF		KBD_RESET
F000:E0C2		E105	F000:1B1A		BLINK_INT
F000:E0DB		E106	F000:1B28		SET_TOD
F000:E0F4		E107	F000:1BCA		D11
F000:E10D		E108	F000:1C18		DUMMY_RETURN_1
F000:E126		E109	F000:1C19		RE_DIRECT
F000:E13F		E161	F000:1C22		INT_287
F000:E168		E162	F000:1C31		PROC_SHUTDOWN
F000:E191		E163	F000:1C38		POST5
F000:E1B7		E164	F000:1D2A		SYSINIT1
F000:E1DB		E201	F000:1EB5		POST6
F000:E1EE		E202	F000:1EB5		STGTST_CNT
F000:E209		E203	F000:1FB5		ROM_ERR
F000:E224		E301	F000:1FE1		XMIT_8042
F000:E239		E302	F000:2022		BOOT_STRAP_1
F000:E2C6		E303	F000:20E3		DISKETTE_IO_1
F000:E2EA		E304	F000:28C1		SEEK
F000:E30E		E401	F000:2A17		DISK_INT_1
F000:E31E		E501	F000:2A2E		DSKETTE_SETUP
F000:E32E		E601	F000:2A82		DISK_SETUP
F000:E343		E602	F000:2C2B		DISK_IO
F000:40A8		EQUIPMENT_1	F000:314F		HD_INT
F000:19B2		ERR_BEEP	F000:3172		KEYBOARD_IO_1
F000:197D		E_MSG	F000:31FE		KB_INT_1
F000:E364		F1780	F000:3267		K16
F000:E379		F1781	F000:366C		SND_DATA
F000:E38E		F1782	F000:3716		PRINTER_IO_1
F000:E3AC		F1790	F000:37A0		RS232_IO_1
F000:E3BF		F1791	F000:38B0		VIDEO_IO_1
F000:E3D2		F3A	F000:38EF		SET_MODE
F000:E25D		F3D	F000:39BF		SET_CTYPE
F000:E3DF		F3D1	F000:39E4		SET_CPOS
F000:E401		FD_TBL	F000:3A0C		READ_CURSOR
F000:4888		FILL	F000:3A23		ACT_DISP_PAGE
F000:FF5E		FLOPPY	F000:3A47		SET_COLOR
F000:4501		GATE_A20	F000:3A6D		VIDEO_STATE
F000:314F		HD_INT	F000:3A90		SCROLL_UP
F000:FF5A		HRD	F000:3B2F		SCROLL_DOWN
F000:1C22		INT_287	F000:3B81		READ_AC_CURRENT
F000:E8E1		K10	F000:3BDB		WRITE_AC_CURRENT
F000:E91B		K11	F000:3C0D		WRITE_C_CURRENT
F000:E955		K12	F000:3CBD		READ_DOT
F000:E95F		K13	F000:3CCE		WRITE_DOT
F000:E969		K14	F000:3F72		WRITE_TTY
F000:E976		K15	F000:3FF9		READ_LPEN
F000:3267		K16	F000:409E		MEMORY_SIZE_DET_1
F000:E87E		K6	F000:40A8		EQUIPMENT_1
F000:0008	Abs	K6L	F000:40B2		NMI_INT_1
F000:E886		K7	F000:4135		CASSETTE_IO_1
F000:E88E		K8	F000:43BF		SHUT9
F000:E8C8		K9	F000:4501		GATE_A20
F000:1AEF		KBD_RESET	F000:45BD		TIME_OF_DAY_1
F000:31FE		KB_INT_1	F000:473F		RTC_INT
F000:3172		KEYBOARD_IO_1	F000:47A9		PRINT_SCREEN_1
F000:0010	Abs	M4	F000:483F		TIMER_INT_1
F000:F0E4		M5	F000:4888		FILL
F000:F0EC		M6	F000:6000		BASIC
F000:F0F4		M7	F000:E020		D1
F000:409E		MEMORY_SIZE_DET_1	F000:E030		D2
F000:E2C3		NMI_INT	F000:E040		D2A
F000:40B2		NMI_INT_1	F000:E05E		E101
F000:03A2		OBF_42	F000:E077		E102
F000:0000		POST1	F000:E090		E103
F000:0C96		POST2	F000:E0A9		E104
F000:1671		POST3	F000:E0C2		E105
F000:1941		POST4	F000:E0DB		E106
F000:1C38		POST5	F000:E0F4		E107
F000:1EB5		POST6	F000:E10D		E108

F000:3716	PRINTER_IO_1	F000:E126	E109
F000:FF54	PRINT_SCREEN	F000:E13F	E161
F000:47A9	PRINT_SCREEN_1	F000:E168	E162
F000:1C31	PROC_SHUTDOWN	F000:E191	E163
F000:1A85	PROT_PRT_HEX	F000:E1B7	E164
F000:1A69	PRT_HEX	F000:E1DB	E201
F000:1A70	PRT_SEG	F000:E1EE	E202
F000:19A4	P_MSG	F000:E209	E203
F000:FFF0	P_O_R	F000:E224	E301
F000:3B81	READ_AC_CURRENT	F000:E239	E302
F000:3A0C	READ_CURSOR	F000:E25D	F3D
F000:3CBD	READ_DOT	F000:E2C3	NMI_INT
F000:3FF9	READ_LPEN	F000:E2C6	E303
F000:1C19	RE_DIRECT	F000:E2EA	E304
F000:1ABD	ROM_CHECK	F000:E30E	E401
F000:1AB1	ROM_CHECKSUM	F000:E31E	E501
F000:1FB5	ROM_ERR	F000:E32E	E601
F000:37A0	RS232_IO_1	F000:E343	E602
F000:473F	RTC_INT	F000:E364	F1780
F000:3B2F	SCROLL_DOWN	F000:E379	F1781
F000:3A90	SCROLL_UP	F000:E38E	F1782
F000:28C1	SEEK	F000:E3AC	F1790
F000:FF62	SEEKS_1	F000:E3BF	F1791
F000:3A47	SET_COLOR	F000:E3D2	F3A
F000:39E4	SET_CPOS	F000:E3DF	F3D1
F000:39BF	SET_CTYPE	F000:E401	FD_TBL
F000:38EF	SET_MODE	F000:E6F5	CONF_TBL
F000:1B28	SET_TOD	F000:E729	A1
F000:10B6	SHUT2	F000:E87E	K6
F000:1052	SHUT3	F000:E886	K7
F000:1613	SHUT4	F000:E88E	K8
F000:10DA	SHUT6	F000:E8C8	K9
F000:10B9	SHUT7	F000:E8E1	K10
F000:43BF	SHUT9	F000:E91B	K11
F000:FF23	SLAVE_VECTOR_TABLE	F000:E955	K12
F000:366C	SND_DATA	F000:E95F	K13
F000:0050	START_1	F000:E969	K14
F000:1EB5	STGTST_CNT	F000:E976	K15
F000:1D2A	SYSINIT1	F000:EFC7	DISK_BASE
F000:483F	TIMER_INT_1	F000:F0A4	VIDEO_PARMS
F000:45BD	TIME_OF_DAY_1	F000:F0E4	M5
F000:FF66	TUTOR	F000:F0EC	M6
F000:FEF3	VECTOR_TABLE	F000:F0F4	M7
F000:38B0	VIDEO_IO_1	F000:FA6E	CRT_CHAR_GEN
F000:F0A4	VIDEO_PARMS	F000:FEF3	VECTOR_TABLE
F000:3A6D	VIDEO_STATE	F000:FF23	SLAVE_VECTOR_TABLE
F000:1A36	WAITF	F000:FF53	DUMMY_RETURN
F000:3BDB	WRITE_AC_CURRENT	F000:FF54	PRINT_SCREEN
F000:3C0D	WRITE_C_CURRENT	F000:FF5A	HRD
F000:3CCE	WRITE_DOT	F000:FF5E	FLOPPY
F000:3F72	WRITE_TTY	F000:FF62	SEEKS_1
F000:1FE1	XMIT_8042	F000:FF66	TUTOR
F000:1A59	XPC_BYTE	F000:FFF0	P_O_R

THE BIOS ROUTINES ARE MEANT TO BE ACCESSED THROUGH SOFTWARE INTERRUPTS ONLY. ANY ADDRESSES PRESENT IN THESE LISTINGS ARE INCLUDED ONLY FOR COMPLETENESS, NOT FOR REFERENCE. APPLICATIONS WHICH REFERENCE ANY ABSOLUTE ADDRESSES WITHIN THE CODE SEGMENTS OF BIOS VIOLATE THE STRUCTURE AND DESIGN OF BIOS. ADDRESSES WITHIN THE BIOS CODE SEGMENT ARE SUBJECT TO CHANGE AND ROUTINES SHOULD BE ACCESSED THROUGH POINTERS IN THE INTERRUPT VECTORS OR WHEN NECESSARY THROUGH THE POINTERS IN THE BIOS "DATA" SEGMENT.

```
PAGE 118,121
TITLE TEST1 ---- 06/10/85  POWER ON SELF TEST (POST)
.286C

;---------------------------------------------------------------------------------
;                                                                                :
; BIOS I/O INTERFACE                                                             :
;                                                                                :
;       THESE LISTINGS PROVIDE INTERFACE INFORMATION FOR ACCESSING               :
;       THE BIOS ROUTINES.  THE POWER ON SELF TEST IS INCLUDED.                  :
;                                                                                :
;       THE  BIOS  ROUTINES  ARE  MEANT  TO  BE  ACCESSED  THROUGH               :
;       SOFTWARE  INTERRUPTS  ONLY.    ANY  ADDRESSES  PRESENT  IN               :
;       THESE  LISTINGS  ARE  INCLUDED  ONLY  FOR  COMPLETENESS,                 :
;       NOT  FOR  REFERENCE.  APPLICATIONS  WHICH  REFERENCE  ANY                :
;       ABSOLUTE  ADDRESSES  WITHIN  THE  CODE  SEGMENTS  OF  BIOS               :
;       VIOLATE  THE  STRUCTURE  AND  DESIGN  OF  BIOS.                          :
;                                                                                :
;---------------------------------------------------------------------------------



;---------------------------------------------------------------------------------
;   MODULE REFERENCE                                                             :
;                                                                                :
;    TEST1.ASM      -->  POST AND MANUFACTURING TEST ROUTINES                    :
;      DSEG.INC     -->   DATA SEGMENTS LOCATIONS                                :
;      POSTEQU.INC  -->   COMMON EQUATES FOR POST AND BIOS                       :
;      SYSDATA.INC  -->   POWER ON SELF TEST EQUATES FOR PROTECTED MODE          :
;                           POST TEST.01 THROUGH TEST.16                         :
;    TEST2.ASM      -->  POST TEST AND INITIALIZATION ROUTINES                   :
;                           POST TEST.17 THROUGH TEST.22                         :
;    TEST3.ASM      -->  POST EXCEPTION INTERRUPT TESTS                          :
;    TEST4.ASM      -->  POST AND BIOS UTILITY ROUTINES                          :
;                          CMOS_READ      - READ CMOS LOCATION ROUTINE           :
;                          CMOS_WRITE     - WRITE CMOS LOCATION ROUTINE          :
;                          DDS            - LOAD (DS:) WITH DATA SEGMENT         :
;                          E_MSG          - POST ERROR MESSAGE HANDLER           :
;                          MFG_HALT       - MANUFACTURING ERROR TRAP             :
;                          P_MSG          - POST STRING DISPLAY ROUTINE          :
;                          ERR_BEEP       - POST ERROR BEEP PROCEDURE            :
;                          BEEP           - SPEAKER BEEP CONTROL ROUTINE         :
;                          WAITF          - FIXED TIME WAIT ROUTINE              :
;                          CONFIG_BAD     - SET BAD_CONFIG IN CMOS_DIAG          :
;                          XPC_BYTE       - DISPLAY HEX BYTE AS 00 - FF          :
;                          PRT_HEX        - DISPLAY CHARACTER                    :
;                          PRT_SEG        - DISPLAY SEGMENT FORMAT ADDRESS       :
;                          PROT_PRT_HEX   - POST PROTECTED MODE DISPLAY          :
;                          ROM_CHECKSUM   - CHECK ROM MODULES FOR CHECKSUM       :
;                          ROM_CHECK      - ROM SCAN AND INITIALIZE              :
;                          KBD_RESET      - POST KEYBOARD RESET ROUTINE          :
;                          BLINK_INT      - MANUFACTURING TOGGLE BIT ROUTINE     :
;                          SET_TOD        - SET TIMER FROM CMOS RTC              :
;                          D11            - DUMMY INTERRUPT HANDLER   ->INT ??H  :
;                          RE_DIRECT      - HARDWARE INT  9 REDIRECT (L 2)       :
;                          INT_287        - HARDWARE INT 13 REDIRECT (287)       :
;                          PROC_SHUTDOWN  - 80286 RESET ROUTINE                  :
;    TEST5.ASM      -->  EXCEPTION INTERRUPT TEST HANDLERS FOR POST TESTS        :
;                          SYSINIT1       - BUILD PROTECTED MODE POINTERS        :
;                          GDT_BLD        - BUILD THE GDT FOR POST               :
;                          SIDT_BLD       - BUILD THE IDT FOR POST               :
;    TEST6.ASM      -->  POST TESTS AND SYSTEM BOOT STRAP                        :
;                          STGTST_CNT     - SEGMENT STORAGE TEST                 :
;                          ROM_ERR        - ROM ERROR DISPLAY ROUTINE            :
;                          XMIT_8042      - KEYBOARD DIAGNOSTIC OUTPUT           :
;                          BOOT_STRAP     - BOOT STRAP LOADER          -INT 19H  :
;                                                                                :
;    DSKETTE.ASM    -->  DISKETTE BIOS                                           :
;                          DISKETTE_IO_1  - INT 13H BIOS ENTRY (40H)   -INT 13H  :
;                          DISK_INT_1     - HARDWARE INTERRUPT HANDLER -INT 0EH  :
;                          DSKETTE_SETUP  - POST SETUP DRIVE TYPES               :
;    DISK.ASM       -->  FIXED DISK BIOS                                         :
;                          DISK_SETUP     - SETUP DISK VECTORS AND TEST          :
;                          DISK_IO        - INT 13H BIOS ENTRY         -INT 13H  :
;                          HD_INT         - HARDWARE INTERRUPT HANDLER -INT 76H  :
;    KYBD.ASM       -->  KEYBOARD BIOS                                           :
;                          KEYBOARD_IO_1  - INT 16H BIOS ENTRY         -INT 16H  :
;                          KB_INT_1       - HARDWARE INTERRUPT         -INT 09H  :
;                          SND_DATA       - KEYBOARD TRANSMISSION                :
;    PRT.ASM        -->  PRINTER ADAPTER BIOS                          -INT 17H  :
;    RS232.ASM      -->  COMMUNICATIONS BIOS FOR RS232                 -INT 14H  :
;    VIDEO1.ASM     -->  VIDEO BIOS                                    -INT 10H  :
;    BIOS.ASM       -->  BIOS ROUTINES                                           :
;                          MEMORY_SIZE_DET_1 - REAL MODE SIZE          -INT 12H  :
;                          EQUIPMENT_1    - EQUIPMENT DETERMINATION    -INT 11H  :
;                          NMI_INT_1      - NMI HANDLER                -INT 02H  :
;    BIOS1.ASM      -->  INTERRUPT 15H BIOS ROUTINES                   -INT 15H  :
;                          DEV_OPEN       - NULL DEVICE OPEN HANDLER             :
;                          DEV_CLOSE      - NULL DEVICE CLOSE HANDLER            :
;                          PROG_TERM      - NULL PROGRAM TERMINATION             :
;                          EVENT_WAIT     - RTC EVENT WAIT/TIMEOUT ROUTINE       :
;                          JOY_STICK      - JOYSTICK PORT HANDLER                :
;                          SYS_REQ        - NULL SYSTEM REQUEST KEY              :
;                          WAIT           - RTC TIMED WAIT ROUTINE               :
;                          BLOCKMOVE      - EXTENDED MEMORY MOVE INTERFACE       :
;                          GATE_A20       - ADDRESS BIT 20 CONTROL               :
;                          EXT_MEMORY     - EXTENDED MEMORY SIZE DETERMINE       :
;                          SET_VMODE      - SWITCH PROCESSOR TO VIRTUAL MODE     :
;                          DEVICE_BUSY    - NULL DEVICE BUSY HANDLER             :
;                          INT_COMPLETE   - NULL INTERRUPT COMPLETE HANDLER      :
;    BIOS2.ASM      -->  BIOS INTERRUPT ROUTINES                                 :
;                          TIME_OF_DAY_1  - TIME OF DAY ROUTINES       -INT 1AH  :
;                          RTC_INT        - IRQ LEVEL 8 ALARM HANDLER  -INT 70H  :
;                          PRINT_SCREEN1  - PRINT SCREEN ROUTINE       -INT 05H  :
;                          TIMER_INT_1    - TIMER1 INTERRUPT HANDLER  ->INT 1CH  :
;    ORGS.ASM       -->  COMPATIBILITY MODULE                                    :
;                          POST ERROR MESSAGES                                   :
;                          DISKETTE - DISK - VIDEO DATA TABLES                   :
;---------------------------------------------------------------------------------
.LIST
```

```
                          PAGE
                      C   INCLUDE DSEG.INC
                      C   ;----------------------------------------
                      C   ;         80286 INTERRUPT LOCATIONS       :
                      C   ;         REFERENCED BY POST & BIOS       :
                      C   ;----------------------------------------
                      C
0000                  C   ABS0            SEGMENT AT 0            ; ADDRESS= 0000:0000
                      C
0000 ??               C   @STG_LOC0       DB      ?               ; START OF INTERRUPT VECTOR TABLE
                      C
0008                  C                   ORG     4*002H
0008 ????????         C   @NMI_PTR        DD      ?               ; NON-MASKABLE INTERRUPT VECTOR
                      C
0014                  C                   ORG     4*005H
0014 ????????         C   @INT5_PTR       DD      ?               ; PRINT SCREEN INTERRUPT VECTOR
                      C
0020                  C                   ORG     4*008H
0020 ????????         C   @INT_PTR        DD      ?               ; HARDWARE INTERRUPT POINTER (8-F)
                      C
0040                  C                   ORG     4*010H
0040 ????????         C   @VIDEO_INT      DD      ?               ; VIDEO I/O INTERRUPT VECTOR
                      C
004C                  C                   ORG     4*013H
004C ????????         C   @ORG_VECTOR     DD      ?               ; DISKETTE/DISK INTERRUPT VECTOR
                      C
0060                  C                   ORG     4*018H
0060 ????????         C   @BASIC_PTR      DD      ?               ; POINTER TO CASSETTE BASIC
                      C
0074                  C                   ORG     4*01DH
0074 ????????         C   @PARM_PTR       DD      ?               ; POINTER TO VIDEO PARAMETERS
                      C
0078                  C                   ORG     4*01EH
0078 ????????         C   @DISK_POINTER   DD      ?               ; POINTER TO DISKETTE PARAMETER TABLE
                      C
007C                  C                   ORG     4*01FH
007C ????????         C   @EXT_PTR        DD      ?               ; POINTER TO GRAPHIC CHARACTERS 128-255
                      C
0100                  C                   ORG     4*040H
0100 ????????         C   @DISK_VECTOR    DD      ?               ; POINTER TO DISKETTE INTERRUPT CODE
                      C
0104                  C                   ORG     4*041H
0104 ????????         C   @HF_TBL_VEC     DD      ?               ; POINTER TO FIRST DISK PARAMETER TABLE
                      C
0118                  C                   ORG     4*046H
0118 ????????         C   @HF1_TBL_VEC    DD      ?               ; POINTER TO SECOND DISK PARAMETER TABLE
                      C
01C0                  C                   ORG     4*070H
01C0 ????????         C   @SLAVE_INT_PTR  DD      ?               ; POINTER TO SLAVE INTERRUPT HANDLER
                      C
01D8                  C                   ORG     4*076H
01D8 ????????         C   @HDISK_INT      DD      ?               ; POINTER TO FIXED DISK INTERRUPT CODE
                      C
0400                  C                   ORG     0400H
0400 ????             C   @TOS            DW      ?               ; STACK -- USED DURING POST ONLY
                      C                                           ;   USE WILL OVERLAY INTERRUPTS VECTORS
                      C
0500                  C                   ORG     0500H
0500                  C   @MFG_TEST_RTN   LABEL   FAR             ; LOAD LOCATION FOR MANUFACTURING TESTS
                      C
7C00                  C                   ORG     7C00H
7C00                  C   @BOOT_LOCN      LABEL   FAR             ; BOOT STRAP CODE LOAD LOCATION
                      C
7C00                  C   ABS0            ENDS
```

SECTION 5

```
                        C  PAGE
                        C  ;----------------------------------------
                        C  ;        ROM BIOS DATA AREAS            :
                        C  ;----------------------------------------
                        C
0000                    C  DATA            SEGMENT AT 40H        ; ADDRESS= 0040:0000
                        C
0000 ????               C  @RS232_BASE     DW      ?             ; BASE ADDRESSES OF RS232 ADAPTERS
0002 ????               C                  DW      ?             ;  SECOND LOGICAL RS232 ADAPTER
0004 ????               C                  DW      ?             ;   RESERVED
0006 ????               C                  DW      ?             ;   RESERVED
0008 ????               C  @PRINTER_BASE   DW      ?             ; BASE ADDRESSES OF PRINTER ADAPTERS
000A ????               C                  DW      ?             ;  SECOND LOGICAL PRINTER ADAPTER
000C ????               C                  DW      ?             ;  THIRD LOGICAL PRINTER ADAPTER
000E ????               C                  DW      ?             ;   RESERVED
0010 ????               C  @EQUIP_FLAG     DW      ?             ; INSTALLED HARDWARE FLAGS
0012 ??                 C  @MFG_TST        DB      ?             ; INITIALIZATION FLAGS
0013 ????               C  @MEMORY_SIZE    DW      ?             ; BASE MEMORY SIZE IN K BYTES  (X 1024)
0015 ??                 C  @MFG_ERR_FLAG   DB      ?             ; SCRATCHPAD FOR MANUFACTURING
0016 ??                 C                  DB      ?             ;  ERROR CODES
                        C
                        C  ;----------------------------------------
                        C  ;        KEYBOARD DATA AREAS            :
                        C  ;----------------------------------------
                        C
0017 ??                 C  @KB_FLAG        DB      ?             ; KEYBOARD SHIFT STATE AND STATUS FLAGS
0018 ??                 C  @KB_FLAG_1      DB      ?             ; SECOND BYTE OF KEYBOARD STATUS
0019 ??                 C  @ALT_INPUT      DB      ?             ; STORAGE FOR ALTERNATE KEY PAD ENTRY
001A ????               C  @BUFFER_HEAD    DW      ?             ; POINTER TO HEAD OF KEYBOARD BUFFER
001C ????               C  @BUFFER_TAIL    DW      ?             ; POINTER TO TAIL OF KEYBOARD BUFFER
                        C
                        C  ;------     HEAD = TAIL    INDICATES THAT THE BUFFER IS EMPTY
                        C
001E    10 [            C  @KB_BUFFER      DW      16 DUP(?)     ; ROOM FOR 15 SCAN CODE ENTRIES
              ????      C
                   ]    C
                        C
                        C  ;----------------------------------------
                        C  ;        DISKETTE DATA AREAS            :
                        C  ;----------------------------------------
                        C
003E ??                 C  @SEEK_STATUS    DB      ?             ; DRIVE RECALIBRATION STATUS
                        C                                        ; BIT 3-0 = DRIVE 3-0 RECALIBRATION
                        C                                        ; BEFORE NEXT SEEK IF BIT IS = 0
003F ??                 C  @MOTOR_STATUS   DB      ?             ; MOTOR STATUS
                        C                                        ; BIT 3-0 = DRIVE 3-0 CURRENTLY RUNNING
                        C                                        ; BIT 7 = CURRENT OPERATION IS A WRITE
0040 ??                 C  @MOTOR_COUNT    DB      ?             ; TIME OUT COUNTER FOR MOTOR(S) TURN OFF
0041 ??                 C  @DSKETTE_STATUS DB      ?             ; RETURN CODE STATUS BYTE
                        C                                        ; CMD_BLOCK  IN STACK FOR DISK OPERATION
0042    07 [            C  @NEC_STATUS     DB      7 DUP(?)      ; STATUS BYTES FROM DISKETTE OPERATION
             ??         C
                  ]     C
                        C
                        C
                        C  ;----------------------------------------
                        C  ;        VIDEO DISPLAY DATA AREA        :
                        C  ;----------------------------------------
                        C
0049 ??                 C  @CRT_MODE       DB      ?             ; CURRENT DISPLAY MODE (TYPE)
004A ????               C  @CRT_COLS       DW      ?             ; NUMBER OF COLUMNS ON SCREEN
004C ????               C  @CRT_LEN        DW      ?             ; LENGTH OF REGEN BUFFER IN BYTES
004E ????               C  @CRT_START      DW      ?             ; STARTING ADDRESS IN REGEN BUFFER
0050    08 [            C  @CURSOR_POSN    DW      8 DUP(?)      ; CURSOR FOR EACH OF UP TO 8 PAGES
              ????      C
                   ]    C
                        C
0060 ????               C  @CURSOR_MODE    DW      ?             ; CURRENT CURSOR MODE SETTING
0062 ??                 C  @ACTIVE_PAGE    DB      ?             ; CURRENT PAGE BEING DISPLAYED
0063 ????               C  @ADDR_6845      DW      ?             ; BASE ADDRESS FOR ACTIVE DISPLAY CARD
0065 ??                 C  @CRT_MODE_SET   DB      ?             ; CURRENT SETTING OF THE 3X8 REGISTER
0066 ??                 C  @CRT_PALETTE    DB      ?             ; CURRENT PALETTE SETTING - COLOR CARD
                        C
                        C  ;----------------------------------------
                        C  ;        POST AND BIOS WORK DATA AREA   :
                        C  ;----------------------------------------
                        C
                        C                                        ; STACK SAVE, etc.
0067 ????               C  @IO_ROM_INIT    DW      ?             ; POINTER TO ROM INITIALIZATION ROUTINE
0069 ????               C  @IO_ROM_SEG     DW      ?             ; POINTER TO I/O ROM SEGMENT
006B ??                 C  @INTR_FLAG      DB      ?             ; FLAG INDICATING AN INTERRUPT HAPPENED
                        C
                        C  ;----------------------------------------
                        C  ;        TIMER DATA AREA                :
                        C  ;----------------------------------------
                        C
006C ????               C  @TIMER_LOW      DW      ?             ; LOW WORD OF TIMER COUNT
006E ????               C  @TIMER_HIGH     DW      ?             ; HIGH WORD OF TIMER COUNT
0070 ??                 C  @TIMER_OFL      DB      ?             ; TIMER HAS ROLLED OVER SINCE LAST READ
                        C
                        C  ;----------------------------------------
                        C  ;        SYSTEM DATA AREA               :
                        C  ;----------------------------------------
                        C
0071 ??                 C  @BIOS_BREAK     DB      ?             ; BIT 7=1 IF BREAK KEY HAS BEEN PRESSED
0072 ????               C  @RESET_FLAG     DW      ?             ; WORD=1234H IF KEYBOARD RESET UNDERWAY
                        C
                        C  ;----------------------------------------
                        C  ;        FIXED DISK DATA AREAS          :
                        C  ;----------------------------------------
                        C
0074 ??                 C  @DISK_STATUS1   DB      ?             ; FIXED DISK STATUS
0075 ??                 C  @HF_NUM         DB      ?             ; COUNT OF FIXED DISK DRIVES
0076 ??                 C  @CONTROL_BYTE   DB      ?             ; HEAD CONTROL BYTE
0077 ??                 C  @PORT_OFF       DB      ?             ;  RESERVED (PORT OFFSET)
```

```
                        C  PAGE
                        C  ;----------------------------------------
                        C  ;        TIME-OUT VARIABLES              :
                        C  ;----------------------------------------
                        C
0078 ??                 C  @PRINT_TIM_OUT  DB    ?          ; TIME OUT COUNTERS FOR PRINTER RESPONSE
0079 ??                 C                  DB    ?          ;  SECOND LOGICAL PRINTER ADAPTER
007A ??                 C                  DB    ?          ;  THIRD LOGICAL PRINTER ADAPTER
007B ??                 C                  DB    ?          ;   RESERVED
007C ??                 C  @RS232_TIM_OUT  DB    ?          ; TIME OUT COUNTERS FOR RS232 RESPONSE
007D ??                 C                  DB    ?          ;  SECOND LOGICAL RS232 ADAPTER
007E ??                 C                  DB    ?          ;   RESERVED
007F ??                 C                  DB    ?          ;   RESERVED
                        C
                        C  ;----------------------------------------
                        C  ;      ADDITIONAL KEYBOARD DATA AREA     :
                        C  ;----------------------------------------
                        C
                        C                                   ; BUFFER LOCATION WITHIN SEGMENT 40H
0080 ????               C  @BUFFER_START   DW    ?          ; OFFSET OF KEYBOARD BUFFER START
0082 ????               C  @BUFFER_END     DW    ?          ; OFFSET OF END OF BUFFER
                        C
                        C  ;----------------------------------------
                        C  ;        EGA/PGA DISPLAY WORK AREA       :
                        C  ;----------------------------------------
                        C
0084 ??                 C  @ROWS           DB    ?          ; ROWS ON THE ACTIVE SCREEN (LESS 1)
0085 ????               C  @POINTS         DW    ?          ; BYTES PER CHARACTER
0087 ??                 C  @INFO           DB    ?          ; MODE OPTIONS
0088 ??                 C  @INFO_3         DB    ?          ; FEATURE BIT SWITCHES
0089 ??                 C                  DB    ?          ; RESERVED FOR DISPLAY ADAPTERS
008A ??                 C                  DB    ?          ; RESERVED FOR DISPLAY ADAPTERS
                        C
                        C  ;----------------------------------------
                        C  ;        ADDITIONAL MEDIA DATA           :
                        C  ;----------------------------------------
                        C
008B ??                 C  @LASTRATE       DB    ?          ; LAST DISKETTE DATA RATE SELECTED
008C ??                 C  @HF_STATUS      DB    ?          ; STATUS REGISTER
008D ??                 C  @HF_ERROR       DB    ?          ; ERROR REGISTER
008E ??                 C  @HF_INT_FLAG    DB    ?          ; FIXED DISK INTERRUPT FLAG
008F ??                 C  @HF_CNTRL       DB    ?          ; COMBO FIXED DISK/DISKETTE CARD BIT 0=1
0090 ??                 C  @DSK_STATE      DB    ?          ; DRIVE 0 MEDIA STATE
0091 ??                 C                  DB    ?          ; DRIVE 1 MEDIA STATE
0092 ??                 C                  DB    ?          ; DRIVE 0 OPERATION START STATE
0093 ??                 C                  DB    ?          ; DRIVE 1 OPERATION START STATE
0094 ??                 C  @DSK_TRK        DB    ?          ; DRIVE 0 PRESENT CYLINDER
0095 ??                 C                  DB    ?          ; DRIVE 1 PRESENT CYLINDER
                        C
                        C  ;----------------------------------------
                        C  ;        ADDITIONAL KEYBOARD FLAGS       :
                        C  ;----------------------------------------
                        C
0096 ??                 C  @KB_FLAG_3      DB    ?          ; KEYBOARD MODE STATE AND TYPE FLAGS
0097 ??                 C  @KB_FLAG_2      DB    ?          ; KEYBOARD LED FLAGS
                        C
                        C  ;----------------------------------------
                        C  ;        REAL TIME CLOCK DATA AREA       :
                        C  ;----------------------------------------
                        C
0098 ????               C  @USER_FLAG      DW    ?          ; OFFSET ADDRESS OF USERS WAIT FLAG
009A ????               C  @USER_FLAG_SEG  DW    ?          ; SEGMENT ADDRESS OF USER WAIT FLAG
009C ????               C  @RTC_LOW        DW    ?          ; LOW WORD OF USER WAIT FLAG
009E ????               C  @RTC_HIGH       DW    ?          ; HIGH WORD OF USER WAIT FLAG
00A0 ??                 C  @RTC_WAIT_FLAG  DB    ?          ; WAIT ACTIVE FLAG (01=BUSY, 80=POSTED)
                        C                                   ;                  (00=POST ACKNOWLEDGED)
                        C  ;----------------------------------------
                        C  ;        AREA FOR NETWORK ADAPTER        :
                        C  ;----------------------------------------
                        C
00A1    07 [            C  @NET            DB    7 DUP(?)   ; RESERVED FOR NETWORK ADAPTERS
              ??        C
                   ]    C
                        C
                        C  ;----------------------------------------
                        C  ;        EGA/PGA PALETTE POINTER         :
                        C  ;----------------------------------------
                        C
00A8 ????????           C  @SAVE_PTR       DD    ?          ; POINTER TO EGA PARAMETER CONTROL BLOCK
                        C
                        C                                   ; RESERVED
                        C  ;----------------------------------------
                        C  ;        DATA AREA - PRINT SCREEN        :
                        C  ;----------------------------------------
                        C
0100                    C                  ORG   100H       ; ADDRESS= 0040:0100   (REF 0050:0000)
                        C
0100 ??                 C  @STATUS_BYTE    DB    ?          ; PRINT SCREEN STATUS BYTE
                        C                                   ;  00=READY/OK, 01=BUSY,  FF=ERROR
                        C
0101                    C  DATA            ENDS             ; END OF BIOS DATA SEGMENT
                        C
                           .LIST
```

SECTION 5

```
                    PAGE
                  C INCLUDE POSTEQU.INC
                  C ;----------------------------------------
                  C ;       EQUATES USED BY POST AND BIOS    :
                  C ;----------------------------------------
                  C
= 00FC            C MODEL_BYTE       EQU     0FCH            ; SYSTEM MODEL BYTE
= 0000            C SUB_MODEL_BYTE   EQU     000H            ; SYSTEM SUB-MODEL TYPE
= 0001            C BIOS_LEVEL       EQU     001H            ; BIOS REVISION LEVEL
= F8A7            C RATE_UPPER       EQU     0F8A7H          ; 0F952H +10%
= F9FD            C RATE_LOWER       EQU     0F9FDH          ; 0F952H -10%
                  C
                  C ;--------- 8042 KEYBOARD INTERFACE AND DIAGNOSTIC CONTROL REGISTERS ------------
= 0060            C PORT_A           EQU     060H            ; 8042 KEYBOARD SCAN CODE/CONTROL PORT
= 0061            C PORT_B           EQU     061H            ; PORT B READ/WRITE DIAGNOSTIC REGISTER
= 00F3            C RAM_PAR_ON       EQU     11110011B       ; AND MASK FOR PARITY CHECKING ENABLE ON
= 000C            C RAM_PAR_OFF      EQU     00001100B       ; OR MASK FOR PARITY CHECKING ENABLE OFF
= 00C0            C PARITY_ERR       EQU     11000000B       ; R/W MEMORY - I/O CHANNEL PARITY ERROR
= 0001            C GATE2            EQU     00000001B       ; TIMER 2 INPUT GATE CLOCK BIT
= 0002            C SPK2             EQU     00000010B       ; SPEAKER OUTPUT DATA ENABLE BIT
= 0010            C REFRESH_BIT      EQU     00010000B       ; REFRESH TEST BIT
= 0020            C OUT2             EQU     00100000B       ; SPEAKER TIMER OUT2 INPUT BIT
= 0040            C IO_CHECK         EQU     01000000B       ; I/O (MEMORY) CHECK OCCURRED BIT MASK
= 0080            C PARITY_CHECK     EQU     10000000B       ; MEMORY PARITY CHECK OCCURRED BIT MASK
= 0064            C STATUS_PORT      EQU     064H            ; 8042 STATUS PORT
= 0001            C OUT_BUF_FULL     EQU     00000001B       ;   0 = +OUTPUT BUFFER FULL
= 0002            C INPT_BUF_FULL    EQU     00000010B       ;   1 = +INPUT BUFFER FULL
= 0004            C SYS_FLAG         EQU     00000100B       ;   2 = -SYSTEM FLAG -POST/-SELF TEST
= 0008            C CMD_DATA         EQU     00001000B       ;   3 = -COMMAND/+DATA
= 0010            C KYBD_INH         EQU     00010000B       ;   4 = +KEYBOARD INHIBITED
= 0020            C TRANS_TMOUT      EQU     00100000B       ;   5 = +TRANSMIT TIMEOUT
= 0040            C RCV_TMOUT        EQU     01000000B       ;   6 = +RECEIVE TIME OUT
= 0080            C PARITY_EVEN      EQU     10000000B       ;   7 = +PARITY IS EVEN
                  C
                  C ;--------- 8042 INPUT PORT BIT DEFINITION SAVED IN @MFG_TST --------------------
= 0008            C BASE_MEM8        EQU     00001000B       ; BASE PLANAR R/W MEMORY EXTENSION 640/X
= 0010            C BASE_MEM         EQU     00010000B       ; BASE PLANAR R/W MEMORY SIZE 256/512
= 0020            C MFG_LOOP         EQU     00100000B       ; LOOP POST JUMPER BIT FOR MANUFACTURING
= 0040            C DSP_JMP          EQU     01000000B       ; DISPLAY TYPE SWITCH JUMPER BIT
= 0080            C KEY_BD_INHIB     EQU     10000000B       ; KEYBOARD INHIBIT SWITCH BIT
                  C
                  C ;--------- 8042 COMMANDS -----------------------------------------------------
= 0060            C WRITE_8042_LOC   EQU     060H            ; WRITE 8042 COMMAND BYTE
= 00AA            C SELF_TEST        EQU     0AAH            ; 8042 SELF TEST
= 00AB            C INTR_FACE_CK     EQU     0ABH            ; CHECK 8042 INTERFACE COMMAND
= 00AD            C DIS_KBD          EQU     0ADH            ; DISABLE KEYBOARD COMMAND
= 00AE            C ENA_KBD          EQU     0AEH            ; ENABLE KEYBOARD COMMAND
= 00C0            C READ_8042_INPUT  EQU     0C0H            ; READ 8042 INPUT PORT
= 00DD            C DISABLE_BIT20    EQU     0DDH            ; DISABLE ADDRESS LINE BIT 20
= 00DF            C ENABLE_BIT20     EQU     0DFH            ; ENABLE ADDRESS LINE BIT 20
= 00E0            C KYBD_CLK_DATA    EQU     0E0H            ; GET KEYBOARD CLOCK AND DATA COMMAND
= 00FE            C SHUT_CMD         EQU     0FEH            ; CAUSE A SHUTDOWN COMMAND
= 0001            C KYBD_CLK         EQU     001H            ; KEYBOARD CLOCK BIT 0
                  C
                  C ;---------- KEYBOARD/LED COMMANDS -------------------------------------------
= 00ED            C LED_CMD          EQU     0EDH            ; LED WRITE COMMAND
= 00F2            C KB_READ_ID       EQU     0F2H            ; READ KEYBOARD ID COMMAND
= 00F4            C KB_ENABLE        EQU     0F4H            ; KEYBOARD ENABLE
                  C
                  C ;---------- 8042 KEYBOARD RESPONSE -------------------------------------------
= 00AA            C KB_OK            EQU     0AAH            ; RESPONSE FROM SELF DIAGNOSTIC
= 00FA            C KB_ACK           EQU     0FAH            ; ACKNOWLEDGE FROM TRANSMISSION
= 00FE            C KB_RESEND        EQU     0FEH            ; RESEND REQUEST
= 00FF            C KB_OVER_RUN      EQU     0FFH            ; OVER RUN SCAN CODE
                  C
                  C ;---------- FLAG EQUATES WITHIN @KB_FLAG -------------------------------------
= 0001            C RIGHT_SHIFT      EQU     00000001B       ; RIGHT SHIFT KEY DEPRESSED
= 0002            C LEFT_SHIFT       EQU     00000010B       ; LEFT SHIFT KEY DEPRESSED
= 0004            C CTL_SHIFT        EQU     00000100B       ; CONTROL SHIFT KEY DEPRESSED
= 0008            C ALT_SHIFT        EQU     00001000B       ; ALTERNATE SHIFT KEY DEPRESSED
= 0010            C SCROLL_STATE     EQU     00010000B       ; SCROLL LOCK STATE HAS BEEN TOGGLED
= 0020            C NUM_STATE        EQU     00100000B       ; NUM LOCK STATE HAS BEEN TOGGLED
= 0040            C CAPS_STATE       EQU     01000000B       ; CAPS LOCK STATE HAS BEEN TOGGLED
= 0080            C INS_STATE        EQU     10000000B       ; INSERT STATE IS ACTIVE
                  C
                  C ;---------- FLAG EQUATES WITHIN @KB_FLAG_1 -----------------------------------
= 0004            C SYS_SHIFT        EQU     00000100B       ; SYSTEM KEY DEPRESSED AND HELD
= 0008            C HOLD_STATE       EQU     00001000B       ; SUSPEND KEY HAS BEEN TOGGLED
= 0010            C SCROLL_SHIFT     EQU     00010000B       ; SCROLL LOCK KEY IS DEPRESSED
= 0020            C NUM_SHIFT        EQU     00100000B       ; NUM LOCK KEY IS DEPRESSED
= 0040            C CAPS_SHIFT       EQU     01000000B       ; CAPS LOCK KEY IS DEPRESSED
= 0080            C INS_SHIFT        EQU     10000000B       ; INSERT KEY IS DEPRESSED
                  C
                  C ;---------- FLAGS EQUATES WITHIN @KB_FLAG_2 ----------------------------------
= 0007            C KB_LEDS          EQU     00000111B       ; KEYBOARD LED STATE BITS
                  C ;                EQU     00001000B       ; RESERVED (MUST BE ZERO)
= 0010            C KB_FA            EQU     00010000B       ; ACKNOWLEDGMENT RECEIVED
= 0020            C KB_FE            EQU     00100000B       ; RESEND RECEIVED FLAG
= 0040            C KB_PR_LED        EQU     01000000B       ; MODE INDICATOR UPDATE
= 0080            C KB_ERR           EQU     10000000B       ; KEYBOARD TRANSMIT ERROR FLAG
                  C
                  C ;---------- FLAGS EQUATES WITHIN @KB_FLAG_3 ----------------------------------
= 0001            C KBX              EQU     00000001B       ; KBX INSTALLED
= 0002            C LC_HC            EQU     00000010B       ; LAST SCAN CODED WAS A HIDDEN CODE
= 0004            C GRAPH_ON         EQU     00000100B       ; ALL GRAPHICS KEY DOWN (W.T. ONLY)
                  C ;                EQU     00011000B       ; RESERVED (MUST BE ZERO)
= 0020            C SET_NUM_LK       EQU     00100000B       ; FORCE NUM LOCK IF READ ID AND KBX
= 0040            C LC_AB            EQU     01000000B       ; LAST CHARACTER WAS FIRST ID CHARACTER
= 0080            C RD_ID            EQU     10000000B       ; DOING A READ ID (MUST BE BIT0)
                  C
                  C ;---------- KEYBOARD SCAN CODES ---------------------------------------------
= 00AB            C ID_1             EQU     0ABH            ; 1ST ID CHARACTER FOR KBX
= 0041            C ID_2             EQU     041H            ; 2ND ID CHARACTER FOR KBX
= 0038            C ALT_KEY          EQU     56              ; SCAN CODE FOR  ALTERNATE SHIFT KEY
= 001D            C CTL_KEY          EQU     29              ; SCAN CODE FOR  CONTROL KEY
= 003A            C CAPS_KEY         EQU     58              ; SCAN CODE FOR  SHIFT LOCK KEY
= 0053            C DEL_KEY          EQU     83              ; SCAN CODE FOR  DELETE KEY
= 0052            C INS_KEY          EQU     82              ; SCAN CODE FOR  INSERT KEY
= 002A            C LEFT_KEY         EQU     42              ; SCAN CODE FOR  LEFT SHIFT
= 0045            C NUM_KEY          EQU     69              ; SCAN CODE FOR  NUMBER LOCK KEY
= 0036            C RIGHT_KEY        EQU     54              ; SCAN CODE FOR  RIGHT SHIFT
= 0046            C SCROLL_KEY       EQU     70              ; SCAN CODE FOR  SCROLL LOCK KEY
= 0054            C SYS_KEY          EQU     84              ; SCAN CODE FOR  SYSTEM KEY
```

```
                C PAGE
                C ;----------------------------------------
                C ;       CMOS EQUATES FOR THIS SYSTEM     :
                C ;-------------------------------------------------------------------------------
 = 0070         C CMOS_PORT       EQU     070H            ; I/O ADDRESS OF CMOS ADDRESS PORT
 = 0071         C CMOS_DATA       EQU     071H            ; I/O ADDRESS OF CMOS DATA PORT
 = 0080         C NMI             EQU     10000000B       ; DISABLE NMI INTERRUPTS MASK -
                C                                         ;  HIGH BIT OF CMOS LOCATION ADDRESS
                C
                C ;---------- CMOS TABLE LOCATION ADDRESS'S ## -----------------------------------
 = 0000         C CMOS_SECONDS    EQU     000H            ; SECONDS
 = 0001         C CMOS_SEC_ALARM  EQU     001H            ; SECONDS ALARM  ## NOTE:  ALL LOCATIONS
 = 0002         C CMOS_MINUTES    EQU     002H            ; MINUTES              | IN THE CMOS AREA
 = 0003         C CMOS_MIN_ALARM  EQU     003H            ; MINUTES ALARM        | ARE IBM USE ONLY
 = 0004         C CMOS_HOURS      EQU     004H            ; HOURS                | AND  SUBJECT  TO
 = 0005         C CMOS_HR_ALARM   EQU     005H            ; HOURS ALARM          | CHANGE. ONLY THE
 = 0006         C CMOS_DAY_WEEK   EQU     006H            ; DAY OF THE WEEK      | POST & BIOS CODE
 = 0007         C CMOS_DAY_MONTH  EQU     007H            ; DAY OF THE MONTH     | SHOULD  DIRECTLY
 = 0008         C CMOS_MONTH      EQU     008H            ; MONTH                | ACCESS LOCATIONS
 = 0009         C CMOS_YEAR       EQU     009H            ; YEAR (TWO DIGITS)    | IN CMOS STORAGE.
 = 000A         C CMOS_REG_A      EQU     00AH            ; STATUS REGISTER A    '-----------------
 = 000B         C CMOS_REG_B      EQU     00BH            ; STATUS REGISTER B  ALARM
 = 000C         C CMOS_REG_C      EQU     00CH            ; STATUS REGISTER C  FLAGS
 = 000D         C CMOS_REG_D      EQU     00DH            ; STATUS REGISTER D  BATTERY
 = 000E         C CMOS_DIAG       EQU     00EH            ; POST DIAGNOSTIC STATUS RESULTS BYTE
 = 000F         C CMOS_SHUT_DOWN  EQU     00FH            ; SHUTDOWN STATUS COMMAND BYTE
 = 0010         C CMOS_DISKETTE   EQU     010H            ; DISKETTE DRIVE TYPE BYTE              ;
                C ;               EQU     011H            ; - RESERVED                            ;C
 = 0012         C CMOS_DISK       EQU     012H            ; FIXED DISK TYPE BYTE                  ;H
                C ;               EQU     013H            ; - RESERVED                            ;E
 = 0014         C CMOS_EQUIP      EQU     014H            ; EQUIPMENT WORD LOW BYTE               ;C
 = 0015         C CMOS_B_M_S_LO   EQU     015H            ; BASE MEMORY SIZE - LOW BYTE (X1024)   ;K
 = 0016         C CMOS_B_M_S_HI   EQU     016H            ; BASE MEMORY SIZE - HIGH BYTE          ;S
 = 0017         C CMOS_E_M_S_LO   EQU     017H            ; EXPANSION MEMORY SIZE - LOW BYTE      ;U
 = 0018         C CMOS_E_M_S_HI   EQU     018H            ; EXPANSION MEMORY SIZE - HIGH BYTE     ;M
 = 0019         C CMOS_DISK_1     EQU     019H            ; FIXED DISK TYPE - DRIVE C EXTENSION   ;E
 = 001A         C CMOS_DISK_2     EQU     01AH            ; FIXED DISK TYPE - DRIVE D EXTENSION   ;D
                C ;               EQU     01BH            ; - 1BH THROUGH 2DH - RESERVED          ;
 = 002E         C CMOS_CKSUM_HI   EQU     02EH            ; CMOS CHECKSUM - HIGH BYTE             ;*
 = 002F         C CMOS_CKSUM_LO   EQU     02FH            ; CMOS CHECKSUM - LOW BYTE              ;*
 = 0030         C CMOS_U_M_S_LO   EQU     030H            ; USABLE MEMORY ABOVE 1 MEG - LOW BYTE
 = 0031         C CMOS_U_M_S_HI   EQU     031H            ; USABLE MEMORY ABOVE 1 MEG - HIGH BYTE
 = 0032         C CMOS_CENTURY    EQU     032H            ; DATE CENTURY BYTE (BCD)
 = 0033         C CMOS_INFO128    EQU     033H            ; 128KB INFORMATION STATUS FLAG BYTE
                C ;               EQU     034H            ; - 34H THROUGH 3FH - RESERVED
                C
                C ;---------- CMOS DIAGNOSTIC STATUS ERROR FLAGS WITHIN CMOS_DIAG ---------------
 = 0004         C CMOS_CLK_FAIL   EQU     00000100B       ; CMOS CLOCK NOT UPDATING OR NOT VALID
 = 0008         C HF_FAIL         EQU     00001000B       ; FIXED DISK FAILURE ON INITIALIZATION
 = 0010         C W_MEM_SIZE      EQU     00010000B       ; MEMORY SIZE NOT EQUAL TO CONFIGURATION
 = 0020         C BAD_CONFIG      EQU     00100000B       ; MINIMUM CONFIG USED INSTEAD OF CMOS
 = 0040         C BAD_CKSUM       EQU     01000000B       ; CHECKSUM ERROR
 = 0080         C BAD_BAT         EQU     10000000B       ; DEAD BATTERY - CMOS LOST POWER
                C
                C ;---------- CMOS INFORMATION FLAGS -------------------------------------------
 = 0080         C M640K           EQU     10000000B       ; 512K -> 640K OPTION INSTALLED  (128K)
                C ;               EQU     01000000B       ; FLAG USED BY CMOS SETUP UTILITY
                C
                C
                C ;---------- DISKETTE EQUATES --------------------------------------------------
 = 0001         C DUAL            EQU     00000001B       ; MASK FOR COMBO/DSP ADAPTER
 = 0080         C INT_FLAG        EQU     10000000B       ; INTERRUPT OCCURRENCE FLAG
 = 0080         C DSK_CHG         EQU     10000000B       ; DISKETTE CHANGE FLAG MASK BIT
 = 0010         C DETERMINED      EQU     00010000B       ; SET STATE DETERMINED IN STATE BITS
 = 0010         C HOME            EQU     00010000B       ; TRACK 0 MASK
 = 0004         C SENSE_DRV_ST    EQU     00000100B       ; SENSE DRIVE STATUS COMMAND
 = 0030         C TRK_SLAP        EQU     030H            ; CRASH STOP (48 TPI DRIVES)
 = 000A         C QUIET_SEEK      EQU     00AH            ; SEEK TO TRACK 10
 = 0002         C MAX_DRV         EQU     2               ; MAX NUMBER OF DRIVES
 = 000F         C HD12_SETTLE     EQU     15              ; 1.2 M HEAD SETTLE TIME
 = 0014         C HD320_SETTLE    EQU     20              ; 320 K HEAD SETTLE TIME
 = 0025         C MOTOR_WAIT      EQU     37              ; 2 SECONDS OF COUNTS FOR MOTOR TURN OFF
                C
                C ;---------- DISKETTE ERRORS ---------------------------------------------------
 = 0080         C TIME_OUT        EQU     080H            ; ATTACHMENT FAILED TO RESPOND
 = 0040         C BAD_SEEK        EQU     040H            ; SEEK OPERATION FAILED
 = 0020         C BAD_NEC         EQU     020H            ; DISKETTE CONTROLLER HAS FAILED
 = 0010         C BAD_CRC         EQU     010H            ; BAD CRC ON DISKETTE READ
 = 0009         C DMA_BOUNDARY    EQU     009H            ; ATTEMPT TO DMA ACROSS 64K BOUNDARY
 = 0008         C BAD_DMA         EQU     008H            ; DMA OVERRUN ON OPERATION
 = 0006         C MEDIA_CHANGE    EQU     006H            ; MEDIA REMOVED ON DUAL ATTACH CARD
 = 0004         C RECORD_NOT_FND  EQU     004H            ; REQUESTED SECTOR NOT FOUND
 = 0003         C WRITE_PROTECT   EQU     003H            ; WRITE ATTEMPTED ON WRITE PROTECT DISK
 = 0002         C BAD_ADDR_MARK   EQU     002H            ; ADDRESS MARK NOT FOUND
 = 0001         C BAD_CMD         EQU     001H            ; BAD COMMAND PASSED TO DISKETTE I/O
                C
                C ;---------- DISK CHANGE LINE EQUATES ------------------------------------------
 = 0001         C NOCHGLN         EQU     001H            ; NO DISK CHANGE LINE AVAILABLE
 = 0002         C CHGLN           EQU     002H            ; DISK CHANGE LINE AVAILABLE
                C
                C ;---------- MEDIA/DRIVE STATE INDICATORS --------------------------------------
 = 0001         C TRK_CAPA        EQU     00000001B       ; 80 TRACK CAPABILITY
 = 0002         C FMT_CAPA        EQU     00000010B       ; MULTIPLE FORMAT CAPABILITY (1.2M)
 = 0004         C DRV_DET         EQU     00000100B       ; DRIVE DETERMINED
 = 0010         C MED_DET         EQU     00010000B       ; MEDIA DETERMINED BIT
 = 0020         C DBL_STEP        EQU     00100000B       ; DOUBLE STEP BIT
 = 00C0         C RATE_MSK        EQU     11000000B       ; MASK FOR CLEARING ALL BUT RATE
 = 0000         C RATE_500        EQU     00000000B       ; 500 KBS DATA RATE
 = 0040         C RATE_300        EQU     01000000B       ; 300 KBS DATA RATE
 = 0080         C RATE_250        EQU     10000000B       ; 250 KBS DATA RATE
 = 000C         C STRT_MSK        EQU     00001100B       ; OPERATION START RATE MASK
 = 00C0         C SEND_MSK        EQU     11000000B       ; MASK FOR SEND RATE BITS
                C
                C ;---------- MEDIA/DRIVE STATE INDICATORS COMPATIBILITY ------------------------
 = 0000         C M3D3U           EQU     00000000B       ; 360 MEDIA/DRIVE NOT ESTABLISHED
 = 0001         C M3D1U           EQU     00000001B       ; 360 MEDIA,1.2DRIVE NOT ESTABLISHED
 = 0002         C M1D1U           EQU     00000010B       ; 1.2 MEDIA/DRIVE NOT ESTABLISHED
 = 0007         C MED_UNK         EQU     00000111B       ; NONE OF THE ABOVE
```

SECTION 5

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                C  PAGE
                C  ;---------- INTERRUPT EQUATES -----------------------------------------------------
 = 0020         C  EOI             EQU     020H            ; END OF INTERRUPT COMMAND TO 8259
 = 0020         C  INTA00          EQU     020H            ; 8259 PORT
 = 0021         C  INTA01          EQU     021H            ; 8259 PORT
 = 00A0         C  INTB00          EQU     0A0H            ; 2ND 8259
 = 00A1         C  INTB01          EQU     0A1H            ;
 = 0070         C  INT_TYPE        EQU     070H            ; START OF 8259 INTERRUPT TABLE LOCATION
 = 0010         C  INT_VIDEO       EQU     010H            ; VIDEO VECTOR
                C  ;------------------------------------------------------------------------------------
 = 0008         C  DMA08           EQU     008H            ; DMA STATUS REGISTER PORT ADDRESS
 = 0000         C  DMA             EQU     000H            ; DMA CH.0 ADDRESS REGISTER PORT ADDRESS
 = 00D0         C  DMA18           EQU     0D0H            ; 2ND DMA STATUS PORT ADDRESS
 = 00C0         C  DMA1            EQU     0C0H            ; 2ND DMA CH.0 ADDRESS REGISTER ADDRESS
                C  ;------------------------------------------------------------------------------------
 = 0040         C  TIMER           EQU     040H            ; 8254 TIMER - BASE ADDRESS
                C
                C  ;--------- MANUFACTURING PORT ----------------------------------------------------
 = 0080         C  MFG_PORT        EQU     80H             ; MANUFACTURING AND POST CHECKPOINT PORT
                C                                          ;  DMA CHANNEL 0 PAGE REGISTER ADDRESS
                C
                C  ;--------- MANUFACTURING BIT DEFINITION FOR @MFG_ERR_FLAG+1 -------------------
 = 0001         C  MEM_FAIL        EQU     00000001B       ; STORAGE TEST FAILED          (ERROR 20X)
 = 0002         C  PRO_FAIL        EQU     00000010B       ; VIRTUAL MODE TEST FAILED     (ERROR 104)
 = 0004         C  LMCS_FAIL       EQU     00000100B       ; LOW MEG CHIP SELECT FAILED   (ERROR 109)
 = 0008         C  KYCLK_FAIL      EQU     00001000B       ; KEYBOARD CLOCK TEST FAILED   (ERROR 304)
 = 0010         C  KY_SYS_FAIL     EQU     00010000B       ; KEYBOARD OR SYSTEM FAILED    (ERROR 303)
 = 0020         C  KYBD_FAIL       EQU     00100000B       ; KEYBOARD FAILED              (ERROR 301)
 = 0040         C  DSK_FAIL        EQU     01000000B       ; DISKETTE TEST FAILED         (ERROR 601)
 = 0080         C  KEY_FAIL        EQU     10000000B       ; KEYBOARD LOCKED              (ERROR 302)
                C
                C  ;------------------------------------------------------------------------------------
 = 0081         C  DMA_PAGE        EQU     081H            ; START OF DMA PAGE REGISTERS
 = 008F         C  LAST_DMA_PAGE   EQU     08FH            ; LAST DMA PAGE REGISTER
                C
                C  ;------------------------------------------------------------------------------------
 = 00F0         C  X287            EQU     0F0H            ; MATH COPROCESSOR CONTROL PORT
                C
                C  ;------------------------------------------------------------------------------------
 = 0000         C  POST_SS         EQU     00000H          ; POST STACK SEGMENT
 = 8000         C  POST_SP         EQU     08000H          ; POST STACK POINTER
                C
                C  ;------------------------------------------------------------------------------------
 = 000D         C  CR              EQU     000DH           ; CARRIAGE RETURN CHARACTER
 = 000A         C  LF              EQU     000AH           ; LINE FEED CHARACTER
 = 0008         C  RVRT            EQU     00001000B       ; VIDEO VERTICAL RETRACE BIT
 = 0001         C  RHRZ            EQU     00000001B       ; VIDEO HORIZONTAL RETRACE BIT
 = 0100         C  H               EQU     256             ; HIGH BYTE FACTOR (X 100H)
 = 0101         C  X               EQU     H+1             ; HIGH AND LOW BYTE FACTOR (X 101H)
                C
                   .LIST
```

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                              PAGE
                         C    INCLUDE SYSDATA.INC
                         C    ;--------------------------------------------------------------------------------
                         C    ;       PROTECTED MODE EQUATES FOR POST TESTS AND BIOS ROUTINES            :
                         C    ;--------------------------------------------------------------------------------
                         C
                         C    ;-----          LENGTH EQUATES FOR PROTECTED MODE TESTS
                         C
 = 0300                  C    SDA_LEN        EQU     00300H           ; SYSTEM DATA AREA LENGTH
 = 0800                  C    SYS_IDT_LEN    EQU     256*8            ; 256 SYSTEM IDT ENTRIES, 8 BYTES EACH
 = 0088                  C    GDT_LEN        EQU     TYPE GDT_DEF     ; GDT STRUCTURE LENGTH
 = 0008                  C    DESC_LEN       EQU     TYPE DATA_DESC   ; LENGTH OF A DESCRIPTOR
 = 1000                  C    MCRT_SIZE      EQU     4*1024           ; MONOCHROME CRT SIZE
 = 4000                  C    CCRT_SIZE      EQU     16*1024          ; COMPATIBLE COLOR CRT SIZE
 = FFFF                  C    ECCRT_SIZE     EQU     0FFFFH           ; SIZE OF EACH PORTION OF THE ENHANCED
 = FFFF                  C    MAX_SEG_LEN    EQU     0FFFFH           ; MAXIMUM SEGMENT LENGTH = 64K
 = 0000                  C    NULL_SEG_LEN   EQU     00000H           ; NULL SEGMENT LENGTH = 0
                         C
                         C    ;-----          LOCATION EQUATES FOR PROTECTED MODE TESTS
                         C
 = D0A0                  C    SYS_IDT_LOC    EQU     0D0A0H           ; THE SYSTEM IDT IS AT THE BOTTOM
 = 0400                  C    SDA_LOC        EQU     00400H           ; SAME AS REAL
 = D8A0                  C    GDT_LOC        EQU     (SYS_IDT_LOC + SYS_IDT_LEN)
 = 0000                  C    MCRT@_LO       EQU     0000H            ; MONOCHROME CRT ADDRESS
 = 000B                  C    MCRT@_HI       EQU     0BH              ; (0B0000H)
 = 8000                  C    CCRT@_LO       EQU     8000H            ; COMPATIBLE COLOR CRT ADDRESS
 = 000B                  C    CCRT@_HI       EQU     0BH              ; (0B8000H)
 = 0000                  C    ECCRT@_LO_LO   EQU     0000H
 = 000A                  C    ECCRT@_LO_HI   EQU     0AH              ; (0A0000H)
 = 0000                  C    ECCRT@_HI_LO   EQU     0000H
 = 000B                  C    ECCRT@_HI_HI   EQU     0BH              ; (0B0000H)
 = 0000                  C    CSEG@_LO       EQU     0000H            ; CODE SEGMENT POST/BIOS
 = 000F                  C    CSEG@_HI       EQU     0FH              ; (0F0000H) FOR TESTS
 = 0000                  C    NSEG@_LO       EQU     0000H            ; ABS0
 = 0000                  C    NSEG@_HI       EQU     00H
                         C
                         C    ;-----  DEFINITIONS FOR ACCESS RIGHTS BYTES
                         C
 = 00F3                  C    CPL3_DATA_ACCESS        EQU     11110011B        ; PRESENT
                         C                                                     ; DPL = 3
                         C                                                     ; CODE/DATA SEGMENT
                         C                                                     ; NOT EXECUTABLE
                         C                                                     ; GROW-UP (OFFSET <= LIMIT)
                         C                                                     ; WRITABLE
                         C                                                     ; ACCESSED
 = 0093                  C    CPL0_DATA_ACCESS        EQU     10010011B        ; DPL = 0
 = 009B                  C    CPL0_CODE_ACCESS        EQU     10011011B        ; CPL 0 - NON-CONFORMING
 = 00E2                  C    LDT_DESC                EQU     11100010B
 = 0081                  C    FREE_TSS                EQU     10000001B
 = 0086                  C    INT_GATE                EQU     10000110B
 = 0087                  C    TRAP_GATE               EQU     10000111B
                         C
 = 0001                  C    VIRTUAL_ENABLE          EQU     0000000000000001B     ; PROTECTED MODE ENABLE
                         C
                         C
                         C    ;-----  THE GLOBAL DESCRIPTOR TABLE DEFINITION FOR POWER ON SELF TESTS
                         C
                         C    GDT_DEF        STRUC
 0000 ???????????????? C                   DQ      ?                ; UNUSED ENTRY
 0008 ???????????????? C    GDT_PTR        DQ      ?                ; THIS ENTRY POINTS TO THIS TABLE
 0010 ???????????????? C    SYS_IDT_PTR    DQ      ?                ; POST INTERRUPT DESCRIPTOR TABLE
 0018 ???????????????? C    RSDA_PTR       DQ      ?                ; THE REAL SYSTEM DATA AREA FOR POST
 0020 ???????????????? C    C_BWCRT_PTR    DQ      ?                ; COMPATIBLE BW CRT FOR POST
 0028 ???????????????? C    C_CCRT_PTR     DQ      ?                ; COMPATIBLE COLOR CRT FOR POST
 0030 ???????????????? C    E_CCRT_PTR     DQ      ?                ; ENHANCED COLOR GRAPHICS CRT (16 BYTES)
 0038 ???????????????? C    E_CCRT_PTR2    DQ      ?
 0040 ???????????????? C    SYS_ROM_CS     DQ      ?                ; CS - POST IDT, ROM RESIDENT
 0048 ???????????????? C    ES_TEMP        DQ      ?                ; DYNAMIC POINTER FOR ES
 0050 ???????????????? C    CS_TEMP        DQ      ?                ; DYNAMIC POINTER FOR CS
 0058 ???????????????? C    SS_TEMP        DQ      ?                ; DYNAMIC POINTER FOR SS
 0060 ???????????????? C    DS_TEMP        DQ      ?                ; DYNAMIC POINTER FOR DS
 0068 ???????????????? C    POST_TR        DQ      ?                ; TR VALUE FOR THIS MACHINE'S TSS
 0070 ???????????????? C    POST_TSS_PTR   DQ      ?
 0078 ???????????????? C    POST_LDTR      DQ      ?                ; LDTR VALUE FOR THIS MACHINE'S LDT
 0080 ???????????????? C    POST_LDT_PTR   DQ      ?
 0088                    C    GDT_DEF        ENDS
                         C
                         C    ;-----  SEGMENT DESCRIPTOR TABLE ENTRY STRUCTURE
                         C
                         C    DATA_DESC      STRUC
 0000 ????               C    SEG_LIMIT      DW      ?                ; SEGMENT LIMIT (1 - 65535 BYTES)
 0002 ????               C    BASE_LO_WORD   DW      ?                ; 24 BIT SEGMENT PHYSICAL
 0004 ??                 C    BASE_HI_BYTE   DB      ?                ;       ADDRESS (0 - (16M-1))
 0005 ??                 C    DATA_ACC_RIGHTS DB     ?                ; ACCESS RIGHTS BYTE
 0006 ????               C    DATA_RESERVED  DW      ?                ; RESERVED - MUST BE 0000 FOR THE 80286
 0008                    C    DATA_DESC      ENDS
                         C
                         C    ;-----  GATE DESCRIPTOR TABLE ENTRY STRUCTURE
                         C
                         C    GATE_DESC      STRUC
 0000 ????               C    ENTRY_POINT    DW      ?                ; DESTINATION ROUTINE ENTRY POINT
 0002 ????               C    CS_SELECTOR    DW      ?                ; SELECTOR FOR DESTINATION SEGMENT
 0004 ??                 C    WORD_COUNT     DB      ?                ; NUMBER OF WORDS TO COPY FROM STACK
 0005 ??                 C    GATE_ACC_RIGHTS DB     ?                ; ACCESS RIGHTS BYTE
 0006 ????               C    GATE_RESERVED  DW      ?                ; RESERVED - MUST BE 0000 FOR THE 80286
 0008                    C    GATE_DESC      ENDS
                         C
                              .LIST
```

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                                PAGE
0000                            CODE    SEGMENT WORD PUBLIC

                                        PUBLIC  C8042
                                        PUBLIC  OBF_42
                                        PUBLIC  POST1
                                        PUBLIC  START_1

                                        EXTRN   CMOS_READ:NEAR
                                        EXTRN   CMOS_WRITE:NEAR
                                        EXTRN   CONFIG_BAD:NEAR
                                        EXTRN   D11:NEAR
                                        EXTRN   DDS:NEAR
                                        EXTRN   DUMMY_RETURN:NEAR
                                        EXTRN   ERR_BEEP:NEAR
                                        EXTRN   GATE_A20:NEAR
                                        EXTRN   KBD_RESET:NEAR
                                        EXTRN   NMI_INT:NEAR
                                        EXTRN   POST2:NEAR
                                        EXTRN   PRINT_SCREEN:NEAR
                                        EXTRN   PROC_SHUTDOWN:NEAR
                                        EXTRN   ROM_CHECK:NEAR
                                        EXTRN   SHUT2:NEAR
                                        EXTRN   SHUT3:NEAR
                                        EXTRN   SHUT4:NEAR
                                        EXTRN   SHUT6:NEAR
                                        EXTRN   SHUT7:NEAR
                                        EXTRN   SHUT9:NEAR
                                        EXTRN   SLAVE_VECTOR_TABLE:NEAR
                                        EXTRN   STGTST_CNT:NEAR
                                        EXTRN   SYSINIT1:NEAR
                                        EXTRN   VECTOR_TABLE:NEAR
                                        EXTRN   VIDEO_PARMS:BYTE

                                        ASSUME  CS:CODE,DS:NOTHING,ES:NOTHING,SS:NOTHING

0000                            POST1   PROC    NEAR

= 0000                          BEGIN   EQU     $
0000 36 34 38 30 30 39                  DB      '6480090COPR. IBM CORP. 1981,1985  '        ;COPYRIGHT NOTICE
     30 43 4F 50 52 2E
     20 49 42 4D 20 43
     4F 52 50 2E 20 31
     39 38 31 2C 31 39
     38 35 20 20
                                        EVEN                                                ;EVEN BOUNDARY
                                        ;        6 4 8 0 0 9 0    C O P R .   I B M    1 9 8 5   ;EVEN MODULE
                                        ;         6 4 8 0 0 9 1    C O P R .   I B M    1 9 8 5  ;ODD  MODULE
0022 36 36 34 34 38 38                  DB      '66448800009901  CCOOPPRR..  IIBBMM  11998855' ;COPYRIGHT NOTICE
     30 30 30 30 39 39
     30 31 20 20 43 43
     4F 4F 50 50 52 52
     2E 2E 20 20 49 49
     42 42 4D 4D 20 20
     31 31 39 39 38 38
     35 35
004E 20 20                              DB      '  '                                        ;PAD

                                ;----------------------------------------------
                                ;       INITIAL RELIABILITY TESTS -- (POST1)    :
                                ;----------------------------------------------

                                ;--------------------------------------
                                ; TEST.01                              :
                                ;       80286 PROCESSOR TEST (REAL MODE) :
                                ; DESCRIPTION                          :
                                ;       VERIFY FLAGS, REGISTERS        :
                                ;       AND CONDITIONAL JUMPS.         :
                                ;--------------------------------------

                                        ASSUME  DS:DATA

0050                            START_1:
0050 FA                                 CLI                             ; DISABLE INTERRUPTS
0051 B8 D58D                            MOV     AX,0D500H+CMOS_REG_D+NMI; FLAG MASK IN (AH) AND NMI MASK IN (AL)
0054 E6 70                              OUT     CMOS_PORT,AL            ; DISABLE NMI INTERRUPTS
0056 9E                                 SAHF                            ; SET "SF" "ZF" "AF" "PF" "CF" FLAGS ON
0057 73 27                              JNC     ERR02                   ; GO TO ERROR ROUTINE IF "CF" NOT SET
0059 75 25                              JNZ     ERR02                   ; GO TO ERROR ROUTINE IF "ZF" NOT SET
005B 7B 23                              JNP     ERR02                   ; GO TO ERROR ROUTINE IF "PF" NOT SET
005D 79 21                              JNS     ERR02                   ; GO TO ERROR ROUTINE IF "SF" NOT SET
005F 9F                                 LAHF                            ; LOAD FLAG IMAGE TO (AH)
0060 B1 05                              MOV     CL,5                    ; LOAD COUNT REGISTER WITH SHIFT COUNT
0062 D2 EC                              SHR     AH,CL                   ; SHIFT "AF" INTO CARRY BIT POSITION
0064 73 1A                              JNC     ERR02                   ; GO TO ERROR ROUTINE IF "AF" NOT SET
0066 B0 40                              MOV     AL,40H                  ; SET THE "OF" FLAG ON
0068 D0 E0                              SHL     AL,1                    ; SETUP FOR TESTING
006A 71 14                              JNO     ERR02                   ; GO TO ERROR ROUTINE IF "OF" NOT SET
006C 32 E4                              XOR     AH,AH                   ; SET (AH) = 0
006E 9E                                 SAHF                            ; CLEAR "SF", "CF", "ZF", AND "PF"
006F 76 0F                              JBE     ERR02                   ; GO TO ERROR ROUTINE IF "CF" ON
                                                                        ; GO TO ERROR ROUTINE IF "ZF" ON
0071 78 0D                              JS      ERR02                   ; GO TO ERROR ROUTINE IF "SF" ON
0073 7A 0B                              JP      ERR02                   ; GO TO ERROR ROUTINE IF "PF" ON
0075 9F                                 LAHF                            ; LOAD FLAG IMAGE TO (AH)
0076 D2 EC                              SHR     AH,CL                   ; SHIFT "AF" INTO CARRY BIT POSITION
0078 72 06                              JC      ERR02                   ; GO TO ERROR ROUTINE IF ON
007A D0 E4                              SHL     AH,1                    ; CHECK THAT "OF" IS CLEAR
007C 70 02                              JO      ERR02                   ; GO TO ERROR ROUTINE IF ON
007E 74 03                              JZ      C7A                     ; CONTINUE CONFIDENCE TESTS IF "ZF" SET
0080                            ERR02:
0080 F4                                 HLT                             ;       ERROR HALT
0081 EB FD                              JMP     ERR02                   ; ERROR LOOP TRAP

0083                            C7A:
0083 B8 ---- R                          MOV     AX,DATA                 ; SET DATA SEGMENT
0086 8E D8                              MOV     DS,AX                   ; INTO THE (DS) SEGMENT REGISTER

                                ;-----  CHECK FOR PROCESSOR SHUTDOWN

0088 E4 64                              IN      AL,STATUS_PORT          ; READ CURRENT KEYBOARD PROCESSOR STATUS
008A A8 04                              TEST    AL,SYS_FLAG             ; CHECK FOR SHUTDOWN IN PROCESS FLAG
008C 75 03                              JNZ     C7B                     ; GO IF YES
008E E9 0123 R                          JMP     SHUT0                   ; ELSE CONTINUE NORMAL POWER ON CODE
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                                PAGE
                                ;-----  CHECK FOR SHUTDOWN 09
      0091                      C7B:
      0091  B0 8F                       MOV     AL,CMOS_SHUT_DOWN+NMI   ; CMOS ADDRESS FOR SHUTDOWN BYTE
      0093  E6 70                       OUT     CMOS_PORT,AL
      0095  EB 00                       JMP     $+2                     ; I/O DELAY
      0097  E4 71                       IN      AL,CMOS_DATA            ; GET REQUEST NUMBER
      0099  3C 09                       CMP     AL,09H                  ; WAS IT SHUTDOWN REQUEST 9?
      009B  86 C4                       XCHG    AL,AH                   ; SAVE THE SHUTDOWN REQUEST
      009D  74 41                       JE      C7C                     ; BYPASS INITIALIZING INTERRUPT CHIPS

                                ;-----  CHECK FOR SHUTDOWN 0A

      009F  80 FC 0A                    CMP     AH,0AH                  ; WAS IT SHUTDOWN REQUEST A?
      00A2  74 3C                       JE      C7C                     ; BYPASS INITIALIZING INTERRUPT CHIPS

      00A4  2A C0                       SUB     AL,AL                   ; INSURE MATH PROCESSOR RESET
      00A6  E6 F1                       OUT     X287+1,AL

                                ;--------------------------------------------------------
                                ;    RE-INITIALIZE THE 8259 INTERRUPT #1 CONTROLLER CHIP :
                                ;--------------------------------------------------------
      00A8  B0 11                       MOV     AL,11H                  ; ICW1 - EDGE, MASTER, ICW4
      00AA  E6 20                       OUT     INTA00,AL
      00AC  EB 00                       JMP     $+2                     ; WAIT STATE FOR I/O
      00AE  B0 08                       MOV     AL,08H                  ; SETUP ICW2 - INTERRUPT TYPE 8H (8-F)
      00B0  E6 21                       OUT     INTA01,AL
      00B2  EB 00                       JMP     $+2                     ; WAIT STATE FOR I/O
      00B4  B0 04                       MOV     AL,04H                  ; SETUP ICW3 - MASTER LEVEL 2
      00B6  E6 21                       OUT     INTA01,AL               ;
      00B8  EB 00                       JMP     $+2                     ; I/O WAIT STATE
      00BA  B0 01                       MOV     AL,01H                  ; SETUP ICW4 - MASTER,8086 MODE
      00BC  E6 21                       OUT     INTA01,AL               ;
      00BE  EB 00                       JMP     $+2                     ; WAIT STATE FOR I/O
      00C0  B0 FF                       MOV     AL,0FFH                 ; MASK ALL INTERRUPTS OFF
      00C2  E6 21                       OUT     INTA01,AL               ; (VIDEO ROUTINE ENABLES INTERRUPTS)
                                ;---------------------------------------------------------
                                ;    RE-INITIALIZE THE 8259 INTERRUPT #2 CONTROLLER CHIP  :
                                ;---------------------------------------------------------
      00C4  B0 11                       MOV     AL,11H                  ; ICW1 - EDGE, SLAVE ICW4
      00C6  E6 A0                       OUT     INTB00,AL
      00C8  EB 00                       JMP     $+2                     ; WAIT STATE FOR I/O
      00CA  B0 70                       MOV     AL,INT_TYPE             ; SETUP ICW2 - INTERRUPT TYPE 70 (70-7F)
      00CC  E6 A1                       OUT     INTB01,AL
      00CE  B0 02                       MOV     AL,02H                  ; SETUP ICW3 - SLAVE LEVEL 2
      00D0  EB 00                       JMP     $+2
      00D2  E6 A1                       OUT     INTB01,AL
      00D4  EB 00                       JMP     $+2                     ; I/O DELAY
      00D6  B0 01                       MOV     AL,01H                  ; SETUP ICW4 - 8086 MODE, SLAVE
      00D8  E6 A1                       OUT     INTB01,AL
      00DA  EB 00                       JMP     $+2                     ; WAIT STATE FOR I/O
      00DC  B0 FF                       MOV     AL,0FFH                 ; MASK ALL INTERRUPTS OFF
      00DE  E6 A1                       OUT     INTB01,AL
                                ;------------------------------------------------------------------------
                                ;  SHUTDOWN - RESTART                                                    :
                                ;       RETURN CONTROL AFTER A SHUTDOWN COMMAND IS ISSUED                :
                                ;  DESCRIPTION                                                           :
                                ;       A TEST IS MADE FOR THE SYSTEM FLAG BEING SET.  IF THE SYSTEM FLAG IS  :
                                ;       SET, THE SHUTDOWN BYTE IN CMOS IS USED TO DETERMINE WHERE CONTROL IS  :
                                ;       RETURNED.                                                        :
                                ;                                                                        :
                                ;       CMOS = 0    SOFT RESET OR UNEXPECTED SHUTDOWN                    :
                                ;       CMOS = 1    SHUT DOWN AFTER MEMORY SIZE                          :
                                ;       CMOS = 2    SHUT DOWN AFTER MEMORY TEST                          :
                                ;       CMOS = 3    SHUT DOWN WITH MEMORY ERROR                          :
                                ;       CMOS = 4    SHUT DOWN WITH BOOT LOADER REQUEST                   :
                                ;       CMOS = 5    JMP DWORD REQUEST - (INTERRUPT CHIPS & 287 ARE INITIALIZED) :
                                ;       CMOS = 6    PROTECTED MODE TEST3 PASSED                          :
                                ;       CMOS = 7    PROTECTED MODE TEST3 FAILED                          :
                                ;       CMOS = 8    PROTECTED MODE TEST1 FAILED                          :
                                ;       CMOS = 9    BLOCK MOVE SHUTDOWN REQUEST                          :
                                ;       CMOS = A    JMP DWORD REQUEST - (W/O INTERRUPT CHIPS INITIALIZED) :
                                ;                                                                        :
                                ;          NOTES:   RETURNS ARE MADE WITH INTERRUPTS AND NMI DISABLED.   :
                                ;                   USER MUST RESTORE SS:SP (POST DEFAULT SET = 0000:0400),  :
                                ;                   ENABLE NON-MASKABLE INTERRUPTS (NMI) WITH AN OUT TO  :
                                ;                   PORT 70H WITH HIGH ORDER BIT OFF, AND THEN ISSUE A   :
                                ;                   STI TO ENABLE INTERRUPTS.  FOR SHUTDOWN (5) THE USER :
                                ;                   MUST ALSO RESTORE THE INTERRUPT MASK REGISTERS.      :
                                ;------------------------------------------------------------------------

                                ;-----  CHECK FROM WHERE
      00E0                      C7C:
      00E0  B0 8F                       MOV     AL,CMOS_SHUT_DOWN+NMI   ; CLEAR CMOS BYTE
      00E2  E6 70                       OUT     CMOS_PORT,AL
      00E4  90                          NOP                             ; I/O DELAY
      00E5  2A C0                       SUB     AL,AL                   ; SET BYTE TO 0
      00E7  E6 71                       OUT     CMOS_DATA,AL
      00E9  86 E0                       XCHG    AH,AL
      00EB  3C 0A                       CMP     AL,0AH                  ; COMPARE WITH MAXIMUM TABLE ENTRIES
      00ED  77 34                       JA      SHUT0                   ; SKIP TO POST IF GREATER THAN MAXIMUM
      00EF  BE 0103 R                   MOV     SI,OFFSET BRANCH        ; POINT TO THE START OF THE BRANCH TABLE
      00F2  03 F0                       ADD     SI,AX
      00F4  03 F0                       ADD     SI,AX                   ; POINT TO BRANCH ADDRESS
      00F6  2E: 8B 1C                   MOV     BX,CS:[SI]              ; MOVE BRANCH TO ADDRESS TO BX REGISTER

                                ;-----  SET TEMPORARY STACK FOR POST

      00F9  B8 ---- R                   MOV     AX,ABS0                 ; SET STACK SEGMENT TO ABS0 SEGMENT
      00FC  8E D0                       MOV     SS,AX
      00FE  BC 0400 R                   MOV     SP,OFFSET @TOS          ; SET STACK POINTER TO END OF VECTORS
      0101  FF E3                       JMP     BX                      ; JUMP BACK TO RETURN ROUTINE

      0103  0123 R              BRANCH: DW      SHUT0                   ; NORMAL POWER UP/UNEXPECTED SHUTDOWN
      0105  0990 R                      DW      SHUT1                   ; SHUT DOWN AFTER MEMORY SIZE
      0107  0000 E                      DW      SHUT2                   ; SHUT DOWN AFTER MEMORY TEST
      0109  0000 E                      DW      SHUT3                   ; SHUT DOWN WITH MEMORY ERROR
      010B  0000 E                      DW      SHUT4                   ; SHUT DOWN WITH BOOT_LOADER REQUEST
      010D  0119 R                      DW      SHUT5                   ; JMP DWORD REQUEST WITH INTERRUPT INIT
      010F  0000 E                      DW      SHUT6                   ; PROTECTED MODE TEST7 PASSED
      0111  0000 E                      DW      SHUT7                   ; PROTECTED MODE TEST7 FAILED
      0113  0793 R                      DW      SHUT8                   ; PROTECTED MODE TEST1 FAILED
      0115  0000 E                      DW      SHUT9                   ; BLOCK MOVE SHUTDOWN REQUEST
      0117  011F R                      DW      SHUTA                   ; JMP DWORD REQUEST (W/O INTERRUPT INIT)
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                              PAGE
                              ;-----  @IO_ROM_INIT MUST BE INITIALIZED BY THE USER FOR VECTORED REQUESTS

0119                          SHUT5:
0119 E4 60                            IN      AL,PORT_A               ; FLUSH THE KEYBOARD BUFFER
011B B0 20                            MOV     AL,EOI                  ; FLUSH LAST TIMER REQUEST IF PENDING
011D E6 20                            OUT     INTA00,AL               ;  - TO ALLOW TIMER INTERRUPTS
011F                          SHUTA:
011F FF 2E 0067 R                     JMP     DWORD PTR @IO_ROM_INIT  ; FAR JUMP TO USER DEFINED LOCATION
                                                                      ;  AFTER SHUTDOWN TO REAL MODE CODE
                                                                      ;  WITH INTERRUPTS AND NMI DISABLED
                              ;-----  CHECKPOINT 01

0123                          SHUT0:
0123 B0 01                            MOV     AL,01H                  ;       <><><><><><><><><><><><><>
0125 E6 80                            OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  01 <><>

                              ;-----  READ/WRITE/TEST THE 80286 REGISTERS WITH ONE'S AND ZERO'S

0127 B8 FFFF                          MOV     AX,0FFFFH               ; SETUP ONE'S PATTERN IN (AX)
012A F9                               STC                             ; SET CARRY FLAG
012B 73 21                            JNC     ERR01                   ; GO IF NO CARRY
012D                          C8:
012D 8E D8                            MOV     DS,AX                   ; WRITE PATTERN TO ALL REGISTERS
012F 8C DB                            MOV     BX,DS
0131 8E C3                            MOV     ES,BX
0133 8C C1                            MOV     CX,ES
0135 8E D1                            MOV     SS,CX
0137 8C D2                            MOV     DX,SS
0139 8B E2                            MOV     SP,DX
013B 8B EC                            MOV     BP,SP
013D 8B F5                            MOV     SI,BP
013F 8B FE                            MOV     DI,SI
0141 73 07                            JNC     C9
0143 33 C7                            XOR     AX,DI                   ; PATTERN MAKE IT THROUGH ALL REGISTERS
0145 75 07                            JNZ     ERR01                   ; NO - GO TO ERROR ROUTINE
0147 F8                               CLC                             ; CLEAR CARRY FLAG
0148 EB E3                            JMP     C8
014A                          C9:                                     ; TST1A
014A 0B C7                            OR      AX,DI                   ; ZERO PATTERN MAKE IT THROUGH ?
014C 74 01                            JZ      C10A                    ; YES - GO TO NEXT TEST
014E                          ERR01:
014E F4                               HLT                             ; HALT SYSTEM

                              ;-----  INSURE THAT CMOS CLOCK INTERRUPTS ARE DISABLED
014F                          C10A:
014F B8 8B8B                          MOV     AX,X*(CMOS_REG_B+NMI)   ; ADDRESS TO BOTH (AH) AND (AL)
0152 E6 70                            OUT     CMOS_PORT,AL            ; ADDRESS CMOS ALARM BYTE WITH NMI=OFF
0154 90                               NOP                             ; I/O DELAY
0155 E4 71                            IN      AL,CMOS_DATA            ; GET THE CURRENT CONTROL REGISTER
0157 24 07                            AND     AL,00000111B            ; CLEAR SET,PIE,AIE, AND SQWE BITS
0159 86 C4                            XCHG    AL,AH                   ; SAVE IT
015B E6 70                            OUT     CMOS_PORT,AL
015D 86 C4                            XCHG    AL,AH
015F E6 71                            OUT     CMOS_DATA,AL

0161 B0 8C                            MOV     AL,CMOS_REG_C+NMI       ; ADDRESS CMOS FLAGS BYTE WITH NMI=OFF
0163 90                               NOP                             ; I/O DELAY
0164 E6 70                            OUT     CMOS_PORT,AL
0166 90                               NOP                             ; I/O DELAY
0167 E4 71                            IN      AL,CMOS_DATA            ; READ STATUS TO CLEAR PENDING INTERRUPT

                              ;-----  RESET VIDEO

0169 B0 00                            MOV     AL,0                    ; CLEAR DATA BYTE TO DISABLE VIDEO
016B BA 03D8                          MOV     DX,03D8H                ; GET COLOR MODE CONTROL PORT ADDRESS
016E EE                               OUT     DX,AL                   ; DISABLE COLOR VIDEO
016F FE C0                            INC     AL                      ; MONOCHROME MODE RESET MASK
0171 B2 B8                            MOV     DL,0B8H                 ; GET ADDRESS OF MONOCHROME MODE CONTROL
0173 EE                               OUT     DX,AL                   ; DISABLE B/W VIDEO, ENABLE HIGH RES
0174 B2 BA                            MOV     DL,0BAH                 ; ADDRESS OF MONOCHROME STATUS REGISTER
0176 EC                               IN      AL,DX                   ; READ STATUS TO DISABLE EGA VIDEO
0177 B2 DA                            MOV     DL,0DAH                 ; ADDRESS OF COLOR MODE STATUS REGISTER
0179 EC                               IN      AL,DX                   ; READ STATUS TO DISABLE EGA VIDEO
017A B0 00                            MOV     AL,0                    ; SELECT ATTRIBUTE PALETTE REGISTER 0
017C B2 C0                            MOV     DL,0C0H                 ; WRITE 0 TO ATTRIBUTE ADDRESS REGISTER
017E EE                               OUT     DX,AL                   ; TO DISABLE EGA VIDEO
017F B0 FC                            MOV     AL,11111100B            ; DISABLE PARITY CHECKERS
0181 E6 61                            OUT     PORT_B,AL

                              ;-----------------------------------------
                              ; TEST.02                                :
                              ;       ROM CHECKSUM TEST I              :
                              ; DESCRIPTION                            :
                              ;       A CHECKSUM IS DONE FOR THE 32K   :
                              ;       READ ONLY MEMORY MODULES (TWO)   :
                              ;       CONTAINING POST, BASIC AND BIOS.:
                              ;-----------------------------------------

                              ;-----  CHECKPOINT 02

0183 B0 02                            MOV     AL,02H                  ;       <><><><><><><><><><><><><>
0185 E6 80                            OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  02 <><>

                                      ASSUME  SS:CODE
0187 8C C8                            MOV     AX,CS                   ; SETUP SS SEGMENT REGISTER
0189 8E D0                            MOV     SS,AX
018B 8E D8                            MOV     DS,AX                   ; SET UP DATA SEGMENT TO POINT TO
018D 33 F6                            XOR     SI,SI                   ; ROM ADDRESS START
018F 33 DB                            XOR     BX,BX                   ; CLEAR CHECK REGISTER
0191 B5 80                            MOV     CH,080H                 ; COUNT FOR 32K WORDS
0193                          C11:
0193 AD                               LODSW                           ; MOVE TWO BYTES INTO AX -- SI=SI+2
0194 02 DC                            ADD     BL,AH                   ; ADD ODD BYTE AT DS:SI+1 TO CHECKSUM
0196 02 D8                            ADD     BL,AL                   ; ADD EVEN BYTE AT DS:SI TO CHECKSUM
0198 E2 F9                            LOOP    C11                     ; LOOP COUNT FOR 65K BYTES (32K WORDS)
019A 73 02                            JNC     C11E                    ;  EXIT IF "LOOP" RESET THE CARRY FLAG
                                                                      ;  (NOTE: MODEL BYTE MUST NOT = ZERO)
019C 74 01                            JZ      C11A                    ; CONTINUE IF CHECKSUM VALID (ZERO)
019E                          C11E:
019E F4                               HLT                             ; ELSE HALT IF CHECKSUM PROBLEM
                              ;-----------------------------------------
                              ; TEST.03                                :
                              ;       VERIFY CMOS SHUTDOWN BYTE        :
```

```
                      ; DESCRIPTION                            :
                      ;         ROLLING BIT WRITTEN AND        :
                      ;         VERIFIED AT SHUTDOWN ADDRESS.  :
                      ;----------------------------------------

                      ;-----  VERIFY AND CLEAR SHUTDOWN FLAG
019F                  C11A:
019F B0 03                    MOV     AL,03H                  ;       <><><><><><><><><><><><><>
01A1 E6 80                    OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  03 <><>

01A3 B9 0009                  MOV     CX,09H                  ; LOOP COUNT
01A6 B4 01                    MOV     AH,1                    ; START WITH BIT 0
01A8                  C11B:
01A8 B0 8F                    MOV     AL,CMOS_SHUT_DOWN+NMI
01AA E6 70                    OUT     CMOS_PORT,AL
01AC 8A C4                    MOV     AL,AH                   ; OUTPUT ROLLING BIT
01AE E6 71                    OUT     CMOS_DATA,AL
01B0 B0 8F                    MOV     AL,CMOS_SHUT_DOWN+NMI   ; READ CMOS
01B2 90                       NOP                             ; I/O DELAY
01B3 E6 70                    OUT     CMOS_PORT,AL
01B5 90                       NOP                             ; I/O DELAY
01B6 E4 71                    IN      AL,CMOS_DATA
01B8 3A C4                    CMP     AL,AH                   ; MUST BE THE SAME
01BA 75 92                    JNZ     ERR01                   ; ERROR IF NOT
01BC D0 D4                    RCL     AH,1                    ; ROLL A BIT THROUGH SHUTDOWN BYTE
01BE E2 E8                    LOOP    C11B                    ; LOOP TILL DONE

                      ;----------------------------------------
                      ; TEST.04                                :
                      ;         8254 CHECK TIMER 1 ALL BITS ON :
                      ; DESCRIPTION                            :
                      ;         SET TIMER COUNT                :
                      ;         CHECK THAT TIMER 1 ALL BITS ON :
                      ;----------------------------------------
                              ASSUME  DS:DATA
01C0 B8 ---- R                MOV     AX,DATA                 ; SET DATA SEGMENT
01C3 8E D8                    MOV     DS,AX
01C5 B0 04                    MOV     AL,04H                  ;       <><><><><><><><><><><><><>
01C7 E6 80                    OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  04 <><>

                      ;-----  DISABLE DMA CONTROLLER
                                                              ; (AL) ALREADY = 04H
01C9 E6 08                    OUT     DMA08,AL                ; DISABLE DMA CONTROLLER 1
01CB E6 D0                    OUT     DMA18,AL                ; DISABLE DMA CONTROLLER 2

                      ;-----  VERIFY THAT TIMER 1 FUNCTIONS OK

01CD 8B 16 0072 R             MOV     DX,@RESET_FLAG          ; SAVE RESET FLAG WHILE REFRESH IS OFF
01D1 B0 54                    MOV     AL,54H                  ; SELECT TIMER 1,LSB,MODE 2
01D3 E6 43                    OUT     TIMER+3,AL
01D5 EB 00                    JMP     $+2                     ; I/O DELAY
01D7 8A C1                    MOV     AL,CL                   ; SET INITIAL TIMER COUNT TO 0
01D9 E6 41                    OUT     TIMER+1,AL
01DB B7 05                    MOV     BH,05H                  ; LOOP COUNT
01DD                  C12:                                    ; TIMER1_BITS_ON
01DD B0 40                    MOV     AL,40H                  ; LATCH TIMER 1 COUNT
01DF EB 00                    JMP     $+2                     ; I/O DELAY
01E1 E6 43                    OUT     TIMER+3,AL
01E3 80 FB FF                 CMP     BL,0FFH                 ; YES - SEE IF ALL BITS GO OFF
01E6 74 0B                    JE      C13                     ; TIMER1_BITS_OFF
01E8 E4 41                    IN      AL,TIMER+1              ; READ TIMER 1 COUNT
01EA 0A D8                    OR      BL,AL                   ; ALL BITS ON IN TIMER
01EC E2 EF                    LOOP    C12                     ; TIMER1_BITS_ON
01EE FE CF                    DEC     BH
01F0 75 EB                    JNZ     C12                     ; TRY AGAIN
01F2 F4                       HLT                             ; TIMER 1 FAILURE, HALT SYSTEM
                                                              ; TIMER1_BITS_OFF
                      ;----------------------------------------
                      ; TEST.05                                :
                      ;         8254 CHECK TIMER 1 ALL BIT OFF :
                      ; DESCRIPTION                            :
                      ;         SET TIMER COUNT                :
                      ;         CHECK THAT TIMER 1 ALL BITS OFF :
                      ;----------------------------------------

                      ;-----  CHECKPOINT 05

01F3 B0 05            C13:    MOV     AL,05H                  ;       <><><><><><><><><><><><><>
01F5 E6 80                    OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  05 <><>

01F7 8A C3                    MOV     AL,BL                   ; SET TIMER 1 COUNT
01F9 2B C9                    SUB     CX,CX
01FB E6 41                    OUT     TIMER+1,AL
01FD B7 05                    MOV     BH,05H                  ; SET TRY AGAIN COUNT
01FF                  C14:                                    ; TIMER_LOOP
01FF B0 40                    MOV     AL,40H                  ; LATCH TIMER 1 COUNT
0201 E6 43                    OUT     TIMER+3,AL
0203 EB 00                    JMP     $+2                     ; DELAY FOR TIMER
0205 EB 00                    JMP     $+2                     ; ADDED DELAY FOR TIMER
0207 E4 41                    IN      AL,TIMER+1              ; READ TIMER 1 COUNT
0209 22 D8                    AND     BL,AL
020B 74 07                    JZ      C15                     ; GO TO WRAP DMA REGISTER TESTS
020D E2 F0                    LOOP    C14                     ; TIMER_LOOP
020F FE CF                    DEC     BH
0211 75 EC                    JNZ     C14
0213 F4                       HLT                             ; HALT SYSTEM

                      ;----------------------------------------
                      ; TEST.06                                :
                      ;         8237 DMA 0 INITIALIZATION      :
                      ;         CHANNEL REGISTER TEST          :
                      ; DESCRIPTION                            :
                      ;         DISABLE THE 8237 DMA CONTROLLER.:
                      ;         WRITE/READ THE CURRENT ADDRESS :
                      ;         AND WORD COUNT REGISTERS FOR   :
                      ;         ALL CHANNELS.                  :
                      ;----------------------------------------

                      ;-----  CHECKPOINT 06

0214                  C15:
0214 B8 ---- R                MOV     AX,DATA                 ; SET DATA SEGMENT
0217 8E D8                    MOV     DS,AX
0219 B0 06                    MOV     AL,06H                  ;       <><><><><><><><><><><><><>
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SECTION 5

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021B E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  06 <><>
021D 89 16 0072 R               MOV     @RESET_FLAG,DX          ; RESTORE SOFT RESET FLAG
0221 E6 0D                      OUT     DMA+0DH,AL              ; SEND MASTER CLEAR TO DMA

                        ;-----  WRAP DMA 0 CHANNEL ADDRESS AND COUNT REGISTERS

0223 B0 FF                      MOV     AL,0FFH                 ; WRITE PATTERN "FF" TO ALL REGISTERS
0225 8A D8              C16:    MOV     BL,AL                   ; SAVE PATTERN FOR COMPARE
0227 8A F8                      MOV     BH,AL
0229 B9 0008                    MOV     CX,8                    ; SETUP LOOP COUNT
022C BA 0000                    MOV     DX,DMA                  ; SETUP I/O PORT ADDRESS OF REGISTER
022F EE                 C17:    OUT     DX,AL                   ; WRITE PATTERN TO REGISTER, LSB
0230 EB 00                      JMP     $+2                     ; I/O DELAY
0232 EE                         OUT     DX,AL                   ; MSB OF 16 BIT REGISTER
0233 B0 01                      MOV     AL,01H                  ; AL TO ANOTHER PATTERN BEFORE READ
0235 EB 00                      JMP     $+2                     ; I/O DELAY
0237 EC                         IN      AL,DX                   ; READ 16-BIT DMA CH REG, LSB  2ST DMA
0238 EB 00                      JMP     $+2                     ; I/O DELAY
023A 8A E0                      MOV     AH,AL                   ; SAVE LSB OF 16-BIT REGISTER
023C EC                         IN      AL,DX                   ; READ MSB OF DMA CHANNEL REGISTER
023D 3B D8                      CMP     BX,AX                   ; PATTERN READ AS WRITTEN?
023F 74 01                      JE      C18                     ; YES - CHECK NEXT REGISTER
0241 F4                         HLT                             ; NO - HALT THE SYSTEM
0242                    C18:                                    ; NXT_DMA_CH
0242 42                         INC     DX                      ; SET I/O PORT TO NEXT CHANNEL REGISTER
0243 E2 EA                      LOOP    C17                     ; WRITE PATTERN TO NEXT REGISTER
0245 FE C0                      INC     AL                      ; SET PATTERN TO 0
0247 74 DC                      JZ      C16                     ; YES CONTINUE

                        ;-----  WRITE DMA WITH 55 PATTERN

0249 80 FB 55   '               CMP     BL,055H                 ; CHECK IF "55" PATTERN DONE
024C 74 09                      JZ      C19                     ; GO IF YES
024E 80 FB AA                   CMP     BL,0AAH                 ; CHECK IF "AA" PATTERN DONE
0251 74 08                      JZ      C20                     ; GO IF YES
0253 B0 55                      MOV     AL,055H
0255 EB CE                      JMP     C16

                        ;-----  WRITE DMA WITH AA PATTERN

0257 B0 AA              C19:    MOV     AL,0AAH
0259 EB CA                      JMP     C16

                        ;---------------------------------------
                        ; TEST.07                               :
                        ;       8237 DMA 1 INITIALIZATION       :
                        ;       CHANNEL REGISTER TEST           :
                        ; DESCRIPTION                           :
                        ;       DISABLE 8237 DMA CONTROLLER 1.  :
                        ;       WRITE/READ THE CURRENT DMA 1    :
                        ;       ADDRESS AND WORD COUNT          :
                        ;       REGISTERS FOR ALL CHANNELS.     :
                        ;---------------------------------------

                        ;-----  CHECKPOINT 07 - DMA 1

025B B0 07              C20:    MOV     AL,07H                  ;       <><><><><><><><><><><><>
025D E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  07 <><>
025F E6 DA                      OUT     DMA1+0DH*2,AL           ; SEND MASTER CLEAR TO 2ND DMA

                        ;-----  WRAP DMA 1 CHANNEL ADDRESS AND COUNT REGISTERS

0261 B0 FF                      MOV     AL,0FFH                 ; WRITE PATTERN FF TO ALL REGISTERS
0263 8A D8              C16A:   MOV     BL,AL                   ; SAVE PATTERN FOR COMPARE
0265 8A F8                      MOV     BH,AL
0267 B9 0008                    MOV     CX,8                    ; SETUP LOOP COUNT
026A BA 00C0                    MOV     DX,DMA1                 ; SETUP I/O PORT ADDRESS OF REGISTER
026D EE                 C17A:   OUT     DX,AL                   ; WRITE PATTERN TO REGISTER, LSB
026E EB 00                      JMP     $+2                     ; I/O DELAY
0270 EE                         OUT     DX,AL                   ; MSB OF 16 BIT REGISTER
0271 B0 01                      MOV     AL,01H                  ; AL TO ANOTHER PAT BEFORE RD
0273 EB 00                      JMP     $+2                     ; I/O DELAY
0275 EC                         IN      AL,DX                   ; READ 16-BIT DMA CH REG, LSB  2ST DMA
0276 EB 00                      JMP     $+2                     ; I/O DELAY
0278 8A E0                      MOV     AH,AL                   ; SAVE LSB OF 16-BIT REGISTER
027A EC                         IN      AL,DX                   ; READ MSB OF DMA CH REGISTER
027B 3B D8                      CMP     BX,AX                   ; PATTERN READ AS WRITTEN?
027D 74 01                      JE      C18A                    ; YES - CHECK NEXT REGISTER
027F F4                         HLT                             ; NO - HALT THE SYSTEM
0280                    C18A:                                   ; NXT_DMA_CH
0280 83 C2 02                   ADD     DX,2                    ; SET I/O PORT TO NEXT CHANNEL REGISTER
0283 E2 E8                      LOOP    C17A                    ; WRITE PATTERN TO NEXT REGISTER
0285 FE C0                      INC     AL                      ; SET PATTERN TO 0
0287 74 DA                      JZ      C16A                    ; YES CONTINUE

                        ;-----  WRITE DMA WITH 55 PATTERN

0289 80 FB 55                   CMP     BL,55H                  ; CHECK IF 55 PATTERN DONE
028C 74 09                      JZ      C20A                    ; GO IF YES
028E 80 FB AA                   CMP     BL,0AAH                 ; CHECK IF AA PATTERN DONE
0291 74 08                      JZ      C21                     ; GO IF YES
0293 B0 55                      MOV     AL,55H
0295 EB CC                      JMP     C16A

                        ;-----  WRITE DMA WITH AA PATTERN

0297 B0 AA              C20A:   MOV     AL,0AAH
0299 EB C8                      JMP     C16A

                        ;-----  INITIALIZE AND START MEMORY REFRESH

029B                    C21:
029B 8B 1E 0072 R               MOV     BX,@RESET_FLAG          ; GET THE RESET FLAG
029F A3 0010 R                  MOV     @EQUIP_FLAG,AX          ; DO A DUMMY MEMORY WRITE BEFORE REFRESH
02A2 B0 12                      MOV     AL,18                   ; START REFRESH TIMER
02A4 E6 41                      OUT     TIMER+1,AL

                        ;-----  SET DMA COMMAND

02A6 2A C0                      SUB     AL,AL                   ; DACK SENSE LOW,DREQ SENSE HIGH
02A8 E6 08                      OUT     DMA+8,AL                ; LATE WRITE, FIXED PRIORITY, NORMAL
                                                                ; TIMING, CONTROLLER ENABLE, CH0 ADDRESS
                                                                ; HOLD DISABLE, MEMORY TO MEMORY DISABLE
02AA E6 D0                      OUT     DMA18,AL                ; SAME TO SECOND CONTROLLER
```

```
                                ;-----  MODE SET ALL DMA CHANNELS
02AC B0 40                              MOV     AL,40H                  ; SET MODE FOR CHANNEL 0
02AE E6 0B                              OUT     DMA+0BH,AL
02B0 B0 C0                              MOV     AL,0C0H                 ; SET CASCADE MODE ON CHANNEL 4
02B2 E6 D6                              OUT     DMA18+06H,AL
02B4 EB 00                              JMP     $+2                     ; I/O DELAY
02B6 B0 41                              MOV     AL,41H                  ; SET MODE FOR CHANNEL 1
02B8 E6 0B                              OUT     DMA+0BH,AL
02BA E6 D6                              OUT     DMA18+06H,AL            ; SET MODE FOR CHANNEL 5
02BC EB 00                              JMP     $+2                     ; I/O DELAY
02BE B0 42                              MOV     AL,42H                  ; SET MODE FOR CHANNEL 2
02C0 E6 0B                              OUT     DMA+0BH,AL
02C2 E6 D6                              OUT     DMA18+06H,AL            ; SET MODE FOR CHANNEL 6
02C4 EB 00                              JMP     $+2                     ; I/O DELAY
02C6 B0 43                              MOV     AL,43H                  ; SET MODE FOR CHANNEL 3
02C8 E6 0B                              OUT     DMA+0BH,AL
02CA E6 D6                              OUT     DMA18+06H,AL            ; SET MODE FOR CHANNEL 7
                                ;-----  RESTORE RESET FLAG
02CC 89 1E 0072 R                       MOV     @RESET_FLAG,BX
                                ;---------------------------------------
                                ; TEST.08                               :
                                ;       DMA PAGE REGISTER TEST          :
                                ; DESCRIPTION                           :
                                ;       WRITE/READ ALL PAGE REGISTERS   :
                                ;---------------------------------------
                                ;-----  CHECKPOINT 08
02D0 B0 08                              MOV     AL,08H                  ;       <><><><><><><><><><><><><>
02D2 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  08 <><>
02D4 2A C0                              SUB     AL,AL
02D6 BA 0081                            MOV     DX,DMA_PAGE
02D9 B9 00FF                            MOV     CX,0FFH                 ; DO ALL DATA PATTERNS
02DC EE                         C22A:   OUT     DX,AL
02DD 42                                 INC     DX
02DE FE C0                              INC     AL
02E0 81 FA 008F                         CMP     DX,8FH                  ; TEST DMA PAGES 81 THROUGH 8EH
02E4 75 F6                              JNZ     C22A
02E6 86 E0                              XCHG    AH,AL                   ; SAVE CURRENT DATA PATTERN
02E8 FE CC                              DEC     AH                      ; CHECK LAST WRITTEN
02EA 4A                                 DEC     DX                      ;
02EB 2A C0                      C22B:   SUB     AL,AL                   ; CHANGE DATA BEFORE READ
02ED EC                                 IN      AL,DX
02EE 3A C4                              CMP     AL,AH                   ; DATA AS WRITTEN?
02F0 75 30                              JNZ     C26                     ; GO ERROR HALT IF NOT
02F2 FE CC                              DEC     AH
02F4 4A                                 DEC     DX
02F5 81 FA 0080                         CMP     DX,MFG_PORT             ; CONTINUE TILL PORT 80
02F9 75 F0                              JNZ     C22B
02FB FE C4                              INC     AH                      ; NEXT PATTERN TO RIPPLE
02FD 8A C4                              MOV     AL,AH
02FF E2 DB                              LOOP    C22A
                                ;-----  TEST LAST DMA PAGE REGISTER (USED FOR ADDRESS LINES DURING REFRESH)
0301 B0 CC                              MOV     AL,0CCH                 ; WRITE AN CC TO PAGE REGISTERS
0303 BA 008F                    C22:    MOV     DX,LAST_DMA_PAGE
0306 8A E0                              MOV     AH,AL                   ; SAVE THE DATA PATTERN
0308 EE                                 OUT     DX,AL                   ; OUTPUT PAGE REGISTER
                                ;-----  VERIFY PAGE REGISTER 8F
0309 2A C0                              SUB     AL,AL                   ; CHANGE DATA PATTERN BEFORE READ
030B EC                                 IN      AL,DX                   ; GET THE DATA FROM PAGE REGISTER
030C 3A C4                              CMP     AL,AH
030E 75 12                              JNZ     C26                     ; GO IF ERROR
0310 80 FC CC                           CMP     AH,0CCH
0313 75 04                              JNZ     C25                     ; GO IF ERROR
0315 B0 33                              MOV     AL,033H                 ; SET UP DATA PATTERN OF 33
0317 EB EA                              JMP     C22                     ; DO DATA 33
0319                            C25:
0319 80 FC 00                           CMP     AH,0                    ; CHECK DONE
031C 74 05                              JZ      C27                     ; GO IF YES
031E 2A C0                              SUB     AL,AL                   ; SET UP FOR DATA PATTERN 00
0320 EB E1                              JMP     C22                     ; DO DATA 0
                                ;-----  ERROR HALT
0322                            C26:
0322 F4                                 HLT                             ; HALT SYSTEM
                                ;---------------------------------------
                                ; TEST.09                               :
                                ;       STORAGE REFRESH TEST            :
                                ; DESCRIPTION                           :
                                ;       VERIFY REFRESH IS OCCURRING     :
                                ;---------------------------------------
                                ;-----  CHECKPOINT 09 - TEST MEMORY REFRESH
0323                            C27:
0323 B0 09                              MOV     AL,09H                  ;       <><><><><><><><><><><><><>
0325 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  09 <><>
0327 2B C9                              SUB     CX,CX                   ;
0329                            C28:
0329 E4 61                              IN      AL,PORT_B               ; INSURE REFRESH BIT IS TOGGLING
032B A8 10                              TEST    AL,REFRESH_BIT
032D E1 FA                              LOOPZ   C28                     ; INSURE REFRESH IS OFF
032F E3 F1                              JCXZ    C26                     ; ERROR HALT IF TIMEOUT
0331                            C29:
0331 E4 61                              IN      AL,PORT_B
0333 A8 10                              TEST    AL,REFRESH_BIT          ; INSURE REFRESH IS ON
0335 E0 FA                              LOOPNZ  C29
0337 E3 E9                              JCXZ    C26                     ; ERROR HALT IF NO REFRESH BIT
                                ;---------------------------------------
                                ; TEST.10                               :
                                ;       8042 INTERFACE TEST             :
                                ;       READ CONFIGURATION JUMPERS      :
                                ; DESCRIPTION                           :
                                ;       ISSUE A SELF TEST TO THE 8042.  :
```

SECTION 5

```
                                ;       INSURE A 55H IS RECEIVED.         :
                                ;       READ MANUFACTURING AND DISPLAY   :
                                ;       JUMPERS AND SAVE IN MFG_TEST.    :
                                ;----------------------------------------

                                ;-----  CHECKPOINT 0A

0339 B0 0A                              MOV     AL,0AH                  ;       <><><><><><><><><><><><><>
033B E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0A <><>

                                ;-----  SOFT RESET (HANDLE ALL POSSIBLE CONDITIONS)

033D 2B C9                              SUB     CX,CX                   ; 100 MILLISECONDS FOR THIS LOOP
033F E4 64                      TST1:   IN      AL,STATUS_PORT          ; CHECK FOR INPUT BUFFER FULL
0341 8A E0                              MOV     AH,AL
0343 F6 C4 01                           TEST    AH,OUT_BUF_FULL
0346 74 02                              JZ      TST2                    ; GO IF NOT
0348 E4 60                              IN      AL,PORT_A               ; FLUSH
034A F6 C4 02                   TST2:   TEST    AH,INPT_BUF_FULL        ; IS THE OUTPUT BUFFER ALSO FULL?
034D E0 F0                              LOOPNZ  TST1                    ; TRY AGAIN
034F 74 01                              JZ      TST4                    ; CONTINUE IF OK

0351 F4                         ERR0:   HLT                             ; HALT SYSTEM IF BUFFER FULL

                                ;-----  ISSUE A RESET TO THE 8042

0352 B0 0B                      TST4:   MOV     AL,0BH                  ;       <><><><><><><><><><><><><>
0354 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0B <><>

0356 B0 AA                              MOV     AL,SELF_TEST            ; SELF TEST COMMAND
0358 BC 03EE R                          MOV     SP,OFFSET C8042A        ; SET RETURN ADDRESS
035B EB 39                              JMP     SHORT C8042
035D A8 01                      TST4_B: TEST    AL,OUT_BUF_FULL         ; IS THE OUTPUT BUFFER FULL?
035F 74 02                              JZ      TST4_A                  ; GO IF NOT
0361 E4 60                              IN      AL,PORT_A               ; FLUSH
0363 BC 03F0 R                  TST4_A: MOV     SP,OFFSET OBF_42A       ; SET RETURN ADDRESS
0366 EB 3A                              JMP     SHORT OBF_42            ; GO WAIT FOR BUFFER
0368 E4 60                      TST4_C: IN      AL,PORT_A               ; GET THE ENDING RESPONSE
036A 3C 55                              CMP     AL,55H

036C B0 0C                              MOV     AL,0CH                  ;       <><><><><><><><><><><><><>
036E E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0C <><>

0370 75 DF                              JNZ     ERR0                    ; GO IF NOT OK

                                ;-----  GET THE SWITCH SETTINGS

0372 B0 C0                              MOV     AL,READ_8042_INPUT      ; READ INPUT COMMAND
0374 BC 03F4 R                          MOV     SP,OFFSET C8042C        ; SET RETURN ADDRESS
0377 EB 1D                              JMP     SHORT C8042             ; ISSUE COMMAND
0379 BC 03F6 R                  E30B:   MOV     SP,OFFSET OBF_42B       ; SET RETURN ADDRESS
037C EB 24                              JMP     SHORT OBF_42            ; GO WAIT FOR RESPONSE
037E E4 60                      E30C:   IN      AL,PORT_A               ; GET THE SWITCH
0380 E6 82                              OUT     DMA_PAGE+1,AL           ; SAVE TEMPORARY

                                ;-----  WRITE BYTE 0 OF 8042 MEMORY

0382 B0 60                              MOV     AL,WRITE_8042_LOC       ; WRITE BYTE COMMAND
0384 BC 03F2 R                          MOV     SP,OFFSET C8042B        ; SET RETURN ADDRESS
0387 EB 0D                              JMP     SHORT C8042             ; ISSUE THE COMMAND
0389 74 05                      TST4_D: JZ      TST4_D1                 ; CONTINUE IF COMMAND ACCEPTED

038B B0 0D                              MOV     AL,0DH                  ;       <><><><><><><><><><><><><>
038D E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0D <><>
038F F4                                 HLT
0390                            TST4_D1:
0390 B0 5D                              MOV     AL,5DH                  ; ENABLE OUTPUT BUFFER FULL INTERRUPT,
0392 E6 60                              OUT     PORT_A,AL               ; DISABLE KEYBOARD, SET SYSTEM FLAG,
0394 EB 1D                              JMP     SHORT E30A              ; PC 1 COMPATIBILITY, INHIBIT OVERRIDE

                                ;-----  ISSUE THE COMMAND TO THE 8042

0396 FA                         C8042:  CLI                             ; NO INTERRUPTS ALLOWED
0397 E6 64                              OUT     STATUS_PORT,AL          ; SEND COMMAND IN AL REGISTER

0399 2B C9                              SUB     CX,CX                   ; LOOP COUNT
039B E4 64                      C42_1:  IN      AL,STATUS_PORT          ; WAIT FOR THE COMMAND ACCEPTED
039D A8 02                              TEST    AL,INPT_BUF_FULL
039F E0 FA                              LOOPNZ  C42_1
03A1 C3                                 RET

                                ;-----  WAIT FOR 8042 RESPONSE

03A2 2B C9                      OBF_42: SUB     CX,CX
03A4 B3 06                              MOV     BL,6                    ; 200MS/PER LOOP * 6  =1200 MS +
03A6 E4 64                      C42_2:  IN      AL,STATUS_PORT          ; CHECK FOR RESPONSE
03A8 A8 01                              TEST    AL,OUT_BUF_FULL
03AA 75 06                              JNZ     C42_3                   ; GO IF RESPONSE
03AC E2 F8                              LOOP    C42_2                   ; TRY AGAIN
03AE FE CB                              DEC     BL                      ; DECREMENT LOOP COUNT
03B0 75 F4                              JNZ     C42_2
03B2 C3                         C42_3:  RET                             ; RETURN TO CALLER

                                ;----------------------------------------
                                ; TEST.11
                                ;       BASE 64K READ/WRITE MEMORY TEST  :
                                ; DESCRIPTION                            :
                                ;       WRITE/READ/VERIFY DATA PATTERNS  :
                                ;       AA,55,FF,01, AND 00 TO 1 ST 64K  :
                                ;       OF STORAGE. VERIFY STORAGE       :
                                ;       ADDRESSABILITY.                  :
                                ;----------------------------------------

                                ;-----  FILL MEMORY WITH DATA

03B3 B0 0E                      E30A:   MOV     AL,0EH                  ;       <><><><><><><><><><><><><>
03B5 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0E <><>

03B7 B8 ---- R                          MOV     AX,DATA                 ; GET THE SYSTEM SEGMENT
03BA 8E D8                              MOV     DS,AX                   ;  OF DATA
03BC 8B 1E 0072 R                       MOV     BX,@RESET_FLAG          ; SAVE @RESET_FLAG IN BX
03C0 FC                                 CLD                             ; SET DIRECTION FLAG TO INCREMENT
03C1 B9 8000                            MOV     CX,2000H*4              ; SET FOR 32K WORDS
03C4 2B FF                              SUB     DI,DI                   ; FIRST 16K
```

```
03C6 2B F6                         SUB     SI,SI
03C8 2B C0                         SUB     AX,AX
03CA 8E D8                         MOV     DS,AX
03CC 8E C0                         MOV     ES,AX
03CE 81 FB 1234                    CMP     BX,1234H                ; WARM START?
03D2 75 03                         JNZ     E30A_0                  ; GO IF NOT
03D4 E9 0582 R                     JMP     CLR_STG

                           ;-----  GET THE INPUT BUFFER (SWITCH SETTINGS)

03D7 B0 0F                 E30A_0: MOV     AL,0FH                  ;        <><><><><><><><><><><><>
03D9 E6 80                         OUT     MFG_PORT,AL             ;        <><> CHECKPOINT  0F <><>

03DB B0 80                         MOV     AL,PARITY_CHECK         ; SET BASE MEMORY PARITY
03DD E6 87                         OUT     DMA_PAGE+6,AL           ; USE AS TEMPORARY SAVE
03DF BC 03EC R                     MOV     SP,OFFSET C2            ; SET RETURN ADDRESS
03E2 E9 0000 E                     JMP     STGTST_CNT
03E5 8B D8                 C30:    MOV     BX,AX                   ; SAVE FAILING BIT PATTERN
03E7 75 0F                         JNZ     C31
03E9 E9 058D R                     JMP     C33                     ; STORAGE OK, CONTINUE

                           ;-----  TEMPORARY STACK FOR POST ROUTINES

03EC 03E5 R                C2      DW      C30
03EE 035D R                C8042A  DW      TST4_B
03F0 0368 R                OBF_42A DW      TST4_C
03F2 0389 R                C8042B  DW      TST4_D
03F4 0379 R                C8042C  DW      E30B
03F6 037E R                OBF_42B DW      E30C

                           ;----------------------------------------
                           ; BASE 64K STORAGE FAILURE
                           ;   DISPLAY THE CHECKPOINT (MFG CHECKPOINT)
                           ;     AND XOR EXPECTED WITH READ IN MFG_PORT
                           ;   DISPLAY CHECKPOINT IN MFG_PORT+3
                           ;   DISPLAY XOR'D DATA HIGH BYTE MFG_PORT+1
                           ;     LOW BYTE IN MFG_PORT+2
                           ;   A READ/WRITE SCOPE LOOP OF THE FIRST
                           ;   WORD FOR POSSIBLE ADDRESS LINE FAILURES
                           ;----------------------------------------

03F8                       C31:
03F8 8A C7                         MOV     AL,BH                   ; SAVE HIGH BYTE
03FA E6 81                         OUT     MFG_PORT+1,AL
03FC 8A C3                         MOV     AL,BL                   ; SAVE LOW BYTE
03FE E6 82                         OUT     MFG_PORT+2,AL

                           ;-----  CHECK FOR VIDEO ROM

0400 B9 C000                       MOV     CX,0C000H               ; START OF I/O ROM
0403 8E D9                 M1:     MOV     DS,CX                   ; POINT TO SEGMENT
0405 2B DB                         SUB     BX,BX                   ; GET THE FIRST 2 LOCATIONS
0407 8B 07                         MOV     AX,[BX]
0409 EB 00                         JMP     $+2                     ; BUS SETTLE
040B 3D AA55                       CMP     AX,0AA55H               ; IS THE VIDEO ROM PRESENT?
040E 6A 00                         POP
0410 74 0C                         JZ      Z5                      ; GO IF YES
0412 81 C1 0080                    ADD     CX,080H                 ; POINT TO NEXT 2K BLOCK
0416 81 F9 C800                    CMP     CX,0C800H               ; TOP OF VIDEO ROM AREA YET?
041A 7C E7                         JL      M1                      ; TRY AGAIN
041C 23 C9                         AND     CX,CX                   ; SET NON ZERO FLAG
041E                       Z5:
041E 75 03                         JNZ     C32                     ; GO IF NOT
0420 E9 050F R                     JMP     C31_0                   ; BYPASS ERROR DISPLAY IF VIDEO ROM

                           ;-----------------------------------------------------
                           ; SET VIDEO MODE TO DISPLAY MEMORY ERROR
                           ;       THIS ROUTINE INITIALIZES THE ATTACHMENT TO
                           ;       TO DISPLAY FIRST 64K STORAGE ERRORS.
                           ; BOTH COLOR AND MONOCHROME ATTACHMENTS ARE INITIALIZED.
                           ;-----------------------------------------------------

                           ;-----  INITIALIZE COLOR/MONOCHROME

0423 BA 03D8               C32:    MOV     DX,3D8H                 ; CONTROL REGISTER ADDRESS OF COLOR CARD
0426 2A C0                         SUB     AL,AL                   ; MODE SET
0428 EE                            OUT     DX,AL

0429 BA 03B8                       MOV     DX,03B8H                ; CONTROL REGISTER ADDRESS OF B/W CARD
042C B0 01                         MOV     AL,1                    ; MODE SET FOR CARD
042E EE                            OUT     DX,AL                   ; RESET VIDEO
042F 83 EA 04                      SUB     DX,4                    ; BACK TO BASE REGISTER

= 0010                     M4      EQU     10H

0432 BB 0030 E                     MOV     BX,OFFSET VIDEO_PARMS+M4*3  ; POINT TO VIDEO PARAMETERS
                                   ASSUME  DS:CODE
0435 B9 0010               Z_2:    MOV     CX,M4                   ; COUNT OF MONOCHROME VIDEO PARAMETERS

                           ;-----  BX POINTS TO CORRECT ROW OF INITIALIZATION TABLE

0438 32 E4                         XOR     AH,AH                   ; AH IS REGISTER NUMBER DURING LOOP

                           ;-----  LOOP THROUGH TABLE, OUTPUTTING REGISTER ADDRESS, THEN VALUE FROM TABLE

043A 8A C4                 M10:    MOV     AL,AH                   ; GET 6845 REGISTER NUMBER
043C EE                            OUT     DX,AL
043D 42                            INC     DX                      ; POINT TO DATA PORT
043E FE C4                         INC     AH                      ; NEXT REGISTER VALUE
0440 2E: 8A 07                     MOV     AL,CS:[BX]              ; GET TABLE VALUE
0443 EE                            OUT     DX,AL                   ; OUT TO CHIP
0444 43                            INC     BX                      ; NEXT IN TABLE
0445 4A                            DEC     DX                      ; BACK TO POINTER REGISTER
0446 E2 F2                         LOOP    M10                     ; DO THE WHOLE TABLE
0448 8A E2                         MOV     AH,DL                   ; CHECK IF COLOR CARD DONE
044A 80 E4 F0                      AND     AH,0F0H                 ; STRIP UNWANTED BITS
044D 80 FC D0                      CMP     AH,0D0H                 ; IS IT THE COLOR CARD?
0450 74 08                         JZ      Z_3                     ; CONTINUE IF COLOR
0452 BB 0000 E                     MOV     BX,OFFSET VIDEO_PARMS   ; POINT TO VIDEO PARAMETERS
0455 BA 03D4                       MOV     DX,3D4H                 ; COLOR BASE
0458 EB DB                         JMP     Z_2                     ; CONTINUE

                           ;-----  FILL REGEN AREA WITH BLANK

```

SECTION 5

```
045A 33 FF              Z_3:    XOR     DI,DI                   ; SET UP POINTER FOR REGEN
045C B8 B000                    MOV     AX,0B000H               ; SET UP ES TO VIDEO REGEN
045F 8E C0                      MOV     ES,AX

0461 B9 0800                    MOV     CX,2048                 ; NUMBER OF WORDS IN MONOCHROME CARD
0464 B8 0720                    MOV     AX,' '+7*H              ; FILL CHARACTER FOR ALPHA + ATTRIBUTE
0467 F3/ AB                     REP     STOSW                   ; FILL THE REGEN BUFFER WITH BLANKS

0469 33 FF                      XOR     DI,DI                   ; CLEAR COLOR VIDEO BUFFER MEMORY
046B BB B800                    MOV     BX,0B800H               ; SET UP ES TO COLOR VIDEO MEMORY
046E 8E C3                      MOV     ES,BX
0470 B9 2000                    MOV     CX,8192
0473 F3/ AB                     REP     STOSW                   ; FILL WITH BLANKS

                        ;-----  ENABLE VIDEO AND CORRECT PORT SETTING

0475 BA 03B8                    MOV     DX,3B8H
0478 B0 29                      MOV     AL,29H
047A EE                         OUT     DX,AL                   ; SET VIDEO ENABLE PORT

                        ;-----  SET UP OVERSCAN REGISTER

047B 42                         INC     DX                      ; SET OVERSCAN PORT TO A DEFAULT
047C B0 30                      MOV     AL,30H                  ; VALUE 30H FOR ALL MODES EXCEPT 640X200
047E EE                         OUT     DX,AL                   ; OUTPUT THE CORRECT VALUE TO 3D9 PORT

                        ;-----  ENABLE COLOR VIDEO AND CORRECT PORT SETTING

047F BA 03D8                    MOV     DX,3D8H
0482 B0 28                      MOV     AL,28H
0484 EE                         OUT     DX,AL                   ; SET VIDEO ENABLE PORT

                        ;-----  SET UP OVERSCAN REGISTER

0485 42                         INC     DX                      ; SET OVERSCAN PORT TO A DEFAULT
0486 B0 30                      MOV     AL,30H                  ; VALUE 30H FOR ALL MODES EXCEPT 640X200
0488 EE                         OUT     DX,AL                   ; OUTPUT THE CORRECT VALUE TO 3D9 PORT

                        ;-----  DISPLAY FAILING CHECKPOINT AND

0489 8C C8                      MOV     AX,CS                   ; SET STACK SEGMENT TO CODE SEGMENT
048B 8E D0                      MOV     SS,AX

048D BB B000                    MOV     BX,0B000H
0490 8E DB                      MOV     DS,BX                   ; SET DS TO B/W DISPLAY BUFFER

0492 B0 30              Z_0:    MOV     AL,'0'                  ; DISPLAY BANK 000000
0494 B9 0006                    MOV     CX,6
0497 2B FF                      SUB     DI,DI                   ; START AT 0
0499 88 05              Z:      MOV     [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
049B 47                         INC     DI                      ; POINT TO NEXT POSITION
049C 47                         INC     DI
049D E2 FA                      LOOP    Z

049F 80 FF B8                   CMP     BH,0B8H                 ; CHECK THAT COLOR BUFFER WRITTEN
04A2 74 0C                      JZ      Z_1
04A4 2B FF                      SUB     DI,DI                   ; POINT TO START OF BUFFER

04A6 B7 B0                      MOV     BH,0B0H
04A8 8E C3                      MOV     ES,BX                   ; ES = MONOCHROME
04AA B7 B8                      MOV     BH,0B8H                 ; SET SEGMENT TO COLOR
04AC 8E DB                      MOV     DS,BX                   ; DS = COLOR
04AE EB E2                      JMP     Z_0

                        ;-----  PRINT FAILING BIT PATTERN

04B0 B0 20              Z_1:    MOV     AL,' '                  ; DISPLAY A BLANK
04B2 88 05                      MOV     [DI],AL                 ; WRITE TO COLOR BUFFER
04B4 26: 88 05                  MOV     ES:[DI],AL              ; WRITE TO MONOCHROME REGEN BUFFER
04B7 47                         INC     DI                      ; POINT TO NEXT POSITION
04B8 47                         INC     DI
04B9 E4 81                      IN      AL,MFG_PORT+1           ; GET THE HIGH BYTE OF FAILING PATTERN
04BB B1 04                      MOV     CL,4                    ; SHIFT COUNT
04BD D2 E8                      SHR     AL,CL                   ; NIBBLE SWAP
04BF BC 057A R                  MOV     SP,OFFSET Z1_0
04C2 EB 1B                      JMP     SHORT PR

04C4 E4 81              Z1:     IN      AL,MFG_PORT+1
04C6 24 0F                      AND     AL,0FH                  ; ISOLATE TO LOW NIBBLE
04C8 BC 057C R                  MOV     SP,OFFSET Z2_0
04CB EB 12                      JMP     SHORT PR
04CD E4 82              Z2:     IN      AL,MFG_PORT+2           ; GET THE HIGH BYTE OF FAILING PATTERN
04CF B1 04                      MOV     CL,4                    ; SHIFT COUNT
04D1 D2 E8                      SHR     AL,CL                   ; NIBBLE SWAP
04D3 BC 057E R                  MOV     SP,OFFSET Z3_0
04D6 EB 07                      JMP     SHORT PR
04D8 E4 82              Z3:     IN      AL,MFG_PORT+2
04DA 24 0F                      AND     AL,0FH                  ; ISOLATE TO LOW NIBBLE
04DC BC 0580 R                  MOV     SP,OFFSET Z4_0          ; RETURN TO Z4:

                        ;-----  CONVERT AND PRINT

                                                                ; CONVERT 00-0F TO ASCII CHARACTER
04DF 04 90              PR:     ADD     AL,090H                 ; ADD FIRST CONVERSION FACTOR
04E1 27                         DAA                             ; ADJUST FOR NUMERIC AND ALPHA RANGE
04E2 14 40                      ADC     AL,040H                 ; ADD CONVERSION AND ADJUST LOW NIBBLE
04E4 27                         DAA                             ; ADJUST HIGH NIBBLE TO ASCII RANGE

04E5 88 05                      MOV     [DI],AL                 ; WRITE TO COLOR BUFFER
04E7 26: 88 05                  MOV     ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER
04EA 47                         INC     DI                      ; POINT TO NEXT POSITION
04EB 47                         INC     DI
04EC C3                         RET

                        ;-----  DISPLAY 201 ERROR

04ED B0 20              Z4:     MOV     AL,' '                  ; DISPLAY A BLANK
04EF 88 05                      MOV     [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
04F1 26: 88 05                  MOV     ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER
04F4 47                         INC     DI                      ; POINT TO NEXT POSITION
04F5 47                         INC     DI
04F6 B0 32                      MOV     AL,'2'                  ; DISPLAY 201 ERROR
04F8 88 05                      MOV     [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
04FA 26: 88 05                  MOV     ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER
04FD 47                         INC     DI                      ; POINT TO NEXT POSITION
```

```
04FE 47                              INC     DI
04FF B0 30                           MOV     AL,'0'
0501 88 05                           MOV     [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
0503 26: 88 05                       MOV     ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER
0506 47                              INC     DI                      ; POINT TO NEXT POSITION
0507 47                              INC     DI
0508 B0 31                           MOV     AL,'1'
050A 88 05                           MOV     [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
050C 26: 88 05                       MOV     ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER

                             ;-----  ROLL ERROR CODE IN MFG_PORT --> FIRST THE CHECKPOINT

050F B0 DD                   C31_0:  MOV     AL,0DDH                 ;       <><><><><><><><><><><><><>
0511 E6 80                           OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  DD <><>
0513 E6 83                           OUT     MFG_PORT+3,AL           ; ALSO DISPLAY CHECK POINT IN PORT 83
0515 2B C9                           SUB     CX,CX
0517                         C31_A:

0517 2B C0                           SUB     AX,AX                   ; SETUP SEGMENT
0519 8E D8                           MOV     DS,AX
051B B8 AA55                         MOV     AX,0AA55H               ; WRITE AN AA55
051E 2B FF                           SUB     DI,DI
0520 89 05                           MOV     [DI],AX
0522 8B 05                           MOV     AX,[DI]                 ; READ THE FIRST WORD
0524 E2 F1                           LOOP    C31_A                   ; DISPLAY CHECKPOINT LONGER
0526                         C31_B:
0526 89 05                           MOV     [DI],AX
0528 8B 05                           MOV     AX,[DI]
052A E2 FA                           LOOP    C31_B
052C                         C31_C:
052C 89 05                           MOV     [DI],AX
052E 8B 05                           MOV     AX,[DI]
0530 E2 FA                           LOOP    C31_C
0532                         C31_D:
0532 89 05                           MOV     [DI],AX
0534 8B 05                           MOV     AX,[DI]
0536 E2 FA                           LOOP    C31_D
0538                         C31_E:
0538 89 05                           MOV     [DI],AX
053A 8B 05                           MOV     AX,[DI]
053C E2 FA                           LOOP    C31_E

                             ;-----  ROLL ERROR CODE IN MFG_PORT --> NEXT THE HIGH BYTE

053E E4 81                           IN      AL,MFG_PORT+1           ; XOR OF FAILING BIT PATTERN
0540 E6 80                           OUT     MFG_PORT,AL             ; HIGH BYTE
0542                         C31_G:
0542 B8 AA55                         MOV     AX,0AA55H               ; WRITE AN AA55
0545 89 05                           MOV     [DI],AX
0547 8B 05                           MOV     AX,[DI]                 ; READ THE FIRST WORD
0549 E2 F7                           LOOP    C31_G
054B                         C31_H:
054B 89 05                           MOV     [DI],AX
054D 8B 05                           MOV     AX,[DI]
054F E2 FA                           LOOP    C31_H
0551                         C31_I:
0551 89 05                           MOV     [DI],AX
0553 8B 05                           MOV     AX,[DI]
0555 E2 FA                           LOOP    C31_I

                             ;-----  ROLL ERROR CODE IN MFG_PORT --> THEN THE LOW BYTE

0557 E4 82                           IN      AL,MFG_PORT+2           ; LOW BYTE
0559 E6 80                           OUT     MFG_PORT,AL
055B B8 AA55                         MOV     AX,0AA55H               ; WRITE AN AA55
055E 2B FF                   C31_K:  SUB     DI,DI
0560 89 05                           MOV     [DI],AX
0562 8B 05                           MOV     AX,[DI]                 ; READ THE FIRST WORD
0564 E2 F8                           LOOP    C31_K
0566                         C31_L:
0566 89 05                           MOV     [DI],AX
0568 8B 05                           MOV     AX,[DI]
056A E2 FA                           LOOP    C31_L
056C                         C31_M:
056C 89 05                           MOV     [DI],AX
056E 8B 05                           MOV     AX,[DI]
0570 E2 FA                           LOOP    C31_M
0572                         C31_N:
0572 89 05                           MOV     [DI],AX
0574 8B 05                           MOV     AX,[DI]
0576 E2 FA                           LOOP    C31_N
0578 EB 95                           JMP     C31_0                   ; DO AGAIN

057A 04C4 R                  Z1_0    DW      Z1                      ; TEMPORARY STACK
057C 04CD R                  Z2_0    DW      Z2                      ; TEMPORARY STACK
057E 04D8 R                  Z3_0    DW      Z3                      ; TEMPORARY STACK
0580 04ED R                  Z4_0    DW      Z4                      ; TEMPORARY STACK


                             ;-----  CLEAR STORAGE ENTRY


0582                         CLR_STG:
                                     ASSUME  DS:DATA
0582 F3/ AB                          REP     STOSW                   ; STORE 32K WORDS OF 0000
0584 B8 ---- R                       MOV     AX,DATA                 ; RESTORE DATA SEGMENT
0587 8E D8                           MOV     DS,AX
0589 89 1E 0072 R                    MOV     @RESET_FLAG,BX          ; RESTORE RESET FLAG

                             ;-----  SETUP STACK SEGMENT AND SP

058D                         C33:
058D B8 ---- R                       MOV     AX,DATA                 ; SET DATA SEGMENT
0590 8E D8                           MOV     DS,AX
0592 BC 0000                         MOV     SP,POST_SS              ; GET STACK VALUE
0595 8E D4                           MOV     SS,SP                   ; SET THE STACK UP
0597 BC 8000                         MOV     SP,POST_SP              ; STACK IS READY TO GO

                             ;-----  INITIALIZE DISPLAY ROW COUNT

059A C6 06 0084 R 18                 MOV     @ROWS,25-1              ; SET ROWS FOR PRINT SCREEN DEFAULT

059F B0 11                           MOV     AL,11H                  ;       <><><><><><><><><><><><><>
05A1 E6 80                           OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  11 <><>
```

SECTION 5

```

                                 ;-----  VERIFY SPEED/REFRESH CLOCK RATES  ( ERROR = 1 LONG AND 1 SHORT BEEP )

 05A3  32 DB                             XOR     BL,BL                   ; CLEAR REFRESH CYCLE REPEAT COUNT
 05A5  33 C9                             XOR     CX,CX                   ; INITIALIZE SPEED RATE REGISTER
 05A7  90                                EVEN                            ; PLACE ON EVEN WORD BOUNDARY
 05A8                            C34:
 05A8  E4 61                             IN      AL,PORT_B               ; READ REFRESH BIT REGISTER
 05AA  A8 10                             TEST    AL,REFRESH_BIT          ; MASK FOR BIT
 05AC  E1 FA                             LOOPZ   C34                     ; DECREMENT LOOP COUNTER TILL ON
 05AE                            C35:
 05AE  E4 61                             IN      AL,PORT_B               ; READ REFRESH BIT REGISTER
 05B0  A8 10                             TEST    AL,REFRESH_BIT          ; MASK FOR BIT
 05B2  E0 FA                             LOOPNZ  C35                     ; DECREMENT LOOP COUNTER TILL OFF

 05B4  FE CB                             DEC     BL                      ; DECREMENT REFRESH CYCLE REPEAT COUNT
 05B6  75 F0                             JNZ     C34                     ; REPEAT TILL CYCLE COUNT DONE

 05B8  81 F9 F8A7                        CMP     CX,RATE_UPPER           ; CHECK FOR RATE BELOW UPPER LIMIT
 05BC  73 07                             JAE     C36                     ; SKIP ERROR BEEP IF BELOW MAXIMUM
 05BE                            C36E:
 05BE  BA 0101                           MOV     DX,0101H                ; GET BEEP COUNTS FOR REFRESH ERROR
 05C1  E8 0000 E                         CALL    ERR_BEEP                ; CALL TO POST ERROR BEEP ROUTINES
 05C4  F4                                HLT                             ; HALT SYSTEM - BAD REFRESH RATE
 05C5                            C36:
 05C5  81 F9 F9FD                        CMP     CX,RATE_LOWER           ; CHECK FOR RATE ABOVE LOWER LIMIT
 05C9  77 F3                             JA      C36E                    ; GO TO ERROR BEEP IF BELOW MINIMUM

                                 ;-----  GET THE INPUT BUFFER (SWITCH SETTINGS)

 05CB  E4 82                             IN      AL,DMA_PAGE+1           ; GET THE SWITCH SETTINGS
 05CD  24 F8                             AND     AL,KEY_BD_INHIB+DSP_JMP+MFG_LOOP+BASE_MEM+BASE_MEM8 ; STRIP BITS
 05CF  A2 0012 R                         MOV     @MFG_TST,AL             ; SAVE SETTINGS
 05D2  2A C0                             SUB     AL,AL                   ; RESET DMA_PAGE
 05D4  E6 82                             OUT     DMA_PAGE+1,AL

                                 ;----------------------------------------
                                 ; TEST.11A                              :
                                 ;       VERIFY 286 LGDT/SGDT LIDT/SIDT  :
                                 ;       INSTRUCTIONS                    :
                                 ; DESCRIPTION                           :
                                 ;       LOAD GDT AND IDT REGISTERS WITH :
                                 ;       AA,55,00 AND VERIFY CORRECT.    :
                                 ;----------------------------------------

                                 ;-----  VERIFY STATUS INDICATE COMPATIBILITY (REAL) MODE

                                         SMSW    AX                      ; GET THE CURRENT STATUS WORD
 05D6  0F 01 E0              +           DB      00FH,001H,0E0H
 05D9  A9 000F                           TEST    AX,0FH                  ; PE/MP/EM/TS BITS SHOULD BE ZERO
 05DC  75 34                             JNZ     ERR_PROT                ; GO IF STATUS NOT REAL MODE

                                 ;-----  TEST PROTECTED MODE REGISTERS

 05DE  B0 12                             MOV     AL,12H                  ;       <><><><><><><><><><><><>
 05E0  E6 80                             OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  12 <><>

 05E2  1E                                PUSH    DS                      ; SET ES TO SAME SEGMENT AS DS
 05E3  07                                POP     ES
 05E4  BF D0A0                           MOV     DI,SYS_IDT_LOC          ; USE THIS AREA TO BUILD TEST PATTERN
 05E7  B9 0003                           MOV     CX,3
 05EA  B8 AAAA                           MOV     AX,0AAAAH               ; FIRST PATTERN
 05ED  E8 0615 R                         CALL    WRT_PAT
 05F0  B8 5555                           MOV     AX,05555H
 05F3  E8 0615 R                         CALL    WRT_PAT                 ; WRITE NEXT PATTERN
 05F6  2B C0                             SUB     AX,AX                   ; WRITE 0
 05F8  E8 0615 R                         CALL    WRT_PAT

                                 ;-----  TEST 286 CONTROL FLAGS

 05FB  FD                                STD                             ; SET DIRECTION FLAG FOR DECREMENT
 05FC  9C                                PUSHF                           ; GET THE FLAGS
 05FD  58                                POP     AX
 05FE  A9 0200                           TEST    AX,0200H                ; INTERRUPT FLAG SHOULD BE OFF
 0601  75 0F                             JNZ     ERR_PROT                ; GO IF NOT
 0603  A9 0400                           TEST    AX,0400H                ; CHECK DIRECTION FLAG
 0606  74 0A                             JZ      ERR_PROT                ; GO IF NOT SET
 0608  FC                                CLD                             ; CLEAR DIRECTION FLAG
 0609  9C                                PUSHF                           ; INSURE DIRECTION FLAG IS RESET
 060A  58                                POP     AX
 060B  A9 0400                           TEST    AX,0400H
 060E  75 02                             JNZ     ERR_PROT                ; GO IF NOT

 0610  EB 3D                             JMP     SHORT C37A              ; TEST OK CONTINUE
 0612                            ERR_PROT:
 0612  F4                                HLT                             ; PROTECTED MODE REGISTER FAILURE
 0613  EB FD                             JMP     SHORT ERR_PROT          ; INSURE NO BREAKOUT OF HALT

                                 ;-----  WRITE TO 286 REGISTERS

 0615  B9 0003                   WRT_PAT:MOV     CX,3
 0618  F3/ AB                            REP     STOSW                   ; STORE 6 BYTES OF PATTERN
 061A  BD D0A0                           MOV     BP,SYS_IDT_LOC
                                         SEGOV   ES                      ; LOAD THE IDT
 061D  26                    +           DB      026H
                                         LIDT    [BP]                    ; REGISTER FROM THIS AREA
 061E  0F                    +           DB      00FH
 061F                        + ??0001    LABEL   BYTE
 061F  8B 5E 00              +           MOV     BX,WORD PTR [BP]
 0622                        + ??0002    LABEL   BYTE
 061F                        +           ORG     OFFSET CS:??0001
 061F  01                    +           DB      001H
 0622                        +           ORG     OFFSET CS:??0002
 0622  BD D0A0                           MOV     BP,SYS_IDT_LOC
                                         SEGOV   ES                      ; LOAD THE GDT
 0625  26                    +           DB      026H
                                         LGDT    [BP]                    ; FROM THE SAME AREA
 0626  0F                    +           DB      00FH
 0627                        + ??0004    LABEL   BYTE
 0627  8B 56 00              +           MOV     DX,WORD PTR [BP]
 062A                        + ??0005    LABEL   BYTE
 0627                        +           ORG     OFFSET CS:??0004
 0627  01                    +           DB      001H
 062A                        +           ORG     OFFSET CS:??0005
```

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                                    ;-----  READ AND VERIFY 286 REGISTERS

0620 BD D8A0                                MOV     BP,GDT_LOC              ; STORE THE REGISTERS HERE
                                            SEGOV   ES
062D 26                         +           DB      026H
                                            SIDT    [BP]                    ; GET THE IDT REGISTERS
062E 0F                         +           DB      00FH
062F                            + ??0007    LABEL   BYTE
062F 8B 4E 00                   +           MOV     CX,[BP]
0632                            + ??0008    LABEL   BYTE
062F                            +           ORG     OFFSET CS:??0007
062F 01                         +           DB      001H
0632                            +           ORG     OFFSET CS:??0008
0632 BD D8A5                                MOV     BP,GDT_LOC+5
                                            SEGOV   ES
0635 26                         +           DB      026H
                                            SGDT    [BP]                    ; GET THE GDT REGISTERS
0636 0F                         +           DB      00FH
0637                            + ??000A    LABEL   BYTE
0637 03 46 00                   +           ADD     AX,[BP]
063A                            + ??000B    LABEL   BYTE
0637                            +           ORG     OFFSET CS:??000A
0637 01                         +           DB      001H
063A                            +           ORG     OFFSET CS:??000B
063A BF D0A0                                MOV     DI,SYS_IDT_LOC
063D 8B 05                                  MOV     AX,[DI]                 ; GET THE PATTERN WRITTEN
063F B9 0005                                MOV     CX,5                    ; CHECK ALL REGISTERS
0642 BE D8A0                                MOV     SI,GDT_LOC              ; POINT TO THE BEGINNING
0645 26: 3B 04                      C37B:   CMP     AX,ES:[SI]
0648 75 C8                                  JNZ     ERR_PROT                ; HALT IF ERROR
064A 46                                     INC     SI                      ; POINT TO NEXT WORD
064B 46                                     INC     SI
064C E2 F7                                  LOOP    C37B                    ; CONTINUE TILL DONE
064E C3                                     RET


                                    ;-------------------------------------------------------
                                    ;       INITIALIZE THE 8259 INTERRUPT #1 CONTROLLER CHIP :
                                    ;-------------------------------------------------------
064F                                C37A:
064F 2A C0                                  SUB     AL,AL                   ; RESET MATH PROCESSOR
0651 E6 F1                                  OUT     X287+1,AL
0653 B0 11                                  MOV     AL,11H                  ; ICW1 - EDGE, MASTER, ICW4
0655 E6 20                                  OUT     INTA00,AL
0657 EB 00                                  JMP     $+2                     ; I/O DELAY
0659 B0 08                                  MOV     AL,8                    ; SETUP ICW2 - INTERRUPT TYPE 8 (8-F)
065B E6 21                                  OUT     INTA01,AL
065D EB 00                                  JMP     $+2                     ; I/O DELAY

065F B0 04                                  MOV     AL,04H                  ; SETUP ICW3 - MASTER LEVEL 2
0661 E6 21                                  OUT     INTA01,AL
0663 EB 00                                  JMP     $+2                     ; I/O DELAY
0665 B0 01                                  MOV     AL,01H                  ; SETUP ICW4 - MASTER,8086 MODE
0667 E6 21                                  OUT     INTA01,AL
0669 EB 00                                  JMP     $+2                     ; I/O DELAY
066B B0 FF                                  MOV     AL,0FFH                 ; MASK ALL INTERRUPTS OFF
066D E6 21                                  OUT     INTA01,AL               ; (VIDEO ROUTINE ENABLES INTERRUPTS)

                                    ;-------------------------------------------------------
                                    ;       INITIALIZE THE 8259 INTERRUPT #2 CONTROLLER CHIP  :
                                    ;-------------------------------------------------------

066F B0 13                                  MOV     AL,13H                  ;       <><><><><><><><><><><><><>
0671 E6 80                                  OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  13 <><>

0673 B0 11                                  MOV     AL,11H                  ; ICW1 - EDGE, SLAVE ICW4
0675 E6 A0                                  OUT     INTB00,AL
0677 EB 00                                  JMP     $+2                     ; I/O DELAY
0679 B0 70                                  MOV     AL,INT_TYPE             ; SETUP ICW2 - INTERRUPT TYPE 70 (70-7F)
067B E6 A1                                  OUT     INTB01,AL
067D B0 02                                  MOV     AL,02H                  ; SETUP ICW3 - SLAVE LEVEL 2
067F EB 00                                  JMP     $+2
0681 E6 A1                                  OUT     INTB01,AL
0683 EB 00                                  JMP     $+2                     ; I/O DELAY
0685 B0 01                                  MOV     AL,01H                  ; SETUP ICW4 - 8086 MODE, SLAVE
0687 E6 A1                                  OUT     INTB01,AL
0689 EB 00                                  JMP     $+2                     ; I/O DELAY
068B B0 FF                                  MOV     AL,0FFH                 ; MASK ALL INTERRUPTS OFF
068D E6 A1                                  OUT     INTB01,AL

                                    ;-----  SET UP THE INTERRUPT VECTORS TO TEMPORARY INTERRUPT

068F B0 14                                  MOV     AL,14H                  ;       <><><><><><><><><><><><><>
0691 E6 80                                  OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  14 <><>

0693 B9 0078                                MOV     CX,78H                  ; FILL ALL INTERRUPT LOCATIONS
0696 2B FF                                  SUB     DI,DI                   ; FIRST INTERRUPT LOCATION
0698 8E C7                                  MOV     ES,DI                   ; SET (ES) ALSO
069A B8 0000 E                      D3:     MOV     AX,OFFSET D11           ; GET ADDRESS OF INTERRUPT OFFSET
069D AB                                     STOSW                           ; PLACE IN INTERRUPT VECTOR LOCATION
069E 8C C8                                  MOV     AX,CS                   ; GET THE CURRENT CODE SEGMENT
06A0 AB                                     STOSW                           ; PLACE CODE SEGMENT IN VECTOR LOCATION
06A1 E2 F7                                  LOOP    D3

                                    ;-----  ESTABLISH BIOS SUBROUTINE CALL INTERRUPT VECTORS

06A3 B0 15                                  MOV     AL,15H                  ;       <><><><><><><><><><><><><>
06A5 E6 80                                  OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  15 <><>


06A7 BF 0040 R                              MOV     DI,OFFSET @VIDEO_INT    ; SET VIDEO INTERRUPT AREA
06AA 0E                                     PUSH    CS
06AB 1F                                     POP     DS                      ; SET UP ADDRESS OF VECTOR TABLE
06AC 8C D8                                  MOV     AX,DS                   ; SET AX=SEGMENT
06AE BE 0010 E                              MOV     SI,OFFSET VECTOR_TABLE+16 ;START WITH VIDEO ENTRY
06B1 B9 0010                                MOV     CX,16

06B4 A5                             D3A:    MOVSW                           ; MOVE VECTOR TABLE TO LOW MEMORY
06B5 47                                     INC     DI
06B6 47                                     INC     DI                      ; SKIP SEGMENT POINTER
06B7 E2 FB                                  LOOP    D3A

                                    ;----------------------------------------
```

SECTION 5

```
                                ; TEST.12                                 :
                                ;       VERIFY CMOS CHECKSUM/BATTERY OK   :
                                ; DESCRIPTION                             :
                                ;       DETERMINE IF CONFIG RECORD        :
                                ;       CAN BE USED FOR INITIALIZATION.   :
                                ;-----------------------------------------
                                        ASSUME  DS:DATA
06B9 E8 0000 E                          CALL    DDS                     ; SET THE DATA SEGMENT

06BC B0 16                              MOV     AL,16H                  ;       <><><><><><><><><><><><>
06BE E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  16 <><>

                                ;-----  IS THE BATTERY LOW THIS POWER UP?

06C0 B0 8D                              MOV     AL,CMOS_REG_D+NMI       ; CHECK BATTERY CONDITION
06C2 E8 0000 E                          CALL    CMOS_READ               ; READ THE BATTERY STATUS
06C5 A8 80                              TEST    AL,10000000B            ; IS THE BATTERY LOW?
06C7 74 0B                              JZ      CMOS1A                  ; ERROR IF YES

06C9 B0 8E                              MOV     AL,CMOS_DIAG+NMI        ; GET THE OLD STATUS
06CB E8 0000 E                          CALL    CMOS_READ               ; FROM DIAGNOSTIC STATUS BYTE
06CE A8 80                              TEST    AL,BAD_BAT              ; HAS CUSTOMER SETUP BEEN EXECUTED?
06D0 74 15                              JZ      CMOS1                   ; GO CHECK CHECKSUM IF YES

06D2 EB 64                              JMP     SHORT CMOS4             ; CONTINUE WITHOUT CONFIGURATION

                                ;-----  SET DEFECTIVE BATTERY FLAG

06D4 B0 17                      CMOS1A: MOV     AL,17H                  ;       <><><><><><><><><><><><>
06D6 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  17 <><>

06D8 B8 8E8E                            MOV     AX,X*(CMOS_DIAG+NMI)    ; CMOS DIAGNOSTIC STATUS BYTE
06DB E8 0000 E                          CALL    CMOS_READ               ; GET THE CURRENT STATUS
06DE 0C 80                              OR      AL,BAD_BAT              ; SET THE DEAD BATTERY FLAG
06E0 86 C4                              XCHG    AL,AH                   ; SAVE
06E2 E8 0000 E                          CALL    CMOS_WRITE              ; OUTPUT THE STATUS
06E5 EB 51                              JMP     SHORT  CMOS4            ; GO TO MINIMUM CONFIGURATION

                                ;-----  VERIFY CHECKSUM

06E7 B8 8E8E                    CMOS1:  MOV     AX,X*(CMOS_DIAG+NMI)    ; CLEAR OLD STATUS
06EA E8 0000 E                          CALL    CMOS_READ               ; GET THE CURRENT STATUS
06ED 81 3E 0072 R 1234                  CMP     @RESET_FLAG,1234H       ; IS THIS A SOFT RESET
06F3 75 04                              JNZ     CMOS1_A                 ; GO IF NOT

06F5 24 10                              AND     AL,W_MEM_SIZE           ; CLEAR ALL BUT THE CMOS/POR MEMORY SIZE
06F7 EB 02                              JMP     SHORT CMOS1_B
06F9                            CMOS1_A:
06F9 2A C0                              SUB     AL,AL                   ; CLEAR STATUS IF POWER ON RESET
06FB                            CMOS1_B:
06FB 86 C4                              XCHG    AL,AH                   ; SAVE THE CURRENT STATUS
06FD E8 0000 E                          CALL    CMOS_WRITE

0700 2B DB                              SUB     BX,BX
0702 2B C9                              SUB     CX,CX
0704 B1 90                              MOV     CL,CMOS_DISKETTE+NMI    ; SET START OF CMOS CHECKSUMED AREA
0706 B5 AE                              MOV     CH,CMOS_CKSUM_HI+NMI    ; SET END OF CMOS CHECKSUMED AREA +1
                                                                        ;  (FIRST BYTE OF CHECKSUM)
0708 8A C1                      CMOS2:  MOV     AL,CL
070A E8 0000 E                          CALL    CMOS_READ               ; ADDRESS THE BEGINNING
070D 2A E4                              SUB     AH,AH                   ; INSURE AH=0
070F 03 D8                              ADD     BX,AX                   ; ADD TO CURRENT VALUE
0711 FE C1                              INC     CL                      ; POINT TO NEXT BYTE ADDRESS IN CMOS
0713 3A E9                              CMP     CH,CL                   ; FINISHED?  (AT CHECKSUM BYTE HIGH)
0715 75 F1                              JNZ     CMOS2                   ; GO IF NOT
0717 0B DB                              OR      BX,BX                   ; BX MUST NOT BE 0
0719 74 10                              JZ      CMOS3                   ; CMOS BAD IF CHECKSUM=0
071B B0 AE                              MOV     AL,CMOS_CKSUM_HI+NMI    ; GET THE CHECK SUM HIGH BYTE
071D E8 0000 E                          CALL    CMOS_READ               ; FIRST BYTE OF CHECKSUM
0720 8A E0                              MOV     AH,AL                   ; SAVE IT
0722 B0 AF                              MOV     AL,CMOS_CKSUM_LO+NMI    ; SECOND BYTE OF CHECKSUM
0724 E8 0000 E                          CALL    CMOS_READ
0727 3B C3                              CMP     AX,BX                   ; IS THE CHECKSUM OK
0729 74 0D                              JZ      CMOS4                   ; GO IF YES

                                ;-----  SET CMOS CHECKSUM ERROR

072B B8 8E8E                    CMOS3:  MOV     AX,X*(CMOS_DIAG+NMI)    ; ADDRESS DIAGNOSTIC STATUS
072E E8 0000 E                          CALL    CMOS_READ               ; GET THE CURRENT STATUS
0731 0C 40                              OR      AL,BAD_CKSUM            ; SET BAD CHECKSUM FLAG
0733 86 C4                              XCHG    AL,AH                   ; SAVE IT
0735 E8 0000 E                          CALL    CMOS_WRITE              ; SET FLAG

                                ;-----  INSURE CMOS DIVIDERS SET

0738                            CMOS4:
0738 B8 8A8A                            MOV     AX,X*(CMOS_REG_A+NMI)   ; ADDRESS CMOS REGISTER A
073B E8 0000 E                          CALL    CMOS_READ               ; GET CURRENT DIVISORS
073E 24 0F                              AND     AL,00FH                 ; LOOK AT PERIODIC RATE BITS
0740 75 07                              JNZ     CMOS9                   ; EXIT IF SET TO SOMETHING USEFUL

0742 B0 26                              MOV     AL,26H                  ; ELSE SET THE STANDARD DEFAULT USED BY
0744 86 C4                              XCHG    AL,AH                   ;  BIOS FOR THE 976.56 US RATE
0746 E8 0000 E                          CALL    CMOS_WRITE              ;  FOR THE PERIODIC CLOCK
0749                            CMOS9:
0749 B0 18                              MOV     AL,18H                  ;       <><><><><><><><><><><><>
074B E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  18 <><>

                                ;-----  ENABLE PROTECTED MODE

074D E4 61                              IN      AL,PORT_B               ; DISABLE MEMORY AND I/O PARITY CHECKS
074F 0C 0C                              OR      AL,RAM_PAR_OFF
0751 E6 61                              OUT     PORT_B,AL

                                ;-----  SET RETURN ADDRESS BYTE IN CMOS

0753 B0 19                              MOV     AL,19H                  ;       <><><><><><><><><><><><>
0755 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  19 <><>

0757 B8 018F                            MOV     AX,1*H+(CMOS_SHUT_DOWN+NMI)   ; SET THE RETURN ADDRESS FOR
075A E8 0000 E                          CALL    CMOS_WRITE              ; THE FIRST SHUTDOWN RETURN ADDRESS

075D BC 0000                            MOV     SP,POST_SS              ; SET STACK FOR SYSINIT1
0760 8E D4                              MOV     SS,SP
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0762 BC 8000                          MOV     SP,POST_SP
0765 E8 0000 E                        CALL    SYSINITI                ; CALL THE DESCRIPTOR TABLE BUILDER
                                                                      ; AND REAL-TO-PROTECTED MODE SWITCHER
0768 B0 1A                            MOV     AL,1AH                  ;       <><><><><><><><><><><><><>
076A E6 80                            OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  1A <><>
                              ;-----  SET TEMPORARY STACK
076C 6A 08                            PUSH    BYTE PTR GDT_PTR        ; SET (DS:) SELECTOR TO GDT SEGMENT
076E 1F                               POP     DS
076F C7 06 005A 0000                  MOV     DS:SS_TEMP.BASE_LO_WORD,0
0775 C6 06 005C 00                    MOV     BYTE PTR DS:(SS_TEMP.BASE_HI_BYTE),0
077A BE 0058                          MOV     SI,SS_TEMP
077D 8E D6                            MOV     SS,SI
077F BC FFFD                          MOV     SP,MAX_SEG_LEN-2
                              ;------------------------------------------------------------------------------------
                              ; TEST.13                                                                             :
                              ;  PROTECTED MODE TEST AND MEMORY SIZE DETERMINE  ( 0 --> 640K )                      :
                              ;                                                                                     :
                              ; DESCRIPTION:                                                                        :
                              ;     THIS ROUTINE RUNS IN PROTECTED MODE IN ORDER TO ADDRESS ALL OF STORAGE.          :
                              ;     IT CHECKS THE MACHINE STATUS WORD (MSW) FOR PROTECTED MODE AND THE BASE          :
                              ;     MEMORY SIZE IS DETERMINED AND SAVED.  BIT 4 OF THE CMOS DIAGNOSTIC               :
                              ;     STATUS BYTE IS SET IF 512K --> 640K MEMORY IS INSTALLED.                         :
                              ;     DURING A POWER UP SEQUENCE THE MEMORY SIZE DETERMINE IS DONE WITH                :
                              ;     PLANAR AND I/O PARITY CHECKS DISABLED.  DURING A SOFT RESET THE MEMORY           :
                              ;     SIZE DETERMINE WILL CHECK FOR PARITY ERRORS.                                     :
                              ;------------------------------------------------------------------------------------
                              ;-----  INSURE PROTECTED MODE
                                      SMSW    AX                      ; GET THE MACHINE STATUS WORD
0782 0F 01 E0             +           DB      00FH,001H,0E0H
0785 A9 0001                          TEST    AX,VIRTUAL_ENABLE       ; ARE WE IN PROTECTED MODE
0788 75 0C                            JNZ     VIR_OK
078A B8 088F                  SHUT_8: MOV     AX,8*H+(CMOS_SHUT_DOWN+NMI)     ; SET THE RETURN ADDRESS
078D E8 0000 E                        CALL    CMOS_WRITE              ; AND SET SHUTDOWN 8
0790 E9 0000 E                        JMP     PROC_SHUTDOWN           ; CAUSE A SHUTDOWN
                              ;-----  VIRTUAL MODE ERROR HALT
0793 F4                       SHUT8:  HLT
0794 EB FD                            JMP     SHUT8                   ; ERROR HALT
                              ;-----  64K SEGMENT LIMIT
0796 C7 06 0048 FFFF          VIR_OK: MOV     DS:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN
                              ;-----  CPL0, DATA ACCESS RIGHTS
079C C6 06 004D 93                    MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS
                              ;-----  START WITH SEGMENT ADDRESS 01-0000 (SECOND 64K)
07A1 C6 06 004C 01                    MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),01H
07A6 C7 06 004A 0000                  MOV     DS:ES_TEMP.BASE_LO_WORD,0H
07AC B0 1B                            MOV     AL,1BH                  ;       <><><><><><><><><><><><><>
07AE E6 80                            OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  1B <><>
07B0 BB 0040                          MOV     BX,16*4                 ; SET THE FIRST 64K DONE
                              ;-----  START STORAGE SIZE/CLEAR
07B3                          NOT_DONE:
07B3 6A 48                            PUSH    BYTE PTR ES_TEMP        ; POINT ES TO DATA
07B5 07                               POP     ES                      ; POINT TO SEGMENT TO TEST
07B6 E8 07D2 R                        CALL    HOW_BIG                 ; DO THE FIRST 64K
07B9 74 03                            JZ      NOT_FIN                 ; CHECK IF TOP OF MEMORY
07BB E9 0870 R                        JMP     DONE
07BE                          NOT_FIN:
07BE 83 C3 40                         ADD     BX,16*4                 ; BUMP MEMORY COUNT BY 64K
                              ;-----  DO NEXT 64K (0X0000) BLOCK
07C1 FE 06 004C                       INC     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE)
                              ;-----  CHECK FOR END OF FIRST 640K (END OF BASE MEMORY)
07C5 80 3E 004C 0A                    CMP     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),0AH
07CA 75 E7                            JNZ     NOT_DONE                ; GO IF NOT
07CC E8 084D R                        CALL    HOW_BIG_END             ; GO SET MEMORY SIZE
07CF E9 0870 R                        JMP     DONE
                              ;-----  FILL/CHECK LOOP
07D2                          HOW_BIG:
07D2 2B FF                            SUB     DI,DI
07D4 B8 AA55                          MOV     AX,0AA55H               ; TEST PATTERN
07D7 8B C8                            MOV     CX,AX                   ; SAVE PATTERN
07D9 26: 89 05                        MOV     ES:[DI],AX              ; WRITE PATTERN TO MEMORY
07DC B0 0F                            MOV     AL,0FH                  ; PUT SOMETHING IN AL
07DE 26: 8B 05                        MOV     AX,ES:[DI]              ; GET PATTERN
07E1 26: 89 05                        MOV     ES:[DI],AX              ; INSURE NO PARITY I/O CHECK
07E4 33 C1                            XOR     AX,CX                   ; COMPARE PATTERNS
07E6 75 65                            JNZ     HOW_BIG_END             ; GO END IF NO COMPARE
07E8 1E                               PUSH    DS
07E9 6A 18                            PUSH    BYTE PTR RSDA_PTR       ; POINT TO SYSTEM DATA AREA
07EB 1F                               POP     DS                      ; GET (DS:)
                              ;-----  IS THIS A SOFT RESET
07EC 81 3E 0072 R 1234                CMP     @RESET_FLAG,1234H       ; SOFT RESET
07F2 1F                               POP     DS                      ; RESTORE DS
07F3 75 36                            JNZ     HOW_BIG_2               ; GO IF NOT SOFT RESET
                              ;-----  INSURE NO PARITY WITH PARITY BITS OFF
07F5 26: C7 05 0101                   MOV     WORD PTR ES:[DI],0101H  ; TURN OFF BOTH PARITY BITS
```

SECTION 5

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07FA E4 61                   IN      AL,PORT_B
07FC 0C 0C                   OR      AL,RAM_PAR_OFF          ; TOGGLE PARITY CHECK ENABLES
07FE E6 61                   OUT     PORT_B,AL
0800 24 F3                   AND     AL,RAM_PAR_ON
0802 E6 61                   OUT     PORT_B,AL
0804 6A FF                   PUSH    BYTE PTR 0FFH           ; PLACE 0FFFFH IN STACK (BUS BITS ON)
0806 58                      POP     AX                      ; DELAY - CAUSING BUS BITS ON
0807 26: 8B 05               MOV     AX,ES:[DI]              ; CHECK PARITY
080A E4 61                   IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
080C 24 C0                   AND     AL,PARITY_ERR
080E 26: 89 05               MOV     ES:[DI],AX              ; CLEAR POSSIBLE PARITY ERROR
0811 75 3A                   JNZ     HOW_BIG_END             ; GO IF PLANAR OR I/O PARITY CHECK
                     ;----- CHECK ALL BITS WRITE OK
0813 26: C7 05 FFFF          MOV     WORD PTR ES:[DI],0FFFFH ; TURN ON ALL BITS
0818 26: 8B 05               MOV     AX,ES:[DI]              ; CHECK FOR FFFFH
081B 50                      PUSH    AX                      ; SAVE RESULTS
081C E4 61                   IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
081E 24 C0                   AND     AL,PARITY_ERR
0820 26: 89 05               MOV     ES:[DI],AX              ; CLEAR POSSIBLE PARITY ERROR
0823 58                      POP     AX                      ; GET RESULTS
0824 75 27                   JNZ     HOW_BIG_END             ; GO IF PARITY CHECK
0826 3D FFFF                 CMP     AX,0FFFFH
0829 75 22                   JNZ     HOW_BIG_END
                     ;----- CHECK 64K BLOCK FOR PARITY CHECK
082B                 HOW_BIG_2:
082B 2B C0                   SUB     AX,AX                   ; WRITE ZEROS
082D B9 8000                 MOV     CX,2000H*4              ; SET COUNT FOR 32K WORDS
0830 F3/ AB                  REP     STOSW                   ; FILL 32K WORDS
0832 1E                      PUSH    DS
0833 06                      PUSH    ES
0834 06                      PUSH    ES                      ; GET ES TO DS
0835 1F                      POP     DS
0836 B9 8000                 MOV     CX,2000H*4              ; SET COUNT FOR 32K WORDS
0839 2B F6                   SUB     SI,SI
083B F3/ AD                  REP     LODSW
083D 2B FF                   SUB     DI,DI                   ; SET TO BEGINNING OF BLOCK
083F E4 61                   IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
0841 24 C0                   AND     AL,PARITY_ERR
0843 26: C7 05 0000          MOV     WORD PTR ES:[DI],0      ; CLEAR POSSIBLE PARITY ERROR
0848 07                      POP     ES                      ; RESTORE SEGMENTS
0849 1F                      POP     DS
084A 75 01                   JNZ     HOW_BIG_END             ; GO IF PLANAR OR I/O PARITY CHECK
084C C3                      RET
084D                 HOW_BIG_END:
084D 9C                      PUSHF                           ; SAVE THE CURRENT FLAGS
084E B0 1C                   MOV     AL,1CH                  ;     <><><><><><><><><><><><><>
0850 E6 80                   OUT     MFG_PORT,AL             ;     <><> CHECKPOINT  1C <><>
                     ;----- SET OR RESET 512 TO 640 INSTALLED FLAG
0852 B8 B3B3                 MOV     AX,X*(CMOS_INFO128+NMI) ; SET/RESET 640K STATUS FLAG
0855 E8 0000 E               CALL    CMOS_READ               ; GET THE DIAGNOSTIC STATUS
0858 0C 80                   OR      AL,M640K
085A 81 FB 0200              CMP     BX,512                  ; CHECK MEMORY SIZE
085E 77 02                   JA      K640                    ; SET FLAG FOR 512 -> 640 INSTALLED
0860 24 7F                   AND     AL,NOT M640K
0862                 K640:
0862 86 C4                   XCHG    AL,AH                   ; SAVE THE STATUS
0864 E8 0000 E               CALL    CMOS_WRITE              ; RESTORE THE STATUS
0867 6A 18                   PUSH    BYTE PTR RSDA_PTR       ; RESTORE THE DATA SEGMENT
0869 1F                      POP     DS
086A 89 1E 0013 R            MOV     @MEMORY_SIZE,BX         ; SAVE MEMORY SIZE
086E 9D                      POPF                            ; RESTORE THE FLAG REGISTER
086F C3                      RET
                     ;--------------------------------------------------------------------------
                     ; TEST.13A                                                                 :
                     ;  PROTECTED MODE TEST AND MEMORY SIZE DETERMINE  ( ABOVE 1024K )          :
                     ;                                                                          :
                     ; DESCRIPTION:                                                             :
                     ;      THIS ROUTINE RUNS IN PROTECTED MODE IN ORDER TO ADDRESS ABOVE 1 MEG. :
                     ;      THE MEMORY SIZE IS DETERMINED AND SAVED IN CMOS.                    :
                     ;      DURING A POWER UP SEQUENCE THE MEMORY SIZE DETERMINE IS DONE WITH   :
                     ;      PLANAR AND I/O PARITY CHECKS DISABLED.  DURING A SOFT RESET THE MEMORY :
                     ;      SIZE DETERMINE WILL CHECK FOR PARITY ERRORS.                        :
                     ;--------------------------------------------------------------------------
0870                 DONE:
0870 6A 08                   PUSH    BYTE PTR GDT_PTR        ; POINT DS TO THE DESCRIPTOR TABLE
0872 1F                      POP     DS
                     ;----- START WITH SEGMENT ADDRESS 10-0000 (ONE MEG AND ABOVE)
0873 C6 06 004C 10           MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),10H
0878 C7 06 004A 0000         MOV     DS:ES_TEMP.BASE_LO_WORD,0H
087E B0 1D                   MOV     AL,1DH                  ;     <><><><><><><><><><><><><>
0880 E6 80                   OUT     MFG_PORT,AL             ;     <><> CHECKPOINT  1D <><>
0882 2B DB                   SUB     BX,BX                   ; START WITH COUNT 0
                     ;----- START STORAGE SIZE/CLEAR
0884                 NOT_DONE1:
0884 6A 48                   PUSH    BYTE PTR ES_TEMP        ; POINT ES TO DATA
0886 07                      POP     ES                      ; POINT TO SEGMENT TO TEST
0887 E8 08A3 R               CALL    HOW_BIG1                ; DO THE FIRST 64K
088A 74 03                   JZ      DONEA                   ; CHECK IF TOP
088C E9 092A R               JMP     DONE1                   ; GO IF TOP
088F 83 C3 40        DONEA:  ADD     BX,16*4                 ; BUMP MEMORY COUNT BY 64K
                     ;----- DO NEXT 64K (XX0000) BLOCK
```

```
0892 FE 06 004C                    INC     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE)

                          ;-----  CHECK FOR TOP OF MEMORY (FE0000)

0896 80 3E 004C FE                 CMP     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),0FEH ; LAST OF MEMORY?
089B 75 E7                         JNZ     NOT_DONE1                              ; GO IF NOT
089D E8 0917 R                     CALL    HOW_BIG_END1                           ; GO SET MEMORY SIZE
08A0 E9 092A R                     JMP     DONE1

                          ;-----  FILL/CHECK LOOP

08A3                      HOW_BIG1:
08A3 2B FF                         SUB     DI,DI
08A5 B8 AA55                       MOV     AX,0AA55H              ; TEST PATTERN
08A8 8B C8                         MOV     CX,AX                  ; SAVE PATTERN
08AA 26: 89 05                     MOV     ES:[DI],AX             ; SEND PATTERN TO MEMORY
08AD B0 0F                         MOV     AL,0FH                 ; PUT SOMETHING IN AL
08AF 26: 8B 05                     MOV     AX,ES:[DI]             ; GET PATTERN
08B2 26: 89 05                     MOV     ES:[DI],AX             ; INSURE NO PARITY I/O CHECK
08B5 33 C1                         XOR     AX,CX                  ; COMPARE PATTERNS
08B7 75 5E                         JNZ     HOW_BIG_END1           ; GO END IF NO COMPARE

                          ;-----  IS THIS A SOFT RESET

08B9 1E                            PUSH    DS
08BA 6A 18                         PUSH    BYTE PTR RSDA_PTR      ; POINT TO SYSTEM DATA AREA
08BC 1F                            POP     DS
08BD 81 3E 0072 R 1234             CMP     @RESET_FLAG,1234H      ; SOFT RESET
08C3 1F                            POP     DS                     ; RESTORE DS
08C4 75 2F                         JNZ     HOW_BIG_2A             ; GO IF NOT SOFT RESET

                          ;-----  CHECK PARITY WITH PARITY BITS OFF

08C6 26: C7 05 0101                MOV     WORD PTR ES:[DI],0101H ; TURN OFF BOTH PARITY BITS
08CB 6A FF                         PUSH    BYTE PTR 0FFH          ; PLACE 0FFFFH IN STACK (BUS BITS ON)
08CD 58                            POP     AX                     ; DELAY - CAUSING BUS BITS ON
08CE 26: 8B 05                     MOV     AX,ES:[DI]             ; CHECK PARITY

08D1 E4 61                         IN      AL,PORT_B              ; CHECK FOR PLANAR OR I/O PARITY CHECK
08D3 24 C0                         AND     AL,PARITY_ERR
08D5 26: 89 05                     MOV     ES:[DI],AX             ; CLEAR POSSIBLE PARITY ERROR
08D8 75 3D                         JNZ     HOW_BIG_END1           ; GO IF PLANAR OR I/O PARITY CHECK

                          ;-----  CHECK ALL BITS

08DA 26: C7 05 FFFF                MOV     WORD PTR ES:[DI],0FFFFH ; TURN ON ALL BITS
08DF 6A 00                         PUSH    BYTE PTR 0             ; PLACE 00000H IN STACK (BUS BITS OFF)
08E1 58                            POP     AX                     ; DELAY - CAUSING BUS BITS OFF
08E2 26: 8B 05                     MOV     AX,ES:[DI]             ; CHECK FOR FFFFH
08E5 50                            PUSH    AX                     ; SAVE RESULTS
08E6 E4 61                         IN      AL,PORT_B              ; CHECK FOR PLANAR OR I/O PARITY CHECK
08E8 24 C0                         AND     AL,PARITY_ERR
08EA 26: 89 05                     MOV     ES:[DI],AX             ; CLEAR POSSIBLE PARITY ERROR
08ED 58                            POP     AX                     ; GET RESULTS
08EE 75 27                         JNZ     HOW_BIG_END1           ; GO IF PLANAR OR I/O PARITY CHECK
08F0 3D FFFF                       CMP     AX,0FFFFH
08F3 75 22                         JNZ     HOW_BIG_END1

                          ;-----  CLEAR 64K BLOCK OF MEMORY

08F5                      HOW_BIG_2A:
08F5 2B C0                         SUB     AX,AX                  ; WRITE ZEROS
08F7 B9 8000                       MOV     CX,2000H*4             ; SET COUNT FOR 32K WORDS
08FA F3/ AB                        REP     STOSW                  ; FILL 32K WORDS

                          ;-----  CHECK 64K BLOCK FOR PARITY CHECK (VALID TEST DURING SOFT RESET ONLY)

08FC 1E                            PUSH    DS
08FD 06                            PUSH    ES
08FE 06                            PUSH    ES                     ; GET ES TO DS
08FF 1F                            POP     DS
0900 B9 8000                       MOV     CX,2000H*4             ; SET COUNT FOR 32K WORDS
0903 2B F6                         SUB     SI,SI
0905 F3/ AD                        REP     LODSW
0907 2B FF                         SUB     DI,DI                  ; SET TO BEGINNING OF BLOCK
0909 E4 61                         IN      AL,PORT_B              ; CHECK FOR PLANAR OR I/O PARITY CHECK
090B 24 C0                         AND     AL,PARITY_ERR
090D 26: C7 05 0000                MOV     WORD PTR ES:[DI],0     ; CLEAR POSSIBLE PARITY ERROR
0912 07                            POP     ES                     ; RESTORE SEGMENT
0913 1F                            POP     DS
0914 75 01                         JNZ     HOW_BIG_END1           ; GO IF PLANAR OR I/O PARITY CHECK

0916 C3                            RET

0917                      HOW_BIG_END1:
0917 B0 1E                         MOV     AL,1EH                 ;       <><><><><><><><><><><><>
0919 E6 80                         OUT     MFG_PORT,AL            ;       <><> CHECKPOINT  1E <><>

                          ;-----  SET EXPANSION MEMORY SIZE DETERMINED IN CMOS

091B B0 B0                         MOV     AL,CMOS_U_M_S_LO+NMI   ; ADDRESS LOW BYTE
091D 8A E3                         MOV     AH,BL                  ; GET LOW MEMORY SIZE
091F E8 0000 E                     CALL    CMOS_WRITE             ; SET LOW BYTE
0922 B0 B1                         MOV     AL,CMOS_U_M_S_HI+NMI   ; ADDRESS HI BYTE
0924 8A E7                         MOV     AH,BH                  ; GET THE HIGH MEMORY SIZE
0926 E8 0000 E                     CALL    CMOS_WRITE             ; PLACE IN CMOS
0929 C3                            RET

                          ;-----  TEST ADDRESS LINES 19 - 23

092A B0 1F                DONE1:   MOV     AL,1FH                 ;       <><><><><><><><><><><><>
092C E6 80                         OUT     MFG_PORT,AL            ;       <><> CHECKPOINT  1F <><>
092E C6 06 004C 00                 MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),00H
0933 2B FF                         SUB     DI,DI                  ; SET LOCATION POINTER TO ZERO
0935 BA FFFF                       MOV     DX,0FFFFH              ; WRITE FFFF AT ADDRESS 0
0938 E8 0967 R                     CALL    SD0
093B 2B D2                         SUB     DX,DX                  ; WRITE 0

093D C6 06 004C 08                 MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),08H
0942 E8 0967 R                     CALL    SD0
0945 C6 06 004C 10                 MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),10H
094A E8 0967 R                     CALL    SD0
094D C6 06 004C 20                 MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),20H
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SECTION 5

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0952 E8 0967 R                  CALL    SD0
0955 C6 06 004C 40              MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),40H
095A E8 0967 R                  CALL    SD0
095D C6 06 004C 80              MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),80H
0962 E8 0967 R                  CALL    SD0
0965 EB 18                      JMP     SHORT SD2               ; TEST PASSED CONTINUE
0967                    SD0:
0967 6A 48                      PUSH    BYTE PTR ES_TEMP        ; POINT ES TO DATA
0969 07                         POP     ES                      ; POINT TO SEGMENT TO TEST
096A 26: 89 15                  MOV     ES:[DI],DX              ; WRITE THE PATTERN
096D C6 06 004C 00              MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),00H
0972 6A 48                      PUSH    BYTE PTR ES_TEMP        ; POINT ES TO DATA
0974 07                         POP     ES                      ; POINT TO SEGMENT TO TEST
0975 26: 83 3D FF               CMP     WORD PTR ES:[DI],0FFFFH ; DID LOCATION 0 CHANGE?
0979 74 03                      JZ      SD1                     ; CONTINUE IF NOT
097B E9 078A R                  JMP     SHUT_8                  ; GO HALT IF YES
097E                    SD1:
097E C3                         RET
                        ;-----  CAUSE A SHUTDOWN
097F B0 20              SD2:    MOV     AL,20H                  ;       <><><><><><><><><><><><>
0981 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  20 <><>
0983 E4 61                      IN      AL,PORT_B
0985 0C 0C                      OR      AL,RAM_PAR_OFF          ; TOGGLE PARITY CHECK ENABLES
0987 E6 61                      OUT     PORT_B,AL
0989 24 F3                      AND     AL,RAM_PAR_ON
098B E6 61                      OUT     PORT_B,AL
098D E9 0000 E                  JMP     PROC_SHUTDOWN           ; CAUSE A SHUTDOWN (RETURN VIA JUMP)
                        ;---------------------------------------
                        ; RETURN 1 FROM SHUTDOWN               :
                        ;---------------------------------------
0990 B0 21              SHUT1:  MOV     AL,21H                  ;       <><><><><><><><><><><><>
0992 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  21 <><>
0994 BC ---- R                  MOV     SP,ABS0                 ; SET REAL MODE STACK
0997 8E D4                      MOV     SS,SP
0999 BC 0400 R                  MOV     SP,OFFSET @TOS
                        ;-----  SET DIVIDE 0 VECTOR OFFSET
099C 2B FF                      SUB     DI,DI                   ; POINT TO FIRST INTERRUPT LOCATION
099E 8E C7                      MOV     ES,DI                   ; SET ES TO ABS0 SEGMENT
09A0 B8 0000 E                  MOV     AX,OFFSET D11           ; GET ADDRESS OF INTERRUPT OFFSET
09A3 AB                         STOSW                           ; PLACE OFFSET IF NULL HANDLER IN VECTOR
09A4 E8 0000 E                  CALL    DDS                     ; SET UP THE REAL DATA AREA
                        ;-----  GET THE CONFIGURATION FROM CMOS
09A7 B8 8E8E                    MOV     AX,X*(CMOS_DIAG+NMI)    ; CHECK CMOS GOOD
09AA E8 0000 E                  CALL    CMOS_READ               ; GET THE STATUS
09AD A8 C0                      TEST    AL,BAD_BAT+BAD_CKSUM    ; VALID CMOS ?
09AF 74 03                      JZ      M_OK                    ; GO IF YES
09B1 E9 0A3A R                  JMP     BAD_MOS                 ; GO IF NOT
09B4                    M_OK:
09B4 24 DF                      AND     AL,0DFH                 ; CLEAR THE MINIMUM CONFIG BIT
09B6 86 C4                      XCHG    AL,AH                   ; SAVE THE STATUS BYTE
09B8 E8 0000 E                  CALL    CMOS_WRITE              ; BACK INTO CMOS
                        ;-----  CHECK FOR CMOS RUN IN MODE
09BB 81 3E 0072 R 1234          CMP     @RESET_FLAG,1234H       ; CHECK FOR SOFT RESET
09C1 74 10                      JE      M_OK_64                 ; BYPASS IF SOFT RESET
09C3 B0 96                      MOV     AL,CMOS_B_M_S_HI+NMI    ; GET THE BASE MEMORY SIZE HIGH BYTE
09C5 E8 0000 E                  CALL    CMOS_READ
09C8 24 C0                      AND     AL,0C0H                 ; MASK FOR MANUFACTURING TEST BITS
09CA 3C C0                      CMP     AL,0C0H                 ; CHECK FOR MANUFACTURING TEST MODE SET
09CC 75 05                      JNE     M_OK_64                 ; SKIP IF NOT MANUFACTURING LINE TEST
09CE C6 06 0072 R 64            MOV     BYTE PTR @RESET_FLAG,64H; ELSE SET THE MFG TEST FLAG
                        ;-----  INSURE CONFIGURATION HAS CORRECT VIDEO TYPE
09D3                    M_OK_64:
09D3 B0 94                      MOV     AL,CMOS_EQUIP+NMI       ; GET THE EQUIPMENT BYTE
09D5 E8 0000 E                  CALL    CMOS_READ
09D8 8A E0                      MOV     AH,AL                   ; SAVE VIDEO TYPE
09DA A8 30                      TEST    AL,030H                 ; ANY VIDEO?
09DC 75 31                      JNZ     MOS_OK_1                ; CONTINUE
09DE E8 09EC R                  CALL    CHK_VIDEO               ; INSURE VIDEO ROM PRESENT
09E1 74 4C                      JZ      MOS_OK                  ; CONTINUE
09E3 F6 06 0012 R 20            TEST    @MFG_TST,MFG_LOOP       ; EXCEPT IF MFG JUMPER IS INSTALLED
09E8 74 6F                      JZ      NORMAL_CONFIG           ; GO IF INSTALLED
09EA EB 4E                      JMP     SHORT BAD_MOS           ; GO DEFAULT
                        ;-----  ROUTINE CHECK FOR VIDEO FEATURE ROM PRESENT
09EC                    CHK_VIDEO:
09EC B9 C000                    MOV     CX,0C000H               ; START OF FEATURE I/O ROM
09EF                    CHK_VIDEO1:
09EF 50                         PUSH    AX                      ; SAVE THE CONFIGURATION
09F0 1E                         PUSH    DS                      ; SAVE THE DATA SEGMENT
09F1 57                         PUSH    DI                      ; SAVE COMPARE REGISTER
09F2 8E D9                      MOV     DS,CX                   ; GET ROM SEGMENT
09F4 BF AA55                    MOV     DI,0AA55H               ; GET THE PRESENCE SIGNATURE
09F7 2B DB                      SUB     BX,BX                   ; CLEAR INDEX POINTER
09F9 8B 07                      MOV     AX,[BX]                 ; GET THE FIRST 2 LOCATIONS
09FB 3B C7                      CMP     AX,DI                   ; IS THE VIDEO FEATURE ROM PRESENT?
09FD 5F                         POP     DI                      ; RESTORE WORK REGISTER
09FE 1F                         POP     DS                      ; RESTORE DATA SEGMENT
09FF 58                         POP     AX                      ; GET THE CONFIGURATION
0A00 74 0C                      JZ      CHK_VIDEO2              ; GO IF VIDEO ROM INSTALLED
0A02 81 C1 0080                 ADD     CX,080H                 ; POINT TO NEXT 2K BLOCK
0A06 81 F9 C800                 CMP     CX,0C800H               ; TOP OF VIDEO ROM AREA YET?
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0A0A 7C E3                      JL      CHK_VIDEO1              ; TRY AGAIN
0A0C 23 C9                      AND     CX,CX                   ; SET NON ZERO FLAG
0A0E                    CHK_VIDEO2:
0A0E C3                         RET                             ; RETURN TO CALLER
                        ;-----  CMOS VIDEO BITS NON ZERO (CHECK FOR PRIMARY DISPLAY AND NO VIDEO ROM)
0A0F                    MOS_OK_1:
0A0F E8 09EC R                  CALL    CHK_VIDEO               ; IS THE VIDEO ROM INSTALLED?
0A12 74 26                      JZ      BAD_MOS                 ; WRONG CONFIGURATION IN CONFIG BYTE
0A14 8A C4                      MOV     AL,AH                   ; RESTORE CONFIGURATION
0A16 F6 06 0012 R 40            TEST    @MFG_TST,DSP_JMP        ; CHECK FOR DISPLAY JUMPER
0A1B 74 0A                      JZ      MOS_OK_2                ; GO IF COLOR CARD IS PRIMARY DISPLAY
                        ;-----  MONOCHROME CARD IS PRIMARY DISPLAY      (NO JUMPER INSTALLED)
0A1D 24 30                      AND     AL,30H                  ; INSURE MONOCHROME IS PRIMARY
0A1F 3C 30                      CMP     AL,30H                  ; CONFIGURATION OK?
0A21 75 17                      JNZ     BAD_MOS                 ; GO IF NOT
0A23 8A C4                      MOV     AL,AH                   ; RESTORE CONFIGURATION
0A25 EB 08                      JMP     SHORT MOS_OK            ; USE THE CONFIGURATION BYTE FOR DISPLAY
                        ;-----  COLOR CARD
0A27                    MOS_OK_2:
0A27 24 30                      AND     AL,30H                  ; STRIP UNWANTED BITS
0A29 3C 30                      CMP     AL,30H                  ; MUST NOT BE MONO WITH JUMPER INSTALLED
0A2B 8A C4                      MOV     AL,AH                   ; RESTORE CONFIGURATION
0A2D 74 0B                      JZ      BAD_MOS                 ; GO IF YES
                        ;-----  CONFIGURATION MUST HAVE AT LEAST ONE DISKETTE
0A2F A8 01              MOS_OK: TEST    AL,01H                  ; MUST HAVE AT LEAST ONE DISKETTE
0A31 75 26                      JNZ     NORMAL_CONFIG           ; GO SET CONFIGURATION IF OK
0A33 F6 06 0012 R 20            TEST    @MFG_TST,MFG_LOOP       ; EXCEPT IF MFG JUMPER IS INSTALLED
0A38 74 1F                      JZ      NORMAL_CONFIG           ; GO IF INSTALLED
                        ;-----  MINIMUM CONFIGURATION WITH BAD CMOS OR NON VALID VIDEO
0A3A                    BAD_MOS:
0A3A B8 008E                    MOV     AX,CMOS_DIAG+NMI        ; GET THE DIAGNOSTIC STATUS
0A3D E8 0000 E                  CALL    CMOS_READ
0A40 A8 C0                      TEST    AL,BAD_BAT+BAD_CKSUM    ; WAS BATTERY DEFECTIVE OR BAD CHECKSUM
0A42 75 03                      JNZ     BAD_MOS1                ; GO IF YES
0A44 E8 0000 E                  CALL    CONFIG_BAD              ; SET THE MINIMUM CONFIGURATION FLAG
0A47                    BAD_MOS1:
0A47 E8 09EC R                  CALL    CHK_VIDEO               ; CHECK FOR VIDEO ROM
0A4A B0 01                      MOV     AL,01H                  ; DISKETTE ONLY
0A4C 74 0B                      JZ      NORMAL_CONFIG           ; GO IF VIDEO ROM PRESENT
0A4E F6 06 0012 R 40            TEST    @MFG_TST,DSP_JMP        ; CHECK FOR DISPLAY JUMPER
0A53 B0 11                      MOV     AL,11H                  ; DEFAULT TO 40X25 COLOR
0A55 74 02                      JZ      NORMAL_CONFIG           ; GO IF JUMPER IS INSTALLED
0A57 B0 31                      MOV     AL,31H                  ; DISKETTE / B/W DISPLAY 80X25
                        ;----------------------------------------
                        ;       CONFIGURATION AND MFG MODE      :
                        ;----------------------------------------
0A59                    NORMAL_CONFIG:
0A59 F6 06 0012 R 20            TEST    @MFG_TST,MFG_LOOP       ; IS THE MANUFACTURING JUMPER INSTALLED
0A5E 75 02                      JNZ     NORM1                   ; GO IF NOT
0A60 24 3E                      AND     AL,03EH                 ; STRIP DISKETTE FOR MFG TEST
0A62 2A E4              NORM1:  SUB     AH,AH
0A64 A3 0010 R                  MOV     @EQUIP_FLAG,AX          ; SAVE SWITCH INFORMATION
0A67 81 3E 0072 R 1234          CMP     @RESET_FLAG,1234H       ; BYPASS IF SOFT RESET
0A6D 74 2C                      JZ      E6
                        ;-----  GET THE FIRST SELF TEST RESULTS FROM KEYBOARD
0A6F B0 60                      MOV     AL,WRITE_8042_LOC       ; ENABLE KEYBOARD
0A71 E8 0396 R                  CALL    C8042                   ; ISSUE WRITE BYTE COMMAND
0A74 B0 4D                      MOV     AL,4DH                  ; ENABLE OUTPUT BUFFER FULL INTERRUPT,
                                                                ; SET SYSTEM FLAG, PC 1 COMPATIBILITY,
0A76 E6 60                      OUT     PORT_A,AL               ; INHIBIT OVERRIDE, ENABLE KEYBOARD
0A78 2B C9                      SUB     CX,CX                   ; WAIT FOR COMMAND ACCEPTED
0A7A E8 039B R                  CALL    C42_1
0A7D B9 7FFF                    MOV     CX,07FFFH               ; SET LOOP COUNT FOR APPROXIMATELY 100MS
                                                                ; TO RESPOND
0A80 E4 64              TST6:   IN      AL,STATUS_PORT          ; WAIT FOR OUTPUT BUFFER FULL
0A82 A8 01                      TEST    AL,OUT_BUF_FULL
0A84 E1 FA                      LOOPZ   TST6                    ; TRY AGAIN IF NOT
0A86 9C                         PUSHF                           ; SAVE FLAGS
0A87 B0 AD                      MOV     AL,DIS_KBD              ; DISABLE KEYBOARD
0A89 E8 0396 R                  CALL    C8042                   ; ISSUE THE COMMAND
0A8C 9D                         POPF                            ; RESTORE FLAGS
0A8D 74 0C                      JZ      E6                      ; CONTINUE WITHOUT RESULTS
0A8F E4 60                      IN      AL,PORT_A               ; GET INPUT FROM KEYBOARD
0A91 A2 0072 R                  MOV     BYTE PTR @RESET_FLAG,AL ; TEMPORARY SAVE FOR AA RECEIVED
                        ;-----  CHECK FOR MFG REQUEST
0A94 3C 65                      CMP     AL,065H                 ; LOAD MANUFACTURING TEST REQUEST?
0A96 75 03                      JNE     E6                      ; CONTINUE IF NOT
0A98 E9 0C27 R                  JMP     MFG_BOOT                ; ELSE GO TO MANUFACTURING BOOTSTRAP
                        ;--------------------------------------------------------
                        ; TEST.14                                               :
                        ;       INITIALIZE AND START CRT CONTROLLER (6845)      :
                        ;       TEST VIDEO READ/WRITE STORAGE.                  :
                        ; DESCRIPTION                                           :
                        ;       RESET THE VIDEO ENABLE SIGNAL.                  :
                        ;       SELECT ALPHANUMERIC MODE, 40 * 25, B & W.       :
                        ;       READ/WRITE DATA PATTERNS TO MEMORY. CHECK       :
                        ;       STORAGE ADDRESSABILITY.                         :
                        ; ERROR = 1 LONG AND 2 SHORT BEEPS                      :
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SECTION 5

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                        ;-----------------------------------------------------

     0A9B               E6:
     0A9B A1 0010 R             MOV     AX,@EQUIP_FLAG          ; GET SENSE INFORMATION
     0A9E 50                    PUSH    AX                      ; SAVE IT
     0A9F B0 30                 MOV     AL,30H                  ; FORCE MONOCHROME TYPE
     0AA1 A3 0010 R             MOV     @EQUIP_FLAG,AX          ; INTO EQUIPMENT FLAG
     0AA4 2B C0                 SUB     AX,AX                   ; MODE SET COMMAND FOR DEFAULT MODE
     0AA6 CD 10                 INT     INT_VIDEO               ; SEND INITIALIZATION TO B/W CARD
     0AA8 B0 20                 MOV     AL,20H                  ; FORCE COLOR AT 80 BY 25
     0AAA A3 0010 R             MOV     @EQUIP_FLAG,AX          ; INTO EQUIPMENT FLAG TO CLEAR BUFFERS
     0AAD B8 0003               MOV     AX,0003H                ; AND INITIALIZATION COLOR CARD 80X25
     0AB0 CD 10                 INT     INT_VIDEO               ; MODE SET 80 X 25
     0AB2 B8 0001               MOV     AX,0001H                ; SET COLOR 40 X 25 MODE
     0AB5 CD 10                 INT     INT_VIDEO               ; SET DEFAULT COLOR MODE
     0AB7 58                    POP     AX                      ; RECOVER REAL SWITCH INFORMATION
     0AB8 A3 0010 R             MOV     @EQUIP_FLAG,AX          ; RESTORE IT
     0ABB 24 30                 AND     AL,30H                  ; ISOLATE VIDEO SWITCHES
     0ABD 75 11                 JNZ     E7                      ; VIDEO SWITCHES SET TO 0?
     0ABF 1E                    PUSH    DS                      ; SAVE THE DATA SEGMENT
     0AC0 50                    PUSH    AX
     0AC1 2B C0                 SUB     AX,AX                   ; SET DATA SEGMENT TO 0
     0AC3 8E D8                 MOV     DS,AX
     0AC5 BF 0040 R             MOV     DI,OFFSET @VIDEO_INT    ; SET INTERRUPT 10H TO DUMMY
     0AC8 C7 05 0000 E          MOV     WORD PTR [DI],OFFSET DUMMY_RETURN  ; RETURN IF NO VIDEO CARD
     0ACC 58                    POP     AX                      ; RESTORE REGISTERS
     0ACD 1F                    POP     DS
     0ACE EB 7F                 JMP     SHORT E18_1             ; BYPASS VIDEO TEST
     0AD0               E7:
     0AD0 3C 30                 CMP     AL,30H                  ; B/W CARD ATTACHED?
     0AD2 74 08                 JE      E8                      ; YES - SET MODE FOR B/W CARD
     0AD4 FE C4                 INC     AH                      ; SET COLOR MODE FOR COLOR CARD
     0AD6 3C 20                 CMP     AL,20H                  ; 80X25 MODE SELECTED?
     0AD8 75 02                 JNE     E8                      ; NO - SET MODE FOR 40X25
     0ADA B4 03                 MOV     AH,3                    ; SET MODE FOR 80X25
     0ADC               E8:
     0ADC 86 E0                 XCHG    AH,AL
     0ADE 50                    PUSH    AX                      ; SAVE VIDEO MODE ON STACK
     0ADF 2A E4                 SUB     AH,AH                   ; INITIALIZE TO ALPHANUMERIC MD
     0AE1 CD 10                 INT     INT_VIDEO               ; CALL VIDEO_IO
     0AE3 58                    POP     AX                      ; RESTORE VIDEO SENSE SWITCHES IN AH
     0AE4 50                    PUSH    AX                      ; SAVE VALUE
     0AE5 BB B000               MOV     BX,0B000H               ; STARTING VIDEO MEMORY ADDRESS B/W CARD
     0AE8 BA 03B8               MOV     DX,3B8H                 ; MODE REGISTER FOR B/W
     0AEB B9 0800               MOV     CX,2048                 ; MEMORY WORD COUNT FOR B/W CARD
     0AEE 80 FC 30              CMP     AH,30H                  ; B/W VIDEO CARD ATTACHED?
     0AF1 74 07                 JE      E9                      ; YES - GO TEST VIDEO STORAGE
     0AF3 B7 B8                 MOV     BH,0B8H                 ; STARTING MEMORY ADDRESS FOR COLOR CARD
     0AF5 BA 03D8               MOV     DX,3D8H                 ; MODE REGISTER FOR COLOR CARD
     0AF8 B5 20                 MOV     CH,20H                  ; MEMORY WORD COUNT FOR COLOR CARD
     0AFA               E9:
     0AFA A0 0065 R             MOV     AL,@CRT_MODE_SET        ; GET CURRENT MODE SET VALUE
     0AFD 24 37                 AND     AL,037H                 ; SET VIDEO BIT OFF
     0AFF EE                    OUT     DX,AL                   ; DISABLE VIDEO FOR COLOR CARD
     0B00 8E C3                 MOV     ES,BX                   ; POINT ES TO VIDEO MEMORY
     0B02 8E DB                 MOV     DS,BX                   ; POINT DS TO VIDEO MEMORY
     0B04 D1 C9                 ROR     CX,1                    ; DIVIDE BY 2 FOR WORD COUNT
     0B06 E8 0000 E             CALL    STGTST_CNT              ; GO TEST VIDEO READ/WRITE STORAGE
     0B09 75 70                 JNE     E17                     ; R/W MEMORY FAILURE - BEEP SPEAKER

                        ;----------------------------------------------
                        ; TEST.15
                        ;       SETUP VIDEO DATA ON SCREEN FOR VIDEO   :
                        ;       LINE TEST.                             :
                        ; DESCRIPTION                                  :
                        ;       ENABLE VIDEO SIGNAL AND SET MODE.      :
                        ;       DISPLAY A HORIZONTAL BAR ON SCREEN.    :
                        ;----------------------------------------------

     0B0B B0 22                 MOV     AL,22H                  ;       <><><><><><><><><><><><>
     0B0D E6 80                 OUT     MFG_PORT,AL             ;       <><> CHECKPOINT 22 <><>

     0B0F 58                    POP     AX                      ; GET VIDEO SENSE SWITCHES (AH)
     0B10 50                    PUSH    AX                      ; SAVE IT
     0B11 B4 00                 MOV     AH,0                    ; ENABLE VIDEO AND SET MODE
     0B13 CD 10                 INT     INT_VIDEO               ; VIDEO
     0B15 B8 7020               MOV     AX,7020H                ; WRITE BLANKS IN REVERSE VIDEO
     0B18 2B FF                 SUB     DI,DI                   ; SETUP STARTING LOCATION
     0B1A B9 0028               MOV     CX,40                   ; NUMBER OF BLANKS TO DISPLAY
     0B1D F3/ AB                REP     STOSW                   ; WRITE VIDEO STORAGE

                        ;----------------------------------------
                        ; TEST.16
                        ;       CRT INTERFACE LINES TEST         :
                        ; DESCRIPTION                            :
                        ;       SENSE ON/OFF TRANSITION OF THE   :
                        ;       VIDEO ENABLE AND HORIZONTAL      :
                        ;       SYNC LINES.                      :
                        ;----------------------------------------

     0B1F 58                    POP     AX                      ; GET VIDEO SENSE SWITCH INFORMATION
     0B20 50                    PUSH    AX                      ; SAVE IT
     0B21 80 FC 30              CMP     AH,30H                  ; B/W CARD ATTACHED?
     0B24 BA 03BA               MOV     DX,03BAH                ; SETUP ADDRESS OF B/W STATUS PORT
     0B27 74 03                 JE      E11                     ; YES - GO TEST LINES
     0B29 BA 03DA               MOV     DX,03DAH                ; COLOR CARD IS ATTACHED
     0B2C               E11:
     0B2C B4 08                 MOV     AH,8
     0B2E               E12:
     0B2E 2B C9                 SUB     CX,CX
     0B30               E13:
     0B30 EC                    IN      AL,DX                   ; READ CRT STATUS PORT
     0B31 22 C4                 AND     AL,AH                   ; CHECK VIDEO/HORIZONTAL LINE
     0B33 75 04                 JNZ     E14                     ; ITS ON - CHECK IF IT GOES OFF
     0B35 E2 F9                 LOOP    E13                     ; LOOP UNTIL ON OR TIMEOUT
     0B37 EB 42                 JMP     SHORT E17               ; GO PRINT ERROR MESSAGE
     0B39               E14:
     0B39 2B C9                 SUB     CX,CX
     0B3B               E15:
     0B3B EC                    IN      AL,DX                   ; READ CRT STATUS PORT
     0B3C 22 C4                 AND     AL,AH                   ; CHECK VIDEO/HORIZONTAL LINE
     0B3E 74 04                 JZ      E16                     ; ITS ON - CHECK NEXT LINE
     0B40 E2 F9                 LOOP    E15                     ; LOOP IF ON UNTIL IT GOES OFF
     0B42 EB 37                 JMP     SHORT E17               ; GO ERROR BEEP
```

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                                ;-----  CHECK HORIZONTAL LINE

0B44 B1 03                      E16:    MOV     CL,3                    ; GET NEXT BIT TO CHECK
0B46 D2 EC                              SHR     AH,CL
0B48 75 E4                              JNZ     E12                     ; CONTINUE
0B4A                            E18:
0B4A 58                                 POP     AX                      ; GET VIDEO SENSE SWITCHES (AH)
0B4B B4 00                              MOV     AH,0                    ; SET MODE AND DISPLAY CURSOR
0B4D CD 10                              INT     INT_VIDEO               ; CALL VIDEO I/O PROCEDURE

                                ;-----  CHECK FOR THE ADVANCED VIDEO CARD

0B4F BA C000                    E18_1:  MOV     DX,0C000H               ; SET THE LOW SEGMENT VALUE
0B52                            E18A:
0B52 B0 23                              MOV     AL,23H                  ;       <><><><><><><><><><><><>
0B54 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  23 <><>
0B56 8E DA                              MOV     DS,DX
0B58 57                                 PUSH    DI                      ; SAVE WORK REGISTER
0B59 BF AA55                            MOV     DI,0AA55H               ; PRESENCE SIGNATURE
0B5C 2B DB                              SUB     BX,BX                   ; CLEAR POINTER
0B5E 8B 07                              MOV     AX,[BX]                 ; GET FIRST 2 LOCATIONS
0B60 3B C7                              CMP     AX,DI                   ; PRESENT?
0B62 5F                                 POP     DI                      ; RECOVER REGISTER
0B63 75 05                              JNZ     E18B                    ; NO? GO LOOK FOR OTHER MODULES

0B65 E8 0000 E                          CALL    ROM_CHECK               ; GO SCAN MODULE
0B68 EB 04                              JMP     SHORT E18C
0B6A                            E18B:
0B6A 81 C2 0080                         ADD     DX,0080H                ; POINT TO NEXT 2K BLOCK
0B6E                            E18C:
0B6E 81 FA C800                         CMP     DX,0C800H               ; TOP OF VIDEO ROM AREA YET?
0B72 7C DE                              JL      E18A                    ; GO SCAN FOR ANOTHER MODULE

0B74 B0 24                              MOV     AL,24H                  ;       <><><><><><><><><><><><>
0B76 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  24 <><>

0B78 E9 0000 E                          JMP     POST2                   ; GO TO NEXT TEST


                                ;-----  CRT ERROR SET MFG CHECKPOINT AND ERROR BEEP

0B7B E8 0000 E                  E17:    CALL    DDS                     ; POINT TO DATA

                                ;-----  CHECKPOINT 0C = MONOCHROME FAILED

0B7E C6 06 0015 R 0C                    MOV     @MFG_ERR_FLAG,0CH       ; <><> CRT ERROR CHECKPOINT  0C <><>
0B83 80 3E 0072 R 64                    CMP     BYTE PTR @RESET_FLAG,064H ; IS THIS A MFG REQUEST?
0B88 74 0D                              JZ      E19                     ; BY PASS ERROR BEEP IF YES
0B8A F6 06 0012 R 20                    TEST    @MFG_TST,MFG_LOOP       ; IS THE MFG LOOP JUMPER INSTALLED?
0B8F 74 06                              JZ      E19                     ; BY PASS ERROR BEEP IF YES
0B91 BA 0102                            MOV     DX,102H
0B94 E8 0000 E                          CALL    ERR_BEEP                ; GO BEEP SPEAKER
0B97                            E19:
0B97 1E                                 PUSH    DS
0B98 A1 0010 R                          MOV     AX,@EQUIP_FLAG          ; GET THE CURRENT VIDEO
0B9B 24 30                              AND     AL,30H                  ; STRIP OTHER BITS
0B9D 3C 30                              CMP     AL,30H                  ; IS IT MONOCHROME ?
0B9F 74 30                              JZ      TRY_COLOR               ; GO IF YES

                                ;-----  COLOR FAILED TRY MONOCHROME - CHECKPOINT 0D = COLOR FAILED

0BA1 C6 06 0015 R 0D                    MOV     @MFG_ERR_FLAG,0DH       ; <><> CRT ERROR CHECKPOINT  0D <><>

0BA6 BA 03B8                            MOV     DX,3B8H                 ; DISABLE B/W
0BA9 B0 01                              MOV     AL,1
0BAB EE                                 OUT     DX,AL                   ; OUTPUT THE DISABLE
0BAC BB B000                            MOV     BX,0B000H               ; CHECK FOR MONOCHROME VIDEO MEMORY
0BAF 8E DB                              MOV     DS,BX
0BB1 B8 AA55                            MOV     AX,0AA55H               ; WRITE AN AA55
0BB4 2B DB                              SUB     BX,BX                   ; TO THE FIRST LOCATION
0BB6 89 07                              MOV     [BX],AX
0BB8 EB 00                              JMP     $+2                     ; ALLOW BUS TO SETTLE
0BBA 8B 07                              MOV     AX,[BX]                 ; READ THE FIRST LOCATION
0BBC 3D AA55                            CMP     AX,0AA55H               ; IS THE MONOCHROME VIDEO CARD THERE?
0BBF 1F                                 POP     DS                      ; RESTORE THE DATA SEGMENT
0BC0 75 55                              JNZ     E17_3                   ; GO IF NOT
0BC2 81 0E 0010 R 0030                  OR      @EQUIP_FLAG,30H         ; TURN ON MONOCHROME BITS IN EQUIP FLAG
0BC8 A1 0010 R                          MOV     AX,@EQUIP_FLAG          ; ENABLE VIDEO
0BCB 2A E4                              SUB     AH,AH
0BCD CD 10                              INT     INT_VIDEO
0BCF EB 34                              JMP     SHORT E17_1             ; CONTINUE

                                ;-----  MONOCHROME FAILED TRY COLOR

0BD1                            TRY_COLOR:
0BD1 B0 01                              MOV     AL,01H                  ; SET MODE COLOR 40X25
0BD3 2A E4                              SUB     AH,AH
0BD5 CD 10                              INT     INT_VIDEO
0BD7 BA 03D8                            MOV     DX,3D8H                 ; DISABLE COLOR
0BDA B0 00                              MOV     AL,0
0BDC EE                                 OUT     DX,AL                   ; OUTPUT THE DISABLE
0BDD BB B800                            MOV     BX,0B800H               ; CHECK FOR COLOR VIDEO MEMORY
0BE0 8E DB                              MOV     DS,BX
0BE2 B8 AA55                            MOV     AX,0AA55H               ; WRITE AN AA55
0BE5 2B DB                              SUB     BX,BX                   ; TO THE FIRST LOCATION
0BE7 89 07                              MOV     [BX],AX
0BE9 EB 00                              JMP     $+2                     ; ALLOW BUS TO SETTLE
0BEB 8B 07                              MOV     AX,[BX]                 ; READ THE FIRST LOCATION
0BED 3D AA55                            CMP     AX,0AA55H               ; IS THE COLOR VIDEO CARD THERE?
0BF0 1F                                 POP     DS                      ; RESTORE THE DATA SEGMENT
0BF1 75 24                              JNZ     E17_3                   ; GO IF NOT
0BF3 81 26 0010 R FFCF                  AND     @EQUIP_FLAG,0FFCFH      ; TURN OFF VIDEO BITS
0BF9 81 0E 0010 R 0010                  OR      @EQUIP_FLAG,10H         ; SET COLOR 40X24
0BFF B0 01                              MOV     AL,01H
0C01 2A E4                              SUB     AH,AH
0C03 CD 10                              INT     INT_VIDEO
0C05                            E17_1:
0C05 58                                 POP     AX                      ; SET NEW VIDEO TYPE ON STACK
0C06 A1 0010 R                          MOV     AX,@EQUIP_FLAG
0C09 24 30                              AND     AL,30H
0C0B 3C 30                              CMP     AL,30H                  ; IS IT THE B/W?
0C0D 2A C0                              SUB     AL,AL
0C0F 74 02                              JZ      E17_2                   ; GO IF YES
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SECTION 5

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0C11 FE C0                      INC     AL                      ; INITIALIZE FOR 40X25
0C13                    E17_2:
0C13 50                         PUSH    AX
0C14                    E17_4:
0C14 E9 0B4A R                  JMP     E18

                        ;-----  BOTH VIDEO CARDS FAILED SET DUMMY RETURN IF RETRACE FAILURE

0C17                    E17_3:
0C17 1E                         PUSH    DS
0C18 2B C0                      SUB     AX,AX                   ; SET DS SEGMENT TO 0
0C1A 8E D8                      MOV     DS,AX
0C1C BF 0040 R                  MOV     DI,OFFSET @VIDEO_INT    ; SET INTERRUPT 10H TO DUMMY
0C1F C7 05 0000 E               MOV     WORD PTR [DI],OFFSET DUMMY_RETURN  ; RETURN IF NO VIDEO CARD
0C23 1F                         POP     DS
0C24 E9 0B4F R                  JMP     E18_1                   ; BYPASS REST OF VIDEO TEST
```

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                              PAGE
                              ;---------------------------------------------------------------------------
                              ; MANUFACTURING BOOT TEST CODE ROUTINE                                      :
                              ;       LOAD A BLOCK OF TEST CODE THROUGH THE KEYBOARD PORT FOR MANUFACTURING :
                              ;       TESTS.                                                              :
                              ;       THIS ROUTINE WILL LOAD A TEST (MAX LENGTH=FAFFH) THROUGH THE KEYBOARD :
                              ;       PORT. CODE WILL BE LOADED AT LOCATION  0000:0500.  AFTER LOADING,    :
                              ;       CONTROL WILL BE TRANSFERRED TO LOCATION  0000:0500.   THE STACK WILL :
                              ;       BE LOCATED AT 0000:0400.  THIS ROUTINE ASSUMES THAT THE FIRST 2 BYTES :
                              ;       TRANSFERRED CONTAIN THE COUNT OF BYTES TO BE LOADED                 :
                              ;        (BYTE 1=COUNT LOW, BYTE 2=COUNT HI.)                               :
                              ;---------------------------------------------------------------------------

                              ;-----  DEGATE ADDRESS LINE 20

 0C27                         MFG_BOOT:
 0C27 B4 DD                           MOV     AH,DISABLE_BIT20        ; DEGATE COMMAND FOR ADDRESS LINE 20
 0C29 E8 0000 E                       CALL    GATE_A20                ; ISSUE TO KEYBOARD ADAPTER AND CLI

                              ;-----  SETUP HARDWARE INTERRUPT VECTOR TABLE LEVEL 0-7 AND SOFTWARE INTERRUPTS

 0C2C 68 ---- R                       PUSH    ABS0                    ; SET ES SEGMENT REGISTER TO ABS0
 0C2F 07                              POP     ES
 0C30 B9 0018                         MOV     CX,24                   ; GET VECTOR COUNT
 0C33 8C C8                           MOV     AX,CS                   ; GET THE CURRENT CODE SEGMENT VALUE
 0C35 8E D8                           MOV     DS,AX                   ; SETUP DS SEGMENT REGISTER TO
 0C37 BE 0000 E                       MOV     SI,OFFSET VECTOR_TABLE  ; POINT TO THE ROUTINE ADDRESS TABLE
 0C3A BF 0020 R                       MOV     DI,OFFSET @INT_PTR      ; SET DESTINATION TO FIRST USED VECTOR
 0C3D                         MFG_B1:
 0C3D A5                              MOVSW                           ; MOVE ONE ROUTINE OFFSET ADDRESS
 0C3E AB                              STOSW                           ; INSERT CODE SEGMENT VALUE
 0C3F E2 FC                           LOOP    MFG_B1                  ; MOVE THE NUMBER OF ENTRIES REQUIRED

                              ;-----  SETUP HARDWARE INTERRUPT VECTORS LEVEL 8-15 (VECTORS START AT INT 70 H)

 0C41 B9 0008                         MOV     CX,08                   ; GET VECTOR COUNT
 0C44 BE 0000 E                       MOV     SI,OFFSET SLAVE_VECTOR_TABLE
 0C47 BF 01C0 R                       MOV     DI,OFFSET @SLAVE_INT_PTR
 0C4A                         MFG_B2:
 0C4A A5                              MOVSW                           ; MOVE ONE ROUTINE OFFSET ADDRESS
 0C4B AB                              STOSW                           ; INSERT CODE SEGMENT VALUE
 0C4C E2 FC                           LOOP    MFG_B2

                              ;-----  SET UP OTHER INTERRUPTS AS NECESSARY

                                      ASSUME  DS:ABS0,ES:ABS0
 0C4E 06                              PUSH    ES                                          ; ES= ABS0
 0C4F 1F                              POP     DS                                          ; SET DS TO ABS0
 0C50 C7 06 0008 R 0000 E             MOV     WORD PTR @NMI_PTR,OFFSET NMI_INT            ; NMI INTERRUPT
 0C56 C7 06 0014 R 0000 E             MOV     WORD PTR @INT5_PTR,OFFSET PRINT_SCREEN      ; PRINT SCREEN
 0C5C C7 06 0062 R F600               MOV     WORD PTR @BASIC_PTR+2,0F600H                ; CASSETTE BASIC SEGMENT

                              ;-----  ENABLE KEYBOARD PORT

 0C62 B0 60                           MOV     AL,60H                  ; WRITE 8042 MEMORY LOCATION 0
 0C64 E8 0396 R                       CALL    C8042                   ; ISSUE THE COMMAND
 0C67 B0 09                           MOV     AL,00001001B            ; SET INHIBIT OVERRIDE/ENABLE OBF
 0C69 E6 60                           OUT     PORT_A,AL               ;   INTERRUPT AND NOT PC COMPATIBLE

 0C6B E8 0C8D R                       CALL    MFG_B4                  ; GET COUNT LOW
 0C6E 8A F8                           MOV     BH,AL                   ; SAVE IT
 0C70 E8 0C8D R                       CALL    MFG_B4                  ; GET COUNT HI
 0C73 8A E8                           MOV     CH,AL
 0C75 8A CF                           MOV     CL,BH                   ; CX NOW HAS COUNT
 0C77 FC                              CLD                             ; SET DIRECTION FLAG TO INCREMENT
 0C78 BF 0500 R                       MOV     DI,OFFSET @MFG_TEST_RTN ; SET TARGET OFFSET (DS=0000)
 0C7B                         MFG_B3:
 0C7B E4 64                           IN      AL,STATUS_PORT          ; GET 8042 STATUS PORT
 0C7D A8 01                           TEST    AL,OUT_BUF_FULL         ; KEYBOARD REQUEST PENDING?
 0C7F 74 FA                           JZ      MFG_B3                  ; LOOP TILL DATA PRESENT
 0C81 E4 60                           IN      AL,PORT_A               ; GET DATA
 0C83 AA                              STOSB                           ; STORE IT
 0C84 E6 80                           OUT     MFG_PORT,AL             ; DISPLAY CHARACTER AT MFG PORT
 0C86 E2 F3                           LOOP    MFG_B3                  ; LOOP TILL ALL BYTES READ

 0C88 EA 0500 ---- R                  JMP     @MFG_TEST_RTN           ; FAR JUMP TO CODE THAT WAS JUST LOADED

 0C8D                         MFG_B4:
 0C8D E4 64                           IN      AL,STATUS_PORT          ; CHECK FOR OUTPUT BUFFER FULL
 0C8F A8 01                           TEST    AL,OUT_BUF_FULL         ;   HANG HERE IF NO DATA AVAILABLE
 0C91 E1 FA                           LOOPZ   MFG_B4

 0C93 E4 60                           IN      AL,PORT_A               ; GET THE COUNT
 0C95 C3                              RET

 0C96                         POST1   ENDP
 0C96                         CODE    ENDS
                                      END
```

SECTION 5

```
                        PAGE 118,121
                        TITLE TEST2 ---- 06/10/85  POST TESTS AND INITIALIZATION ROUTINES
                        .286C
                        .287
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC
                                PUBLIC  C21
                                PUBLIC  POST2
                                PUBLIC  SHUT2
                                PUBLIC  SHUT3
                                PUBLIC  SHUT4
                                PUBLIC  SHUT6
                                PUBLIC  SHUT7

                                EXTRN   BLINK_INT:NEAR
                                EXTRN   C8042:NEAR
                                EXTRN   CMOS_READ:NEAR
                                EXTRN   CMOS_WRITE:NEAR
                                EXTRN   CONFIG_BAD:NEAR
                                EXTRN   D1:NEAR
                                EXTRN   D2:NEAR
                                EXTRN   DDS:NEAR
                                EXTRN   DISK_SETUP:NEAR
                                EXTRN   DSKETTE_SETUP:NEAR
                                EXTRN   ERR_BEEP:NEAR
                                EXTRN   E_MSG:NEAR
                                EXTRN   F3D:NEAR
                                EXTRN   F3D1:NEAR
                                EXTRN   GATE_A20:NEAR
                                EXTRN   HD_INT:NEAR
                                EXTRN   KBD_RESET:NEAR
                                EXTRN   NMI_INT:NEAR
                                EXTRN   OBF_42:NEAR
                                EXTRN   POST3:NEAR
                                EXTRN   PRINT_SCREEN:NEAR
                                EXTRN   PROC_SHUTDOWN:NEAR
                                EXTRN   PROT_PRT_HEX:NEAR
                                EXTRN   PRT_HEX:NEAR
                                EXTRN   P_MSG:NEAR
                                EXTRN   ROM_CHECK:NEAR
                                EXTRN   ROM_CHECKSUM:NEAR
                                EXTRN   SEEK:NEAR
                                EXTRN   SET_TOD:NEAR
                                EXTRN   SLAVE_VECTOR_TABLE:NEAR
                                EXTRN   SND_DATA:NEAR
                                EXTRN   START_1:NEAR
                                EXTRN   STGTST_CNT:NEAR
                                EXTRN   SYSINIT1:NEAR
                                EXTRN   VECTOR_TABLE:NEAR
                                EXTRN   WAITF:NEAR
                                EXTRN   XPC_BYTE:NEAR

                                EXTRN   E101:NEAR               ; 101 ERROR CODE - INTERRUPT FAILURE
                                EXTRN   E102:NEAR               ; 102 ERROR CODE - TIMER FAILURE
                                EXTRN   E103:NEAR               ; 103 ERROR CODE - TIMER INTERRUPT
                                EXTRN   E104:NEAR               ; 104 ERROR CODE - PROTECTED MODE ERROR
                                EXTRN   E105:NEAR               ; 105 ERROR CODE - 8042 COMMAND FAILURE
                                EXTRN   E106:NEAR               ; 106 ERROR CODE - CONVERTING LOGIC
                                EXTRN   E107:NEAR               ; 107 ERROR CODE - NMI ERROR
                                EXTRN   E108:NEAR               ; 108 ERROR CODE - TIMER BUS ERROR
                                EXTRN   E109:NEAR               ; 109 ERROR CODE - MEMORY SELECT ERROR
                                EXTRN   E161:NEAR               ; 161 ERROR CODE - BAD BATTERY
                                EXTRN   E162:NEAR               ; 162 ERROR CODE - CMOS CHECKSUM/CONFIG
                                EXTRN   E163:NEAR               ; 163 ERROR CODE - BAD REAL TIME CLOCK
                                EXTRN   E164:NEAR               ; 164 ERROR CODE - MEMORY SIZE WRONG
                                EXTRN   E201:NEAR               ; 201 ERROR CODE - MEMORY DATA ERROR
                                EXTRN   E202:NEAR               ; 202 ERROR CODE - MEMORY ADDRESS ERROR
                                EXTRN   E203:NEAR               ; 203 ERROR CODE - SEGMENT ADDRESS ERROR
                                EXTRN   E301:NEAR               ; 301 ERROR CODE - KEYBOARD ERROR
                                EXTRN   E302:NEAR               ; 302 ERROR CODE - LOCK IS ON
                                EXTRN   E303:NEAR               ; 303 ERROR CODE - KEYBOARD/PLANAR ERROR
                                EXTRN   E304:NEAR               ; 304 ERROR CODE - KEYBOARD/PLANAR ERROR
                                EXTRN   E401:NEAR               ; 401 ERROR CODE - MONOCHROME ADAPTER
                                EXTRN   E501:NEAR               ; 501 ERROR CODE - COLOR ADAPTER
                                EXTRN   E601:NEAR               ; 601 ERROR CODE - DISKETTE ADAPTER

                        ;---------------------------------------------------------
                        ; TEST.17                                                :
                        ;       8259 INTERRUPT CONTROLLER TEST                   :
                        ; DESCRIPTION                                            :
                        ;       READ/WRITE THE INTERRUPT MASK REGISTER (IMR)     :
                        ;       WITH ALL ONES AND ZEROES. ENABLE SYSTEM          :
                        ;       INTERRUPTS.  MASK DEVICE INTERRUPTS OFF. CHECK   :
                        ;       FOR HOT INTERRUPTS (UNEXPECTED).                 :
                        ;---------------------------------------------------------

                                ASSUME  CS:CODE,DS:DATA

0000                    POST2   PROC    NEAR

0000 B0 0A              C21:    MOV     AL,10                   ; LINE FEED ON DISPLAY
0002 E8 0000 E                  CALL    PRT_HEX
0005 E8 0000 E                  CALL    DDS                     ;SET DATA SEGMENT

                        ;-----  CLEAR ERROR FLAG REGISTER (BP) <=> 0 FLAGS ERROR

0008 2B ED                      SUB     BP,BP                   ; CLEAR (BP) REGISTER AS ERROR FLAG REG

                        ;-----  TEST THE INTERRUPT MASK REGISTER REGISTERS

000A FA                 C21A:   CLI                             ; TURN OFF INTERRUPTS
000B B0 00                      MOV     AL,0                    ; SET INTERRUPT MASK REGISTER TO ZERO
000D E6 21                      OUT     INTA01,AL
000F E6 A1                      OUT     INTB01,AL               ; SEND TO 2ND INTERRUPT CONTROLLER ALSO
0011 EB 00                      JMP     $+2
0013 E4 21                      IN      AL,INTA01               ; READ INTERRUPT MASK REGISTER
0015 8A E0                      MOV     AH,AL                   ; SAVE RESULTS
0017 E4 A1                      IN      AL,INTB01               ; READ 2ND INTERRUPT MASK REGISTER

0019 0A E0                      OR      AH,AL                   ; BOTH IMR = 0?
001B 75 2C                      JNZ     D6                      ; GO TO ERR ROUTINE IF NOT 0

001D B0 25                      MOV     AL,25H                  ;       <><><><><><><><><><><><>
001F E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  25 <><>
```

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0021 B0 FF                      MOV     AL,0FFH                 ; DISABLE DEVICE INTERRUPTS
0023 E6 21                      OUT     INTA01,AL               ; WRITE TO INTERRUPT MASK REGISTER
0025 E6 A1                      OUT     INTB01,AL               ; WRITE TO 2ND INTERRUPT MASK REGISTER
0027 EB 00                      JMP     $+2                     ; I/O DELAY
0029 E4 21                      IN      AL,INTA01               ; READ INTERRUPT MASK REGISTER
002B 8A E0                      MOV     AH,AL                   ; SAVE RESULTS
002D E4 A1                      IN      AL,INTB01               ; READ 2ND INTERRUPT MASK REGISTER

002F 05 0001                    ADD     AX,1                    ; ALL IMR BITS ON?
0032 75 15                      JNZ     D6                      ; NO - GO TO ERR ROUTINE

                        ;-----  CHECK FOR HOT INTERRUPTS

                        ;-----  INTERRUPTS ARE MASKED OFF.  CHECK THAT NO INTERRUPTS OCCUR.

0034 A2 006B R                  MOV     @INTR_FLAG,AL           ; CLEAR INTERRUPT FLAG

0037 B0 26                      MOV     AL,26H                  ;       <><><><><><><><><><><><>
0039 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  26 <><>

003B FB                         STI                             ; ENABLE EXTERNAL INTERRUPTS
003C B9 19E4                    MOV     CX,6628                 ; WAIT 100 MILLISECONDS FOR ANY
003F E8 0000 E                  CALL    WAITF                   ;  INTERRUPTS THAT OCCUR
0042 80 3E 006B R 00            CMP     @INTR_FLAG,00H          ; DID ANY INTERRUPTS OCCUR?
0047 74 0D                      JZ      D7                      ; NO - GO TO NEXT TEST

0049 C6 06 0015 R 05    D6:     MOV     @MFG_ERR_FLAG,05H       ;       <><><><><><><><><><><><>
                                                                ;       <><> CHECKPOINT   5 <><>
004E BE 0000 E                  MOV     SI,OFFSET E101          ; DISPLAY 101 ERROR
0051 E8 0000 E          D6A:    CALL    E_MSG
0054 FA                         CLI
0055 F4                         HLT                             ; HALT THE SYSTEM

                        ;-----  CHECK THE CONVERTING LOGIC

0056 B0 27              D7:     MOV     AL,27H                  ;       <><><><><><><><><><><><>
0058 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  27 <><>

005A B8 AA55                    MOV     AX,0AA55H
005D E7 82                      OUT     MFG_PORT+2,AX           ; WRITE A WORD
005F E4 82                      IN      AL,MFG_PORT+2           ;  GET THE FIRST BYTE
0061 86 C4                      XCHG    AL,AH                   ;  SAVE IT
0063 E4 83                      IN      AL,MFG_PORT+3           ;  GET THE SECOND BYTE
0065 3D 55AA                    CMP     AX,55AAH                ; IS IT OK?
0068 74 05                      JZ      D7_A                    ; GO IF YES

006A BE 0000 E                  MOV     SI,OFFSET E106          ; DISPLAY 106 ERROR
006D EB E2                      JMP     D6A

                        ;-----  CHECK FOR HOT NMI INTERRUPTS WITHOUT I/O-MEMORY PARITY ENABLED

006F                    D7_A:
006F B0 0D                      MOV     AL,CMOS_REG_D           ; TURN ON NMI
0071 E6 70                      OUT     CMOS_PORT,AL            ; ADDRESS DEFAULT READ ONLY REGISTER
0073 B9 0007                    MOV     CX,7                    ; DELAY COUNT FOR 100 MICROSECONDS
0076 E8 0000 E                  CALL    WAITF                   ; WAIT FOR HOT NMI TO PROCESS
0079 B0 8D                      MOV     AL,CMOS_REG_D+NMI       ; TURN NMI ENABLE BACK OFF
007B E6 70                      OUT     CMOS_PORT,AL
007D 80 3E 006B R 00            CMP     @INTR_FLAG,00H          ; DID ANY INTERRUPTS OCCUR?
0082 74 09                      JZ      D7_C                    ; CONTINUE IF NOT

0084 B0 28                      MOV     AL,28H                  ;       <><><><><><><><><><><><>
0086 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  28 <><>

0088 BE 0000 E                  MOV     SI,OFFSET E107          ; DISPLAY 107 ERROR
008B EB C4                      JMP     D6A

                        ;-----  TEST THE DATA BUS TO TIMER 2

008D B0 29              D7_C:   MOV     AL,29H                  ;       <><><><><><><><><><><><>
008F E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  29 <><>
0091 E4 61                      IN      AL,PORT_B               ; GET CURRENT SETTING OF PORT
0093 8A E0                      MOV     AH,AL                   ; SAVE THAT SETTING
0095 24 FC                      AND     AL,0FCH                 ; INSURE SPEAKER OFF
0097 E6 61                      OUT     PORT_B,AL

0099 B0 B0                      MOV     AL,10110000B            ; SELECT TIM 2,LSB,MSB,BINARY,MODE 0
009B E6 43                      OUT     TIMER+3,AL              ; WRITE THE TIMER MODE REGISTER
009D EB 00                      JMP     $+2                     ; I/O DELAY
009F B8 AA55                    MOV     AX,0AA55H               ; WRITE AN AA55
00A2 E6 42                      OUT     TIMER+2,AL              ; WRITE TIMER 2 COUNT - LSB
00A4 EB 00                      JMP     $+2                     ; I/O DELAY
00A6 8A C4                      MOV     AL,AH
00A8 E6 42                      OUT     TIMER+2,AL              ; WRITE TIMER 2 COUNT - MSB
00AA EB 00                      JMP     $+2                     ; I/O DELAY
00AC E4 42                      IN      AL,TIMER+2              ; GET THE LSB
00AE 86 E0                      XCHG    AH,AL                   ; SAVE IT
00B0 EB 00                      JMP     $+2                     ; I/O DELAY
00B2 E4 42                      IN      AL,TIMER+2              ; GET THE MSB
00B4 3D 55AA                    CMP     AX,055AAH               ; BUS OK?
00B7 74 05                      JZ      D7_D                    ; GO IF OK

00B9 BE 0000 E                  MOV     SI,OFFSET E108          ; DISPLAY 108 ERROR
00BC EB 93                      JMP     D6A

                        ;--------------------------------------------------------
                        ; TEST.18                                               :
                        ;       8254 TIMER CHECKOUT                             :
                        ; DESCRIPTION                                           :
                        ;       VERIFY THAT THE SYSTEM TIMER (0) DOESN'T COUNT  :
                        ;       TOO FAST OR TOO SLOW.                           :
                        ;--------------------------------------------------------

00BE B0 2A              D7_D:   MOV     AL,2AH                  ;       <><><><><><><><><><><><>
00C0 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  2A <><>
00C2 FA                         CLI                             ;
00C3 B0 FE                      MOV     AL,0FEH                 ; MASK ALL INTERRUPTS EXCEPT LEVEL 0
00C5 E6 21                      OUT     INTA01,AL               ; WRITE THE 8259 IMR
00C7 B0 10                      MOV     AL,00010000B            ; SELECT TIM 0, LSB, MODE 0, BINARY
00C9 E6 43                      OUT     TIMER+3,AL              ; WRITE TIMER CONTROL MODE REGISTER
00CB B9 002C                    MOV     CX,2CH                  ; SET PROGRAM LOOP COUNT

00CE EB 00                      JMP     $+2                     ; I/O DELAY
```

SECTION 5

```
00D0 8A C1                          MOV     AL,CL                   ; SET TIMER 0 COUNT REGISTER
00D2 E6 40                          OUT     TIMER+0,AL              ; WRITE TIMER 0 COUNT REGISTER
00D4 FB                             STI
00D5 F6 06 006B R 01        D8:     TEST    @INTR_FLAG,01H
                                                                    ; DID TIMER 0 INTERRUPT OCCUR?
00DA 75 0D                          JNZ     D9                      ; CHECK TIMER OPERATION FOR SLOW TIME
00DC E2 F7                          LOOP    D8                      ; WAIT FOR INTERRUPT FOR SPECIFIED TIME

00DE C6 06 0015 R 02                MOV     @MFG_ERR_FLAG,02H       ;       <><><><><><><><><><><><><><><><><>
                                                                    ;       <><> TIMER CHECKPOINT (2) <><>


00E3 BE 0000 E              D8_A:   MOV     SI,OFFSET E102          ; DISPLAY 102 ERROR
00E6 E9 0051 R                      JMP     D6A                     ; TIMER 0 INTERRUPT DID NOT OCCUR= ERROR


00E9 B0 2B                  D9:     MOV     AL,2BH                  ;       <><><><><><><><><><><><><><>
00EB E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  2B <><>

00ED FA                             CLI
00EE B1 0C                          MOV     CL,12                   ; SET PROGRAM LOOP COUNT
00F0 B0 FF                          MOV     AL,0FFH                 ; WRITE TIMER 0 COUNT REGISTER
00F2 E6 40                          OUT     TIMER+0,AL
00F4 C6 06 006B R 00                MOV     @INTR_FLAG,0            ; RESET INTERRUPT RECEIVED FLAG
00F9 B0 FE                          MOV     AL,0FEH                 ; RE-ENABLE TIMER 0 INTERRUPTS
00FB E6 21                          OUT     INTA01,AL
00FD FB                             STI
00FE F6 06 006B R 01        D10:    TEST    @INTR_FLAG,01H          ; DID TIMER 0 INTERRUPT OCCUR?
0103 75 DE                          JNZ     D8_A                    ; YES - TIMER COUNTING TOO FAST, ERROR
0105 E2 F7                          LOOP    D10                     ; WAIT FOR INTERRUPT FOR SPECIFIED TIME

                            ;-----  WAIT FOR INTERRUPT

0107 2B C9                          SUB     CX,CX

0109 B0 2C                          MOV     AL,2CH                  ;       <><><><><><><><><><><><><><>
010B E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  2C <><>
010D                        D110:
010D F6 06 006B R 01                TEST    @INTR_FLAG,01H          ; DID TIMER 0 INTERRUPT OCCUR?
0112 75 08                          JNZ     D12                     ; GO IF YES
0114 E2 F7                          LOOP    D110                    ; TRY AGAIN

0116 BE 0000 E                      MOV     SI,OFFSET E103          ; DISPLAY 103 ERROR
0119 E9 0051 R                      JMP     D6A                     ; ERROR IF NOT

                            ;-----  SETUP TIMER 0 TO MODE 3

011C FA                     D12:    CLI
011D B0 FF                          MOV     AL,0FFH                 ; DISABLE ALL DEVICE INTERRUPTS
011F E6 21                          OUT     INTA01,AL
0121 B0 36                          MOV     AL,36H                  ; SELECT TIMER 0,LSB,MSB,MODE 3
0123 E6 43                          OUT     TIMER+3,AL              ; WRITE TIMER MODE REGISTER
0125 EB 00                          JMP     $+2                     ; I/O DELAY
0127 B0 00                          MOV     AL,0
0129 E6 40                          OUT     TIMER+0,AL              ; WRITE LSB TO TIMER 0 REGISTER
012B EB 00                          JMP     $+2                     ; I/O DELAY
012D E6 40                          OUT     TIMER+0,AL              ; WRITE MSB TO TIMER 0 REGISTER

                            ;-----  CHECK 8042 FOR LAST COMMAND ACCEPTED

012F 2B C9                          SUB     CX,CX                   ; SET WAIT TIME
0131 B0 2D                          MOV     AL,2DH                  ;       <><><><><><><><><><><><><><>
0133 E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  2D <><>
0135 E4 64                  D13:    IN      AL,STATUS_PORT          ; GET THE 8042 STATUS
0137 A8 02                          TEST    AL,INPT_BUF_FULL        ; HAS THE LAST COMMAND BEEN ACCEPTED?
0139 74 08                          JZ      E19                     ; GO IF YES
013B E2 F8                          LOOP    D13                     ; TRY AGAIN

                            ;-----  ERROR EXIT (MESSAGE 105)

013D BE 0000 E                      MOV     SI,OFFSET E105          ; PRINT 105 ERROR
0140 E9 0051 R                      JMP     D6A                     ; GO ERROR HALT

                            ;-----------------------------------------------------------------------
                            ; TEST.19                                                               :
                            ;       ADDITIONAL READ/WRITE STORAGE TEST                              :
                            ;       ++++ MUST RUN IN PROTECTED MODE ++++                            :
                            ; DESCRIPTION                                                           :
                            ;       WRITE/READ DATA PATTERNS TO ANY READ/WRITE STORAGE AFTER THE    :
                            ;       FIRST 64K.  STORAGE ADDRESSABILITY IS CHECKED.                  :
                            ;-----------------------------------------------------------------------

                                    ASSUME  DS:DATA
0143                        E19:
0143 E8 0000 E                      CALL    DDS                     ; SET DATA SEGMENT
0146 B0 2F                          MOV     AL,2FH                  ;       <><><><><><><><><><><><><><>
0148 E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  2F <><>

014A 81 3E 0072 R 1234              CMP     @RESET_FLAG,1234H       ; WARM START?
0150 75 03                          JNE     E19A                    ; GO IF NOT
0152 E9 0420 R                      JMP     SHUT2                   ; GO TO NEXT TEST IF WARM START

                            ;-----  SET SHUTDOWN RETURN 2

0155 B0 30                  E19A:   MOV     AL,30H                  ;       <><><><><><><><><><><><><><>
0157 E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  30 <><>

0159 B8 028F                        MOV     AX,2*H+CMOS_SHUT_DOWN+NMI       ; ADDRESS FOR SHUTDOWN BYTE
015C E8 0000 E                      CALL    CMOS_WRITE              ; SECOND ENTRY IN SHUTDOWN TABLE

                            ;-----  ENABLE PROTECTED MODE

015F BC 0000                        MOV     SP,POST_SS              ; SET STACK FOR SYSINIT1
0162 8E D4                          MOV     SS,SP
0164 BC 8000                        MOV     SP,POST_SP

0167 E8 0000 E                      CALL    SYSINIT1                ; GO ENABLE PROTECTED MODE

016A B0 31                          MOV     AL,31H                  ;       <><><><><><><><><><><><><><>
016C E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  31 <><>

                            ;-----  SET TEMPORARY STACK

016E 6A 08                          PUSH    BYTE PTR GDT_PTR
```

```
0170 07                         POP     ES
0171 26: C7 06 005A 0000        MOV     ES:SS_TEMP.BASE_LO_WORD,0
0178 26: C6 06 005C 00          MOV     BYTE PTR ES:(SS_TEMP.BASE_HI_BYTE),0
017E BE 0058                    MOV     SI,SS_TEMP
0181 8E D6                      MOV     SS,SI
0183 BC FFFD                    MOV     SP,MAX_SEG_LEN-2

                        ;-----  DATA SEGMENT TO SYSTEM DATA AREA

0186 6A 18                      PUSH    BYTE PTR RSDA_PTR       ; POINT TO DATA AREA
0188 1F                         POP     DS

0189 B0 80                      MOV     AL,PARITY_CHECK         ; SET CHECK PARITY
018B E6 87                      OUT     DMA_PAGE+6,AL           ; SAVE WHICH CHECK TO USE

                        ;-----  PRINT 64 K BYTES OK

018D B8 0040                    MOV     AX,64                   ; STARTING AMOUNT OF MEMORY OK
0190 E8 099F R                  CALL    PRT_OK                  ; POST 65K OK MESSAGE

                        ;-----  GET THE MEMORY SIZE DETERMINED (PREPARE BX AND DX FOR BAD CMOS)

0193 B8 B0B1                    MOV     AX,(CMOS_U_M_S_LO+NMI)*H+CMOS_U_M_S_HI+NMI
0196 E8 0000 E                  CALL    CMOS_READ               ; HIGH BYTE
0199 86 E0                      XCHG    AH,AL                   ; SAVE HIGH BYTE
019B E8 0000 E                  CALL    CMOS_READ               ; LOW BYTE
019E 8B 1E 0013 R               MOV     BX,@MEMORY_SIZE         ; LOAD THE BASE MEMORY SIZE
01A2 8B D3                      MOV     DX,BX                   ; SAVE BASE MEMORY SIZE
01A4 03 D8                      ADD     BX,AX                   ; SET TOTAL MEMORY SIZE

                        ;-----  IS CMOS GOOD?

01A6 B0 8E                      MOV     AL,CMOS_DIAG+NMI        ; DETERMINE THE CONDITION OF CMOS
01A8 E8 0000 E                  CALL    CMOS_READ               ; GET THE CMOS STATUS

01AB A8 C0                      TEST    AL,BAD_BAT+BAD_CKSUM    ; CMOS OK?
01AD 74 02                      JZ      E20B0                   ; GO IF YES
01AF EB 5B                      JMP     SHORT E20C              ; DEFAULT IF NOT

                        ;-----  GET THE BASE 0->640K MEMORY SIZE FROM CONFIGURATION IN CMOS
01B1                    E20B0:
01B1 B8 9596                    MOV     AX,(CMOS_B_M_S_LO+NMI)*H+CMOS_B_M_S_HI+NMI
01B4 E8 0000 E                  CALL    CMOS_READ               ; HIGH BYTE
01B7 24 3F                      AND     AL,03FH                 ; MASK OFF THE MANUFACTURING TEST BITS
01B9 86 E0                      XCHG    AH,AL                   ; SAVE HIGH BYTE
01BB E8 0000 E                  CALL    CMOS_READ               ; LOW BYTE OF BASE MEMORY SIZE
01BE 3B D0                      CMP     DX,AX                   ; IS MEMORY SIZE GREATER THAN CONFIG?
01C0 74 13                      JZ      E20B1                   ; GO IF EQUAL

                        ;-----  SET MEMORY SIZE DETERMINE NOT EQUAL TO CONFIGURATION

01C2 50                         PUSH    AX                      ; SAVE AX
01C3 B8 8E8E                    MOV     AX,X*(CMOS_DIAG+NMI)    ; ADDRESS THE STATUS BYTE
01C6 E8 0000 E                  CALL    CMOS_READ               ; GET THE STATUS
01C9 0C 10                      OR      AL,W_MEM_SIZE           ; SET CMOS FLAG
01CB 86 C4                      XCHG    AL,AH                   ; SAVE AL AND GET ADDRESS
01CD E8 0000 E                  CALL    CMOS_WRITE              ; WRITE UPDATED STATUS
01D0 58                         POP     AX                      ; RESTORE AX
01D1 3B D0                      CMP     DX,AX                   ; IS MEMORY SIZE GREATER THAN CONFIG ?
01D3 77 37                      JA      E20C                    ; DEFAULT TO MEMORY SIZE DETERMINED ?
01D5                    E20B1:
01D5 8B D8                      MOV     BX,AX                   ; SET BASE MEMORY SIZE IN TOTAL REGISTER
01D7 8B D0                      MOV     DX,AX                   ; SAVE IN BASE SIZE REGISTER

                        ;-----  CHECK MEMORY SIZE ABOVE 640K FROM CONFIGURATION

01D9 B8 9798                    MOV     AX,(CMOS_E_M_S_LO+NMI)*H+(CMOS_E_M_S_HI+NMI)
01DC E8 0000 E                  CALL    CMOS_READ               ; HIGH BYTE
01DF 86 E0                      XCHG    AH,AL                   ; SAVE HIGH BYTE
01E1 E8 0000 E                  CALL    CMOS_READ               ; LOW BYTE
01E4 8B C8                      MOV     CX,AX                   ; SAVE THE ABOVE 640K MEMORY SIZE
                        ;-----  ABOVE 640K SIZE FROM MEMORY SIZE DETERMINE
                        ;-----  CX=CONFIG  AX=MEMORY SIZE DETERMINE
01E6 B8 B0B1                    MOV     AX,(CMOS_U_M_S_LO+NMI)*H+(CMOS_U_M_S_HI+NMI)
01E9 E8 0000 E                  CALL    CMOS_READ               ; HIGH BYTE
01EC 86 E0                      XCHG    AH,AL                   ; SAVE HIGH BYTE
01EE E8 0000 E                  CALL    CMOS_READ               ; LOW BYTE
                        ;------ WHICH IS GREATER - AX = MEMORY SIZE DETERMINE
                        ;------ CX = CONFIGURATION (ABOVE 640) BX = SIZE (BELOW 640)

01F1 3B C8                      CMP     CX,AX                   ; IS CONFIGURATION EQUAL TO DETERMINED?
01F3 74 0F                      JZ      SET_MEM1                ; GO IF EQUAL

                        ;-----  SET MEMORY SIZE DETERMINE NOT EQUAL TO CONFIGURATION

01F5 50                         PUSH    AX                      ; SAVE AX
01F6 B8 8E8E                    MOV     AX,X*(CMOS_DIAG+NMI)    ; ADDRESS THE STATUS BYTE
01F9 E8 0000 E                  CALL    CMOS_READ               ; GET THE STATUS
01FC 0C 10                      OR      AL,W_MEM_SIZE           ; SET CMOS FLAG
01FE 86 C4                      XCHG    AL,AH                   ; SAVE AL
0200 E8 0000 E                  CALL    CMOS_WRITE              ; UPDATE STATUS BYTE
0203 58                         POP     AX                      ; RESTORE AX

0204                    SET_MEM1:
0204 3B C8                      CMP     CX,AX                   ; IS CONFIG GREATER THAN DETERMINED?
0206 77 02                      JA      SET_MEM                 ;  GO IF YES
0208 8B C8                      MOV     CX,AX                   ; USE MEMORY SIZE DETERMINE IF NOT
020A                    SET_MEM:
020A 03 D9                      ADD     BX,CX                   ; SET TOTAL MEMORY SIZE
020C                    E20C:
020C 81 FA 0201                 CMP     DX,513                  ; CHECK IF BASE MEMORY LESS 512K
0210 72 0D                      JB      NO_640                  ; GO IF YES

0212 B8 B3B3                    MOV     AX,X*(CMOS_INFO128+NMI) ; SET 640K BASE MEMORY BIT
0215 E8 0000 E                  CALL    CMOS_READ               ; GET THE CURRENT STATUS
0218 0C 80                      OR      AL,M640K                ; TURN ON 640K BIT IF NOT ALREADY ON
021A 86 C4                      XCHG    AL,AH                   ; SAVE THE CURRENT DIAGNOSTIC STATUS
021C E8 0000 E                  CALL    CMOS_WRITE              ; RESTORE THE STATUS
021F                    NO_640:
021F 89 1E 0017 R               MOV     WORD PTR @KB_FLAG,BX    ; SAVE TOTAL SIZE FOR LATER TESTING
0223 C1 EB 06                   SHR     BX,6                    ; DIVIDE BY 64
0226 4B                         DEC     BX                      ; 1ST 64K ALREADY DONE
0227 C1 EA 06                   SHR     DX,6                    ; DIVIDE BY 64 FOR BASE
```

SECTION 5

```
                          ;-----  SAVE COUNTS IN STACK FOR BOTH MEMORY AND ADDRESSING TESTS

 022A 52                          PUSH    DX                      ; SAVE BASE MEMORY SIZE COUNT
 022B 6A 40                       PUSH    BYTE PTR 64             ; SAVE STARTING AMOUNT OF MEMORY OK
 022D 53                          PUSH    BX                      ; SAVE COUNT OF 64K BLOCKS TO BE TESTED

 022E 52                          PUSH    DX                      ; SAVE BASE MEMORY SIZE COUNT
 022F 6A 40                       PUSH    BYTE PTR 64             ; SAVE STARTING AMOUNT OF MEMORY OK
 0231 53                          PUSH    BX                      ; SAVE COUNT OF 64K BLOCKS TO BE TESTED

                          ;-----  MODIFY DESCRIPTOR TABLES

 0232 6A 08                       PUSH    BYTE PTR GDT_PTR        ; MODIFY THE DESCRIPTOR TABLE
 0234 07                          POP     ES

                          ;-----  SET TEMPORARY ES DESCRIPTOR 64K SEGMENT LIMIT STARTING AT 000000

 0235 26: C7 06 0048 FFFF         MOV     ES:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN
 023C 26: C7 06 004A 0000         MOV     ES:ES_TEMP.BASE_LO_WORD,0
 0243 26: C6 06 004C 00           MOV     BYTE PTR ES:(ES_TEMP.BASE_HI_BYTE),0          ; FIRST 65K
 0249 26: C6 06 004D 93           MOV     BYTE PTR ES:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS

                          ;-----  SET TEMPORARY DS DESCRIPTOR 64K SEGMENT LIMIT AT FIRST 65K BLOCK

 024F 26: C7 06 0060 FFFF         MOV     ES:DS_TEMP.SEG_LIMIT,MAX_SEG_LEN
 0256 26: C7 06 0062 0000         MOV     ES:DS_TEMP.BASE_LO_WORD,0
 025D 26: C6 06 0064 00           MOV     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),0
 0263 26: C6 06 0065 93           MOV     BYTE PTR ES:(DS_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS

                          ;-----  TEMPORARY SEGMENT SAVE IN DMA PAGE REGISTER FOR SECOND 65K BLOCK

 0269 2A C0                       SUB     AL,AL                   ; INITIALIZE VALUES TO 010000
 026B E6 85                       OUT     DMA_PAGE+4,AL           ; HIGH BYTE OF LOW WORD OF SEGMENT
 026D E6 86                       OUT     DMA_PAGE+5,AL           ; LOW BYTE OF LOW WORD OF SEGMENT
 026F FE C0                       INC     AL                      ; SET HIGH BYTE OF SEGMENT WORD
 0271 E6 84                       OUT     DMA_PAGE+3,AL           ; HIGH BYTE OF SEGMENT


                          ;-----  MEMORY TEST LOOP - POINT TO NEXT BLOCK OF 32K WORDS (64K)

 0273                     E21:                                    ;       MEMORY TEST LOOP
 0273 6A 08                       PUSH    BYTE PTR GDT_PTR        ; POINT TO START OF DESCRIPTOR TABLE
 0275 1F                          POP     DS
 0276 FE 06 0064                  INC     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE)      ; POINT TO NEXT BLOCK
 027A FE 06 004C                  INC     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE)

                          ;-----  CHECK FOR END OF 256K PLANAR MEMORY

 027E 80 3E 0064 04               CMP     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE),04H
 0283 72 04                       JB      E21_0                   ; GO IF STILL FIRST 256K OF BASE MEMORY

 0285 B0 C0                       MOV     AL,PARITY_CHECK+IO_CHECK; CHECK FOR ANY TYPE OF PARITY ERROR
 0287 E6 87                       OUT     DMA_PAGE+6,AL           ; AFTER FIRST 256K

                          ;-----  CHECK END OF FIRST 640K OR ABOVE (END OF MAXIMUM BASE MEMORY)
 0289                     E21_0:
 0289 80 3E 0064 0A               CMP     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE),0AH
 028E 77 16                       JA      NEXT                    ; CONTINUE IF ABOVE 1 MEG

                          ;-----  CHECK FOR END OF BASE MEMORY TO BE TESTED

 0290 59                          POP     CX                      ; GET COUNT
 0291 5B                          POP     BX                      ; GET COUNT TESTED
 0292 58                          POP     AX                      ; RECOVER COUNT OF BASE MEMORY BLOCKS
 0293 50                          PUSH    AX                      ; SAVE BASE COUNT
 0294 53                          PUSH    BX                      ; SAVE TESTED COUNT
 0295 51                          PUSH    CX                      ; SAVE TOTAL COUNT
 0296 38 06 0064                  CMP     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE),AL         ; MAX BASE COUNT
 029A 72 0A                       JB      NEXT                    ; CONTINUE IF NOT DONE WITH BASE MEMORY

                          ;-----  DO ADDITIONAL STORAGE ABOVE 1 MEG

 029C C6 06 0064 10               MOV     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE),10H
 02A1 C6 06 004C 10               MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),10H

                          ;-----  SAVE BASE_HI_BYTE IN DMA PAGE REGISTERS 3

 02A6 A0 0064             NEXT:   MOV     AL,BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE)
 02A9 E6 84                       OUT     DMA_PAGE+3,AL           ; SAVE THE HIGH BYTE OF SEGMENT
                                                                  ;  FOR POSSIBLE ERROR

                          ;-----  CHECK FOR TOP OF MEMORY (FE0000) 16 MEG

 02AB 80 3E 004C FE               CMP     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),0FEH ; TOP OF MEMORY?
 02B0 74 29                       JE      KB_LOOP3                                ; EXIT NEXT TEST IF DONE

                          ;-----  SET ES AND DS REGISTERS TO MEMORY BLOCK

 02B2 6A 60                       PUSH    BYTE PTR DS_TEMP
 02B4 1F                          POP     DS
 02B5 6A 48                       PUSH    BYTE PTR ES_TEMP
 02B7 07                          POP     ES

 02B8 B0 31                       MOV     AL,31H                  ;       <><><><><><><><><><><><>
 02BA E6 80                       OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  31 <><>

 02BC B9 8000                     MOV     CX,8000H                ; SET COUNT FOR 32K WORDS
 02BF E8 0000 E                   CALL    STGTST_CNT
 02C2 74 03                       JZ      N1                      ; SKIP IF OK
 02C4 E9 0367 R                   JMP     E21A                    ; GO PRINT ERROR
 02C7                     N1:
 02C7 59                          POP     CX                      ; POP CX TO GET AX
 02C8 58                          POP     AX                      ; RECOVER TESTED MEMORY

                          ;-----  WRITE THE CURRENT SIZE FOR (ADDRESS LINE 23-17 TEST) USED LATER

 02C9 2B FF                       SUB     DI,DI                   ; POINT TO BEGINNING OR A BLOCK
 02CB AB                          STOSW                           ; WRITE THE CURRENT SIZE
                                                                  ;  AT THE STARTING ADDRESS
 02CC 05 0040                     ADD     AX,64                   ; ADVANCE COUNT TO NEXT BLOCK
 02CF 50                          PUSH    AX                      ; SAVE TESTED MEMORY
 02D0 51                          PUSH    CX                      ; SAVE LOOP COUNT

 02D1 E8 099F R                   CALL    PRT_OK                  ; DISPLAY "0XXXX OK" MESSAGE
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02D4 59                         POP     CX                      ; RECOVER 64K BLOCK COUNT
02D5 49                         DEC     CX                      ; DECREMENT BLOCK COUNT FOR LOOP
02D6 E3 03                      JCXZ    KB_LOOP3                ; CONTINUE TO NEXT TEST IF DONE

02D8 51                         PUSH    CX                      ; SAVE LOOP COUNT
02D9 EB 98                      JMP     E21                     ; LOOP TILL ALL MEMORY CHECKED

02DB                    KB_LOOP3:                               ;       END MAIN TEST LOOP
02DB 58                         POP     AX                      ; CLEAR MAXIMUM BLOCK COUNT
02DC 58                         POP     AX                      ; CLEAR BASE SIZE COUNT FROM STACK
                                                                ; ADDRESS TEST VALUES ARE IN STACK
                        ;-----  ADDRESS LINE 16-23 TEST
                                                                ;       LET FIRST PASS BE SEEN
02DD B9 40BB                    MOV     CX,16571                ; COUNT FOR 250 MS FIXED TIME DELAY
02E0 E8 0000 E                  CALL    WAITF                   ; ALLOW SIX DISPLAY REFRESH CYCLES

                        ;-----  INITIALIZE DS DESCRIPTOR

02E3 6A 08                      PUSH    BYTE PTR GDT_PTR
02E5 07                         POP     ES
02E6 26: C6 06 0064 00          MOV     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),0
02EC 26: C7 06 0062 0000        MOV     ES:DS_TEMP.BASE_LO_WORD,0

                        ;-----  TEMPORARY SEGMENT SAVE IN DMA PAGE REGISTER

02F3 2A C0                      SUB     AL,AL
02F5 E6 85                      OUT     DMA_PAGE+4,AL           ; HIGH BYTE OF LOW WORD OF SEGMENT
02F7 E6 86                      OUT     DMA_PAGE+5,AL           ; LOW BYTE OF LOW WORD OF SEGMENT
02F9 B0 01                      MOV     AL,01H                  ; SET HIGH BYTE OF SEGMENT WORD
02FB E6 84                      OUT     DMA_PAGE+3,AL           ; HIGH BYTE OF SEGMENT

                        ;-----  POINT TO NEXT BLOCK OF 64K

02FD                    E21_A:
02FD B0 33                      MOV     AL,33H                  ;       <><><><><><><><><><><><>
02FF E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  33 <><>
0301 26: 80 06 0064 01          ADD     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),01

                        ;-----  CHECK FOR END OF BASE MEMORY TO BE TESTED

0307 26: 80 3E 0064 0A          CMP     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),0AH
030D 77 13                      JA      NEXT_A                  ; CONTINUE IF ABOVE 1 MEG

030F 59                         POP     CX                      ; GET COUNT
0310 5B                         POP     BX                      ; GET COUNT TESTED
0311 58                         POP     AX                      ; RECOVER COUNT OF BASE MEMORY BLOCKS
0312 50                         PUSH    AX                      ; SAVE BASE COUNT
0313 53                         PUSH    BX                      ; SAVE TESTED COUNT
0314 51                         PUSH    CX                      ; SAVE TOTAL COUNT
0315 26: 38 06 0064             CMP     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),AL           ; MAX BASE COUNT
031A 72 06                      JB      NEXT_A                  ; CONTINUE IF NOT DONE WITH BASE MEMORY

                        ;-----  DO ADDITIONAL STORAGE ABOVE 1 MEG

031C                    NEXT_A2:
031C 26: C6 06 0064 10          MOV     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),10H
0322                    NEXT_A:
0322 26: A0 0064                MOV     AL,BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE)

                        ;-----  DMA PAGE REGISTERS 3
                                                                ; SAVE THE HIGH BYTE OF SEGMENT
0326 E6 84                      OUT     DMA_PAGE+3,AL           ;  FOR POSSIBLE ERROR

                        ;-----  CHECK FOR TOP OF MEMORY (FE0000) 16 MEG

0328 3C FE                      CMP     AL,0FEH                 ; TOP OF MEMORY?
032A 74 34                      JZ      KB_LOOP_3               ; GO NEXT TEST IF IT IS

                        ;-----  SET DS REGISTER

032C 6A 60                      PUSH    BYTE PTR DS_TEMP
032E 1F                         POP     DS
032F 2B FF                      SUB     DI,DI                   ; POINT TO START OF BLOCK
0331 8B 15                      MOV     DX,DS:[DI]              ; GET THE VALUE OF THIS BLOCK
0333 8B F7                      MOV     SI,DI                   ; SET SI FOR POSSIBLE ERROR
0335 2B C0                      SUB     AX,AX                   ; CLEAR MEMORY LOCATION
0337 89 05                      MOV     [DI],AX

                        ;-----  ALLOW DISPLAY TIME TO DISPLAY MESSAGE AND REFRESH TO RUN

0339 B9 1A69                    MOV     CX,6761                 ; COUNT FOR 102 MS FIXED TIME DELAY
033C E8 0000 E                  CALL    WAITF                   ; ALLOW FIVE DISPLAY REFRESH CYCLES
033F 59                         POP     CX                      ; GET THE LOOP COUNT
0340 58                         POP     AX                      ; RECOVER TESTED MEMORY
0341 50                         PUSH    AX                      ; SAVE TESTED MEMORY
0342 51                         PUSH    CX                      ; SAVE LOOP COUNT
0343 3B C2                      CMP     AX,DX                   ; DOES THE BLOCK ID MATCH
0345 8B C2                      MOV     AX,DX                   ; GET THE BLOCK ID FOR POSSIBLE ERROR
0347 75 1E                      JNZ     E21A                    ; GO PRINT ERROR

                        ;-----  CHECK FOR CHECK PARITY

0349 E4 61                      IN      AL,PORT_B               ; CHECK FOR I/O OR PARITY CHECK
034B 24 C0                      AND     AL,PARITY_ERR           ; STRIP UNWANTED BITS
034D 75 18                      JNZ     E21A                    ; EXIT IF PARITY ERROR

034F 59                         POP     CX                      ; POP CX TO GET AX
0350 58                         POP     AX                      ; RECOVER TESTED MEMORY
0351 05 0040                    ADD     AX,64                   ; 64K INCREMENTS
0354 50                         PUSH    AX                      ; SAVE TESTED MEMORY
0355 51                         PUSH    CX                      ; SAVE LOOP COUNT
0356 E8 099F R                  CALL    PRT_OK                  ; DISPLAY OK MESSAGE
0359 59                         POP     CX                      ; RECOVER 64K BLOCK COUNT
035A 49                         DEC     CX                      ; LOOP TILL ALL MEMORY CHECKED
035B E3 03                      JCXZ    KB_LOOP_3               ; CONTINUE

035D 51                         PUSH    CX                      ; SAVE LOOP COUNT
035E EB 9D                      JMP     E21_A                   ; CONTINUE TILL DONE

                        ;-----  BACK TO REAL MODE - MEMORY TESTS DONE

0360                    KB_LOOP_3:
0360 B0 34                      MOV     AL,34H                  ;       <><><><><><><><><><><><>
0362 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  34 <><>
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SECTION 5

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                                                                ; BACK TO REAL MODE
0364 E9 0000 E                  JMP     PROC_SHUTDOWN           ; NEXT TEST VIA JUMP TABLE (SHUT2)


                        ;-----  PRINT FAILING ADDRESS AND XOR'ED PATTERN IF DATA COMPARE ERROR
                        ;-----  USE DMA PAGE REGISTERS AS TEMPORARY SAVE AREA FOR ERROR
                        ;       SET SHUTDOWN 3

0367 E6 82              E21A:   OUT     DMA_PAGE+1,AL           ; SAVE FAILING BIT PATTERN (LOW BYTE)
0369 8A C4                      MOV     AL,AH                   ; SAVE HIGH BYTE
036B E6 83                      OUT     DMA_PAGE+2,AL
036D 8B C6                      MOV     AX,SI                   ; GET THE FAILING OFFSET
036F E6 86                      OUT     DMA_PAGE+5,AL
0371 86 E0                      XCHG    AH,AL
0373 E6 85                      OUT     DMA_PAGE+4,AL

                        ;-----  CLEAR I/O CHANNEL CHECK OR R/W PARITY CHECK

0375 2B F6                      SUB     SI,SI                   ; WRITE TO FAILING BLOCK
0377 AB                         STOSW
0378 E4 61                      IN      AL,PORT_B               ; GET PARITY CHECK LATCHES
037A E6 88                      OUT     DMA_PAGE+7,AL           ; SAVE FOR ERROR HANDLER
037C 0C 0C                      OR      AL,RAM_PAR_OFF          ; TOGGLE I/O-PARITY CHECK ENABLE
037E E6 61                      OUT     PORT_B,AL               ;  TO RESET CHECKS
0380 24 F3                      AND     AL,RAM_PAR_ON
0382 E6 61                      OUT     PORT_B,AL

                        ;-----  GET THE LAST OF GOOD MEMORY

0384 58                         POP     AX                      ; CLEAR BLOCK COUNT
0385 58                         POP     AX                      ; GET THE LAST OF GOOD MEMORY
0386 5B                         POP     BX                      ; GET BASE MEMORY COUNTER
0387 C1 E3 06                   SHL     BX,6                    ; CONVERT TO MEMORY SIZE COUNTS
038A 2B C3                      SUB     AX,BX                   ; COMPARE LAST GOOD MEMORY WITH BASE
038C 73 17                      JAE     E211                    ; IF ABOVE OR EQUAL, USE REMAINDER IN
                                                                ;  CMOS_U_M_S_(H/L)
                        ;-----  ELSE SET BASE MEMORY SIZE

038E 6A 18                      PUSH    BYTE PTR RSDA_PTR       ; SET THE DATA SEGMENT
0390 1F                         POP     DS                      ; IN PROTECTED MODE

0391 03 C3                      ADD     AX,BX                   ; CONVERT BACK TO LAST WORKING MEMORY
0393 A3 0013 R                  MOV     @MEMORY_SIZE,AX         ; TO INDICATE HOW MUCH MEMORY WORKING

                        ;-----  RESET 512K --> 640K OPTION IF SET

0396 B8 B3B3                    MOV     AX,X*(CMOS_INFO128+NMI) ; ADDRESS OPTIONS INFORMATION BYTE
0399 E8 0000 E                  CALL    CMOS_READ               ; READ THE MEMORY INFORMATION FLAG
039C 24 7F                      AND     AL,NOT M640K            ; SET 640K OPTION OFF
039E 86 C4                      XCHG    AL,AH                   ; MOVE TO WORK REGISTER
03A0 E8 0000 E                  CALL    CMOS_WRITE              ; UPDATE STATUS IF IT WAS ON
03A3 33 C0                      XOR     AX,AX                   ; CLEAR VALUE FOR EXTENSION MEMORY
03A5                    E211:
03A5 8B C8                      MOV     CX,AX                   ; SAVE ADJUSTED MEMORY SIZE
03A7 B0 B1                      MOV     AL,CMOS_U_M_S_HI+NMI
03A9 E8 0000 E                  CALL    CMOS_WRITE              ; SAVE THE HIGH BYTE MEMORY SIZE
03AC 8A E1                      MOV     AH,CL                   ; GET THE LOW BYTE
03AE B0 B0                      MOV     AL,CMOS_U_M_S_LO+NMI    ; DO THE LOW BYTE
03B0 E8 0000 E                  CALL    CMOS_WRITE              ; WRITE IT

                        ;-----  SET SHUTDOWN 3

03B3 B8 038F                    MOV     AX,3*H+CMOS_SHUT_DOWN+NMI       ; ADDRESS FOR SHUTDOWN RETURN
03B6 E8 0000 E                  CALL    CMOS_WRITE                      ; SET RETURN 3

                        ;-----  SHUTDOWN

03B9 E9 0000 E                  JMP     PROC_SHUTDOWN
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                                PAGE
                                ;---------------------------------------------------------------------
                                ; MEMORY ERROR REPORTING          (R/W/ MEMORY OR PARITY ERRORS)      :
                                ;                                                                     :
                                ; DESCRIPTION FOR ERRORS 201 (CMP ERROR OR PARITY)                    :
                                ;                        OR 202 (ADDRESS LINE 0-15 ERROR)             :
                                ;                                                                     :
                                ;       "AABBCC DDEE 201" (OR 202)                                    :
                                ;                       AA=HIGH BYTE OF 24 BIT ADDRESS                :
                                ;                       BB=MIDDLE BYTE OF 24 BIT ADDRESS              :
                                ;                       CC=LOW BYTE OF 24 BIT ADDRESS                 :
                                ;                       DD=HIGH BYTE OF XOR FAILING BIT PATTERN       :
                                ;                       EE=LOW BYTE OF XOR FAILING BIT PATTERN        :
                                ;                                                                     :
                                ; DESCRIPTION FOR ERROR 202 (ADDRESS LINE 00-15)                      :
                                ;       A WORD OF FFFF IS WRITTEN AT THE FIRST WORD AND LAST WORD     :
                                ;       OF EACH 64K BLOCK WITH ZEROS AT ALL OTHER LOCATIONS OF THE    :
                                ;       BLOCK.  A SCAN OF THE BLOCK IS MADE TO INSURE ADDRESS LINE    :
                                ;       0-15 ARE FUNCTIONING.                                         :
                                ;                                                                     :
                                ; DESCRIPTION FOR ERROR 203 (ADDRESS LINE 16-23)                      :
                                ;       AT THE LAST PASS OF THE STORAGE TEST, FOR EACH BLOCK OF       :
                                ;       64K, THE CURRENT STORAGE SIZE (ID) IS WRITTEN AT THE FIRST    :
                                ;       WORD OF EACH BLOCK. IT IS USED TO FIND ADDRESSING FAILURES.   :
                                ;                                                                     :
                                ;       "AABBCC DDEE 203"                                             :
                                ;                       SAME AS ABOVE EXCEPT FOR DDEE                 :
                                ;                                                                     :
                                ; GENERAL DESCRIPTION FOR BLOCK ID (DDEE WILL NOW CONTAINED THE ID)   :
                                ;       DD=HIGH BYTE OF BLOCK ID                                      :
                                ;       EE=LOW BYTE OF BLOCK ID                                       :
                                ;                                                                     :
                                ;       BLOCK ID        ADDRESS RANGE                                 :
                                ;       0000            000000 --> 00FFFF                             :
                                ;       0040            010000 --> 01FFFF                             :
                                ;       //                                                            :
                                ;       0200            090000 --> 09FFFF (512->576K) IF 640K BASE    :
                                ;                       100000 --> 10FFFF (1024->1088K) IF 512K BASE  :
                                ;                                                                     :
                                ; EXAMPLE (640K BASE MEMORY + 512K I/O MEMORY = 1152K TOTAL)          :
                                ;       NOTE: THE CORRECT BLOCK ID FOR THIS FAILURE IS 0280 HEX.      :
                                ;             DUE TO AN ADDRESS FAILURE THE BLOCK ID+128K OVERLAYED   :
                                ;             THE CORRECT BLOCK ID.                                   :
                                ;                                                                     :
                                ;       00640K OK          <-- LAST OK MEMORY                         :
                                ;       10000 0300 202     <-- ERROR DUE TO ADDRESS FAILURE           :
                                ;                                                                     :
                                ; IF A PARITY LATCH WAS SET THE CORRESPONDING MESSAGE WILL DISPLAY.   :
                                ;                                                                     :
                                ;       "PARITY CHECK 1" (OR 2)                                       :
                                ;                                                                     :
                                ; DMA PAGE REGISTERS ARE USED AS TEMPORARY SAVE AREAS FOR SEGMENT     :
                                ; DESCRIPTOR VALUES.                                                  :
                                ;---------------------------------------------------------------------
 03BC                           SHUT3:                                  ;       ENTRY FROM PROCESSOR SHUTDOWN 3
 03BC E8 0000 E                         CALL    DDS                     ; SET REAL MODE DATA SEGMENT

                                                                        ;       <><> MEMORY FAILED  <><>
 03BF C6 06 0016 R 01                   MOV     @MFG_ERR_FLAG+1,MEM_FAIL; CLEAR AND SET MANUFACTURING ERROR FLAG
 03C4 B0 0D                             MOV     AL,CR                   ; CARRIAGE RETURN
 03C6 E8 0000 E                         CALL    PRT_HEX
 03C9 B0 0A                             MOV     AL,LF                   ; LINE FEED
 03CB E8 0000 E                         CALL    PRT_HEX
 03CE E4 84                             IN      AL,DMA_PAGE+3           ; GET THE HIGH BYTE OF 24 BIT ADDRESS
 03D0 E8 0000 E                         CALL    XPC_BYTE                ; CONVERT AND PRINT CODE
 03D3 E4 85                             IN      AL,DMA_PAGE+4           ; GET THE MIDDLE BYTE OF 24 BIT ADDRESS
 03D5 E8 0000 E                         CALL    XPC_BYTE
 03D8 E4 86                             IN      AL,DMA_PAGE+5           ; GET THE LOW BYTE OF 24 BIT ADDRESS
 03DA E8 0000 E                         CALL    XPC_BYTE
 03DD B0 20                             MOV     AL,' '                  ; SPACE TO MESSAGE
 03DF E8 0000 E                         CALL    PRT_HEX
 03E2 E4 83                             IN      AL,DMA_PAGE+2           ; GET HIGH BYTE FAILING BIT PATTERN
 03E4 E8 0000 E                         CALL    XPC_BYTE                ; CONVERT AND PRINT CODE
 03E7 E4 82                             IN      AL,DMA_PAGE+1           ; GET LOW BYTE FAILING BIT PATTERN
 03E9 E8 0000 E                         CALL    XPC_BYTE                ; CONVERT AND PRINT CODE

                                ;-----  CHECK FOR ADDRESS ERROR

 03EC E4 80                             IN      AL,MFG_PORT             ; GET THE CHECKPOINT
 03EE 3C 33                             CMP     AL,33H                  ; IS IT AN ADDRESS FAILURE?
 03F0 BE 0000 E                         MOV     SI,OFFSET E203          ; LOAD ADDRESS ERROR 16->23
 03F3 74 0A                             JZ      ERR2                    ; GO IF YES

 03F5 BE 0000 E                         MOV     SI,OFFSET E202          ; LOAD ADDRESS ERROR 00->15
 03F8 3C 32                             CMP     AL,32H                  ; GO IF YES
 03FA 74 03                             JZ      ERR2

 03FC BE 0000 E                         MOV     SI,OFFSET E201          ; SETUP ADDRESS OF ERROR MESSAGE
 03FF                           ERR2:
 03FF E8 0000 E                         CALL    E_MSG                   ; PRINT ERROR MESSAGE
 0402 E4 88                             IN      AL,DMA_PAGE+7           ; GET THE PORT_B VALUE

                                ;-----  DISPLAY "PARITY CHECK ?" ERROR MESSAGES

 0404 A8 80                             TEST    AL,PARITY_CHECK         ; CHECK FOR PLANAR ERROR
 0406 74 0B                             JZ      NMI_M1                  ; SKIP IF NOT

 0408 50                                PUSH    AX                      ; SAVE STATUS
 0409 E8 098F R                         CALL    PADING                  ; INSERT BLANKS
 040C BE 0000 E                         MOV     SI,OFFSET D1            ; PLANAR ERROR, ADDRESS "PARITY CHECK 1"
 040F E8 0000 E                         CALL    P_MSG                   ; DISPLAY "PARITY CHECK 1" MESSAGE
 0412 58                                POP     AX                      ; AND RECOVER STATUS
 0413                           NMI_M1:
 0413 A8 40                             TEST    AL,IO_CHECK             ; I/O PARITY CHECK ?
 0415 74 09                             JZ      NMI_M2                  ; SKIP IF CORRECT ERROR DISPLAYED

 0417 E8 098F R                         CALL    PADING                  ; INSERT BLANKS
 041A BE 0000 E                         MOV     SI,OFFSET D2            ; ADDRESS OF "PARITY CHECK 2" MESSAGE
 041D E8 0000 E                         CALL    P_MSG                   ; DISPLAY "PARITY CHECK 2" ERROR
 0420                           NMI_M2:
                                                                        ; CONTINUE TESTING SYSTEM ....
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                                PAGE
                                ;----- ENTRY FROM SHUTDOWN

0420                            SHUT2:

                                ;-------------------------------------------------------
                                ; TEST.20                                              :
                                ;       ADDITIONAL PROTECTED (VIRTUAL MODE) TEST       :
                                ; DESCRIPTION                                          :
                                ;       THE PROCESSOR IS PUT IN PROTECTED MODE AND     :
                                ;       THE FOLLOWING FUNCTIONS ARE VERIFIED           :
                                ;                                                      :
                                ;       1. VERIFY PROTECTED MODE                       :
                                ;          THE MACHINE STATUS IS CHECK FOR VIRTUAL MODE :
                                ;       2. PROGRAMMED INTERRUPT TEST                   :
                                ;          AN PROGRAMMED INTERRUPT 32 IS ISSUED AND    :
                                ;          AND VERIFIED                                :
                                ;       3. EXCEPTION INTERRUPT 13 TEST                 :
                                ;          A DESCRIPTOR SEGMENT LIMIT IS SET TO ZERO   :
                                ;          AND A WRITE TO THAT SEGMENT IS ATTEMPTED    :
                                ;          AN EXCEPTION 13 IS EXPECTED AND VERIFIED    :
                                ;       4. LDT/SDT LTR/STR TEST                        :
                                ;          LOAD LDT REGISTER AND VERIFY CORRECT        :
                                ;          LOAD TASK REGISTER AND VERIFY CORRECT       :
                                ;          THEY ARE VERIFIED VIA THE STORE INSTRUCTION :
                                ;       5. THE CONTROL FLAGS OF THE 286 FOR DIRECTION  :
                                ;          ARE VERIFIED VIA THE STD AND CLD COMMANDS   :
                                ;          IN PROTECTED MODE                           :
                                ;       6. BOUND INSTRUCTION TEST (EXCEPTION INT 5)    :
                                ;          CREATE A SIGNED ARRAY INDEX WITHIN AND      :
                                ;          OUTSIDE THE LIMITS.  CHECK THAT NO EXC INT  :
                                ;          IF WITHIN LIMIT AND THAT AN EXC INT 5       :
                                ;          OCCURS IF OUTSIDE THE LIMITS.               :
                                ;       7. PUSH ALL POP ALL TEST                       :
                                ;          SET GENERAL PURPOSE REGISTERS TO DIFFERENT  :
                                ;          VALUES, ISSUE A PUSH ALL, CLEAR THE REGISTERS:
                                ;          THEN ISSUE A POP ALL AND VERIFY CORRECT.    :
                                ;       8. CHECK THE VERR/VERW INSTRUCTIONS            :
                                ;          THE ACCESS BYTE IS SET TO READ ONLY THEN TO :
                                ;          A WRITE ONLY AND THE VERR/VERW INSTRUCTIONS :
                                ;          ARE VERIFIED.                               :
                                ;       9. CAUSE AN INTERRUPT 13 VIA A WRITE TO A      :
                                ;          READ ONLY SEGMENT                           :
                                ;      10. VERIFY THE ARPL INSTRUCTION FUNCTIONS       :
                                ;          SET THE RPL FIELD OF A SELECTOR AND         :
                                ;          VERIFY THAT CURRENT SELECTOR RPL IS SET     :
                                ;          CORRECTLY.                                  :
                                ;      11. VERIFY THE LAR INSTRUCTION FUNCTIONS        :
                                ;      12. VERIFY THE LSL INSTRUCTION FUNCTIONS        :
                                ;      13. LOW MEG CHIP SELECT TEST                    :
                                ;-------------------------------------------------------

0420 E9 0000 E                          JMP     POST3                   ; GO TEST THE 286 PROTECTED MODE

                                ;----- FAILURE ENTRY FROM A SHUTDOWN

0423 E8 0000 E                  SHUT7:  CALL    DDS                     ; ESTABLISH THE DATA SEGMENT
0426 E4 80                              IN      AL,MFG_PORT             ; CHECK FOR CHIP SELECT ERROR
0428 3C 35                              CMP     AL,35H
042A BE 0000 E                          MOV     SI,OFFSET E109          ; PRINT ERROR 109
042D 74 0D                              JZ      SHUT7B                  ; GO IF NOT
042F BE 0000 E                  SHUT7A: MOV     SI,OFFSET E104          ; PROTECTED MODE FAILED

0432 80 0E 0016 R 02                    OR      @MFG_ERR_FLAG+1,PRO_FAIL;       <><><><><><><><><><><><><><><><><>
                                                                        ;       <><> VIRTUAL MODE FAILED  <><>

0437 E8 0000 E                          CALL    E_MSG                   ; PRINT MESSAGE
043A EB 08                              JMP     SHORT SHUT6
043C E8 0000 E                  SHUT7B: CALL    E_MSG                   ; PRINT MESSAGE

043F 80 0E 0016 R 04                    OR      @MFG_ERR_FLAG+1,LMCS_FAIL;      <><><><><><><><><><><><><><><><><>
                                                                        ;       <><> LOW MEG CHIP SELECT  <><>

                                ;----- PROTECTED MODE TEST PASSED ENTRY FROM A SHUTDOWN

0444 E8 0000 E                  SHUT6:  CALL    DDS                     ; PROTECTED MODE TEST PASSED
0447 2B C0                              SUB     AX,AX                   ; CLEAR KEYBOARD STATE FLAGS
0449 A3 0017 R                          MOV     WORD PTR @KB_FLAG,AX
044C B9 000E                            MOV     CX,0EH                  ; CLEAR PAGE REGISTERS
044F BA 0082                            MOV     DX,DMA_PAGE+1
0452                            CLR_LOOP:
0452 2A C0                              SUB     AL,AL
0454 EE                                 OUT     DX,AL
0455 42                                 INC     DX
0456 E2 FA                              LOOP    CLR_LOOP

                                ;----------------------------------------------
                                ; TEST.21                                     :
                                ;       KEYBOARD TEST                         :
                                ; DESCRIPTION                                 :
                                ;       RESET THE KEYBOARD AND CHECK THAT SCAN :
                                ;       CODE "AA" IS RETURNED TO THE PROCESSOR. :
                                ;       CHECK FOR STUCK KEYS.                 :
                                ;----------------------------------------------

0458 B0 35                              MOV     AL,35H                  ;       <><><><><><><><><><><><><><>
045A E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  35 <><>

045C F6 06 0012 R 20                    TEST    @MFG_TST,MFG_LOOP       ; MANUFACTURING BURN IN TEST MODE?
0461 75 03                              JNZ     F7_A
0463 E9 0516 R                          JMP     F7                      ; YES - SKIP KEYBOARD TEST
0466 80 3E 0072 R 64            F7_A:   CMP     BYTE PTR @RESET_FLAG,064H ; MANUFACTURING RUN IN MODE?
046B 75 03                              JNZ     F7_B
046D E9 0516 R                          JMP     F7                      ; YES - SKIP KEYBOARD TEST
0470 B0 36                      F7_B:   MOV     AL,36H                  ;       <><><><><><><><><><><><><><>
0472 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  36 <><>
0474 FA                                 CLI
0475 81 3E 0072 R 1234                  CMP     @RESET_FLAG,1234H       ; SOFT RESET?
047B 74 17                              JZ      G10
047D 80 3E 0072 R AA                    CMP     BYTE PTR @RESET_FLAG,KB_OK ; CHECK FOR AA ALREADY RECEIVED
0482 74 10                              JZ      G10                     ; GO IF YES
0484 B0 AE                              MOV     AL,ENA_KBD
0486 E8 0000 E                          CALL    C8042                   ; ENABLE KEYBOARD
0489 B7 04                              MOV     BH,4                    ; TRY 4 TIMES
```

```
0048B E8 0000 E           LOOP1:  CALL    OBF_42                  ; CHECK FOR OUTPUT BUFFER FULL
048E 75 04                        JNZ     G10                     ; GO IF BUFFER FULL
0490 FE CF                        DEC     BH
0492 75 F7                        JNZ     LOOP1
0494 B0 AD                G10:    MOV     AL,DIS_KBD              ; DISABLE KEYBOARD
0496 E8 0000 E                    CALL    C8042
0499 E4 60                        IN      AL,PORT_A               ; FLUSH
049B B0 E0                        MOV     AL,KYBD_CLK_DATA        ; GET THE CLOCK AND DATA LINES
049D E8 0000 E                    CALL    C8042
04A0 E8 0000 E                    CALL    OBF_42                  ; WAIT FOR OUTPUT BUFFER FULL
04A3 E4 60                        IN      AL,PORT_A               ; GET THE RESULTS
04A5 A8 01                        TEST    AL,KYBD_CLK             ; KEYBOARD CLOCK MUST BE LOW
04A7 74 0A                        JZ      G11

04A9 80 0E 0016 R 08              OR      @MFG_ERR_FLAG+1,KYCLK_FAIL ;    <><><><><><><><><><><><><><>
                                                                  ;       <><> KEYBOARD CLOCK HIGH  <><>
04AE BE 0000 E                    MOV     SI,OFFSET E304          ; DISPLAY 304 ERROR
04B1 EB 60                        JMP     SHORT F6D               ; REPORT ERROR
04B3 E8 0000 E            G11:    CALL    KBD_RESET               ; ISSUE RESET TO KEYBOARD
04B6 E3 29                        JCXZ    F6                      ; PRINT ERROR MESSAGE IF NO INTERRUPT
04B8 B0 37                        MOV     AL,37H                  ;       <><><><><><><><><><><><><>
04BA E6 80                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  37 <><>
04BC 80 FB AA                     CMP     BL,KB_OK                ; SCAN CODE AS EXPECTED?
04BF 75 20                        JNE     F6                      ; NO - DISPLAY ERROR MESSAGE

                          ;-----  CHECK FOR STUCK KEYS

04C1 B0 38                        MOV     AL,38H                  ;       <><><><><><><><><><><><><>
04C3 E6 80                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  38 <><>

04C5 B0 AE                        MOV     AL,ENA_KBD              ; ASSURE KEYBOARD ENABLED
04C7 E8 0000 E                    CALL    C8042                   ; ISSUE THE COMMAND
04CA B9 19E4                      MOV     CX,6628                 ; COUNT FOR 100 MILLISECONDS
04CD E8 0000 E                    CALL    WAITF                   ; DELAY FOR A WHILE
04D0 E4 64                        IN      AL,STATUS_PORT          ; CHECK FOR STUCK KEYS
04D2 A8 01                        TEST    AL,OUT_BUF_FULL         ; OUT BUFFER FULL?
04D4 74 40                        JE      F7                      ; YES - CONTINUE TESTING

04D6 B0 39                        MOV     AL,39H                  ;       <><><><><><><><><><><><><>
04D8 E6 80                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  39 <><>

04DA E4 60                        IN      AL,PORT_A               ; GET THE SCAN CODE
04DC E8 0000 E                    CALL    XPC_BYTE                ; CONVERT AND PRINT
04DF EB 2A                        JMP     SHORT F6C               ; CONTINUE

                          ;-----  KEYBOARD ERROR TRY TO DETERMINE IF 8042 INTERFACE IS WORKING

04E1 FA                   F6:     CLI
04E2 B0 AB                        MOV     AL,INTR_FACE_CK         ; COMMAND TO 8042
04E4 E6 64                        OUT     STATUS_PORT,AL
04E6 2B C9                        SUB     CX,CX
04E8 B7 05                        MOV     BH,05                   ; WAIT FOR OUTPUT BUFFER FULL
04EA E4 64                F6A:    IN      AL,STATUS_PORT
04EC A8 01                        TEST    AL,OUT_BUF_FULL         ; 8042 FINISHED TEST?
04EE E1 FA                        LOOPZ   F6A
04F0 75 09                        JNZ     F6B                     ; GO CHECK RESULTS
04F2 FE CF                        DEC     BH
04F4 75 F4                        JNZ     F6A                     ; TRY AGAIN
04F6 BE 0000 E                    MOV     SI,OFFSET E303          ; INDICATE PLANAR FAILURE
04F9 EB 18                        JMP     SHORT F6D               ;    (REMOVE KEYBOARD TRY AGAIN)
04FB E4 60                F6B:    IN      AL,PORT_A               ; GET THE RESULTS OF INTERFACE TEST
04FD 3C 00                        CMP     AL,0                    ; IS THE INTERFACE OK?
04FF 74 0A                        JZ      F6C
0501 80 0E 0016 R 10              OR      @MFG_ERR_FLAG+1,KY_SYS_FAIL ;   <><><><><><><><><><><><><>
                                                                  ;       <><> KEYBOARD/SYSTEM  <><>
0506 BE 0000 E                    MOV     SI,OFFSET E303          ; PLANAR FAILURE
0509 EB 08                        JMP     SHORT F6D               ; GO IF YES
050B BE 0000 E            F6C:    MOV     SI,OFFSET E301          ; GET MESSAGE ADDRESS

050E 80 0E 0016 R 20              OR      @MFG_ERR_FLAG+1,KYBD_FAIL;      <><><><><><><><><><><><><><>
                                                                  ;       <><> KEYBOARD FAILED  <><>

0513 E8 0000 E            F6D:    CALL    E_MSG                   ; PRINT MESSAGE ON SCREEN

                          ;-----  INITIALIZE 8042 TO HONOR KEY LOCK

0516 B0 3A                F7:     MOV     AL,3AH                  ;       <><><><><><><><><><><><><>
0518 E6 80                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3A <><>

051A B0 FF                        MOV     AL,0FFH                 ; DISABLE INTERRUPTS
051C E6 21                        OUT     INTA01,AL
051E FA                           CLI
051F B0 60                        MOV     AL,WRITE_8042_LOC       ; WRITE 8042 MEMORY COMMAND
0521 E8 0000 E                    CALL    C8042                   ; ISSUE THE COMMAND
0524 B0 45                        MOV     AL,45H                  ; SET SYSTEM FLAG - OUTBUF INTERRUPT -
0526 E6 60                        OUT     PORT_A,AL               ; PC 1 COMPATIBILITY
                                                                  ; RESET INHIBIT OVER RIDE
                          ;-----  DEGATE ADDRESS LINE 20

0528 B4 DD                        MOV     AH,DISABLE_BIT20        ; SET COMMAND IN AH
052A E8 0000 E                    CALL    GATE_A20                ; ISSUE THE COMMAND

                          ;-----  SETUP HARDWARE INTERRUPT VECTOR TABLE LEVEL 0-7

052D 2B C0                        SUB     AX,AX
052F 8E C0                        MOV     ES,AX
0531 B9 0008                      MOV     CX,08                   ; GET VECTOR COUNT
0534 0E                           PUSH    CS                      ; SETUP DS SEGMENT REGISTER
0535 1F                           POP     DS
0536 BE 0000 E                    MOV     SI,OFFSET VECTOR_TABLE
0539 BF 0020 R                    MOV     DI,OFFSET @INT_PTR
053C A5                   F7A:    MOVSW
053D 47                           INC     DI                      ; SKIP OVER SEGMENT
053E 47                           INC     DI
053F E2 FB                        LOOP    F7A

                          ;-----  SETUP HARDWARE INTERRUPT VECTORS LEVEL 8-15 (VECTORS START AT INT 70H)

                                  ASSUME  ES:ABS0
0541 2B C0                        SUB     AX,AX
0543 8E C0                        MOV     ES,AX
0545 B9 0008                      MOV     CX,08                   ; GET VECTOR COUNT
0548 0E                           PUSH    CS                      ; SETUP DS SEGMENT REGISTER
0549 1F                           POP     DS
```

SECTION 5

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 054A BE 0000 E                        MOV     SI,OFFSET SLAVE_VECTOR_TABLE
 054D BF 01C0 R                        MOV     DI,OFFSET @SLAVE_INT_PTR
 0550 A5                      F7A1:    MOVSW
 0551 47                               INC     DI                          ; SKIP OVER SEGMENT
 0552 47                               INC     DI
 0553 E2 FB                            LOOP    F7A1

                              ;-----   SET UP OTHER INTERRUPTS AS NECESSARY

                                       ASSUME  DS:ABS0
 0555 2B C0                            SUB     AX,AX                       ; DS=0
 0557 8E D8                            MOV     DS,AX
 0559 C7 06 0008 R 0000 E              MOV     WORD PTR @NMI_PTR,OFFSET NMI_INT ; NMI INTERRUPT
 055F C7 06 0014 R 0000 E              MOV     WORD PTR @INT5_PTR,OFFSET PRINT_SCREEN    ; PRINT SCREEN
 0565 C7 06 0062 R F600                MOV     WORD PTR @BASIC_PTR+2,0F600H     ; SEGMENT FOR CASSETTE BASIC

                              ;-----   ZERO RESERVED VECTORS

 056B BF 0180                          MOV     DI,60H*4                    ; FILL INTERRUPT 60 THRU 67 WITH ZERO
 056E B9 0010                          MOV     CX,16                       ; CLEAR 16 WORDS
 0571 C7 05 0000              F7A2:    MOV     WORD PTR DS:[DI],0
 0575 83 C7 02                         ADD     DI,2                        ; POINT TO NEXT LOCATION
 0578 E2 F7                            LOOP    F7A2

                              ;-----   SETUP TIMER 0 TO BLINK LED IF MANUFACTURING TEST MODE

                                       ASSUME  DS:DATA
 057A E8 0000 E                        CALL    DDS                         ; ESTABLISH DATA SEGMENT

 057D F6 06 0012 R 20                  TEST    @MFG_TST,MFG_LOOP           ; MFG. TEST MODE?
 0582 75 0B                            JNZ     F9
 0584 26: C7 06 0020 R 0000 E          MOV     WORD PTR ES:@INT_PTR,OFFSET BLINK_INT ; SETUP TIMER TO BLINK LED
 058B B0 FE                            MOV     AL,0FEH                     ; ENABLE TIMER INTERRUPT
 058D E6 21                            OUT     INTA01,AL
 058F FB                      F9:      STI                                 ; ALLOW INTERRUPTS

                              ;-----   ISSUE A RESET TO THE HARD FILE IF SOFT RESET

 0590 81 3E 0072 R 1234                CMP     @RESET_FLAG,1234H           ; SOFT RESET?
 0596 75 0E                            JNZ     F9A                         ; CONTINUE IF NOT
 0598 B9 00FF                          MOV     CX,0FFH
 059B BA 03F6                          MOV     DX,03F6H
 059E B0 04                            MOV     AL,04H                      ; RESET
 05A0 EE                               OUT     DX,AL
 05A1 E2 FE                   F9_A:    LOOP    F9_A                        ; HOLD RESET
 05A3 2A C0                            SUB     AL,AL
 05A5 EE                               OUT     DX,AL                       ; REMOVE RESET

                              ;---------------------------------------------------------------
                              ; TEST.23                                                      :
                              ;        DISKETTE ATTACHMENT TEST                              :
                              ; DESCRIPTION                                                  :
                              ;        CHECK IF IPL DISKETTE DRIVE IS ATTACHED TO SYSTEM.  IF :
                              ;        ATTACHED, VERIFY STATUS OF NEC FDC AFTER A RESET. ISSUE :
                              ;        A RECALIBRATE AND SEEK COMMAND TO FDC AND CHECK STATUS. :
                              ;        COMPLETE SYSTEM INITIALIZATION THEN PASS CONTROL TO THE :
                              ;        BOOT LOADER PROGRAM.                                  :
                              ;---------------------------------------------------------------

 05A6 B0 3C                   F9A:     MOV     AL,3CH                      ;       <><><><><><><><><><><><><>
 05A8 E6 80                            OUT     MFG_PORT,AL                 ;       <><> CHECKPOINT  3C <><>

 05AA B0 02                            MOV     AL,02H                      ; SET DATA RATE TO 250 K BITS PER SECOND
 05AC BA 03F7                          MOV     DX,3F7H
 05AF EE                               OUT     DX,AL
 05B0 F6 06 0010 R 01                  TEST    BYTE PTR @EQUIP_FLAG,1H ; DISKETTE PRESENT?
 05B5 74 55                            JZ      F15
 05B7 F6 06 0012 R 20                  TEST    @MFG_TST,MFG_LOOP           ; MFG JUMPER INSTALLED?
 05BC 74 4E                            JZ      F15                         ; GO IF YES
 05BE                         F10:                                         ; DISK_TEST:
 05BE E4 21                            IN      AL,INTA01
 05C0 EB 00                            JMP     $+2                         ; I/O DELAY
 05C2 24 BF                            AND     AL,0BFH                     ; ENABLE DISKETTE INTERRUPTS
 05C4 E6 21                            OUT     INTA01,AL
 05C6 B4 00                            MOV     AH,0                        ; RESET NEC FDC
 05C8 8A D4                            MOV     DL,AH                       ; SET FOR DRIVE 0
 05CA CD 13                            INT     13H                         ; VERIFY STATUS AFTER RESET
 05CC F6 C4 FF                         TEST    AH,0FFH                     ; STATUS OK?
 05CF 75 25                            JNZ     F13                         ; NO - FDC FAILED

                              ;-----   TURN DRIVE 0 MOTOR ON

 05D1 BA 03F2                          MOV     DX,03F2H                    ; GET ADDRESS OF FDC CARD
 05D4 B0 1C                            MOV     AL,1CH                      ; TURN MOTOR ON, ENABLE DMA, INTERRUPTS
 05D6 EE                               OUT     DX,AL                       ; WRITE FDC CONTROL REGISTER
 05D7 2B C9                            SUB     CX,CX                       ; WAITF COUNT FOR 0.988 SECONDS
 05D9 E8 0000 E                        CALL    WAITF                       ; WAIT 1 SECOND FOR MOTOR

 05DC 33 FF                            XOR     DI,DI                       ; SELECT DRIVE 0
 05DE B5 01                            MOV     CH,1                        ; SELECT TRACK 1
 05E0 C6 06 003E R 00                  MOV     @SEEK_STATUS,0              ; INSURE RECALIBRATE
 05E5 80 0E 00A0 R 01                  OR      @RTC_WAIT_FLAG,01           ; NO REAL TIME CLOCK, USE WAIT LOOP
 05EA E8 0000 E                        CALL    SEEK                        ; RECALIBRATE DISKETTE
 05ED 72 07                            JC      F13                         ; GO TO ERR SUBROUTINE IF ERR
 05EF B5 22                            MOV     CH,34                       ; SELECT TRACK 34
 05F1 E8 0000 E                        CALL    SEEK                        ; SEEK TO TRACK 34
 05F4 73 0B                            JNC     F14                         ; OK, TURN MOTOR OFF
 05F6                         F13:                                         ; DSK_ERR:
 05F6 80 0E 0016 R 40                  OR      @MFG_ERR_FLAG+1,DSK_FAIL;         <><><><><><><><><><><><><>
                                                                           ;         <><> DISKETTE FAILED  <><>
 05FB BE 0000 E                        MOV     SI,OFFSET E601              ; GET ADDRESS OF MESSAGE
 05FE E8 0000 E                        CALL    E_MSG                       ; GO PRINT ERROR MESSAGE

                              ;-----   TURN DRIVE 0 MOTOR OFF

 0601                         F14:                                         ; DR0_OFF:
 0601 80 26 00A0 R FE                  AND     @RTC_WAIT_FLAG,0FEH         ; ALLOW FOR RTC WAIT
 0606 B0 0C                            MOV     AL,0CH                      ; TURN DRIVE 0 MOTOR OFF
 0608 BA 03F2                          MOV     DX,03F2H                    ; FDC CONTROLLER ADDRESS
 060B EE                               OUT     DX,AL

                              ;-----   SETUP KEYBOARD PARAMETERS

 060C C6 06 006B R 00         F15:     MOV     @INTR_FLAG,00H              ; SET STRAY INTERRUPT FLAG = 00
```

```
0611 BE 001E R                     MOV     SI,OFFSET @KB_BUFFER      ; SETUP KEYBOARD PARAMETERS
0614 89 36 001A R                  MOV     @BUFFER_HEAD,SI
0618 89 36 001C R                  MOV     @BUFFER_TAIL,SI
061C 89 36 0080 R                  MOV     @BUFFER_START,SI
0620 83 C6 20                      ADD     SI,32                     ; DEFAULT BUFFER OF 32 BYTES
0623 89 36 0082 R                  MOV     @BUFFER_END,SI

                           ;-----  SET PRINTER TIMEOUT DEFAULT

0627 BF 0078 R                     MOV     DI,OFFSET @PRINT_TIM_OUT; SET DEFAULT PRINTER TIMEOUT
062A 1E                            PUSH    DS
062B 07                            POP     ES
062C B8 1414                       MOV     AX,1414H                  ; DEFAULT=20
062F AB                            STOSW
0630 AB                            STOSW

                           ;-----  SET RS232 DEFAULT

0631 B8 0101                       MOV     AX,0101H                  ; RS232 DEFAULT=01
0634 AB                            STOSW
0635 AB                            STOSW

                           ;-----  ENABLE TIMER INTERRUPTS

0636 E4 21                         IN      AL,INTA01
0638 24 FE                         AND     AL,0FEH                   ; ENABLE TIMER INTERRUPTS
063A EB 00                         JMP     $+2                       ; I/O DELAY
063C E6 21                         OUT     INTA01,AL

                           ;-----  CHECK CMOS BATTERY AND CHECKSUM

063E F6 06 0012 R 20               TEST    @MFG_TST,MFG_LOOP         ; MFG JUMPER?
0643 75 03                         JNZ     B1_OK                     ; GO IF NOT
0645 E9 072E R                     JMP     F15C                      ; BYPASS IF YES
0648                       B1_OK:
0648 B0 8E                         MOV     AL,CMOS_DIAG+NMI          ; ADDRESS DIAGNOSTIC STATUS BYTE
064A E8 0000 E                     CALL    CMOS_READ                 ; READ IT FROM CMOS

064D BE 0000 E                     MOV     SI,OFFSET E161            ; LOAD BAD BATTERY MESSAGE 161
0650 A8 80                         TEST    AL,BAD_BAT                ; BATTERY BAD?
0652 75 07                         JNZ     B1_ER                     ; DISPLAY ERROR IF BAD

0654 BE 0000 E                     MOV     SI,OFFSET E162            ; LOAD CHECKSUM BAD MESSAGE 162
0657 A8 60                         TEST    AL,BAD_CKSUM+BAD_CONFIG ; CHECK FOR CHECKSUM OR NO DISKETTE
0659 74 09                         JZ      C_OK                      ; SKIP AND CONTINUE TESTING CMOS CLOCK
065B                       B1_ER:
065B E8 0000 E                     CALL    E_MSG                     ; ELSE DISPLAY ERROR MESSAGE
065E 81 CD 8000                    OR      BP,08000H                 ; FLAG "SET SYSTEM OPTIONS" DISPLAYED
0662 EB 45                         JMP     SHORT H_OK1A              ; SKIP CLOCK TESTING IF ERROR

                           ;-----  TEST CLOCK UPDATING

0664 B3 04                 C_OK:   MOV     BL,04H                    ; OUTER LOOP COUNT
0666 2B C9                 D_OK:   SUB     CX,CX                     ; INNER LOOP COUNT
0668 B0 8A                 E_OK:   MOV     AL,CMOS_REG_A+NMI         ; GET THE CLOCK UPDATE BYTE
066A E8 0000 E                     CALL    CMOS_READ
066D A8 80                         TEST    AL,80H                    ; CHECK FOR UPDATE IN PROGRESS
066F 75 1B                         JNZ     G_OK                      ; GO IF YES
0671 E2 F5                         LOOP    E_OK                      ; TRY AGAIN
0673 FE CB                         DEC     BL                        ; DEC OUTER LOOP
0675 75 EF                         JNZ     D_OK                      ; TRY AGAIN
0677 BE 0000 E             F_OK:   MOV     SI,OFFSET E163            ; PRINT MESSAGE
067A E8 0000 E                     CALL    E_MSG

                           ;-----  SET CMOS DIAGNOSTIC STATUS TO 04 (CLOCK ERROR)

067D B8 0E8E                       MOV     AX,X*CMOS_DIAG+NMI        ; SET CLOCK ERROR
0680 E8 0000 E                     CALL    CMOS_READ                 ; GET THE CURRENT STATUS
0683 0C 04                         OR      AL,CMOS_CLK_FAIL          ; SET NEW STATUS
0685 86 C4                         XCHG    AL,AH                     ; GET STATUS ADDRESS AND SAVE NEW STATUS
0687 E8 0000 E                     CALL    CMOS_WRITE                ; MOVE NEW DIAGNOSTIC STATUS TO CMOS
068A EB 0E                         JMP     SHORT H_OK                ; CONTINUE

                           ;-----  CHECK CLOCK UPDATE

068C B9 0320               G_OK:   MOV     CX,800                    ; LOOP COUNT
068F B0 8A                 I_OK:   MOV     AL,CMOS_REG_A+NMI         ; CHECK FOR OPPOSITE STATE
0691 E8 0000 E                     CALL    CMOS_READ
0694 A8 80                         TEST    AL,80H
0696 E0 F7                         LOOPNZ  I_OK                      ; TRY AGAIN
0698 E3 DD                         JCXZ    F_OK                      ; PRINT ERROR IF TIMEOUT

                           ;-----  CHECK MEMORY SIZE DETERMINED = CONFIGURATION

069A                       H_OK:
069A B0 8E                         MOV     AL,CMOS_DIAG+NMI          ; GET THE STATUS BYTE
069C E8 0000 E                     CALL    CMOS_READ
069F A8 10                         TEST    AL,W_MEM_SIZE             ; WAS THE CONFIG= MEM_SIZE_DETERMINED?
06A1 74 06                         JZ      H_OKTA                    ; GO IF YES

                           ;-----  MEMORY SIZE ERROR

06A3 BE 0000 E                     MOV     SI,OFFSET E164            ; PRINT SIZE ERROR
06A6 E8 0000 E                     CALL    E_MSG                     ; DISPLAY ERROR

                           ;-----  CHECK FOR CRT ADAPTER ERROR

06A9 80 3E 0015 R 0C       H_OK1A: CMP     @MFG_ERR_FLAG,0CH         ; CHECK FOR MONOCHROME CRT ERROR
06AE BE 0000 E                     MOV     SI,OFFSET E401            ; LOAD MONOCHROME CRT ERROR
06B1 74 0A                         JZ      H_OK1B                    ; GO IF YES

06B3 80 3E 0015 R 0D               CMP     @MFG_ERR_FLAG,0DH         ; CHECK FOR COLOR CRT ADAPTER ERROR
06B8 75 06                         JNZ     J_OK                      ; CONTINUE IF NOT
06BA BE 0000 E                     MOV     SI,OFFSET E501            ; CRT ADAPTER ERROR MESSAGE
06BD                       H_OK1B:
06BD E8 0000 E                     CALL    E_MSG

                           ;-----  CHECK FOR MULTIPLE DATA RATE CAPABILITY

06C0                       J_OK:
06C0 BA 03F1                       MOV     DX,03F1H                  ; D/S/P DIAGNOSTIC REGISTER
06C3 EC                            IN      AL,DX                     ; READ D/S/P TYPE CODE
06C4 24 F8                         AND     AL,11111000B              ; KEEP ONLY UNIQUE CODE FOR D/S/P
06C6 3C 50                         CMP     AL,01010000B              ; D/S/P CARD - MULTIPLE DATA RATE ?
```

SECTION 5

```
06C8 74 46                      JZ      J_OK3                   ; IF SO JUMP

06CA BA 05F7                    MOV     DX,05F7H                ; FIXED DISK DIAGNOSTIC REGISTER
06CD EC                         IN      AL,DX                   ; READ FIXED DISK TYPE CODE
06CE 24 F0                      AND     AL,11110000B            ; KEEP ONLY UNIQUE CODE FOR F/D
06D0 3C A0                      CMP     AL,10100000B            ; FIXED DISK ADAPTER ?
06D2 74 2F                      JZ      J_FAIL                  ; MUST BE COMBO ELSE ERROR

06D4 B3 0F                      MOV     BL,0FH                  ; OUTER LOOP COUNT WAIT FOR BUSY OFF
06D6 2B C9                      SUB     CX,CX
06D8 BA 01F7                    MOV     DX,01F7H                ; HARD FILE STATUS PORT
06DB                    J_OK1:
06DB EC                         IN      AL,DX                   ; GET THE STATUS
06DC A8 80                      TEST    AL,080H                 ; IS THE CONTROLLER BUSY?
06DE 74 0C                      JZ      J_OK2                   ; CONTINUE IF NOT
06E0 E2 F9                      LOOP    J_OK1                   ; TRY AGAIN
06E2 FE CB                      DEC     BL                      ; DECREMENT OUTER LOOP
06E4 75 F5                      JNZ     J_OK1                   ; TRY AGAIN IF NOT ZERO
06E6 24 0C                      AND     AL,0CH                  ; BITS 2 & 3 = 0 IF MULTI DATA CAPABLE
06E8 74 26                      JZ      J_OK3                   ; GO IF YES
06EA EB 17                      JMP     SHORT J_FAIL            ; NO MULTIPLE DATA RATE CAPABILITY
06EC                    J_OK2:
06EC BA 01F4                    MOV     DX,1F4H                 ; VERIFY MULTIPLE DATA RATE CAPABLE
06EF B0 55                      MOV     AL,055H                 ;  WRITE TO THE CYLINDER BYTE
06F1 EE                         OUT     DX,AL
06F2 EB 00                      JMP     $+2                     ; I/O DELAY
06F4 EC                         IN      AL,DX                   ; CHECK DATA WRITTEN = DATA READ
06F5 3C 55                      CMP     AL,055H
06F7 75 0A                      JNZ     J_FAIL                  ; GO IF NOT
06F9 B0 AA                      MOV     AL,0AAH                 ; WRITE ANOTHER PATTERN
06FB EE                         OUT     DX,AL
06FC EB 00                      JMP     $+2                     ; I/O DELAY
06FE EC                         IN      AL,DX
06FF 3C AA                      CMP     AL,0AAH                 ; IS DATA PATTERN THE SAME?
0701 74 0D                      JZ      J_OK3                   ; GO IF SO

0703                    J_FAIL:
0703 80 0E 0016 R 40            OR      @MFG_ERR_FLAG+1,DSK_FAIL;       <><><><><><><><><><><><><>
                                                                ;       <><> DISKETTE FAILED  <><>
0708 BE 0000 E                  MOV     SI,OFFSET E601          ; GET ADDRESS OF MESSAGE
070B E8 0000 E                  CALL    E_MSG                   ; GO PRINT ERROR MESSAGE
070E EB 1E                      JMP     SHORT F15C              ; SKIP SETUP IF ERROR

0710                    J_OK3:
0710 80 0E 008B R 01            OR      @LASTRATE,DUAL          ; TURN ON DSP/COMBO FLAG

                        ;-----  INITIALIZE FLOPPY FOR DRIVE TYPE

0715 B0 3D                      MOV     AL,3DH                  ;       <><><><><><><><><><><><>
0717 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3D <><>
0719 E8 0000 E                  CALL    DSKETTE_SETUP           ; INITIALIZE FLOPPY

                        ;-----  CHECK FOR 2ND DISKETTE DRIVE

071C E8 0000 E                  CALL    DDS                     ; INSURE DATA SEGMENT
071F 8A 26 0091 R               MOV     AH,@DSK_STATE+1         ; GET STATE OF SECOND DRIVE
0723 0A E4                      OR      AH,AH                   ; IS THERE A DRIVE 2 ATTACHED?
0725 74 07                      JZ      F15C                    ; SKIP IF NOT
0727 80 0E 0010 R 40            OR      BYTE PTR @EQUIP_FLAG,40H; ELSE SET SECOND DRIVE INSTALLED
072C B4 FF                      MOV     AH,0FFH                 ; SET TEST MASK FOR DRIVE PRESENT
072E                    F15C:
072E B0 8E                      MOV     AL,CMOS_DIAG+NMI        ; GET THE CMOS DIAGNOSTIC STATUS
0730 E8 0000 E                  CALL    CMOS_READ
0733 A8 C0                      TEST    AL,BAD_BAT+BAD_CKSUM    ; BATTERY/CHECKSUM OK
0735 75 22                      JNZ     ROM_SCAN1               ; BYPASS DISK SETUP IF NOT

0737 B0 90                      MOV     AL,CMOS_DISKETTE+NMI    ; ADDRESS DISKETTE TYPE BYTE
0739 E8 0000 E                  CALL    CMOS_READ               ; GET DISKETTE TYPES
073C 24 0F                      AND     AL,00FH                 ; LOOK AT SECOND DRIVE TYPE DEFINED
073E 3A C4                      CMP     AL,AH                   ; ARE BOTH INDICATORS ZERO
0740 74 07                      JE      F15D                    ; SKIP IF NO SECOND DRIVE

0742 22 C4                      AND     AL,AH                   ; ARE BOTH INDICATORS NON-ZERO
0744 75 03                      JNZ     F15D                    ; SKIP IF DRIVE FOUND AND DEFINED

0746 E8 0000 E                  CALL    CONFIG_BAD              ; SET BAD_CONFIG IN CMOS_DIAG

                        ;-----  INITIALIZE HARD FILE
0749                    F15D:
0749 B0 3E                      MOV     AL,3EH                  ;       <><><><><><><><><><><><>
074B E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3E <><>

074D B0 92                      MOV     AL,CMOS_DISK+NMI        ; INSURE CMOS DEFINES TYPE OF FIXED DISK
074F E8 0000 E                  CALL    CMOS_READ
0752 3C 00                      CMP     AL,0H                   ; INSURE TYPE IS DEFINED
0754 74 03                      JZ      ROM_SCAN1               ; BYPASS DISK SETUP IF NOT

0756 E8 0000 E                  CALL    DISK_SETUP              ; INITIALIZE HARD FILE(S)


                        ;--------------------------------------------------------
                        ; TEST.22                                               :
                        ; CHECK FOR OPTIONAL ROM FROM C800->E000 IN 2K BLOCKS   :
                        ;       (A VALID MODULE HAS '55AA' IN THE FIRST 2 LOCATIONS:
                        ;       LENGTH INDICATOR (LENGTH/512) IN THE 3RD LOCATION  :
                        ;       AND TEST/INIT. CODE STARTING IN THE 4TH LOCATION)  :
                        ;--------------------------------------------------------
0759                    ROM_SCAN1:
0759 FB                         STI                             ; ALLOW INTERRUPTS
075A B0 3B                      MOV     AL,3BH                  ;       <><><><><><><><><><><><>
075C E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3B <><>
075E E8 0000 E                  CALL    DDS                     ; SET REAL MODE DATA SEGMENT
0761 B0 0A                      MOV     AL,10                   ; LINE FEED ON DISPLAY
0763 E8 0000 E                  CALL    PRT_HEX
0766                    ROM_SCAN:

                        ;-----  SET DMA MASK AND REQUEST REGISTERS

0766 2A C0                      SUB     AL,AL
0768 E6 D2                      OUT     DMA18+2,AL              ; SEND ZERO TO MASK REGISTER
076A EB 00                      JMP     $+2
076C E6 D4                      OUT     DMA18+4,AL              ; SEND ZERO TO REQUEST REGISTER
076E BA C800                    MOV     DX,0C800H               ; SET BEGINNING ADDRESS
0771                    ROM_SCAN2:
0771 8E DA                      MOV     DS,DX
```

```
0773 57                         PUSH    DI                      ; SAVE WORK REGISTER
0774 BF AA55                    MOV     DI,0AA55H               ; GET TEST PATTERN
0777 2B DB                      SUB     BX,BX                   ; SET BX=0000
0779 8B 07                      MOV     AX,[BX]                 ; GET 1ST WORD FROM MODULE
077B 3B C7                      CMP     AX,DI                   ; = TO ID WORD?
077D 5F                         POP     DI                      ; RECOVER WORK REGISTER
077E 75 05                      JNZ     NEXT_ROM                ; PROCEED TO NEXT ROM IF NOT
0780 E8 0000 E                  CALL    ROM_CHECK               ; GO CHECK OUT MODULE
0783 EB 04                      JMP     SHORT ARE_WE_DONE       ; CHECK FOR END OF ROM SPACE
0785                    NEXT_ROM:
0785 81 C2 0080                 ADD     DX,0080H                ; POINT TO NEXT 2K ADDRESS
0789                    ARE_WE_DONE:
0789 81 FA E000                 CMP     DX,0E000H               ; AT E0000 YET?
078D 7C E2                      JL      ROM_SCAN2               ; GO CHECK ANOTHER ADD. IF NOT

                        ;-----  TEST FOR KEYBOARD LOCKED

078F E8 0000 E                  CALL    DDS                     ; SET DATA SEGMENT
0792 E4 64                      IN      AL,STATUS_PORT          ; IS KEYBOARD UNLOCKED?
0794 24 10                      AND     AL,KYBD_INH
0796 74 02                      JZ      KEY1                    ; NO - SET ERROR FLAGS AND PRINT MESSAGE
0798 EB 0B                      JMP     SHORT KEY10             ; GO IF OFF
079A                    KEY1:
079A 80 0E 0016 R 80            OR      @MFG_ERR_FLAG+1,KEY_FAIL;       <><><><><><><><><><><><><><>
                                                                ;       <><> KEYBOARD IS LOCKED <><>
                                ASSUME  DS:DATA
079F BE 0000 E                  MOV     SI,OFFSET E302          ; PRINT LOCKED MESSAGE  (302)
07A2 E8 0000 E                  CALL    E_MSG
07A5                    KEY10:
                                ;====================
                        ;-----   SETUP @PRINTER_BASE
                                ;====================

07A5 BF 09D5 R                  MOV     DI,OFFSET F4            ; OFFSET OF PRINTER ADDRESS TABLE
07A8 BE 0000                    MOV     SI,0
07AB                    F16:
07AB 2E: 8B 15                  MOV     DX,CS:[DI]              ; GET PRINTER BASE ADDRESS
07AE B0 AA                      MOV     AL,0AAH                 ; WRITE DATA TO PORT A
07B0 EE                         OUT     DX,AL
07B1 EB 00                      JMP     $+2                     ; I/O DELAY
07B3 1E                         PUSH    DS                      ; BUS SETTLING
07B4 EC                         IN      AL,DX                   ; READ PORT A
07B5 1F                         POP     DS
07B6 3C AA                      CMP     AL,0AAH                 ; DATA PATTERN SAME
07B8 75 06                      JNE     F17                     ; NO - CHECK NEXT PRINTER CARD
07BA 89 94 0008 R               MOV     @PRINTER_BASE[SI],DX    ; YES - STORE PRINTER BASE ADDRESS
07BE 46                         INC     SI                      ; INCREMENT TO NEXT WORD
07BF 46                         INC     SI
07C0                    F17:
07C0 47                         INC     DI                      ; POINT TO NEXT BASE ADDRESS
07C1 47                         INC     DI
07C2 81 FF 09DB R               CMP     DI,OFFSET F4E           ; ALL POSSIBLE ADDRESSES CHECKED?
07C6 75 E3                      JNE     F16                     ; PRT_BASE
                                ;=============
                        ;-----  SETUP RS232
                                ;=============
07C8 BB 0000                    MOV     BX,0                    ; POINTER TO RS232 TABLE
07CB BA 03FA                    MOV     DX,3FAH                 ; CHECK IF RS232 CARD 1 ATTACHED ?
07CE EC                         IN      AL,DX                   ; READ INTERRUPT ID REGISTER
07CF A8 F8                      TEST    AL,0F8H
07D1 75 08                      JNZ     F18
07D3 C7 87 0000 R 03F8          MOV     @RS232_BASE[BX],3F8H    ; SETUP RS232 CARD #1 ADDRESS
07D9 43                         INC     BX
07DA 43                         INC     BX
07DB BA 02FA            F18:    MOV     DX,2FAH                 ; CHECK IF RS232 CARD 2 ATTACHED
07DE EC                         IN      AL,DX                   ; READ INTERRUPT ID REGISTER
07DF A8 F8                      TEST    AL,0F8H
07E1 75 08                      JNZ     F19                     ; BASE_END
07E3 C7 87 0000 R 02F8          MOV     @RS232_BASE[BX],2F8H    ; SETUP RS232 CARD #2
07E9 43                         INC     BX
07EA 43                         INC     BX
                                ;==============================================================
                        ;-----  SET UP @EQUIP_FLAG TO INDICATE NUMBER OF PRINTERS AND RS232 CARDS
                                ;==============================================================
07EB                    F19:                                    ; BASE_END:
07EB 8B C6                      MOV     AX,SI                   ; SI HAS 2* NUMBER OF RS232
07ED B1 03                      MOV     CL,3                    ; SHIFT COUNT
07EF D2 C8                      ROR     AL,CL                   ; ROTATE RIGHT 3 POSITIONS
07F1 0A C3                      OR      AL,BL                   ; OR IN THE PRINTER COUNT
07F3 A2 0011 R                  MOV     BYTE PTR @EQUIP_FLAG+1,AL       ; STORE AS SECOND BYTE

                        ;-----  INSURE CMOS CLOCK HAS VALID HOURS.MINUTES.SECONDS

07F6 E8 0000 E                  CALL    SET_TOD                 ; INSURE CMOS CLOCK IS VALID

                        ;-----  ENABLE HARDWARE INTERRUPT IF MATH PROCESSOR (80287)

07F9 B0 40                      MOV     AL,40H                  ;       <><><><><><><><><><><><>
07FB E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  40 <><>

07FD BF 0067 R                  MOV     DI,OFFSET @IO_ROM_INIT  ; ADDRESS WORK STORAGE LOCATION
0800 33 C0                      XOR     AX,AX                   ; CLEAR WORK REGISTER  (AH)= 0 (NO 287)
0802 89 05                      MOV     WORD PTR [DI],AX        ; CLEAR THE WORK LOCATION
0804 DB E3                      FNINIT                          ; INITIALIZE THE 80287 WITH NO WAIT
0806 EB 00                      JMP     $+2                     ; DELAY
0808 D9 3D                      FNSTCW  WORD PTR [DI]           ; WRITE THE CURRENT 80287 CONTROL WORD
080A 60                         PUSHA                           ; TIME FOR 80287 TO RESPOND
080B 61                         POPA
080C 81 25 1F3F                 AND     WORD PTR [DI],01F3FH    ; CLEAR UNUSED 80287 BITS
0810 81 3D 033F                 CMP     WORD PTR [DI],0033FH    ; IS THE 80287 INSTALLED?
0814 75 13                      JNE     NO_287                  ; GO IF MATH PROCESSOR IS NOT INSTALLED

0816 9B DD 3D                   FSTSW   WORD PTR [DI]           ; STORE THE STATUS WORD (WITH WAIT)
0819 60                         PUSHA                           ; TIME FOR 80287 TO RESPOND
081A 61                         POPA
081B F7 05 B8BF                 TEST    WORD PTR [DI],0B8BFH    ; ALL BITS SHOULD BE OFF (OR ERROR)
081F 75 08                      JNZ     NO_287                  ; GO IF NOT INSTALLED

0821 E4 A1                      IN      AL,INTB01               ; GET THE SLAVE INTERRUPT MASK
0823 24 DF                      AND     AL,0DFH                 ; ENABLE 80287 INTERRUPTS
0825 B4 02                      MOV     AH,002H                 ; SET WORK REGISTER FOR 80287 FOUND
0827 E6 A1                      OUT     INTB01,AL
0829                    NO_287:
0829 A0 0010 R                  MOV     AL,BYTE PTR @EQUIP_FLAG ; GET LOW EQUIPMENT FLAG
```

SECTION 5

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082C 24 02                      AND     AL,002H                 ; STRIP OFF OTHER BITS
082E 3A C4                      CMP     AL,AH                   ; DOES CMOS MATCH HARDWARE ?
0830 74 08                      JE      OK_287                  ; SKIP IF EQUIPMENT FLAG CORRECT
0832 80 36 0010 R 02            XOR     BYTE PTR @EQUIP_FLAG,2H ; ELSE SET 80287 BIT TO CORRECT VALUE
0837 E8 0000 E                  CALL    CONFIG_BAD              ; AND SET THE CONFIGURATION ERROR FLAG
083A                    OK_287:
                        ;-----  SET KEYBOARD STATE FLAGS
083A C7 06 0017 R 0000          MOV     WORD PTR @KB_FLAG,0     ; RESET ALL KEYBOARD STATUS FLAGS
                        ;-----  ENABLE KEYBOARD/TIMER INTERRUPTS
0840 E4 21                      IN      AL,INTA01
0842 24 FC                      AND     AL,0FCH                 ; ENABLE TIMER AND KEYBOARD INTERRUPTS
0844 EB 00                      JMP     $+2                     ; I/O DELAY
0846 E6 21                      OUT     INTA01,AL
0848 C6 06 0015 R 00            MOV     @MFG_ERR_FLAG,0         ; CLEAR MFG ERROR FLAG
                        ;-----  READ KEYBOARD ID TO INITIALIZE KEYBOARD TYPE AND NUM LOCK STATE
084D C6 06 0096 R A0            MOV     @KB_FLAG_3,RD_ID+SET_NUM_LK     ; SET READ ID COMMAND FOR KBX
0852 B0 F2                      MOV     AL,KB_READ_ID           ; GET THIS SYSTEMS KEYBOARD ID REQUEST
0854 E8 0000 E                  CALL    SND_DATA                ; USE KEYBOARD TRANSMISSION ROUTINE
0857 B9 067A                    MOV     CX,1658                 ; SET DELAY COUNT TO 25 MILLISECONDS
085A E8 0000 E                  CALL    WAITF                   ; WAIT FOR READ ID RESPONSE (20 MS)
085D 80 26 0096 R 1F            AND     @KB_FLAG_3,NOT RD_ID+LC_AB+SET_NUM_LK   ; RESET READ ID COMMAND
                        ;-----  CHECK FOR SECOND FIXED DISK PRESENT BUT NOT DEFINED
0862 80 3E 0075 R 02            CMP     @HF_NUM,2               ; CHECK FOR TWO DRIVES DEFINED BY CMOS
0867 74 13                      JE      F15G                    ; SKIP TEST IF TWO DRIVES DEFINED
0869 B4 10                      MOV     AH,010H                 ; GET TEST DRIVE READY COMMAND
086B B2 81                      MOV     DL,081H                 ; POINT TO SECOND FIXED DISK
086D FE 06 0075 R               INC     @HF_NUM                 ; TELL BIOS IT HAS TWO DRIVES
0871 CD 13                      INT     13H                     ; CHECK READY THROUGH BIOS
0873 FE 0E 0075 R               DEC     @HF_NUM                 ; RESTORE CORRECT COUNT (RETAIN CY)
0877 72 03                      JC      F15G                    ; SKIP IF SECOND DRIVE NOT READY
                                                                ;   SECOND DRIVE NOT DEFINED
0879 E8 0000 E                  CALL    CONFIG_BAD              ; SET CONFIGURATION BAD
087C                    F15G:
                        ;----------------------------------------
                        ;  TEST FOR ANY ERRORS (BP NOT ZERO)   :
                        ;----------------------------------------
087C 0B ED                      OR      BP,BP                   ; CHECK (BP)= NON-ZERO  (ERROR HAPPENED)
087E 74 55                      JE      F15A_0                  ; SKIP PAUSE IF NO ERROR
0880 80 3E 0072 R 64            CMP     BYTE PTR @RESET_FLAG,64H; MFG RUN IN MODE?
0885 BA 0002                    MOV     DX,2                    ; 2 SHORT BEEP COUNT FOR ERROR(S)
0888 75 0E                      JNZ     ERR_WAIT                ; GO IF NOT
                        ;-----  MFG RUN IN MODE -> SET ERROR FLAG
088A C6 06 0015 R AA            MOV     @MFG_ERR_FLAG,0AAH      ; INDICATE ERROR
088F E4 64                      IN      AL,STATUS_PORT          ; CHECK KEY LOCK STATUS
0891 24 10                      AND     AL,KYBD_INH             ; IS THE KEYBOARD LOCKED
0893 75 40                      JNZ     F15A_0                  ; CONTINUE MFG MODE IF NOT LOCKED
                                                                ; ELSE
0895 BA 0005                    MOV     DX,5                    ; 5 SHORT BEEPS FOR MFG SETUP ERROR
0898                    ERR_WAIT:
0898 E8 0000 E                  CALL    ERR_BEEP                ; BEEPS FOR ERROR(S)
089B B0 0E                      MOV     AL,CMOS_DIAG            ; ADDRESS CMOS
089D E8 0000 E                  CALL    CMOS_READ               ; GET THE DIAGNOSTIC STATUS BYTE
08A0 A8 20                      TEST    AL,BAD_CONFIG           ; CHECK FOR BAD HARDWARE CONFIGURATION
08A2 74 0C                      JZ      ERR_WKEY                ; SKIP IF NOT SET
08A4 F7 C5 8000                 TEST    BP,08000H               ; ELSE CHECK FOR E161/E162 POSTED
08A8 75 06                      JNZ     ERR_WKEY                ; SKIP IF DISPLAYED BEFORE NOW
08AA BE 0000 E                  MOV     SI,OFFSET E162          ; ELSE DISPLAY "OPTIONS NOT SET"
08AD E8 0000 E                  CALL    P_MSG                   ; WITH NON HALTING ROUTINE
                        ;-----  CHECK FOR "UNLOCK SYSTEM UNIT KEYLOCK" MESSAGE REQUIRED
08B0                    ERR_WKEY:
08B0 E4 64                      IN      AL,STATUS_PORT          ; CHECK IF RESUME MESSAGE NEEDED
08B2 24 10                      AND     AL,KYBD_INH             ; IS THE KEYBOARD LOCKED
08B4 75 06                      JNZ     ERR_WAIT2               ; SKIP LOCK MESSAGE IF NOT
08B6 BE 0000 E                  MOV     SI,OFFSET F3D1          ; ERROR MESSAGE FOR KEYBOARD LOCKED
08B9 E8 0000 E                  CALL    P_MSG
                        ;-----  DISPLAY '(RESUME = "F1" KEY)' FOR ERRORS
08BC                    ERR_WAIT2:
08BC BE 0000 E                  MOV     SI,OFFSET F3D           ; RESUME ERROR MESSAGE
08BF E8 0000 E                  CALL    P_MSG
                        ;-----  INITIALIZE PRINTER  (ALTERNATE DISPLAY DEVICE)
08C2 B4 01                      MOV     AH,1                    ;
08C4 2B D2                      SUB     DX,DX                   ; FIRST PRINTER
08C6 CD 17                      INT     17H                     ;
08C8                    ERR_WAIT1:
08C8 B0 3F                      MOV     AL,3FH                  ;       <><><><><><><><><><><><><>
08CA E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3F <><>
08CC B4 00                      MOV     AH,00
08CE CD 16                      INT     16H                     ; WAIT FOR 'F1' KEY
08D0 80 FC 3B                   CMP     AH,3BH
08D3 75 F3                      JNE     ERR_WAIT1
08D5                    F15A_0:
08D5 F6 06 0012 R 20            TEST    @MFG_TST,MFG_LOOP       ; MFG BURN IN MODE
08DA 75 03                      JNZ     F15A                    ; GO IF NOT
08DC E9 0000 E                  JMP     START_1                 ; GO LOOP POST
08DF 80 3E 0072 R 64    F15A:   CMP     BYTE PTR @RESET_FLAG,64H; MFG RUN IN?
08E4 74 06                      JZ      F15B                    ; BYPASS BEEP IF YES
08E6 BA 0001                    MOV     DX,1                    ; 1 SHORT BEEP (NO ERRORS)
08E9 E8 0000 E                  CALL    ERR_BEEP
                                ;===============
                        ;-----  SET TIME OF DAY
                                ;===============
```

```
08EC E8 0000 E          F15B:   CALL    SET_TOD

                        ;-----  CLEAR DISPLAY SCREEN

08EF 2A E4                      SUB     AH,AH                   ; CLEAR FLAGS
08F1 A0 0049 R                  MOV     AL,@CRT_MODE
08F4 CD 10                      INT     10H                     ; CLEAR SCREEN

                        ;-----  CLEAR DESCRIPTOR TABLES

08F6 B9 01F4            F20:    MOV     CX,0500                 ; CLEAR 1K
08F9 BF D0A0                    MOV     DI,SYS_IDT_LOC          ; POINT ES TO START OF DESCRIPTORS
08FC 2B C0                      SUB     AX,AX
08FE 8E C0                      MOV     ES,AX
0900 26: 89 05          F20_A:  MOV     ES:[DI],AX              ; CLEAR
0903 83 C7 02                   ADD     DI,2                    ; POINT TO NEXT LOCATION
0906 E2 F8                      LOOP    F20_A                   ; CONTINUE TILL DONE

                        ;-----  SET POST SYSTEM STACK

0908 B8 ---- R                  MOV     AX,ABS0                 ; GET THE POST STACK SEGMENT
090B 8E D0                      MOV     SS,AX
090D BC 0400 R                  MOV     SP,OFFSET @TOS

                        ;-----  ENSURE THAT MASTER LEVEL 2 ENABLED

0910 E4 21                      IN      AL,INTA01               ; GET THE CURRENT MASK
0912 24 FB                      AND     AL,0FBH
0914 EB 00                      JMP     $+2                     ; I/O DELAY
0916 E6 21                      OUT     INTA01,AL

                        ;-----  TEST FOR MFG RUN-IN TEST

0918 80 3E 0072 R 64            CMP     BYTE PTR @RESET_FLAG,64H; IS THE THE MFG RUN-IN TEST?
091D 75 02                      JNZ     END_287                 ; GO IF NOT
091F EB 5C                      JMP     SHORT SHUT4             ; BOOT LOAD IF YES

                        ;-----  UNMASK SLAVE HARDWARE INTERRUPT 9 (LEVEL 71)
0921                    END_287:
0921 E4 A1                      IN      AL,INTB01               ; GET THE CURRENT MASK
0923 24 FD                      AND     AL,0FDH
0925 EB 00                      JMP     $+2                     ; I/O DELAY
0927 E6 A1                      OUT     INTB01,AL               ; SET NEW MASK

                        ;---------------------------------------------------------------
                        ; TEST FOR SYSTEM CODE AT SEGMENT E000:0
                        ;    FIRST WORD = AA55H
                        ;    LAST BYTE = CHECKSUM
                        ;    ENTRY POINT = FIRST BYTE + 3
                        ; IF TEST IS SUCCESSFUL A CALL FAR TO THE ENTRY POINT IS EXECUTED
                        ;---------------------------------------------------------------
0929 B0 41                      MOV     AL,41H                  ;       <><><><><><><><><><><><><>
092B E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  41 <><>

092D B0 8D                      MOV     AL,CMOS_REG_D+NMI       ; INSURE NMI OFF AND CMOS AT DEFAULT
092F E6 70                      OUT     CMOS_PORT,AL

                        ENDIF

0931 C6 06 0072 R 00            MOV     BYTE PTR @RESET_FLAG,0  ; CLEAR FLAG
0936 B8 E000                    MOV     AX,0E000H               ; SEGMENT OF SYSTEM CODE
0939 8E C0                      MOV     ES,AX
093B 2B FF                      SUB     DI,DI
093D 26: 8B 05                  MOV     AX,ES:[DI]              ; CHECK FOR AA55
0940 53                         PUSH    BX                      ; BUS SETTLE
0941 5B                         POP     BX
0942 3D AA55                    CMP     AX,0AA55H
0945 9C                         PUSHF                           ; SAVE FLAGS
0946 26: 89 05                  MOV     ES:[DI],AX              ; CLEAR POSSIBLE PARITY CHECK
0949 E4 61                      IN      AL,PORT_B
094B 0C 0C                      OR      AL,RAM_PAR_OFF          ; TOGGLE I/O-PARITY CHECK ENABLES
094D E6 61                      OUT     PORT_B,AL
094F 24 F3                      AND     AL,RAM_PAR_ON
0951 E6 61                      OUT     PORT_B,AL
0953 9D                         POPF                            ; RESTORE FLAGS
0954 75 27                      JNZ     SHUT4                   ; CONTINUE

                        ;-----  CHECKSUM SYSTEM CODE

0956 1E                         PUSH    DS
0957 06                         PUSH    ES                      ; SET SEGMENT TO TEST
0958 1F                         POP     DS
0959 2B DB                      SUB     BX,BX                   ; STARTING OFFSET
095B E8 0000 E                  CALL    ROM_CHECKSUM
095E 1F                         POP     DS                      ; RESTORE DATA SEGMENT
095F 75 1C                      JNZ     SHUT4                   ; GO IF CHECKSUM NOT OK

                        ;-----  ENABLE NMI AND I/O-MEMORY PARITY CHECKS

0961 B0 0D                      MOV     AL,CMOS_REG_D           ; ENABLE NMI AND SET DEFAULT ADDRESS
0963 E6 70                      OUT     CMOS_PORT,AL

0965 E4 61                      IN      AL,PORT_B               ; ENABLE PARITY
0967 24 F3                      AND     AL,RAM_PAR_ON           ; ENABLE MEMORY PARITY CHECK / I/O CHECK
0969 E6 61                      OUT     PORT_B,AL

096B C7 06 0067 R 0003          MOV     @IO_ROM_INIT,0003H      ; SET THE OFFSET
0971 8C 06 0069 R               MOV     @IO_ROM_SEG,ES          ; SET THE SEGMENT

0975 B0 42                      MOV     AL,42H                  ;       <><><><><><><><><><><><><>
0977 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  42 <><>

                        ;-----  EXIT TO SYSTEM CODE

0979 FF 1E 0067 R               CALL    DWORD PTR @IO_ROM_INIT  ; GO TO SYSTEM CODE
                                                                ; VIA CALL THROUGH DATA AREA LOCATION

                        ;-----  ENABLE NMI INTERRUPTS + ENTRY FROM SHUTDOWN WITH BOOT REQUEST

097D B0 0D              SHUT4:  MOV     AL,CMOS_REG_D           ; ENABLE NMI AND SET DEFAULT ADDRESS
097F E6 70                      OUT     CMOS_PORT,AL
0981 E4 61                      IN      AL,PORT_B               ; ENABLE PARITY
0983 24 F3                      AND     AL,RAM_PAR_ON           ; ENABLE MEMORY PARITY CHECK / I/O CHECK
```

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0985 E6 61                          OUT     PORT_B,AL

0987 B0 43                          MOV     AL,43H                  ;       <><><><><><><><><><><><><><>
0989 E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  43 <><>
098B FB                             STI                             ; ENABLE INTERRUPTS IF DISABLED

098C CD 19                          INT     19H                     ; GO TO BOOT LOADER

098E F4                             HLT



098F                        PADING  PROC    NEAR                    ;       INSERT PADDING
098F B9 000F                        MOV     CX,15                   ; GET BLANK CHARACTER COUNT
0992                        PAD1:
0992 B0 20                          MOV     AL,' '                  ; GET FILL SPACE
0994 E8 0000 E                      CALL    PRT_HEX                 ; WRITE A SPACE
0997 E2 F9                          LOOP    PAD1                    ; LOOP TILL INSERT DONE
0999 B0 2D                          MOV     AL,'-'                  ; GET DASH CHARACTER
099B E8 0000 E                      CALL    PRT_HEX                 ; WRITE TO DISPLAY
099E C3                             RET
099F                        PADING  ENDP


099F                        PRT_OK  PROC    NEAR                    ;       PRINT "00000 KB OK"
099F 50                             PUSH    AX                      ; SAVE WORK REGISTER
09A0 BB 000A                        MOV     BX,10                   ; SET DECIMAL CONVERT

                            ;-----  CONVERT AND SAVE

09A3 B9 0005                        MOV     CX,5                    ; OF 5 NIBBLES XX,XXX KB
09A6 2B FF                          SUB     DI,DI                   ; DISPLAY REGEN BUFFER POSITION
09A8                        PRT_DIV:
09A8 33 D2                          XOR     DX,DX
09AA F7 F3                          DIV     BX                      ; DIVIDE BY 10
09AC 80 CA 30                       OR      DL,30H                  ; MAKE INTO ASCII
09AF 52                             PUSH    DX                      ; SAVE
09B0 E2 F6                          LOOP    PRT_DIV

                            ;-----  DISPLAY LAST OK MEMORY

09B2 B9 0005                        MOV     CX,5
09B5                        PRT_DEC:
09B5 58                             POP     AX                      ; RECOVER A NUMBER
09B6 E8 0000 E                      CALL    PROT_PRT_HEX
09B9 47                             INC     DI                      ; POINT TO DISPLAY REGEN BUFFER
09BA E2 F9                          LOOP    PRT_DEC
09BC B9 0007                        MOV     CX,OFFSET F3B_PAD-OFFSET F3B    ; LOAD MESSAGE LENGTH
09BF BE 09CE R                      MOV     SI,OFFSET F3B           ; POINT TO PRINT ' KB OK',' ' MESSAGE
09C2                        PRT_LOOP:
09C2 2E: 8A 04                      MOV     AL,CS:[SI]
09C5 46                             INC     SI
09C6 E8 0000 E                      CALL    PROT_PRT_HEX
09C9 47                             INC     DI                      ; INCREMENT BUFF PTR
09CA E2 F6                          LOOP    PRT_LOOP
09CC 58                             POP     AX                      ; RECOVER WORK REGISTERS
09CD C3                             RET

09CE 20 4B 42 20 4F 4B      F3B     DB      ' KB OK'                ; OK MESSAGE
09D4 20                     F3B_OK  DB      ' '                     ; PAD A SPACE
= 09D5                      F3B_PAD EQU     $
                            .LIST
09D5                        PRT_OK  ENDP


                            ;-----------------------
                            ;       PRINTER TABLE   :
                            ;-----------------------

09D5 03BC                   F4      DW      03BCH                   ; ADDRESS OF MONOCHROME PARALLEL ADAPTER
09D7 0378                           DW      0378H                   ; BASE ADDRESS STANDARD PARALLEL ADAPTER
09D9 0278                           DW      0278H                   ; ADDRESS OF ALTERNATE PARALLEL ADAPTER
09DB                        F4E     LABEL   WORD

09DB                        POST2   ENDP
09DB                        CODE    ENDS
                                    END
```

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                                PAGE 118,121
                                TITLE TEST3 ---- 06/10/85  POST EXCEPTION INTERRUPT TESTS
                                .286C
                                .LIST
                                ;--------------------------------------------------------
                                ; TEST.20                                               :
                                ;       ADDITIONAL PROTECTED (VIRTUAL MODE) TEST        :
                                ; DESCRIPTION                                           :
                                ;       THE PROCESSOR IS PUT IN PROTECTED MODE AND      :
                                ;       THE FOLLOWING FUNCTIONS ARE VERIFIED            :
                                ;                                                       :
                                ;       1. VERIFY PROTECTED MODE                        :
                                ;          THE MACHINE STATUS IS CHECK FOR VIRTUAL MODE :
                                ;       2. PROGRAMMED INTERRUPT TEST                    :
                                ;          AN PROGRAMMED INTERRUPT 32 IS ISSUED AND     :
                                ;          AND VERIFIED                                 :
                                ;       3. EXCEPTION INTERRUPT 13 TEST                  :
                                ;          A DESCRIPTOR SEGMENT LIMIT IS SET TO ZERO    :
                                ;          AND A WRITE TO THAT SEGMENT IS ATTEMPTED     :
                                ;          AN EXCEPTION 13 IS EXPECTED AND VERIFIED     :
                                ;       4. LDT/SDT LTR/STR TEST                         :
                                ;          LOAD LDT REGISTER AND VERIFY CORRECT         :
                                ;          LOAD TASK REGISTER AND VERIFY CORRECT        :
                                ;          THEY ARE VERIFIED VIA THE STORE INSTRUCTION  :
                                ;       5. THE CONTROL FLAGS OF THE 286 FOR DIRECTION   :
                                ;          ARE VERIFIED VIA THE STD AND CLD COMMANDS    :
                                ;          IN PROTECTED MODE                            :
                                ;       6. BOUND INSTRUCTION TEST (EXCEPTION INT 5)     :
                                ;          CREATE A SIGNED ARRAY INDEX WITHIN AND       :
                                ;          OUTSIDE THE LIMITS.  CHECK THAT NO EXC INT   :
                                ;          IF WITHIN LIMIT AND THAT AN EXC INT 5        :
                                ;          OCCURS IF OUTSIDE THE LIMITS.                :
                                ;       7. PUSH ALL POP ALL TEST                        :
                                ;          SET GENERAL PURPOSE REGISTERS TO DIFFERENT   :
                                ;          VALUES ISSUE A PUSH ALL, CLEAR THE REGISTERS :
                                ;          ISSUE A POP ALL AND VERIFY CORRECT.          :
                                ;       8. CHECK THE VERR/VERW INSTRUCTIONS             :
                                ;          THE ACCESS BYTE IS SET TO READ ONLY THEN TO  :
                                ;          A WRITE ONLY AND THE VERR/VERW INSTRUCTIONS  :
                                ;          ARE VERIFIED.                                :
                                ;       9. CAUSE AN INTERRUPT 13 VIA A WRITE TO A       :
                                ;          READ ONLY SEGMENT                            :
                                ;      10. VERIFY THE ARPL INSTRUCTION FUNCTIONS        :
                                ;          SET THE RPL FIELD OF A SELECTOR AND          :
                                ;          VERIFY THAT CURRENT SELECTOR RPL IS SET      :
                                ;          CORRECTLY.                                   :
                                ;      11. VERIFY THE LAR INSTRUCTION FUNCTIONS         :
                                ;      12. VERIFY THE LSL INSTRUCTION FUNCTIONS         :
                                ;      13. LOW MEG CHIP SELECT TEST                     :
                                ;--------------------------------------------------------
 0000                           CODE    SEGMENT BYTE PUBLIC
                                        PUBLIC  POST3
                                        EXTRN   CMOS_WRITE:NEAR
                                        EXTRN   DDS:NEAR
                                        EXTRN   PROC_SHUTDOWN:NEAR
                                        EXTRN   SYSINIT1:NEAR
                                        ASSUME  CS:CODE
 0000                           POST3   PROC
 0000 E8 0000 E                         CALL    DDS                     ; SET DATA SEGMENT
 0003 B0 F0                             MOV     AL,0F0H                 ;       <><><><><><><><><><><><><>
 0005 E6 80                             OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F0 <><>
                                ;-----  SET SHUTDOWN RETURN 7
 0007 B8 078F                           MOV     AX,7*H+CMOS_SHUT_DOWN+NMI       ; ADDRESS FOR SHUTDOWN BYTE
 000A E8 0000 E                         CALL    CMOS_WRITE              ; SET ERROR EXIT (DOUBLE EXCEPTION?)
                                ;-----  ENABLE PROTECTED MODE
 000D BC 0000                           MOV     SP,POST_SS              ; SET STACK FOR SYSINIT1
 0010 8E D4                             MOV     SS,SP
 0012 BC 8000                           MOV     SP,POST_SP
 0015 E8 0000 E                         CALL    SYSINIT1                ; GO ENABLE PROTECTED MODE
                                ;-----  SET TEMPORARY STACK
 0018 B8 0008                           MOV     AX,GDT_PTR
 001B 8E C0                             MOV     ES,AX
 001D 8E D8                             MOV     DS,AX
 001F 26: C7 06 005A 0000               MOV     ES:SS_TEMP.BASE_LO_WORD,0
 0026 26: C6 06 005C 00                 MOV     BYTE PTR ES:(SS_TEMP.BASE_HI_BYTE),0
 002C BE 0058                           MOV     SI,SS_TEMP
 002F 8E D6                             MOV     SS,SI
 0031 BC FFFD                           MOV     SP,MAX_SEG_LEN-2
                                ;-----   VERIFY PROTECTED MODE
                                        SMSW    AX                      ; GET THE MACHINE STATUS WORD
 0034 0F 01 E0               +          DB      00FH,001H,0E0H
 0037 A9 0001                           TEST    AX,VIRTUAL_ENABLE       ; ARE WE IN PROTECTED MODE
 003A 75 03                             JNZ     T7_1
 003C E9 02CD R                         JMP     ERROR_EXIT              ; ERROR IF NOT
 003F B0 F1                     T7_1:   MOV     AL,0F1H                 ;       <><><><><><><><><><><><><>
 0041 E6 80                             OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F1 <><>
                                ;-----   INTERRUPT TEST (PROGRAMMED INTERRUPT 32)
 0043 B0 B0                             MOV     AL,0B0H                 ; SET EXCEPTION FLAG
 0045 E6 8B                             OUT     DMA_PAGE+0AH,AL         ;   FOR INTERRUPT 10
 0047 CD 20                             INT     32                      ; INTERRUPT
 0049 2B C9                             SUB     CX,CX                   ; WAIT FOR INTERRUPT
 004B E4 8B                     LOOP1:  IN      AL,DMA_PAGE+0AH
 004D 22 C0                             AND     AL,AL                   ; DID THE INTERRUPT OCCUR?
 004F E0 FA                             LOOPNZ  LOOP1
 0051 74 03                             JZ      T7_2
 0053 E9 02CD R                         JMP     ERROR_EXIT              ; MISSING INTERRUPT
                                ;-----  CAUSE AN EXCEPTION INTERRUPT (GENERAL PROTECTION INTERRUPT 13D)
 0056 B0 F2                     T7_2:   MOV     AL,0F2H                 ;       <><><><><><><><><><><><><>
```

SECTION 5

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0058 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F2 <><>
005A B0 9D                      MOV     AL,9DH                  ; SET INTERRUPT 13 FLAG
005C E6 8B                      OUT     DMA_PAGE+0AH,AL         ; FOR THE INTERRUPT HANDLER

                        ;-----  MODIFY DESCRIPTOR TABLES
                        ;-----   SET TEMPORARY ES DESCRIPTOR TO SEGMENT LIMIT

005E C7 06 0048 0000            MOV     DS:ES_TEMP.SEG_LIMIT,0  ; SET SEGMENT TO 0

                        ;-----  CPL0, DATA ACCESS RIGHTS

0064 C6 06 004D 93              MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS
0069 C6 06 004C 01              MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),01  ; DO ALL TESTS ON 2ND 64K
006E C7 06 004A 0000            MOV     WORD PTR DS:(ES_TEMP.BASE_LO_WORD),0

                        ;-----  SET ES REGISTER

0074 6A 48                      PUSH    BYTE PTR ES_TEMP        ; LOAD ES
0076 07                         POP     ES

                        ;-----  CAUSE AN EXCEPTION 13 INTERRUPT

0077 2B FF                      SUB     DI,DI
0079 26: 8B 05                  MOV     AX,ES:[DI]              ; THIS SHOULD CAUSE AND EXCEPTION
007C 2B C9                      SUB     CX,CX                   ; WAIT FOR INTERRUPT
007E E4 8B              LOOP2:  IN      AL,DMA_PAGE+0AH
0080 22 C0                      AND     AL,AL                   ; DID THE INTERRUPT OCCUR?
0082 E0 FA                      LOOPNZ  LOOP2
0084 74 03                      JZ      T7_3                    ; CONTINUE IF INTERRUPT
0086 E9 02CD R                  JMP     ERROR_EXIT              ; MISSING INTERRUPT

                        ;----------------------------------------
                        ;                                       :
                        ;       VERIFY 286 LDT/SDT LTR/STR      :
                        ;       INSTRUCTIONS                    :
                        ; DESCRIPTION                           :
                        ;       LOAD LDT  REGISTERS WITH A      :
                        ;       DESCRIPTOR AND VERIFY CORRECT   :
                        ;----------------------------------------

                        ;-----  WRITE TO 286 LDT REGISTER
0089                    T7_3:
0089 B0 F3                      MOV     AL,0F3H                 ;       <><><><><><><><><><><><>
008B E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F3 <><>
008D BF 0078                    MOV     DI,POST_LDTR
                                LLDT    DI                      ; REGISTER FROM THIS AREA
0090 0F                 +       DB      00FH
0091                    + ??0000 LABEL  BYTE
0091 8B D7              +       MOV     DX,DI
0093                    + ??0001 LABEL  BYTE
0091                    +       ORG     OFFSET CS:??0000
0091 00                 +       DB      000H
0093                    +       ORG     OFFSET CS:??0001

                        ;-----  READ AND VERIFY 286 LDT SELECTOR

0093 2B C0                      SUB     AX,AX                   ; CLEAR AX
                                SLDT    AX                      ; GET THE LDT SELECTOR
0095 0F                 +       DB      00FH
0096                    + ??0002 LABEL  BYTE
0096 03 C0              +       ADD     AX,AX
0098                    + ??0003 LABEL  BYTE
0096                    +       ORG     OFFSET CS:??0002
0096 00                 +       DB      000H
0098                    +       ORG     OFFSET CS:??0003
0098 25 00F8                    AND     AX,0F8H                 ; STRIP TI/RPL
009B 3D 0078                    CMP     AX,POST_LDTR            ; CORRECT SELECTOR?
009E 75 1B                      JNZ     ERROR                   ; GO IF NOT

                        ;-----  WRITE TO 286 TR

00A0 BF 0068                    MOV     DI,POST_TR
                                LTR     DI                      ; REGISTER FROM THIS AREA
00A3 0F                 +       DB      00FH
00A4                    + ??0004 LABEL  BYTE
00A4 8B DF              +       MOV     BX,DI
00A6                    + ??0005 LABEL  BYTE
00A4                    +       ORG     OFFSET CS:??0004
00A4 00                 +       DB      000H
00A6                    +       ORG     OFFSET CS:??0005

                        ;-----  VERIFY 286 TR REGISTERS

00A6 2B C0                      SUB     AX,AX
                                STR     AX                      ; GET THE TR  REGISTER
00A8 0F                 +       DB      00FH
00A9                    + ??0006 LABEL  BYTE
00A9 8B C8              +       MOV     CX,AX
00AB                    + ??0007 LABEL  BYTE
00A9                    +       ORG     OFFSET CS:??0006
00A9 00                 +       DB      000H
00AB                    +       ORG     OFFSET CS:??0007
00AB 25 00F8                    AND     AX,0F8H
00AE 3D 0068                    CMP     AX,POST_TR              ; CORRECT SELECTOR?
00B1 75 08                      JNZ     ERROR

                        ;-----  TEST 286 CONTROL FLAGS

00B3 FD                         STD                             ; SET DIRECTION FLAG FOR DECREMENT
00B4 9C                         PUSHF                           ; GET THE FLAGS
00B5 58                         POP     AX
00B6 A9 0200                    TEST    AX,0200H                ; INTERRUPT FLAG SHOULD BE OFF
00B9 74 03                      JZ      T7_4                    ; CONTINUE IF OFF
00BB E9 02CD R          ERROR:  JMP     ERROR_EXIT              ; GO IF NOT
00BE                    T7_4:
00BE A9 0400                    TEST    AX,0400H                ; CHECK DIRECTION FLAG
00C1 75 03                      JNZ     T7_5
00C3 E9 02CD R                  JMP     ERROR_EXIT              ; GO IF NOT SET
00C6                    T7_5:
00C6 FC                         CLD                             ; CLEAR DIRECTION FLAG
00C7 9C                         PUSHF                           ; INSURE DIRECTION FLAG IS RESET
00C8 58                         POP     AX
00C9 A9 0400                    TEST    AX,0400H
00CC 74 03                      JZ      T7_6
```

```
00CE E9 02CD R                 JMP     ERROR_EXIT              ; GO IF NOT

                          ;----------------------------------------
                          ;        VERIFY 286 BOUND INSTRUCTION    :
                          ; DESCRIPTION                            :
                          ;        CREATE A SIGNED ARRAY INDEX     :
                          ;        WITHIN AND OUTSIDE THE LIMITS   :
                          ;        (EXPECT INT 5)                  :
                          ;----------------------------------------

00D1                      T7_6:
00D1 B0 F4                     MOV     AL,0F4H                 ;       <><><><><><><><><><><><><>
00D3 E6 80                     OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F4 <><>
00D5 6A 48                     PUSH    BYTE PTR ES_TEMP        ; LOAD ES REGISTER
00D7 07                        POP     ES

                          ;-----   CHECK BOUND FUNCTIONS CORRECTLY

00D8 2B FF                     SUB     DI,DI                   ; POINT BEGINNING OF THE BLOCK
00DA 26: C7 05 0000            MOV     WORD PTR ES:[DI],0      ; SET FIRST WORD TO ZERO
00DF 26: C7 45 02 7FFF         MOV     WORD PTR ES:[DI+2],07FFFH ; SET SECOND TO 07FFFH
00E5 B0 95                     MOV     AL,095H                 ; SET INTERRUPT 5 FLAG
00E7 E6 8B                     OUT     DMA_PAGE+0AH,AL
00E9 B8 1000                   MOV     AX,1000H                ; SET AX WITHIN BOUNDS
00EC 26: 62 05                 BOUND   AX,DWORD PTR ES:[DI]    ; USE THE ES SEGMENT POINTER
00EF 2B C9                     SUB     CX,CX                   ; WAIT FOR POSSIBLE INTERRUPT
00F1 E2 FE                LOOPA:  LOOP    LOOPA
00F3 E4 8B                     IN      AL,DMA_PAGE+0AH         ; GET THE RESULTS
00F5 3C 00                     CMP     AL,0                    ; DID AN INTERRUPT OCCUR?
00F7 75 03                     JNZ     T7_7                    ; CONTINUE IF NOT
00F9 E9 02CD R                 JMP     ERROR_EXIT              ; GO IF YES

                          ;-----   CHECK LOW BOUND WORD CAUSES INTERRUPT 5
00FC                      T7_7:
00FC 2B FF                     SUB     DI,DI                   ; POINT BEGINNING OF THE BLOCK
00FE 26: C7 05 3FF0            MOV     WORD PTR ES:[DI],03FF0H ; SET FIRST WORD TO 03FF0H
0103 B8 1000                   MOV     AX,1000H                ; SET AX OUT OF BOUNDS
0106 26: 62 05                 BOUND   AX,DWORD PTR ES:[DI]
0109 2B C9                     SUB     CX,CX                   ; WAIT FOR POSSIBLE INTERRUPT
010B                      LOOPB:
010B E4 8B                     IN      AL,DMA_PAGE+0AH         ; GET THE RESULTS
010D 3C 00                     CMP     AL,0H                   ; DID AN INTERRUPT OCCUR?
010F E0 FA                     LOOPNZ  LOOPB                   ; TRY AGAIN
0111 74 03                     JZ      T7_8                    ; CONTINUE IF INTERRUPT
0113 E9 02CD R                 JMP     ERROR_EXIT              ; GO IF NO INTERRUPT

                          ;-----   CHECK HIGH BOUND WORD CAUSES INTERRUPT 5

0116 B0 95                T7_8:  MOV     AL,95H                ; SET FLAG FOR INTERRUPT
0118 E6 8B                     OUT     DMA_PAGE+0AH,AL

011A 2B FF                     SUB     DI,DI                   ; POINT BEGINNING OF THE BLOCK
011C 26: C7 05 0000            MOV     WORD PTR ES:[DI],0      ; SET FIRST WORD TO 0
0121 26: C7 45 02 0FFF         MOV     WORD PTR ES:[DI+2],0FFFH; SET SECOND TO 0FFFH
0127 B8 1000                   MOV     AX,1000H                ; SET AX OUT OF BOUNDS
012A 26: 62 05                 BOUND   AX,DWORD PTR ES:[DI]
012D 2B C9                     SUB     CX,CX                   ; WAIT FOR POSSIBLE INTERRUPT
012F                      LOOPC:
012F E4 8B                     IN      AL,DMA_PAGE+0AH         ; GET THE RESULTS
0131 3C 00                     CMP     AL,0H                   ; DID AN INTERRUPT OCCUR?
0133 E0 FA                     LOOPNZ  LOOPC                   ; TRY AGAIN
0135 74 03                     JZ      T7_9
0137 E9 02CD R                 JMP     ERROR_EXIT              ; GO IF NO INTERRUPT

                          ;----------------------------------------------
                          ;        VERIFY PUSH ALL AND POP ALL INSTRUCTIONS:
                          ; DESCRIPTION                                   :
                          ;        SET REGISTERS TO A KNOWN VALUE AND     :
                          ;        PUSH ALL.  RESET THE REGISTERS, POP ALL :
                          ;        AND VERIFY                             :
                          ;----------------------------------------------

013A                      T7_9:
013A B0 F5                     MOV     AL,0F5H                 ;       <><><><><><><><><><><><><>
013C E6 80                     OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F5 <><>
013E B8 0001                   MOV     AX,01                   ; SET AX=1
0141 8B D8                     MOV     BX,AX                   ; SET BX=2
0143 43                        INC     BX
0144 8B CB                     MOV     CX,BX                   ; SET CX=3
0146 41                        INC     CX
0147 8B D1                     MOV     DX,CX
0149 42                        INC     DX                      ; SET DX=4
014A 8B FA                     MOV     DI,DX
014C 47                        INC     DI                      ; SET DI=5
014D 8B F7                     MOV     SI,DI
014F 46                        INC     SI                      ; SET SI=6
0150 55                        PUSH    BP                      ; SAVE THE (BP) ERROR FLAG REGISTER
0151 8B EE                     MOV     BP,SI                   ; SET BP=7
0153 45                        INC     BP
0154 60                        PUSHA                           ; ISSUE THE PUSH ALL COMMAND
0155 2B C0                     SUB     AX,AX                   ; CLEAR ALL REGISTERS
0157 8B D8                     MOV     BX,AX
0159 8B C8                     MOV     CX,AX
015B 8B D0                     MOV     DX,AX
015D 8B F8                     MOV     DI,AX
015F 8B F0                     MOV     SI,AX
0161 8B E8                     MOV     BP,AX
0163 61                        POPA                            ; GET THE REGISTERS BACK
0164 83 FD 07                  CMP     BP,07                   ; BP SHOULD BE 7
0167 5D                        POP     BP                      ; RESTORE (BP) ERROR FLAG REGISTER
0168 75 1E                     JNZ     ERROR_EXIT1             ; GO IF NOT
016A 3D 0001                   CMP     AX,01                   ; AX SHOULD BE 1
016D 75 19                     JNZ     ERROR_EXIT1             ; GO IF NOT
016F 83 FB 02                  CMP     BX,02                   ; BX SHOULD BE 2
0172 75 14                     JNZ     ERROR_EXIT1             ; GO IF NOT
0174 83 F9 03                  CMP     CX,03                   ; CX SHOULD BE 3
0177 75 0F                     JNZ     ERROR_EXIT1             ; GO IF NOT
0179 83 FA 04                  CMP     DX,04                   ; DX SHOULD BE 4
017C 75 0A                     JNZ     ERROR_EXIT1             ; GO IF NOT
017E 83 FF 05                  CMP     DI,05                   ; DI SHOULD BE 5
0181 75 05                     JNZ     ERROR_EXIT1             ; GO IF NOT
0183 83 FE 06                  CMP     SI,06                   ; SI SHOULD BE 6
0186 74 03                     JZ      T7_10                   ; CONTINUE IF IT IS
```

SECTION 5

```
                                ;-----  ERROR EXIT

 0188                           ERROR_EXIT1:
 0188 E9 02CD R                         JMP     ERROR_EXIT

                                ;-----------------------------------------------
                                ;       VERIFY ACCESS RIGHTS FUNCTION CORRECTLY :
                                ; DESCRIPTION                                   :
                                ;       SET ACCESS RIGHTS OF DESCRIPTOR TO      :
                                ;       READ ONLY.  VERIFY THE VERW/VERR INSTR  :
                                ;       ACCESS A READ ONLY WITH A WRITE AND     :
                                ;       VERIFY AN EXCEPTION INTERRUPT 13        :
                                ;-----------------------------------------------

 018B B0 F6                     T7_10:  MOV     AL,0F6H                 ;       <><><><><><><><><><><><>
 018D E6 80                             OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F6 <><>
 018F C7 06 0048 FFFF                   MOV     DS:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN        ; SET SEGMENT TO 0FFFFH
 0195 C6 06 004C 00                     MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),0    ; SET THE ADDRESS
 019A C7 06 004A F000                   MOV     DS:ES_TEMP.BASE_LO_WORD,0F000H
 01A0 B8 0048                           MOV     AX,ES_TEMP              ; LOAD ES REGISTER
 01A3 8E C0                             MOV     ES,AX                   ; THIS SEGMENT SHOULD BE WRITEABLE

                                ;-----  INSURE ACCESS RIGHTS MAY BE WRITTEN

                                        SEGOV   DS                      ; SET SEGMENT OVERRIDE TO START OF TABLE
 01A5 3E                        +       DB      03EH
                                        VERW    AX                      ; CHECK THE ACCESS RIGHTS OF ES_TEMP
 01A6 0F                        +       DB      00FH
 01A7                           + ??0009  LABEL BYTE
 01A7 8B E8                     +       MOV     BP,AX
 01A9                           + ??000A  LABEL BYTE
 01A7                           +       ORG     OFFSET CS:??0009
 01A7 00                        +       DB      000H
 01A9                           +       ORG     OFFSET CS:??000A
 01A9 75 DD                             JNZ     ERROR_EXIT1             ; ERROR IF SEGMENT CAN NOT WRITE

                                ;-----  SET ACCESS RIGHTS TO READ ONLY

 01AB C6 06 004D 91                     MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),91H
 01B0 B8 0048                           MOV     AX,ES_TEMP              ; LOAD ES REGISTER
 01B3 8E C0                             MOV     ES,AX
                                        SEGOV   DS                      ; SET SEGMENT OVERRIDE TO START OF TABLE
 01B5 3E                        +       DB      03EH
                                        VERW    AX                      ; CHECK THE ACCESS RIGHTS OF ES_TEMP
 01B6 0F                        +       DB      00FH
 01B7                           + ??000C  LABEL BYTE
 01B7 8B E8                     +       MOV     BP,AX
 01B9                           + ??000D  LABEL BYTE
 01B7                           +       ORG     OFFSET CS:??000C
 01B7 00                        +       DB      000H
 01B9                           +       ORG     OFFSET CS:??000D
 01B9 74 CD                             JZ      ERROR_EXIT1             ; ERROR IF SEGMENT IS WRITEABLE

 01BB B8 0048                           MOV     AX,ES_TEMP              ; INSURE THAT SEGMENT IS READABLE
                                        SEGOV   DS
 01BE 3E                        +       DB      03EH
                                        VERR    AX
 01BF 0F                        +       DB      00FH
 01C0                           + ??000F  LABEL BYTE
 01C0 8B E0                     +       MOV     SP,AX
 01C2                           + ??0010  LABEL BYTE
 01C0                           +       ORG     OFFSET CS:??000F
 01C0 00                        +       DB      000H
 01C2                           +       ORG     OFFSET CS:??0010
 01C2 75 C4                             JNZ     ERROR_EXIT1             ; GO IF SEGMENT NOT READABLE

                                ;-----  CAUSE AN EXCEPTION 13 INTERRUPT

 01C4 B0 9D                             MOV     AL,09DH                 ; SET EXCEPTION FLAG
 01C6 E6 8B                             OUT     DMA_PAGE+0AH,AL         ;   FOR INTERRUPT 13
 01C8 2B F6                             SUB     SI,SI
 01CA 26: C6 04 00                      MOV     BYTE PTR ES:[SI],00     ; WRITE A BYTE THAT SHOULD
 01CE 2B C9                             SUB     CX,CX                   ; WAIT FOR INTERRUPT
 01D0 E4 8B                     LOOPD:  IN      AL,DMA_PAGE+0AH
 01D2 22 C0                             AND     AL,AL                   ; DID THE INTERRUPT OCCUR?
 01D4 E0 FA                             LOOPNZ  LOOPD
 01D6 75 B0                             JNZ     ERROR_EXIT1             ; MISSING INTERRUPT

                                ;-----  RESTORE THE ACCESS RIGHTS BYTE

 01D8 C6 06 004D 93                     MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS

                                ;-----------------------------------------------
                                ;       VERIFY ADJUST RPL FIELD OF SELECTOR     :
                                ;       INSTRUCTION (ARPL) FUNCTIONS            :
                                ; DESCRIPTION                                   :
                                ;       SET THE RPL FIELD OF A SELECTOR         :
                                ;       AND VERIFY THAT THE ZERO FLAG IS SET    :
                                ;       CORRECTLY AND THAT THE SELECTOR RPL     :
                                ;       FIELD IS SET CORRECTLY                  :
                                ;-----------------------------------------------

 01DD B0 F7                             MOV     AL,0F7H                 ;       <><><><><><><><><><><><>
 01DF E6 80                             OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F7 <><>
 01E1 B8 0048                           MOV     AX,ES_TEMP              ; PUT A SELECTOR IN AX
 01E4 BB 0060                           MOV     BX,DS_TEMP              ; PUT A SELECTOR IN BX
 01E7 0D 0003                           OR      AX,03H                  ; MAKE ACCESS OF AX < BX

                                ;-----  NOTE BX = FIRST OPERAND  AX = SECOND OPERAND

                                        ARPL    AX,BX                   ; ISSUE THE RPL COMMAND
 01EA                           + ??0011  LABEL BYTE
 01EA 8B C3                     +       MOV     AX,BX
 01EC                           + ??0012  LABEL BYTE
 01EA                           +       ORG     OFFSET CS:??0011
 01EA 63                        +       DB      063H
 01EC                           +       ORG     OFFSET CS:??0012
 01EC 75 9A                             JNZ     ERROR_EXIT1             ; GO IF RPL WAS NOT CHANGED
 01EE 80 E3 03                          AND     BL,03H                  ; STRIP UNWANTED BITS
 01F1 80 FB 03                          CMP     BL,03H                  ; AS EXPECTED?
 01F4 75 92                             JNZ     ERROR_EXIT1             ; GO IF NOT

                                ;-----  CHECK THAT ACCESS RIGHTS DO NOT CHANGE

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```
01F6 BB 0060                        MOV     BX,DS_TEMP              ; PUT A SELECTOR IN BX
01F9 B8 0048                        MOV     AX,ES_TEMP              ; PUT A SELECTOR IN AX
01FC 80 CB 03                       OR      BL,03H                  ; MAKE ACCESS OF BX < AX

                            ;-----  NOTE BX = FIRST OPERAND  AX = SECOND OPERAND

                                    ARPL    AX,BX                   ; ISSUE THE RPL COMMAND
01FF                        + ??0013 LABEL  BYTE
01FF 8B C3                  +       MOV     AX,BX
0201                        + ??0014 LABEL  BYTE
01FF                        +       ORG     OFFSET CS:??0013
01FF 63                     +       DB      063H
0201                        +       ORG     OFFSET CS:??0014
0201 74 85                          JZ      ERROR_EXIT1             ; GO IF RPL WAS NOT CHANGED
0203 80 E3 03                       AND     BL,03H                  ; STRIP UNWANTED BITS
0206 80 FB 03                       CMP     BL,03H                  ; AS EXPECTED?
0209 75 2F                          JNZ     ERROR_EXIT2             ; GO IF NOT

                            ;-----  VERIFY LOAD SEGMENT LIMIT (LSL)
                            ;-----  AND LOAD ACCESS RIGHTS (LAR) INSTRUCTION

                            ;-----   CHECK THE LAR INSTRUCTION

020B B0 F8                          MOV     AL,0F8H                 ;       <><><><><><><><><><><><><>
020D E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F8 <><>

                            ;-----  SET THE DESCRIPTOR TO LEVEL 3

020F C6 06 004D F3                  MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL3_DATA_ACCESS
0214 BB 0048                        MOV     BX,ES_TEMP
0217 2B C0                          SUB     AX,AX                   ; CLEAR AX

                            ;-----  GET THE CURRENT DESCRIPTORS ACCESS RIGHTS

                                    LAR     AX,BX                   ; ISSUE THE LAR COMMAND
0219 0F                     +       DB      00FH
021A                        + ??0015 LABEL  BYTE
021A 8B C3                  +       MOV     AX,BX
021C                        + ??0016 LABEL  BYTE
021A                        +       ORG     OFFSET CS:??0015
021A 02                     +       DB      002H
021C                        +       ORG     OFFSET CS:??0016

                            ;-----  INSURE THE DESCRIPTOR WAS VISIBLE

021C 75 1C                          JNZ     ERROR_EXIT2             ; GO IF LAR WAS NOT CHANGED

                            ;-----  THE DESCRIPTORS ACCESS RIGHTS MUST BE 3

021E 80 FC F3                       CMP     AH,CPL3_DATA_ACCESS     ; AS EXPECTED?
0221 75 17                          JNZ     ERROR_EXIT2             ; GO IF NOT

                            ;-----  CHECK THE LSL (LOAD SEGMENT LIMITS)

0223 B0 F9                          MOV     AL,0F9H                 ;       <><><><><><><><><><><><><>
0225 E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F9 <><>
0227 C7 06 0048 AAAA                MOV     DS:ES_TEMP.SEG_LIMIT,0AAAAH     ; SET SEGMENT LIMIT TO 0AAAAH

022D C6 06 004D 93                  MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS
0232 B8 0048                        MOV     AX,ES_TEMP              ; LOAD ES REGISTER
                                    LSL     BX,AX                   ; GET THE DESCRIPTOR SEGMENT LIMIT
0235 0F                     +       DB      00FH
0236                        + ??0017 LABEL  BYTE
0236 8B D8                  +       MOV     BX,AX
0238                        + ??0018 LABEL  BYTE
0236                        +       ORG     OFFSET CS:??0017
0236 03                     +       DB      003H
0238                        +       ORG     OFFSET CS:??0018
0238 74 03                          JZ      R07                     ; GO IF OK

023A                        ERROR_EXIT2:
023A E9 02CD R                      JMP     ERROR_EXIT              ; GO IF NOT SUCCESSFUL

023D 81 FB AAAA             R07:    CMP     BX,0AAAAH               ; INSURE CORRECT SEGMENT LIMIT
0241 C7 06 0048 5555                MOV     DS:ES_TEMP.SEG_LIMIT,05555H     ;SET THE SEGMENT LIMIT TO 05555H
0247 B8 0048                        MOV     AX,ES_TEMP
                                    LSL     BX,AX                   ; GET THE DESCRIPTOR SEGMENT LIMIT
024A 0F                     +       DB      00FH
024B                        + ??0019 LABEL  BYTE
024B 8B D8                  +       MOV     BX,AX
024D                        + ??001A LABEL  BYTE
024B                        +       ORG     OFFSET CS:??0019
024B 03                     +       DB      003H
024D                        +       ORG     OFFSET CS:??001A
024D 75 EB                          JNZ     ERROR_EXIT2             ; GO IF NOT SUCCESSFUL

024F 81 FB 5555                     CMP     BX,05555H               ; INSURE CORRECT SEGMENT LIMIT
0253 75 E5                          JNZ     ERROR_EXIT2             ; GO IF NOT

                            ;-------------------------------------------------------
                            ; LOW MEG CHIP SELECT TEST                              :
                            ;  TEST THAT A WRITE TO ADDRESS 1B0000 DOES NOT WRITE   :
                            ;  TO B000:0, OR 1B8000 DOES NOT WRITE TO B800:0        :
                            ;-------------------------------------------------------

0255 B0 FA                          MOV     AL,0FAH                 ;       <><><><><><><><><><><><><>
0257 E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  FA <><>
0259 6A 08                          PUSH    BYTE PTR GDT_PTR        ; MODIFY THE DESCRIPTOR TABLE
025B 1F                             POP     DS

                            ;-----  SET TEMPORARY ES DESCRIPTOR 64K SEGMENT LIMIT/CPL0 DATA ACCESS

025C C7 06 0048 FFFF                MOV     DS:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN
0262 C6 06 004D 93                  MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS

                            ;-----  START WITH SEGMENT 1B0000

0267 C6 06 004C 1B                  MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),1BH
026C C7 06 004A 0000                MOV     DS:ES_TEMP.BASE_LO_WORD,0
0272 6A 48                          PUSH    BYTE PTR  ES_TEMP       ; LOAD ES REGISTER
0274 07                             POP     ES
0275 2B FF                          SUB     DI,DI                   ; POINT TO FIRST LOCATION
0277 26: C7 05 AA55                 MOV     WORD PTR ES:[DI],0AA55H ; WRITE A TEST PATTERN
```

```
                                  ;-----  DO FOR SEGMENT 1B8000

     027C C7 06 004A 8000                  MOV     DS:ES_TEMP.BASE_LO_WORD,8000H
     0282 6A 48                            PUSH    BYTE PTR ES_TEMP         ; LOAD ES REGISTER
     0284 07                               POP     ES
     0285 26: C7 05 AA55                   MOV     WORD PTR ES:[DI],0AA55H ; WRITE A TEST PATTERN

                                  ;-----  DO FOR SEGMENT 1A0000

     028A C6 06 004C 1A                    MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),1AH
     028F C7 06 004A 0000                  MOV     DS:ES_TEMP.BASE_LO_WORD,0
     0295 6A 48                            PUSH    BYTE PTR ES_TEMP         ; LOAD ES REGISTER
     0297 07                               POP     ES
     0298 26: C7 05 AA55                   MOV     WORD PTR ES:[DI],0AA55H ; WRITE A TEST PATTERN

                                  ;-----  B/W VIDEO CARD

     029D 6A 20                            PUSH    BYTE PTR  C_BWCRT_PTR
     029F 1F                               POP     DS                        ; SET DS TO B/W DISPLAY REGEN BUFFER
     02A0 8B 05                            MOV     AX,DS:[DI]                ; GET THE WORD FROM B/W VIDEO

                                  ;-----  COMPATIBLE COLOR

     02A2 6A 28                            PUSH    BYTE PTR C_CCRT_PTR       ; SET DS TO COMPATIBLE COLOR MEMORY
     02A4 1F                               POP     DS
     02A5 8B 1D                            MOV     BX,DS:[DI]                ; GET THE WORD FROM COLOR MEMORY

                                  ;-----  EGA COLOR

     02A7 6A 30                            PUSH    BYTE PTR E_CCRT_PTR             ; EGA COLOR CRT POINTER LOW 64K
     02A9 1F                               POP     DS
     02AA 8B 0D                            MOV     CX,DS:[DI]

                                  ;-----  TEST FOR ERROR

     02AC 50                               PUSH    AX                        ; SAVE RESULTS
     02AD B0 35                            MOV     AL,35H                    ;       <><><><><><><><><><><><>
     02AF E6 80                            OUT     MFG_PORT,AL               ;       <><> CHECKPOINT  35 <><>
     02B1 58                               POP     AX
     02B2 3D AA55                          CMP     AX,0AA55H
     02B5 74 16                            JZ      ERROR_EXIT
     02B7 81 FB AA55                       CMP     BX,0AA55H
     02BB 74 10                            JZ      ERROR_EXIT
     02BD 81 F9 AA55                       CMP     CX,0AA55H
     02C1 74 0A                            JZ      ERROR_EXIT
     02C3 B0 34                            MOV     AL,34H                    ; RESTORE CHECKPOINT
     02C5 E6 80                            OUT     MFG_PORT,AL               ;       <><> CHECKPOINT  34 <><>

                                  ;-----  SHUTDOWN

     02C7                         NORMAL_EXIT:
     02C7 B8 068F                          MOV     AX,6*H+CMOS_SHUT_DOWN+NMI        ; ADDRESS FOR SHUTDOWN BYTE
     02CA E8 0000 E                        CALL    CMOS_WRITE                       ; SET GOOD ENDING
     02CD                         ERROR_EXIT:
     02CD E9 0000 E                        JMP     PROC_SHUTDOWN

     02D0                         POST3       ENDP

     02D0                         CODE        ENDS
                                              END
```

```
                                PAGE 118,121
                                TITLE TEST4 ---- 06/10/85  POST AND BIOS UTILITY ROUTINES
                                .286C
                                .LIST
0000                            CODE    SEGMENT BYTE PUBLIC

                                        PUBLIC  BEEP
                                        PUBLIC  BLINK_INT
                                        PUBLIC  CMOS_READ
                                        PUBLIC  CMOS_WRITE
                                        PUBLIC  CONFIG_BAD
                                        PUBLIC  DII
                                        PUBLIC  DDS
                                        PUBLIC  DUMMY_RETURN_1
                                        PUBLIC  ERR_BEEP
                                        PUBLIC  E_MSG
                                        PUBLIC  INT_287
                                        PUBLIC  KBD_RESET
                                        PUBLIC  POST4
                                        PUBLIC  PROT_PRT_HEX
                                        PUBLIC  PROC_SHUTDOWN
                                        PUBLIC  PRT_HEX
                                        PUBLIC  PRT_SEG
                                        PUBLIC  P_MSG
                                        PUBLIC  RE_DIRECT
                                        PUBLIC  ROM_CHECK
                                        PUBLIC  ROM_CHECKSUM
                                        PUBLIC  SET_TOD
                                        PUBLIC  WAITF
                                        PUBLIC  XPC_BYTE

                                        EXTRN   E163:NEAR
                                        EXTRN   OBF_42:NEAR
                                        EXTRN   ROM_ERR:NEAR
                                        EXTRN   XMIT_8042:NEAR

                                        ASSUME  CS:CODE,DS:DATA
0000                            POST4:
                                ;--- CMOS_READ -----------------------------------------------------------
                                ;               READ BYTE FROM CMOS SYSTEM CLOCK CONFIGURATION TABLE    :
                                ;                                                                       :
                                ; INPUT: (AL)=  CMOS TABLE ADDRESS TO BE READ                           :
                                ;               BIT    7 = 0 FOR NMI ENABLED AND 1 FOR NMI DISABLED ON EXIT :
                                ;               BITS 6-0 = ADDRESS OF TABLE LOCATION TO READ            :
                                ;                                                                       :
                                ; OUTPUT: (AL)  VALUE AT LOCATION (AL) MOVED INTO (AL).  IF BIT 7 OF (AL) WAS :
                                ;               ON THEN NMI LEFT DISABLED.  DURING THE CMOS READ BOTH NMI AND :
                                ;               NORMAL INTERRUPTS ARE DISABLED TO PROTECT CMOS DATA INTEGRITY. :
                                ;               THE CMOS ADDRESS REGISTER IS POINTED TO A DEFAULT VALUE AND :
                                ;               THE INTERRUPT FLAG RESTORED TO THE ENTRY STATE ON RETURN. :
                                ;               ONLY THE (AL) REGISTER AND THE NMI STATE IS CHANGED.    :
                                ;-----------------------------------------------------------------------

0000                            CMOS_READ       PROC    NEAR            ;       READ LOCATION (AL) INTO (AL)
0000 9C                                 PUSHF                           ; SAVE INTERRUPT ENABLE STATUS AND FLAGS
0001 D0 C0                              ROL     AL,1                    ; MOVE NMI BIT TO LOW POSITION
0003 F9                                 STC                             ; FORCE NMI BIT ON IN CARRY FLAG
0004 D0 D8                              RCR     AL,1                    ; HIGH BIT ON TO DISABLE NMI - OLD IN CY
0006 FA                                 CLI                             ; DISABLE INTERRUPTS
0007 E6 70                              OUT     CMOS_PORT,AL            ; ADDRESS LOCATION AND DISABLE NMI
0009 90                                 NOP                             ; I/O DELAY
000A E4 71                              IN      AL,CMOS_DATA            ; READ THE REQUESTED CMOS LOCATION
000C 50                                 PUSH    AX                      ; SAVE (AH) REGISTER VALUE AND CMOS BYTE
000D B0 1A                              MOV     AL,CMOS_REG_D*2         ; GET ADDRESS OF DEFAULT LOCATION
000F D0 D8                              RCR     AL,1                    ; PUT ORIGINAL NMI MASK BIT INTO ADDRESS
0011 E6 70                              OUT     CMOS_PORT,AL            ; SET DEFAULT TO READ ONLY REGISTER
0013 58                                 POP     AX                      ; RESTORE (AH) AND (AL)= CMOS BYTE
0014 0E                                 PUSH    CS                      ; *PLACE CODE SEGMENT IN STACK AND
0015 E8 0019 R                          CALL    CMOS_POPF               ; *HANDLE POPF FOR B- LEVEL 80286
0018 C3                                 RET                             ; RETURN WITH FLAGS RESTORED

0019                            CMOS_READ       ENDP

0019                            CMOS_POPF       PROC    NEAR            ;       POPF FOR LEVEL B- PARTS
0019 CF                                 IRET                            ; RETURN FAR AND RESTORE FLAGS

001A                            CMOS_POPF       ENDP

                                ;--- CMOS_WRITE ----------------------------------------------------------
                                ;               WRITE BYTE TO CMOS SYSTEM CLOCK CONFIGURATION TABLE     :
                                ;                                                                       :
                                ; INPUT: (AL)=  CMOS TABLE ADDRESS TO BE WRITTEN TO                     :
                                ;               BIT    7 = 0 FOR NMI ENABLED AND 1 FOR NMI DISABLED ON EXIT :
                                ;               BITS 6-0 = ADDRESS OF TABLE LOCATION TO WRITE           :
                                ;        (AH)=  NEW VALUE TO BE PLACED IN THE ADDRESSED TABLE LOCATION  :
                                ;                                                                       :
                                ; OUTPUT:       VALUE IN (AH) PLACED IN LOCATION (AL) WITH NMI LEFT DISABLED :
                                ;               IF BIT 7 OF (AL) IS ON.  DURING THE CMOS UPDATE BOTH NMI AND :
                                ;               NORMAL INTERRUPTS ARE DISABLED TO PROTECT CMOS DATA INTEGRITY. :
                                ;               THE CMOS ADDRESS REGISTER IS POINTED TO A DEFAULT VALUE AND :
                                ;               THE INTERRUPT FLAG RESTORED TO THE ENTRY STATE ON RETURN. :
                                ;               ONLY THE CMOS LOCATION AND THE NMI STATE IS CHANGED.    :
                                ;-----------------------------------------------------------------------

001A                            CMOS_WRITE      PROC    NEAR            ;       WRITE (AH) TO LOCATION (AL)
001A 9C                                 PUSHF                           ; SAVE INTERRUPT ENABLE STATUS AND FLAGS
001B 50                                 PUSH    AX                      ; SAVE WORK REGISTER VALUES
001C D0 C0                              ROL     AL,1                    ; MOVE NMI BIT TO LOW POSITION
001E F9                                 STC                             ; FORCE NMI BIT ON IN CARRY FLAG
001F D0 D8                              RCR     AL,1                    ; HIGH BIT ON TO DISABLE NMI - OLD IN CY
0021 FA                                 CLI                             ; DISABLE INTERRUPTS
0022 E6 70                              OUT     CMOS_PORT,AL            ; ADDRESS LOCATION AND DISABLE NMI
0024 8A C4                              MOV     AL,AH                   ; GET THE DATA BYTE TO WRITE
0026 E6 71                              OUT     CMOS_DATA,AL            ; PLACE IN REQUESTED CMOS LOCATION
0028 B0 1A                              MOV     AL,CMOS_REG_D*2         ; GET ADDRESS OF DEFAULT LOCATION
002A D0 D8                              RCR     AL,1                    ; PUT ORIGINAL NMI MASK BIT INTO ADDRESS
002C E6 70                              OUT     CMOS_PORT,AL            ; SET DEFAULT TO READ ONLY REGISTER
002E 58                                 POP     AX                      ; RESTORE WORK REGISTERS
002F 0E                                 PUSH    CS                      ; *PLACE CODE SEGMENT IN STACK AND
0030 E8 0019 R                          CALL    CMOS_POPF               ; *HANDLE POPF FOR B- LEVEL 80286
0033 C3                                 RET

0034                            CMOS_WRITE      ENDP
```

SECTION 5

```
                                PAGE
     0034                       DDS     PROC    NEAR                    ;       LOAD (DS) TO DATA AREA
     0034 2E: 8E 1E 003A R              MOV     DS,CS:DDSDATA           ; PUT SEGMENT VALUE OF DATA AREA INTO DS
     0039 C3                            RET                             ; RETURN TO USER WITH (DS)= DATA

     003A ---- R                DDSDATA DW      DATA                    ; SEGMENT SELECTOR VALUE FOR DATA AREA

     003C                       DDS     ENDP

                                ;--- E_MSG -- P_MSG -----------------------------------------------------
                                ;       THIS SUBROUTINE WILL PRINT A MESSAGE ON THE DISPLAY            :
                                ;                                                                      :
                                ; ENTRY REQUIREMENTS:                                                  :
                                ;       SI = OFFSET(ADDRESS) OF MESSAGE BUFFER                         :
                                ;       CX = MESSAGE BYTE COUNT                                        :
                                ;           MAXIMUM MESSAGE LENGTH IS 36 CHARACTERS                    :
                                ;       BP = BIT 0=E161/E162, BIT 1=CONFIG_BAD, 2-15= FIRST MSG OFFSET :
                                ;-----------------------------------------------------------------------

     003C                       E_MSG   PROC    NEAR
     003C F7 C5 3FFF                    TEST    BP,03FFFH               ; CHECK FOR NOT FIRST ERROR MESSAGE
     0040 75 08                         JNZ     E_MSG1                  ; SKIP IF NOT FIRST ERROR MESSAGE

     0042 56                            PUSH    SI                      ; SAVE MESSAGE POINTER
     0043 81 E6 3FFF                    AND     SI,03FFFH               ; USE LOW 14 BITS OF MESSAGE OFFSET
     0047 0B EE                         OR      BP,SI                   ;  AS FIRST ERROR MESSAGE FLAG
     0049 5E                            POP     SI                      ; (BIT 0 = E161/E162, BIT 1 = BAD_CONFIG
     004A                       E_MSG1:
     004A E8 0063 R                     CALL    P_MSG                   ; PRINT MESSAGE
     004D 1E                            PUSH    DS                      ; SAVE CALLERS (DS)
     004E E8 0034 R                     CALL    DDS                     ; POINT TO POST/BIOS DATA SEGMENT
     0051 F6 06 0010 R 01               TEST    BYTE PTR @EQUIP_FLAG,01H; LOOP/HALT ON ERROR SWITCH ON ?
     0056 74 02                         JZ      MFG_HALT                ; YES - THEN GO TO MANUFACTURING HALT

     0058 1F                            POP     DS                      ; RESTORE CALLERS (DS)
     0059 C3                            RET

     005A                       MFG_HALT:                               ; MANUFACTURING LOOP MODE ERROR TRAP
     005A FA                            CLI                             ; DISABLE INTERRUPTS
     005B A0 0015 R                     MOV     AL,@MFG_ERR_FLAG        ; RECOVER ERROR INDICATOR
     005E E6 80                         OUT     MFG_PORT,AL             ; SET INTO MANUFACTURING PORT
     0060 F4                            HLT                             ; HALT SYSTEM
     0061 EB F7                         JMP     MFG_HALT                ; HOT NMI TRAP

     0063                       E_MSG   ENDP


     0063                       P_MSG   PROC    NEAR                    ;       DISPLAY STRING FROM (CS:)
     0063 2E: 8A 04                     MOV     AL,CS:[SI]              ; PUT CHARACTER IN (AL)
     0066 46                            INC     SI                      ; POINT TO NEXT CHARACTER
     0067 50                            PUSH    AX                      ; SAVE PRINT CHARACTER
     0068 E8 0128 R                     CALL    PRT_HEX                 ; CALL VIDEO_IO
     006B 58                            POP     AX                      ; RECOVER PRINT CHARACTER
     006C 3C 0A                         CMP     AL,LF                   ; WAS IT LINE FEED?
     006E 75 F3                         JNE     P_MSG                   ; NO, KEEP PRINTING STRING
     0070 C3                            RET

     0071                       P_MSG   ENDP

                                ;--- ERR_BEEP -----------------------------------------------------------
                                ;       THIS PROCEDURE WILL ISSUE LONG TONES (1-3/4 SECONDS) AND ONE OR :
                                ;       MORE SHORT TONES (9/32 SECOND) TO INDICATE A FAILURE ON THE     :
                                ;       PLANAR BOARD, A BAD MEMORY MODULE, OR A PROBLEM WITH THE CRT.   :
                                ; ENTRY PARAMETERS:                                                     :
                                ;       DH = NUMBER OF LONG TONES TO BEEP.                              :
                                ;       DL = NUMBER OF SHORT TONES TO BEEP.                             :
                                ;------------------------------------------------------------------------

     0071                       ERR_BEEP        PROC    NEAR
     0071 9C                            PUSHF                           ; SAVE FLAGS
     0072 FA                            CLI                             ; DISABLE SYSTEM INTERRUPTS
     0073 0A F6                         OR      DH,DH                   ; ANY LONG ONES TO BEEP
     0075 74 1E                         JZ      G3                      ; NO, DO THE SHORT ONES
     0077                       G1:                                     ;       LONG BEEPS
     0077 B3 70                         MOV     BL,112                  ; COUNTER FOR LONG BEEPS (1-3/4 SECONDS)
     0079 B9 0500                       MOV     CX,1280                 ; DIVISOR FOR 932 HZ
     007C E8 00AF R                     CALL    BEEP                    ; DO THE BEEP
     007F B9 C233                       MOV     CX,49715                ; 2/3 SECOND DELAY AFTER LONG BEEP
     0082 E8 00F5 R                     CALL    WAITF                   ; DELAY BETWEEN BEEPS
     0085 FE CE                         DEC     DH                      ; ANY MORE LONG BEEPS TO DO
     0087 75 EE                         JNZ     G1                      ; LOOP TILL DONE

     0089 1E                            PUSH    DS                      ; SAVE DS REGISTER CONTENTS
     008A E8 0034 R                     CALL    DDS
     008D 80 3E 0012 R 01               CMP     @MFG_TST,01H            ; MANUFACTURING TEST MODE?
     0092 1F                            POP     DS                      ; RESTORE ORIGINAL CONTENTS OF (DS)
     0093 74 C5                         JE      MFG_HALT                ; YES - STOP BLINKING LED

     0095                       G3:                                     ;       SHORT BEEPS
     0095 B3 12                         MOV     BL,18                   ; COUNTER FOR A SHORT BEEP (9/32)
     0097 B9 04B8                       MOV     CX,1208                 ; DIVISOR FOR 987 HZ
     009A E8 00AF R                     CALL    BEEP                    ; DO THE SOUND
     009D B9 8178                       MOV     CX,33144                ; 1/2 SECOND DELAY AFTER SHORT BEEP
     00A0 E8 00F5 R                     CALL    WAITF                   ; DELAY BETWEEN BEEPS
     00A3 FE CA                         DEC     DL                      ; DONE WITH SHORT BEEPS COUNT
     00A5 75 EE                         JNZ     G3                      ; LOOP TILL DONE

     00A7 B9 8178                       MOV     CX,33144                ; 1/2 SECOND DELAY AFTER LAST BEEP
     00AA E8 00F5 R                     CALL    WAITF                   ; MAKE IT ONE SECOND DELAY BEFORE RETURN
     00AD 9D                            POPF                            ; RESTORE FLAGS TO ORIGINAL SETTINGS
     00AE C3                            RET                             ; RETURN TO CALLER

     00AF                       ERR_BEEP        ENDP
```

```
                            PAGE
                            ;--- BEEP --------------------------------------------------------------
                            ;       ROUTINE TO SOUND THE BEEPER USING TIMER 2 FOR TONE                :
                            ; ENTRY:                                                                  :
                            ;       (BL) = DURATION COUNTER  ( 1 FOR 1/64 SECOND )                    :
                            ;       (CX) = FREQUENCY DIVISOR (1193180/FREQUENCY) (1331 FOR 886 HZ)    :
                            ; EXIT:                                                                   :
                            ;       (AX),(BL),(CX) MODIFIED.                                          :
                            ;-----------------------------------------------------------------------

 00AF                       BEEP    PROC    NEAR                    ;       SETUP TIMER 2
 00AF 9C                            PUSHF                           ; SAVE INTERRUPT STATUS
 00B0 FA                            CLI                             ; BLOCK INTERRUPTS DURING UPDATE
 00B1 B0 B6                         MOV     AL,10110110B            ; SELECT TIMER 2,LSB,MSB,BINARY
 00B3 E6 43                         OUT     TIMER+3,AL              ; WRITE THE TIMER MODE REGISTER
 00B5 EB 00                         JMP     $+2                     ; I/O DELAY
 00B7 8A C1                         MOV     AL,CL                   ; DIVISOR FOR HZ (LOW)
 00B9 E6 42                         OUT     TIMER+2,AL              ; WRITE TIMER 2 COUNT - LSB
 00BB EB 00                         JMP     $+2                     ; I/O DELAY
 00BD 8A C5                         MOV     AL,CH                   ; DIVISOR FOR HZ (HIGH)
 00BF E6 42                         OUT     TIMER+2,AL              ; WRITE TIMER 2 COUNT - MSB
 00C1 E4 61                         IN      AL,PORT_B               ; GET CURRENT SETTING OF PORT
 00C3 8A E0                         MOV     AH,AL                   ; SAVE THAT SETTING
 00C5 0C 03                         OR      AL,GATE2+SPK2           ; GATE TIMER 2 AND TURN SPEAKER ON
 00C7 E6 61                         OUT     PORT_B,AL               ; AND RESTORE INTERRUPT STATUS
 00C9 9D                            POPF
 00CA                       G7:                                     ;       1/64 SECOND PER COUNT (BL)
 00CA B9 040B                       MOV     CX,1035                 ; DELAY COUNT FOR 1/64 OF A SECOND
 00CD E8 00F5 R                     CALL    WAITF                   ; GO TO BEEP DELAY 1/64 COUNT
 00D0 FE CB                         DEC     BL                      ; (BL) LENGTH COUNT EXPIRED?
 00D2 75 F6                         JNZ     G7                      ; NO - CONTINUE BEEPING SPEAKER

 00D4 9C                            PUSHF                           ; SAVE INTERRUPT STATUS
 00D5 FA                            CLI                             ; BLOCK INTERRUPTS DURING UPDATE
 00D6 E4 61                         IN      AL,PORT_B               ; GET CURRENT PORT VALUE
 00D8 0C FC                         OR      AL,NOT (GATE2+SPK2)     ; ISOLATE CURRENT SPEAKER BITS IN CASE
 00DA 22 E0                         AND     AH,AL                   ;  SOMEONE TURNED THEM OFF DURING BEEP
 00DC 8A C4                         MOV     AL,AH                   ; RECOVER VALUE OF PORT
 00DE 24 FC                         AND     AL,NOT (GATE2+SPK2)     ; FORCE SPEAKER DATA OFF
 00E0 E6 61                         OUT     PORT_B,AL               ; AND STOP SPEAKER TIMER
 00E2 9D                            POPF                            ; RESTORE INTERRUPT FLAG STATE
 00E3 B9 040B                       MOV     CX,1035                 ; FORCE 1/64 SECOND DELAY (SHORT)
 00E6 E8 00F5 R                     CALL    WAITF                   ; MINIMUM DELAY BETWEEN ALL BEEPS
 00E9 9C                            PUSHF                           ; SAVE INTERRUPT STATUS
 00EA FA                            CLI                             ; BLOCK INTERRUPTS DURING UPDATE
 00EB E4 61                         IN      AL,PORT_B               ; GET CURRENT PORT VALUE IN CASE
 00ED 24 03                         AND     AL,GATE2+SPK2           ;  SOMEONE TURNED THEM ON
 00EF 0A C4                         OR      AL,AH                   ; RECOVER VALUE OF PORT_B
 00F1 E6 61                         OUT     PORT_B,AL               ; RESTORE SPEAKER STATUS
 00F3 9D                            POPF                            ; RESTORE INTERRUPT FLAG STATE
 00F4 C3                            RET

 00F5                       BEEP    ENDP

                            ;--- WAITF -------------------------------------------------------------
                            ;       FIXED TIME WAIT ROUTINE (HARDWARE CONTROLLED - NOT PROCESSOR)     :
                            ;                                                                         :
                            ; ENTRY:                                                                  :
                            ;       (CX) = COUNT OF 15.085737 MICROSECOND INTERVALS TO WAIT           :
                            ;              MEMORY REFRESH TIMER 1 OUTPUT USED AS REFERENCE            :
                            ; EXIT:                                                                   :
                            ;              AFTER (CX) TIME COUNT (PLUS OR MINUS 16 MICROSECONDS)      :
                            ;       (CX) = 0                                                          :
                            ;-----------------------------------------------------------------------

 00F5                       WAITF   PROC    NEAR                    ;       DELAY FOR  (CX)*15.085737 US
 00F5 50                            PUSH    AX                      ; SAVE WORK REGISTER (AH)

 00F6                       WAITF1:                                 ;       USE TIMER 1 OUTPUT BITS
 00F6 E4 61                         IN      AL,PORT_B               ; READ CURRENT COUNTER OUTPUT STATUS
 00F8 24 10                         AND     AL,REFRESH_BIT          ; MASK FOR REFRESH DETERMINE BIT
 00FA 3A C4                         CMP     AL,AH                   ; DID IT JUST CHANGE
 00FC 74 F8                         JE      WAITF1                  ; WAIT FOR A CHANGE IN OUTPUT LINE

 00FE 8A E0                         MOV     AH,AL                   ; SAVE NEW FLAG STATE
 0100 E2 F4                         LOOP    WAITF1                  ; DECREMENT HALF CYCLES TILL COUNT END

 0102 58                            POP     AX                      ; RESTORE (AH)
 0103 C3                            RET                             ; RETURN  (CX)= 0

 0104                       WAITF   ENDP

                            ;--- CONFIG_BAD --------------------------------------------------------
                            ;       SET CMOS_DIAG WITH CONFIG ERROR BIT (WITH NMI DISABLED)           :
                            ;       (BP) BIT 14 SET ON TO INDICATE CONFIGURATION ERROR                :
                            ;-----------------------------------------------------------------------

 0104                       CONFIG_BAD      PROC    NEAR
 0104 50                            PUSH    AX
 0105 B8 8E8E                       MOV     AX,X*(CMOS_DIAG+NMI)    ; ADDRESS CMOS DIAGNOSTIC STATUS BYTE
 0108 E8 0000 R                     CALL    CMOS_READ               ; GET CURRENT VALUE
 010B 0C 20                         OR      AL,BAD_CONFIG           ; SET BAD CONFIGURATION BIT
 010D 86 E0                         XCHG    AH,AL                   ; SETUP FOR WRITE
 010F E8 001A R                     CALL    CMOS_WRITE              ; UPDATE CMOS WITH BAD CONFIGURATION
 0112 58                            POP     AX
 0113 81 CD 4000                    OR      BP,04000H               ; SET CONFIGURATION BAD FLAG IN (BP)
 0117 C3                            RET

 0118                       CONFIG_BAD      ENDP
```

```
                                PAGE
                                ;--- XPC_BYTE -- XLATE_PR -- PRT_HEX -----------------------------------
                                ;                                                                      :
                                ;       CONVERT AND PRINT ASCII CODE CHARACTERS                        :
                                ;                                                                      :
                                ;       AL CONTAINS NUMBER TO BE CONVERTED.                            :
                                ;       AX AND BX DESTROYED.                                           :
                                ;-----------------------------------------------------------------------

0118                            XPC_BYTE        PROC    NEAR            ;       DISPLAY TWO HEX DIGITS
0118 50                                 PUSH    AX                      ; SAVE FOR LOW NIBBLE DISPLAY
0119 C0 E8 04                           SHR     AL,4                    ; NIBBLE SWAP
011C E8 0122 R                          CALL    XLAT_PR                 ; DO THE HIGH NIBBLE DISPLAY
011F 58                                 POP     AX                      ; RECOVER THE NIBBLE
0120 24 0F                              AND     AL,0FH                  ; ISOLATE TO LOW NIBBLE
                                                                        ; FALL INTO LOW NIBBLE CONVERSION

0122                            XLAT_PR PROC    NEAR                    ;       CONVERT 00-0F TO ASCII CHARACTER
0122 04 90                              ADD     AL,090H                 ; ADD FIRST CONVERSION FACTOR
0124 27                                 DAA                             ; ADJUST FOR NUMERIC AND ALPHA RANGE
0125 14 40                              ADC     AL,040H                 ; ADD CONVERSION AND ADJUST LOW NIBBLE
0127 27                                 DAA                             ; ADJUST HIGH NIBBLE TO ASCII RANGE

0128                            PRT_HEX PROC    NEAR
0128 B4 0E                              MOV     AH,0EH                  ; DISPLAY CHARACTER IN (AL) COMMAND
012A B7 00                              MOV     BH,0
012C CD 10                              INT     10H                     ; CALL VIDEO_IO
012E C3                                 RET

012F                            PRT_HEX ENDP
012F                            XLAT_PR ENDP
012F                            XPC_BYTE        ENDP

                                ;--- PRT_SEG -------------------------------------------------
                                ;       PRINT A SEGMENT VALUE TO LOOK LIKE A 21 BIT ADDRESS    :
                                ;       DX MUST CONTAIN SEGMENT VALUE TO BE PRINTED            :
                                ;-------------------------------------------------------------

012F                            PRT_SEG PROC    NEAR
012F 8A C6                              MOV     AL,DH                   ; GET MSB
0131 E8 0118 R                          CALL    XPC_BYTE                ; DISPLAY SEGMENT HIGH BYTE
0134 8A C2                              MOV     AL,DL                   ; LSB
0136 E8 0118 R                          CALL    XPC_BYTE                ; DISPLAY SEGMENT LOW BYTE
0139 B0 30                              MOV     AL,'0'                  ; PRINT A '0 '
013B E8 0128 R                          CALL    PRT_HEX                 ;  TO MAKE LOOK LIKE ADDRESS
013E B0 20                              MOV     AL,' '                  ; ADD ENDING SPACE
0140 E8 0128 R                          CALL    PRT_HEX
0143 C3                                 RET

0144                            PRT_SEG ENDP

                                ;--- PROT_PRT_HEX ------------------------------------------------------
                                ;                                                                      :
                                ;       PUT A CHARACTER TO THE DISPLAY BUFFERS WHEN IN PROTECTED MODE  :
                                ;                                                                      :
                                ;       (AL)= ASCII CHARACTER                                          :
                                ;       (DI)= DISPLAY REGEN BUFFER POSITION                            :
                                ;-----------------------------------------------------------------------

0144                            PROT_PRT_HEX    PROC    NEAR
0144 06                                 PUSH    ES                      ; SAVE CURRENT SEGMENT REGISTERS
0145 57                                 PUSH    DI
0146 D1 E7                              SAL     DI,1                    ; MULTIPLY OFFSET BY TWO

                                ;-----  MONOCHROME VIDEO CARD

0148 6A 20                              PUSH    BYTE PTR C_BWCRT_PTR    ; GET MONOCHROME BUFFER SEGMENT SELECTOR
014A 07                                 POP     ES                      ; SET (ES) TO B/W DISPLAY BUFFER
014B AA                                 STOSB                           ; PLACE CHARACTER IN BUFFER
014C 4F                                 DEC     DI                      ; ADJUST POINTER BACK

                                ;-----  ENHANCED GRAPHICS ADAPTER

014D 6A 30                              PUSH    BYTE PTR E_CCRT_PTR     ; ENHANCED COLOR DISPLAY POINTER LOW 64K
014F 07                                 POP     ES                      ; LOAD SEGMENT SELECTOR
0150 AA                                 STOSB                           ; PLACE CHARACTER IN BUFFER
0151 4F                                 DEC     DI                      ; ADJUST POINTER BACK
0152 6A 38                              PUSH    BYTE PTR E_CCRT_PTR2    ; ENHANCED COLOR DISPLAY POINTER HI 64K
0154 07                                 POP     ES                      ; LOAD SEGMENT SELECTOR
0155 AA                                 STOSB                           ; PLACE CHARACTER IN BUFFER
0156 4F                                 DEC     DI                      ; ADJUST POINTER BACK

                                ;-----  COMPATIBLE COLOR

0157 6A 28                              PUSH    BYTE PTR C_CCRT_PTR     ; SET (DS) TO COMPATIBLE COLOR MEMORY
0159 07                                 POP     ES
015A 53                                 PUSH    BX                      ; SAVE WORK REGISTERS
015B 52                                 PUSH    DX
015C 51                                 PUSH    CX
015D 33 C9                              XOR     CX,CX                   ; TIMEOUT LOOP FOR "BAD" HARDWARE
015F BA 03DA                            MOV     DX,03DAH                ; STATUS ADDRESS OF COLOR CARD
0162 93                                 XCHG    AX,BX                   ; SAVE IN (BX) REGISTER
0163                            PROT_S:
0163 EC                                 IN      AL,DX                   ; GET COLOR CARD STATUS
0164 A8 09                              TEST    AL,RVRT+RHRZ            ; CHECK FOR VERTICAL RETRACE (OR HORZ)
0166 E1 FB                              LOOPZ   PROT_S                  ; TIMEOUT LOOP TILL FOUND
0168 93                                 XCHG    AX,BX                   ; RECOVER CHARACTERS
0169 AA                                 STOSB                           ; PLACE CHARACTER IN BUFFER

016A 59                                 POP     CX                      ; RESTORE REGISTERS
016B 5A                                 POP     DX
016C 5B                                 POP     BX
016D 5F                                 POP     DI
016E 07                                 POP     ES
016F C3                                 RET

0170                            PROT_PRT_HEX    ENDP
```

```
                                        PAGE
                                        ;----------------------------------------
                                        ;           ROM CHECKSUM SUBROUTINE        :
                                        ;----------------------------------------

 0170                                   ROM_CHECKSUM    PROC    NEAR
 0170  2B C9                                    SUB     CX,CX                   ; NUMBER OF BYTES TO ADD IS 64K

 0172                                   ROM_CHECKSUM_CNT:                       ; ENTRY FOR OPTIONAL ROM TEST
 0172  32 C0                                    XOR     AL,AL
 0174                                   ROM_L:
 0174  02 07                                    ADD     AL,[BX]                 ; GET (DS:BX)
 0176  43                                       INC     BX                      ; POINT TO NEXT BYTE
 0177  E2 FB                                    LOOP    ROM_L                   ; ADD ALL BYTES IN ROM MODULE

 0179  0A C0                                    OR      AL,AL                   ; SUM = 0?
 017B  C3                                       RET

 017C                                   ROM_CHECKSUM    ENDP

                                        ;---------------------------------------------------------------------
                                        ;       THIS ROUTINE CHECKSUMS OPTIONAL ROM MODULES AND                :
                                        ;       IF CHECKSUM IS OK, CALLS INITIALIZATION/TEST CODE IN MODULE    :
                                        ;---------------------------------------------------------------------

 017C                                   ROM_CHECK       PROC    NEAR
 017C  B8 ---- R                                MOV     AX,DATA                 ; POINT ES TO DATA AREA
 017F  8E C0                                    MOV     ES,AX
 0181  2A E4                                    SUB     AH,AH                   ; ZERO OUT AH
 0183  8A 47 02                                 MOV     AL,[BX+2]               ; GET LENGTH INDICATOR
 0186  C1 E0 09                                 SHL     AX,9                    ; MULTIPLY BY 512
 0189  8B C8                                    MOV     CX,AX                   ; SET COUNT
 018B  C1 E8 04                                 SHR     AX,4
 018E  03 D0                                    ADD     DX,AX                   ; SET POINTER TO NEXT MODULE
 0190  E8 0172 R                                CALL    ROM_CHECKSUM_CNT        ; DO CHECKSUM
 0193  74 05                                    JZ      ROM_CHECK_1

 0195  E8 0000 E                                CALL    ROM_ERR                 ; POST CHECKSUM ERROR
 0198  EB 13                                    JMP     SHORT ROM_CHECK_END     ; AND EXIT

 019A                                   ROM_CHECK_1:
 019A  52                                       PUSH    DX                      ; SAVE POINTER
 019B  26: C7 06 0067 R 0003                    MOV     ES:@IO_ROM_INIT,0003H   ; LOAD OFFSET
 01A2  26: 8C 1E 0069 R                         MOV     ES:@IO_ROM_SEG,DS       ; LOAD SEGMENT
 01A7  26: FF 1E 0067 R                         CALL    DWORD PTR ES:@IO_ROM_INIT; CALL INITIALIZE/TEST ROUTINE
 01AC  5A                                       POP     DX

 01AD                                   ROM_CHECK_END:
 01AD  C3                                       RET                             ; RETURN TO CALLER

 01AE                                   ROM_CHECK       ENDP

                                        ;--- KBD_RESET -------------------------------------------------------
                                        ;       THIS PROCEDURE WILL SEND A SOFTWARE RESET TO THE KEYBOARD.     :
                                        ;       SCAN CODE  0AAH  SHOULD BE RETURNED TO THE PROCESSOR.          :
                                        ;       SCAN CODE  065H  IS DEFINED FOR MANUFACTURING TEST             :
                                        ;---------------------------------------------------------------------

 01AE                                   KBD_RESET       PROC    NEAR
 01AE  B0 FF                                    MOV     AL,0FFH                 ; SET KEYBOARD RESET COMMAND
 01B0  E8 0000 E                                CALL    XMIT_8042               ; GO ISSUE THE COMMAND
 01B3  E3 23                                    JCXZ    G13                     ; EXIT IF ERROR

 01B5  3C FA                                    CMP     AL,KB_ACK
 01B7  75 1F                                    JNZ     G13

 01B9  B0 FD                                    MOV     AL,0FDH                 ; ENABLE KEYBOARD INTERRUPTS
 01BB  E6 21                                    OUT     INTA01,AL               ; WRITE 8259 INTERRUPT MASK REGISTER
 01BD  C6 06 006B R 00                          MOV     @INTR_FLAG,0            ; RESET INTERRUPT INDICATOR
 01C2  FB                                       STI                             ; ENABLE INTERRUPTS
 01C3  B3 0A                                    MOV     BL,10                   ; TRY FOR 400 MILLISECONDS
 01C5  2B C9                                    SUB     CX,CX                   ; SETUP INTERRUPT TIMEOUT COUNT
 01C7                                   G11:
 01C7  F6 06 006B R 02                          TEST    @INTR_FLAG,02H          ; DID A KEYBOARD INTERRUPT OCCUR ?
 01CC  75 06                                    JNZ     G12                     ; YES - READ SCAN CODE RETURNED
 01CE  E2 F7                                    LOOP    G11                     ; NO - LOOP TILL TIMEOUT

 01D0  FE CB                                    DEC     BL
 01D2  75 F3                                    JNZ     G11                     ; TRY AGAIN
 01D4                                   G12:
 01D4  E4 60                                    IN      AL,PORT_A               ; READ KEYBOARD SCAN CODE
 01D6  8A D8                                    MOV     BL,AL                   ; SAVE SCAN CODE JUST READ
 01D8                                   G13:
 01D8  C3                                       RET                             ; RETURN TO CALLER

 01D9                                   KBD_RESET       ENDP

                                        ;---------------------------------------------------
                                        ;       BLINK LED PROCEDURE FOR MFG RUN-IN TESTS     :
                                        ;        IF LED IS ON, TURN IT OFF. IF OFF, TURN ON.  :
                                        ;---------------------------------------------------

 01D9                                   BLINK_INT       PROC    NEAR
 01D9  FB                                       STI
 01DA  50                                       PUSH    AX                      ; SAVE AX REGISTER CONTENTS
 01DB  E4 80                                    IN      AL,MFG_PORT             ; READ CURRENT VALUE OF MFG_PORT
 01DD  34 40                                    XOR     AL,01000000B            ; FLIP CONTROL BIT
 01DF  E6 80                                    OUT     MFG_PORT,AL
 01E1  B0 20                                    MOV     AL,EOI
 01E3  E6 20                                    OUT     INTA00,AL
 01E5  58                                       POP     AX                      ; RESTORE AX REGISTER
 01E6  CF                                       IRET

 01E7                                   BLINK_INT       ENDP
```

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                                PAGE
                                ;--------------------------------------------------------------------------
                                ;       THIS ROUTINE INITIALIZES THE TIMER DATA AREA IN THE ROM BIOS         :
                                ;       DATA AREA.  IT IS CALLED BY THE POWER ON ROUTINES.  IT CONVERTS      :
                                ;       HR:MIN:SEC  FROM CMOS TO TIMER TICS.  IF CMOS IS INVALID, TIMER     :
                                ;       IS SET TO ZERO.                                                      :
                                ;                                                                            :
                                ; INPUT     NONE PASSED TO ROUTINE BY CALLER                                 :
                                ;           CMOS LOCATIONS USED FOR TIME                                     :
                                ;                                                                            :
                                ; OUTPUT    @TIMER_LOW                                                       :
                                ;           @TIMER_HIGH                                                      :
                                ;           @TIMER_OFL                                                       :
                                ;           ALL REGISTERS UNCHANGED                                          :
                                ;--------------------------------------------------------------------------
 = 0012                         COUNTS_SEC      EQU     18              ; TIMER DATA CONVERSION EQUATES
 = 0444                         COUNTS_MIN      EQU     1092
 = 0007                         COUNTS_HOUR     EQU     7               ; 65543 - 65536
 = 0080                         UPDATE_TIMER    EQU     10000000B       ; RTC UPDATE IN PROCESS BIT MASK

 01E7                           SET_TOD PROC    NEAR
 01E7 60                                PUSHA
 01E8 1E                                PUSH    DS
 01E9 E8 0034 R                         CALL    DDS                     ; ESTABLISH SEGMENT
 01EC 2B C0                             SUB     AX,AX
 01EE A2 0070 R                         MOV     @TIMER_OFL,AL           ; RESET TIMER ROLL OVER INDICATOR
 01F1 A3 006C R                         MOV     @TIMER_LOW,AX           ; AND TIMER COUNT
 01F4 A3 006E R                         MOV     @TIMER_HIGH,AX
 01F7 B0 8E                             MOV     AL,CMOS_DIAG+NMI        ; CHECK CMOS VALIDITY
 01F9 E8 0000 R                         CALL    CMOS_READ               ; READ DIAGNOSTIC LOCATION IN CMOS
 01FC 24 C4                             AND     AL,BAD_BAT+BAD_CKSUM+CMOS_CLK_FAIL
 01FE 2B C9                             SUB     CX,CX                   ; BAD BATTERY, CHKSUM ERROR, CLOCK ERROR
 0200 75 64                             JNZ     POD_DONE                ; CMOS NOT VALID -- TIMER SET TO ZERO
 0202                           UIP:
 0202 B0 8A                             MOV     AL,CMOS_REG_A+NMI       ; ACCESS REGISTER A
 0204 E8 0000 R                         CALL    CMOS_READ               ; READ CMOS CLOCK REGISTER A
 0207 A8 80                             TEST    AL,UPDATE_TIMER
 0209 E1 F7                             LOOPZ   UIP                     ; WAIT TILL UPDATE BIT IS ON

 020B E3 59                             JCXZ    POD_DONE                ; CMOS CLOCK STUCK IF TIMEOUT
 020D                           UIPOFF:
 020D B0 8A                             MOV     AL,CMOS_REG_A+NMI       ; ACCESS REGISTER A
 020F E8 0000 R                         CALL    CMOS_READ               ; READ CMOS CLOCK REGISTER A
 0212 A8 80                             TEST    AL,UPDATE_TIMER
 0214 E0 F7                             LOOPNZ  UIPOFF                  ; NEXT WAIT TILL END OF UPDATE

 0216 E3 4E                             JCXZ    POD_DONE                ; CMOS CLOCK STUCK IF TIMEOUT

 0218 B0 80                             MOV     AL,CMOS_SECONDS+NMI     ;       TIME JUST UPDATED
 021A E8 0000 R                         CALL    CMOS_READ               ; ACCESS SECONDS VALUE IN CMOS
 021D 3C 59                             CMP     AL,59H                  ; ARE THE SECONDS WITHIN LIMITS?
 021F 77 48                             JA      TOD_ERROR               ; GO IF NOT

 0221 E8 027F R                         CALL    CVT_BINARY              ; CONVERT IT TO BINARY
 0224 8B C8                             MOV     CX,AX                   ; MOVE COUNT TO ACCUMULATION REGISTER
 0226 C1 E9 02                          SHR     CX,2                    ; ADJUST FOR SYSTEMATIC SECONDS ERROR
 0229 B3 12                             MOV     BL,COUNTS_SEC
 022B F6 E3                             MUL     BL                      ; COUNT FOR SECONDS
 022D 03 C8                             ADD     CX,AX
 022F B0 82                             MOV     AL,CMOS_MINUTES+NMI
 0231 E8 0000 R                         CALL    CMOS_READ               ; ACCESS MINUTES VALUE IN CMOS
 0234 3C 59                             CMP     AL,59H                  ; ARE THE MINUTES WITHIN LIMITS?
 0236 77 31                             JA      TOD_ERROR               ; GO IF NOT
 0238 E8 027F R                         CALL    CVT_BINARY              ; CONVERT IT TO BINARY
 023B 50                                PUSH    AX                      ; SAVE MINUTES COUNT
 023C D1 E8                             SHR     AX,1                    ; ADJUST FOR SYSTEMATIC MINUTES ERROR
 023E 03 C8                             ADD     CX,AX                   ; ADD ADJUSTMENT TO COUNT
 0240 58                                POP     AX                      ; RECOVER BCD MINUTES VALUE
 0241 BB 0444                           MOV     BX,COUNTS_MIN
 0244 F7 E3                             MUL     BX                      ; COUNT FOR MINUTES
 0246 03 C8                             ADD     CX,AX                   ; ADD TO ACCUMULATED VALUE
 0248 B0 84                             MOV     AL,CMOS_HOURS+NMI
 024A E8 0000 R                         CALL    CMOS_READ               ; ACCESS HOURS VALUE IN CMOS
 024D 3C 23                             CMP     AL,23H                  ; ARE THE HOURS WITHIN LIMITS?
 024F 77 18                             JA      TOD_ERROR               ; GO IF NOT

 0251 E8 027F R                         CALL    CVT_BINARY              ; CONVERT IT TO BINARY
 0254 8B D0                             MOV     DX,AX
 0256 B3 07                             MOV     BL,COUNTS_HOUR
 0258 F6 E3                             MUL     BL                      ; COUNT FOR HOURS
 025A 03 C1                             ADD     AX,CX
 025C 83 D2 00                          ADC     DX,0000H
 025F 89 16 006E R                      MOV     @TIMER_HIGH,DX
 0263 A3 006C R                         MOV     @TIMER_LOW,AX
 0266                           POD_DONE:
 0266 1F                                POP     DS
 0267 61                                POPA
 0268 C3                                RET

 0269                           TOD_ERROR:
 0269 1F                                POP     DS                      ; RESTORE SEGMENT
 026A 61                                POPA                            ; RESTORE REGISTERS
 026B BE 0000 E                         MOV     SI,OFFSET E163          ; DISPLAY CLOCK ERROR
 026E E8 003C R                         CALL    E_MSG
 0271 B8 8E8E                           MOV     AX,X*(CMOS_DIAG+NMI)    ; SET CLOCK ERROR IN STATUS
 0274 E8 0000 R                         CALL    CMOS_READ               ; READ DIAGNOSTIC CMOS LOCATION
 0277 0C 04                             OR      AL,CMOS_CLK_FAIL        ; SET NEW STATUS WITH CMOS CLOCK ERROR
 0279 86 C4                             XCHG    AL,AH                   ; MOVE NEW STATUS TO WORK REGISTER
 027B E8 001A R                         CALL    CMOS_WRITE              ; UPDATE STATUS LOCATION
 027E C3                                RET

 027F                           SET_TOD ENDP

 027F                           CVT_BINARY      PROC    NEAR
 027F 8A E0                             MOV     AH,AL                   ; UNPACK 2 BCD DIGITS IN AL
 0281 C0 EC 04                          SHR     AH,4
 0284 24 0F                             AND     AL,0FH                  ; RESULT IS IN AX
 0286 D5 0A                             AAD                             ; CONVERT UNPACKED BCD TO BINARY
 0288 C3                                RET

 0289                           CVT_BINARY      ENDP
```

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                                PAGE
                                ;--- D11 -- INT ?? H -- ( IRQ LEVEL ?? ) ------------------------------------
                                ; TEMPORARY INTERRUPT SERVICE ROUTINE FOR POST                              :
                                ;                                                                           :
                                ;       THIS ROUTINE IS ALSO LEFT IN PLACE AFTER THE POWER ON DIAGNOSTICS   :
                                ;       TO SERVICE UNUSED INTERRUPT VECTORS.  LOCATION "@INTR_FLAG" WILL    :
                                ;       CONTAIN EITHER:                                                     :
                                ;        1) LEVEL OF HARDWARE INTERRUPT THAT CAUSED CODE TO BE EXECUTED, OR :
                                ;        2) "FF" FOR A NON-HARDWARE INTERRUPT THAT WAS EXECUTED ACCIDENTALLY. :
                                ;----------------------------------------------------------------------------

 0289                           D11     PROC    NEAR
 0289  50                               PUSH    AX                      ; SAVE REGISTER AX CONTENTS
 028A  53                               PUSH    BX
 028B  B0 0B                            MOV     AL,0BH                  ; READ IN-SERVICE REGISTER
 028D  E6 20                            OUT     INTA00,AL               ; (FIND OUT WHAT LEVEL BEING
 028F  EB 00                            JMP     $+2                     ;  SERVICED)
 0291  E4 20                            IN      AL,INTA00               ; GET LEVEL
 0293  8A E0                            MOV     AH,AL                   ; SAVE IT
 0295  0A C4                            OR      AL,AH                   ; 00? (NO HARDWARE ISR ACTIVE)
 0297  75 04                            JNZ     HW_INT

 0299  B4 FF                            MOV     AH,0FFH
 029B  EB 2F                            JMP     SHORT SET_INTR_FLAG     ; SET FLAG TO "FF" IF NON-HARDWARE
 029D                           HW_INT:
 029D  B0 0B                            MOV     AL,0BH                  ; READ IN-SERVICE REGISTER FROM
 029F  E6 A0                            OUT     INTB00,AL               ; INTERRUPT CHIP #2
 02A1  EB 00                            JMP     $+2                     ; I/O DELAY
 02A3  E4 A0                            IN      AL,INTB00               ; CHECK THE SECOND INTERRUPT CHIP
 02A5  8A F8                            MOV     BH,AL                   ; SAVE IT
 02A7  0A FF                            OR      BH,BH
 02A9  74 10                            JZ      NOT_SEC                 ; CONTINUE IF NOT

 02AB  E4 A1                            IN      AL,INTB01               ; GET SECOND INTERRUPT MASK
 02AD  0A C7                            OR      AL,BH                   ; MASK OFF LEVEL BEING SERVICED
 02AF  EB 00                            JMP     $+2                     ; I/O DELAY
 02B1  E6 A1                            OUT     INTB01,AL
 02B3  B0 20                            MOV     AL,EOI                  ; SEND EOI TO SECOND CHIP
 02B5  EB 00                            JMP     $+2                     ; I/O DELAY
 02B7  E6 A0                            OUT     INTB00,AL
 02B9  EB 0D                            JMP     SHORT IS_SEC
 02BB                           NOT_SEC:
 02BB  E4 21                            IN      AL,INTA01               ; GET CURRENT MASK VALUE
 02BD  EB 00                            JMP     $+2                     ; I/O DELAY
 02BF  80 E4 FB                         AND     AH,0FBH                 ; DO NOT DISABLE SECOND CONTROLLER
 02C2  0A C4                            OR      AL,AH                   ; MASK OFF LEVEL BEING SERVICED
 02C4  E6 21                            OUT     INTA01,AL               ; SET NEW INTERRUPT MASK
 02C6  EB 00                            JMP     $+2                     ; I/O DELAY
 02C8                           IS_SEC:
 02C8  B0 20                            MOV     AL,EOI
 02CA  E6 20                            OUT     INTA00,AL
 02CC                           SET_INTR_FLAG:
 02CC  5B                               POP     BX                      ; RESTORE (BX) FROM STACK
 02CD  1E                               PUSH    DS                      ; SAVE ACTIVE (DS)
 02CE  E8 0034 R                        CALL    DDS                     ; SET DATA SEGMENT
 02D1  88 26 006B R                     MOV     @INTR_FLAG,AH           ; SET FLAG
 02D5  1F                               POP     DS
 02D6  58                               POP     AX                      ; RESTORE REGISTER AX CONTENTS
 02D7                           DUMMY_RETURN_1:                         ; NEED IRET FOR VECTOR TABLE
 02D7  CF                               IRET

 02D8                           D11     ENDP

                                ;--- HARDWARE INT 71 H -- ( IRQ LEVEL 9 ) -- TO INT 0A H -------------------
                                ; REDIRECT SLAVE INTERRUPT 9 TO INTERRUPT LEVEL 2                           :
                                ;       THIS ROUTINE FIELDS LEVEL 9 INTERRUPTS AND                          :
                                ;       CONTROL IS PASSED TO MASTER INTERRUPT LEVEL 2                       :
                                ;----------------------------------------------------------------------------

 02D8                           RE_DIRECT PROC  NEAR
 02D8  50                               PUSH    AX                      ; SAVE (AX)
 02D9  B0 20                            MOV     AL,EOI
 02DB  E6 A0                            OUT     INTB00,AL               ; EOI TO SLAVE INTERRUPT CONTROLLER
 02DD  58                               POP     AX                      ; RESTORE (AX)
 02DE  CD 0A                            INT     0AH                     ; GIVE CONTROL TO HARDWARE LEVEL 2

 02E0  CF                               IRET                            ; RETURN

 02E1                           RE_DIRECT ENDP

                                ;--- HARDWARE INT 75 H -- ( IRQ LEVEL 13 ) ----------------------------------
                                ; SERVICE X287 INTERRUPTS                                                   :
                                ;       THIS ROUTINE FIELDS X287 INTERRUPTS AND CONTROL                     :
                                ;       IS PASSED TO THE NMI INTERRUPT HANDLER FOR                          :
                                ;       COMPATIBILITY.                                                      :
                                ;----------------------------------------------------------------------------

 02E1                           INT_287 PROC    NEAR
 02E1  50                               PUSH    AX                      ; SAVE (AX)
 02E2  32 C0                            XOR     AL,AL
 02E4  E6 F0                            OUT     X287,AL                 ; REMOVE THE INTERRUPT REQUEST

 02E6  B0 20                            MOV     AL,EOI                  ; ENABLE THE INTERRUPT
 02E8  E6 A0                            OUT     INTB00,AL               ;  THE SLAVE
 02EA  E6 20                            OUT     INTA00,AL               ;  THE MASTER
 02EC  58                               POP     AX                      ; RESTORE (AX)
 02ED  CD 02                            INT     02H                     ; GIVE CONTROL TO NMI

 02EF  CF                               IRET                            ; RETURN

 02F0                           INT_287 ENDP

 02F0                           PROC_SHUTDOWN   PROC                    ;       COMMON 80286 SHUTDOWN WAIT

 02F0  B0 FE                            MOV     AL,SHUT_CMD             ; SHUTDOWN COMMAND
 02F2  E6 64                            OUT     STATUS_PORT,AL          ; SEND TO KEYBOARD CONTROL PORT
 02F4                           PROC_S:
 02F4  F4                               HLT                             ; WAIT FOR 80286 RESET
 02F5  EB FD                            JMP     PROC_S                  ; INSURE HALT

 02F7                           PROC_SHUTDOWN   ENDP
 02F7                           CODE    ENDS
                                        END
```

```
                               PAGE 118,121
                               TITLE TEST5 ---- 06/10/85  EXCEPTION INTERRUPT TEST HANDLERS
                               .286C
                               .LIST
 0000                          CODE      SEGMENT BYTE PUBLIC

                                         PUBLIC  POST5
                                         PUBLIC  SYSINITI

                               ;----------------------------------------
                               ;         EXCEPTION INTERRUPT ROUTINE    :
                               ;----------------------------------------

                                         ASSUME  CS:CODE,DS:ABS0
 0000                          POST5:
 0000                          EXC_00:
 0000 B0 90                              MOV     AL,90H                  ;        <><> SET CHECKPOINT <><>
 0002 E9 00B2 R                          JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
 0005                          EXC_01:
 0005 B0 91                              MOV     AL,91H                  ;        <><> SET CHECKPOINT <><>
 0007 E9 00B2 R                          JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
 000A                          EXC_02:
 000A B0 92                              MOV     AL,92H                  ;        <><> SET CHECKPOINT <><>
 000C E9 00B2 R                          JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
 000F                          EXC_03:
 000F B0 93                              MOV     AL,93H                  ;        <><> SET CHECKPOINT <><>
 0011 E9 00B2 R                          JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
 0014                          EXC_04:
 0014 B0 94                              MOV     AL,94H                  ;        <><> SET CHECKPOINT <><>
 0016 E9 00B2 R                          JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
 0019                          EXC_05:
 0019 06                                 PUSH    ES
 001A 6A 48                              PUSH    BYTE PTR ES_TEMP        ; LOAD ES REGISTER WITH SELECTOR
 001C 07                                 POP     ES

                               ;-----    FIX BOUND PARAMETERS

 001D 2B FF                              SUB     DI,DI                   ; POINT BEGINNING OF THE BLOCK
 001F 26: C7 05 0000                     MOV     WORD PTR ES:[DI],0      ; SET FIRST WORD TO ZERO
 0024 26: C7 45 02 7FFF                  MOV     WORD PTR ES:[DI+2],07FFFH ; SET SECOND TO 07FFFH
 002A 07                                 POP     ES
 002B B0 95                              MOV     AL,95H                  ;        <><> SET CHECKPOINT <><>
 002D E9 00B2 R                          JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED

 0030                          EXC_06:
 0030 B0 96                              MOV     AL,96H                  ;        <><> SET CHECKPOINT <><>
 0032 EB 7E                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0034                          EXC_07:
 0034 B0 97                              MOV     AL,97H                  ;        <><> SET CHECKPOINT <><>
 0036 EB 7A                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0038                          EXC_08:
 0038 B0 98                              MOV     AL,98H                  ;        <><> SET CHECKPOINT <><>
 003A EB 76                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 003C                          EXC_09:
 003C B0 99                              MOV     AL,99H                  ;        <><> SET CHECKPOINT <><>
 003E EB 72                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0040                          EXC_10:
 0040 B0 9A                              MOV     AL,9AH                  ;        <><> SET CHECKPOINT <><>
 0042 EB 6E                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0044                          EXC_11:
 0044 B0 9B                              MOV     AL,9BH                  ;        <><> SET CHECKPOINT <><>
 0046 EB 6A                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0048                          EXC_12:
 0048 B0 9C                              MOV     AL,9CH                  ;        <><> SET CHECKPOINT <><>
 004A EB 66                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 004C                          EXC_13:
 004C B0 9D                              MOV     AL,9DH                  ;        <><> SET CHECKPOINT <><>
 004E EB 62                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0050                          EXC_14:
 0050 B0 9E                              MOV     AL,9EH                  ;        <><> SET CHECKPOINT <><>
 0052 EB 5E                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0054                          EXC_15:
 0054 B0 9F                              MOV     AL,9FH                  ;        <><> SET CHECKPOINT <><>
 0056 EB 5A                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0058                          EXC_16:
 0058 B0 A0                              MOV     AL,0A0H                 ;        <><> SET CHECKPOINT <><>
 005A EB 56                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 005C                          EXC_17:
 005C B0 A1                              MOV     AL,0A1H                 ;        <><> SET CHECKPOINT <><>
 005E EB 52                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0060                          EXC_18:
 0060 B0 A2                              MOV     AL,0A2H                 ;        <><> SET CHECKPOINT <><>
 0062 EB 4E                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0064                          EXC_19:
 0064 B0 A3                              MOV     AL,0A3H                 ;        <><> SET CHECKPOINT <><>
 0066 EB 4A                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0068                          EXC_20:
 0068 B0 A4                              MOV     AL,0A4H                 ;        <><> SET CHECKPOINT <><>
 006A EB 46                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 006C                          EXC_21:
 006C B0 A5                              MOV     AL,0A5H                 ;        <><> SET CHECKPOINT <><>
 006E EB 42                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0070                          EXC_22:
 0070 B0 A6                              MOV     AL,0A6H                 ;        <><> SET CHECKPOINT <><>
 0072 EB 3E                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0074                          EXC_23:
 0074 B0 A7                              MOV     AL,0A7H                 ;        <><> SET CHECKPOINT <><>
 0076 EB 3A                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0078                          EXC_24:
 0078 B0 A8                              MOV     AL,0A8H                 ;        <><> SET CHECKPOINT <><>
 007A EB 36                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 007C                          EXC_25:
 007C B0 A9                              MOV     AL,0A9H                 ;        <><> SET CHECKPOINT <><>
 007E EB 32                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0080                          EXC_26:
 0080 B0 AA                              MOV     AL,0AAH                 ;        <><> SET CHECKPOINT <><>
 0082 EB 2E                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0084                          EXC_27:
 0084 B0 AB                              MOV     AL,0ABH                 ;        <><> SET CHECKPOINT <><>
 0086 EB 2A                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0088                          EXC_28:
 0088 B0 AC                              MOV     AL,0ACH                 ;        <><> SET CHECKPOINT <><>
 008A EB 26                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 008C                          EXC_29:
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008C B0 AD                      MOV     AL,0ADH                 ;       <><> SET CHECKPOINT <><>
008E EB 22                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0090                    EXC_30:
0090 B0 AE                      MOV     AL,0AEH                 ;       <><> SET CHECKPOINT <><>
0092 EB 1E                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0094                    EXC_31:
0094 B0 AF                      MOV     AL,0AFH                 ;       <><> SET CHECKPOINT <><>
0096 EB 1A                      JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
0098                    SYS_32:
0098 B0 B0                      MOV     AL,0B0H                 ;       <><> SET CHECKPOINT <><>
009A EB 16                      JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
009C                    SYS_33:
009C B0 B1                      MOV     AL,0B1H                 ;       <><> SET CHECKPOINT <><>
009E EB 12                      JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
00A0                    SYS_34:
00A0 B0 B2                      MOV     AL,0B2H                 ;       <><> SET CHECKPOINT <><>
00A2 EB 0E                      JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
00A4                    SYS_35:
00A4 B0 B3                      MOV     AL,0B3H                 ;       <><> SET CHECKPOINT <><>
00A6 EB 0A                      JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
00A8                    SYS_36:
00A8 B0 B4                      MOV     AL,0B4H                 ;       <><> SET CHECKPOINT <><>
00AA EB 06                      JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
00AC                    SYS_37:
00AC B0 B5                      MOV     AL,0B5H                 ;       <><> SET CHECKPOINT <><>
00AE EB 02                      JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
00B0                    SYS_38:
00B0 B0 B6                      MOV     AL,0B6H                 ;       <><> SET CHECKPOINT <><>
                                                                ; GO TEST IF INTERRUPT WAS EXPECTED

00B2                    TEST_EXC:
00B2 E6 80                      OUT     MFG_PORT,AL             ; OUTPUT THE CHECKPOINT
00B4 3C AF                      CMP     AL,0AFH                 ; CHECK FOR EXCEPTION
00B6 77 1C                      JA      TEST_EXC0               ; GO IF A SYSTEM INTERRUPT

00B8 1E                         PUSH    DS                      ; SAVE THE CURRENT DATA SEGMENT
00B9 6A 08                      PUSH    BYTE PTR GDT_PTR
00BB 1F                         POP     DS
00BC C7 06 0048 FFFF            MOV     DS:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN
00C2 C6 06 004D 93              MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS
00C7 6A 48                      PUSH    BYTE PTR ES_TEMP
00C9 07                         POP     ES
00CA 1F                         POP     DS                      ; RESTORE REGISTERS
00CB 5A                         POP     DX                      ; CHECK IF CODE SEGMENT SECOND ON STACK
00CC 59                         POP     CX
00CD 51                         PUSH    CX
00CE 83 F9 40                   CMP     CX,SYS_ROM_CS
00D1 75 01                      JNZ     TEST_EXC0               ; CONTINUE IF ERROR CODE

00D3 52                         PUSH    DX                      ; PUT SEGMENT BACK ON STACK
00D4                    TEST_EXC0:
00D4 86 E0                      XCHG    AH,AL                   ; SAVE THE CHECKPOINT
00D6 E4 8B                      IN      AL,DMA_PAGE+0AH
00D8 3A C4                      CMP     AL,AH                   ; WAS THE EXCEPTION EXPECTED?
00DA 74 0E                      JZ      TEST_EXC3               ; GO IF YES
00DC                    TEST_EXC1:
00DC E4 80                      IN      AL,MFG_PORT             ; CHECK THE CURRENT CHECKPOINT
00DE 3C 3B                      CMP     AL,03BH                 ;  HALT IF CHECKPOINT BELOW 3BH
00E0 72 01                      JB      TEST_EXC2
00E2 CF                         IRET

00E3                    TEST_EXC2:
00E3 86 E0                      XCHG    AH,AL                   ; OUTPUT THE CURRENT CHECKPOINT
00E5 E6 80                      OUT     MFG_PORT,AL             ;   <><> CHECKPOINT  90 THRU  B5 <><>
00E7 F4                         HLT
00E8 EB F9                      JMP     TEST_EXC2               ; INSURE SYSTEM HALT

00EA                    TEST_EXC3:
00EA 2A C0                      SUB     AL,AL                   ; CLEAR DMA PAGE
00EC E6 8B                      OUT     DMA_PAGE+0AH,AL
00EE B8 0100                    MOV     AX,0100H                ; FOR BOUND INSTRUCTION EXPECTED (INT 5)
00F1 CF                         IRET                            ; RETURN

                        ;-----------------------------------------------------------------
                        ;       THIS BUILDS THE DESCRIPTOR TABLES REQUIRED FOR PROTECTED MODE   :
                        ;               PROCESSOR MUST BE IN REAL MODE                          :
                        ;-----------------------------------------------------------------
                                ASSUME  CS:CODE,DS:NOTHING,ES:NOTHING,SS:NOTHING

00F2                    SYSINIT1        PROC    NEAR
00F2 FA                         CLI                             ; NO INTERRUPTS ALLOWED
00F3 55                         PUSH    BP                      ; SAVE BP
00F4 B0 81                      MOV     AL,81H                  ;       <><><><><><><><><><><><>
00F6 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  81 <><>
00F8 E8 0149 R                  CALL    SIDT_BLD
00FB 8B EF                      MOV     BP,DI                   ; SAVE THE POINTER TO JUST PAST THE IDT
                                                                ; AS WE HAVE NO SDA, USE THE SIX BYTES
                                                                ;   HERE TO LOAD THE IDTR.  WE WILL SIDT
                                                                ;   WHEN WE GET TO SDA INITIALIZATION.
00FD B8 0800                    MOV     AX,SYS_IDT_LEN          ; SEGMENT LIMIT = LENGTH OF IDT
0100 AB                         STOSW                           ; STORE THAT AS IDT LIMIT
0101 B8 D0A0                    MOV     AX,SYS_IDT_LOC          ; IDT ADDRESS
0104 AB                         STOSW                           ;   AND ACCESS RIGHTS BYTE (UNDEFINED)
0105 B8 0000                    MOV     AX,0
0108 AB                         STOSW
                                SEGOV   ES                      ; LOAD THE IDT
0109 26                 +       DB      026H
                                LIDT    [BP]                    ;   REGISTER FROM THIS AREA
010A 0F                 +       DB      00FH
010B                    + ??0001        LABEL   BYTE
010B 8B 5E 00           +       MOV     BX,WORD PTR [BP]
010E                    + ??0002        LABEL   BYTE
010B                    +       ORG     OFFSET CS:??0001
010B 01                 +       DB      001H
010E                    +       ORG     OFFSET CS:??0002
010E 8B FD                      MOV     DI,BP                   ; ES:DI NOW --> END OF IDT AGAIN

                        ;-----  BUILD THE GDT.

0110 BF D8A0                    MOV     DI,GDT_LOC
0113 E8 0140 R                  CALL    GDT_BLD
0116 8B EF                      MOV     BP,DI                   ; SAVE THE ES:DI POINTER
0118 B8 0088                    MOV     AX,GDT_LEN              ; AX = LENGTH OF THE GDT
011B AB                         STOSW                           ; PUT THAT IN THE LIMIT FIELD
```

SECTION 5

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0 11C B8 D8A0                    MOV     AX,GDT_LOC              ; AX = LOW WORD OF GDT ADDRESS
0 11F AB                         STOSW                           ; PUT THAT IN BASE FIELD - LOW
0120 B8 0000                     MOV     AX,0                    ; AX = HIGH BYTE OF ADDRESS, AND
0123 AB                          STOSW                           ;   ACCESS RIGHTS BYTE IS UNDEFINED
                                 SEGOV   ES                      ; LOAD THE GDTR
0124 26                  +       DB      026H
                                 LGDT    [BP]                    ;    FROM THIS AREA
0125 0F                  +       DB      00FH
0126                     + ??0004 LABEL  BYTE
0126 8B 56 00            +       MOV     DX,WORD PTR [BP]
0129                     + ??0005 LABEL  BYTE
0126                     +       ORG     OFFSET CS:??0004
0126 01                  +       DB      001H
0129                     +       ORG     OFFSET CS:??0005
0129 8B FD                       MOV     DI,BP                   ; RESTORE THE ES:DI POINTER
012B AB                          STOSW
012C AB                          STOSW
012D 8B FD                       MOV     DI,BP

                         ;----- SWITCH TO VIRTUAL MODE

012F 5D                          POP     BP                      ; RESTORE BP
0130 B8 0001                     MOV     AX,VIRTUAL_ENABLE       ; MACHINE STATUS WORD NEEDED TO
                                 LMSW    AX                      ;  SWITCH TO VIRTUAL MODE
0133 0F 01 F0            +       DB      00FH,001H,0F0H

0136 EA                          DB      0EAH                    ; JUMP FAR TO PURGE PRE-FETCH QUEUE
0137 013B R                      DW      OFFSET DONE             ;   TO OFFSET
0139 0040                        DW      SYS_ROM_CS              ;   IN SEGMENT
013B                     DONE:
013B B0 85                       MOV     AL,85H                  ;       <><><><><><><><><><><><>
013D E6 80                       OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  82 <><>
013F C3                          RET                             ; SYSTEM INITIALIZATION

0140                     SYSINITI        ENDP


0140                     GDT_BLD PROC    NEAR
0140 BE 01AF R                   MOV     SI,OFFSET GDT_DATA_START           ; DS:SI --> GDT
0143 B9 0044                     MOV     CX,(OFFSET GDT_DATA_END-OFFSET GDT_DATA_START)/2  ; WORD COUNT
0146 F3/ A5                      REP     MOVSW                              ; COPY GDT INTO MEMORY
0148 C3                          RET
0149                     GDT_BLD ENDP


0149                     SIDT_BLD        PROC    NEAR

                         ;----- BUILD THE IDT.  THE IDT WILL CONTAIN VECTORS FOR EXCEPTION HANDLERS

0149 BE 0237 R                   MOV     SI,OFFSET SYS_IDT_OFFSETS  ; MAKE DS:SI POINT TO
014C 8C C8                       MOV     AX,CS                   ;    INTERRUPT ENTRY POINTS
014E 8E D8                       MOV     DS,AX
0150 BF D0A0                     MOV     DI,SYS_IDT_LOC          ; POINT TO SYS_IDT_LOC
0153 2B C0                       SUB     AX,AX
0155 8E C0                       MOV     ES,AX                   ;     WHERE THE IDT WILL BE.
0157 BB 0040                     MOV     BX,SYS_ROM_CS           ; CS IS THE SAME FOR ALL INTERRUPTS
015A B6 87                       MOV     DH,TRAP_GATE            ; ACCESS RIGHTS BYTE FOR THE GATE
015C B2 00                       MOV     DL,0                    ; THE WORD COUNT FIELD IS UNUSED
015E B9 0020                     MOV     CX,32                   ; THERE ARE 32 RESERVED INTERRUPTS
0161                     LOW_IDT:                                ; THIS LOOP BUILDS 32 DESCRIPTORS IN THE
                                                                 ;   IDT FOR THE RESERVED INTERRUPTS
0161 A5                          MOVSW                           ; GET A ROUTINE ENTRY POINT
                                                                 ;   AND PUT IT IN THE OFFSET FIELD
0162 8B C3                       MOV     AX,BX                   ; GET THE SYSTEM CODE SEGMENT SELECTOR
0164 AB                          STOSW                           ;   AND PUT IT IN THE SELECTOR FIELD
0165 8B C2                       MOV     AX,DX                   ; GET THE INTERRUPT GATE BYTE
0167 AB                          STOSW                           ;   AND PUT IN THE ACCESS RIGHTS FIELD
0168 B8 0000                     MOV     AX,0                    ; ZERO OUT
016B AB                          STOSW                           ;   THE RESERVED POSITIONS
016C E2 F3                       LOOP    LOW_IDT                 ;     AND REPEAT AS DIRECTED
016E B9 00E0                     MOV     CX,256-32               ; 256 TOTAL - 32 DONE = WHATEVER IS LEFT
0171 BD 0277 R                   MOV     BP,OFFSET FREE_INTS     ; THERE IS A COPY OF AN UN-INITIALIZED
                                                                 ;   INTERRUPT DESCRIPTOR AT FREE_INTS
0174                     HIGH_IDT:
0174 8B F5                       MOV     SI,BP                   ; DS:SI --> FREE DESCRIPTOR
                                                                 ; (ES:DI LEFT OFF AT INT 32)
0176 A5                          MOVSW                           ; MOVE OFFSET OF THE IRET INSTRUCTION
0177 A5                          MOVSW                           ; MOVE THE CS SELECTOR
0178 A5                          MOVSW                           ; MOVE THE ACCESS RIGHTS BYTE
0179 AB                          STOSW                           ; ZERO OUT THE RESERVED WORD
017A E2 F8                       LOOP    HIGH_IDT                ; FILL THE REMAINDER OF THE TABLE

                         ;----- INITIALIZE THE ENTRY POINTS FOR POST TEST

017C 26: C7 06 D1A0 0098 R       MOV     ES:(SYS_IDT_LOC+(032*DESC_LEN).ENTRY_POINT),OFFSET SYS_32
0183 26: C7 06 D1A8 009C R       MOV     ES:(SYS_IDT_LOC+(033*DESC_LEN).ENTRY_POINT),OFFSET SYS_33
018A 26: C7 06 D1B0 00A0 R       MOV     ES:(SYS_IDT_LOC+(034*DESC_LEN).ENTRY_POINT),OFFSET SYS_34
0191 26: C7 06 D1B8 00A4 R       MOV     ES:(SYS_IDT_LOC+(035*DESC_LEN).ENTRY_POINT),OFFSET SYS_35
0198 26: C7 06 D1C0 00A8 R       MOV     ES:(SYS_IDT_LOC+(036*DESC_LEN).ENTRY_POINT),OFFSET SYS_36
019F 26: C7 06 D1C8 00AC R       MOV     ES:(SYS_IDT_LOC+(037*DESC_LEN).ENTRY_POINT),OFFSET SYS_37
01A6 26: C7 06 D1D0 00B0 R       MOV     ES:(SYS_IDT_LOC+(038*DESC_LEN).ENTRY_POINT),OFFSET SYS_38
01AD C3                          RET

01AE                     IRET_ADDR       LABEL   WORD            ; FOR UN-INITIALIZED INTERRUPTS
01AE CF                          IRET                            ; NULL RETURN
```

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                               PAGE
                               ;       THE FOLLOWING DATA DEFINES THE PRE-INITIALIZED GDT FOR POST TESTS.
                               ;       THESE MUST BE INITIALIZED IN THE ORDER IN WHICH THEY APPEAR IN THE
                               ;       GDT_DEF STRUCTURE DEFINITION AS IT IS IN "SYSDATA.INC".

 = 01AF                        GDT_DATA_START  EQU     $

                               ;-----  FIRST ENTRY UNUSABLE  - (UNUSED_ENTRY)

 01AF 0000                             DW      0                       ; SEGMENT LIMIT
 01B1 0000                             DW      0                       ; SEGMENT BASE ADDRESS - LOW WORD
 01B3 00                               DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
 01B4 00                               DB      0                       ; ACCESS RIGHTS BYTE
 01B5 0000                             DW      0                       ; RESERVED - MUST BE ZERO

                               ;-----  THE GDT ITSELF  - (GDT_PTR)

 01B7 0088                             DW      GDT_LEN                 ; SEGMENT LIMIT
 01B9 D8A0                             DW      GDT_LOC                 ; SEGMENT BASE ADDRESS - LOW WORD
 01BB 00                               DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
 01BC 93                               DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01BD 0000                             DW      0                       ; RESERVED - MUST BE ZERO

                               ;-----  THE SYSTEM IDT DESCRIPTOR  - (SYS_IDT_PTR)

 01BF 0800                             DW      SYS_IDT_LEN             ; SEGMENT LIMIT
 01C1 D0A0                             DW      SYS_IDT_LOC             ; SEGMENT BASE ADDRESS - LOW WORD
 01C3 00                               DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
 01C4 93                               DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01C5 0000                             DW      0                       ; RESERVED - MUST BE ZERO

                               ;-----  THE SYSTEM DATA AREA DESCRIPTOR  - (RSDA_PTR)

 01C7 0300                             DW      SDA_LEN                 ; SEGMENT LIMIT
 01C9 0400                             DW      SDA_LOC                 ; SEGMENT BASE ADDRESS - LOW WORD
 01CB 00                               DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
 01CC 93                               DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01CD 0000                             DW      0                       ; RESERVED - MUST BE ZERO

                               ;-----  COMPATIBLE MONOCHROME DISPLAY REGEN BUFFER  - (C_BWCRT_PTR)

 01CF 1000                             DW      MCRT_SIZE               ; SEGMENT LIMIT
 01D1 0000                             DW      MCRT@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
 01D3 0B                               DB      MCRT@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
 01D4 93                               DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01D5 0000                             DW      0                       ; RESERVED - MUST BE ZERO

                               ;-----  COMPATIBLE COLOR DISPLAY REGEN BUFFER  - (C_CCRT_PTR)

 01D7 4000                             DW      CCRT_SIZE               ; SEGMENT LIMIT
 01D9 8000                             DW      CCRT@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
 01DB 0B                               DB      CCRT@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
 01DC 93                               DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01DD 0000                             DW      0                       ; RESERVED - MUST BE ZERO

                               ;-----  ENHANCED GRAPHIC ADAPTER REGEN BUFFER  - (E_CCRT_PRT)

 01DF FFFF                             DW      ECCRT_SIZE              ; SEGMENT LIMIT
 01E1 0000                             DW      ECCRT@_LO_LO            ; SEGMENT BASE ADDRESS - LOW WORD
 01E3 0A                               DB      ECCRT@_LO_HI            ; SEGMENT BASE ADDRESS - HIGH BYTE
 01E4 93                               DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01E5 0000                             DW      0                       ; RESERVED - MUST BE ZERO

                               ;-----  SECOND PART OF EGA  - (E_CCRT_PTR2)

 01E7 FFFF                             DW      ECCRT_SIZE              ; SEGMENT LIMIT
 01E9 0000                             DW      ECCRT@_HI_LO            ; SEGMENT BASE ADDRESS - LOW WORD
 01EB 0B                               DB      ECCRT@_HI_HI            ; SEGMENT BASE ADDRESS - HIGH BYTE
 01EC 93                               DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01ED 0000                             DW      0                       ; RESERVED - MUST BE ZERO

                               ;-----  CODE SEGMENT FOR POST CODE, SYSTEM IDT  - (SYS_ROM_CS)

 01EF FFFF                             DW      MAX_SEG_LEN             ; SEGMENT LIMIT
 01F1 0000                             DW      CSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
 01F3 0F                               DB      CSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
 01F4 9B                               DB      CPL0_CODE_ACCESS        ; ACCESS RIGHTS BYTE
 01F5 0000                             DW      0                       ; RESERVED - MUST BE ZERO

                               ;-----  TEMPORARY DESCRIPTOR FOR ES  - (ES_TEMP)

 01F7 FFFF                             DW      MAX_SEG_LEN             ; SEGMENT LIMIT
 01F9 0000                             DW      NSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
 01FB 00                               DB      NSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
 01FC 93                               DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01FD 0000                             DW      0                       ; RESERVED - MUST BE ZERO

                               ;-----  TEMPORARY DESCRIPTOR FOR CS AS A DATA SEGMENT  - (CS_TEMP)

 01FF FFFF                             DW      MAX_SEG_LEN             ; SEGMENT LIMIT
 0201 0000                             DW      NSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
 0203 00                               DB      NSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
 0204 93                               DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 0205 0000                             DW      0                       ; RESERVED - MUST BE ZERO

                               ;-----  TEMPORARY DESCRIPTOR FOR SS  - (SS_TEMP)

 0207 FFFF                             DW      MAX_SEG_LEN             ; SEGMENT LIMIT
 0209 0000                             DW      NSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
 020B 00                               DB      NSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
 020C 93                               DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 020D 0000                             DW      0                       ; RESERVED - MUST BE ZERO

                               ;-----  TEMPORARY DESCRIPTOR FOR DS  - (DS_TEMP)

 020F FFFF                             DW      MAX_SEG_LEN             ; SEGMENT LIMIT
 0211 0000                             DW      NSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
 0213 00                               DB      NSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
 0214 93                               DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 0215 0000                             DW      0                       ; RESERVED - MUST BE ZERO
```

SECTION 5

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                                PAGE
                                ;-----  (POST_TR)
0217                            TR_LOC:
0217 0800                               DW      00800H                  ; SEGMENT LIMIT
0219 C000                               DW      0C000H                  ; SEGMENT BASE ADDRESS - LOW WORD
021B 00                                 DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
021C 81                                 DB      FREE_TSS                ; ACCESS RIGHTS BYTE
021D 0000                               DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  (POST_TSS_PTR)

021F 0800                               DW      00800H                  ; SEGMENT LIMIT
0221 0217 R                             DW      TR_LOC                  ; SEGMENT BASE ADDRESS - LOW WORD
0223 00                                 DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
0224 93                                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
0225 0000                               DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  (POST_LDTR)
0227                            LDT_LOC:
0227 0088                               DW      GDT_LEN                 ; SEGMENT LIMIT
0229 D000                               DW      0D000H                  ; SEGMENT BASE ADDRESS - LOW WORD
022B 00                                 DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
022C E2                                 DB      LDT_DESC                ; ACCESS RIGHTS BYTE
022D 0000                               DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  (POST_LDT_PTR)

022F 0088                               DW      GDT_LEN                 ; SEGMENT LIMIT
0231 0227 R                             DW      LDT_LOC                 ; SEGMENT BASE ADDRESS - LOW WORD
0233 00                                 DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
0234 93                                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
0235 0000                               DW      0                       ; RESERVED - MUST BE ZERO

= 0237                          GDT_DATA_END    EQU     $

                                ;-----  END OF PRE-ALLOCATED GDT


                                ;-----  ENTRY POINTS FOR THE FIRST 32 SYSTEM INTERRUPTS

0237                            SYS_IDT_OFFSETS         LABEL   WORD
                                                                        ; INTERRUPTS AS DEFINED
0237 0000 R                             DW      OFFSET EXC_00           ; EXCPT 00 - DIVIDE ERROR
0239 0005 R                             DW      OFFSET EXC_01           ; EXCPT 01 - SINGLE STEP
023B 000A R                             DW      OFFSET EXC_02           ; EXCPT 02 - NMI, SYSTEM REQUEST FOR DI
023D 000F R                             DW      OFFSET EXC_03           ; EXCPT 03 - BREAKPOINT
023F 0014 R                             DW      OFFSET EXC_04           ; EXCPT 04 - INTO DETECT
0241 0019 R                             DW      OFFSET EXC_05           ; EXCPT 05 - BOUND
0243 0030 R                             DW      OFFSET EXC_06           ; EXCPT 06 - INVALID OPCODE
0245 0034 R                             DW      OFFSET EXC_07           ; EXCPT 07 - PROCESSOR EXT NOT AVAIL
0247 0038 R                             DW      OFFSET EXC_08           ; EXCPT 08 - DOUBLE EXCEPTION
0249 003C R                             DW      OFFSET EXC_09           ; EXCPT 09 - PROCESSOR EXT SEGMENT ERR
024B 0040 R                             DW      OFFSET EXC_10           ; EXCPT 10 - TSS BAD IN GATE TRANSFER
024D 0044 R                             DW      OFFSET EXC_11           ; EXCPT 11 - SEGMENT NOT PRESENT
024F 0048 R                             DW      OFFSET EXC_12           ; EXCPT 12 - STACK SEGMENT NOT PRESENT
0251 004C R                             DW      OFFSET EXC_13           ; EXCPT 13 - GENERAL PROTECTION
0253 0050 R                             DW      OFFSET EXC_14
0255 0054 R                             DW      OFFSET EXC_15
0257 0058 R                             DW      OFFSET EXC_16           ; EXCPT 16 - PROCESSOR EXTENSION ERROR
0259 005C R                             DW      OFFSET EXC_17
025B 0060 R                             DW      OFFSET EXC_18
025D 0064 R                             DW      OFFSET EXC_19
025F 0068 R                             DW      OFFSET EXC_20
0261 006C R                             DW      OFFSET EXC_21
0263 0070 R                             DW      OFFSET EXC_22
0265 0074 R                             DW      OFFSET EXC_23
0267 0078 R                             DW      OFFSET EXC_24
0269 007C R                             DW      OFFSET EXC_25
026B 0080 R                             DW      OFFSET EXC_26
026D 0084 R                             DW      OFFSET EXC_27
026F 0088 R                             DW      OFFSET EXC_28
0271 008C R                             DW      OFFSET EXC_29
0273 0090 R                             DW      OFFSET EXC_30
0275 0094 R                             DW      OFFSET EXC_31

                                ;-----  FORMAT INTERRUPT DESCRIPTORS (GATES) 32 - 255

0277 01AE R                     FREE_INTS       DW      OFFSET IRET_ADDR        ; DESTINATION OFFSET
0279 0040                                       DW      SYS_ROM_CS              ; DESTINATION SEGMENT
027B 00 86                                      DB      0,INT_GATE              ; UNUSED AND ACCESS RIGHTS BYTE
027D                            SIDT_BLD        ENDP

027D                            CODE    ENDS
                                        END
```

```
                              PAGE 118,121
                              TITLE TEST6 ---- 06/10/85  POST TESTS AND SYSTEM BOOT STRAP
                              .286C
                              .LIST
0000                          CODE      SEGMENT BYTE PUBLIC

                                        PUBLIC  BOOT_STRAP_1
                                        PUBLIC  POST6
                                        PUBLIC  STGTST_CNT
                                        PUBLIC  ROM_ERR
                                        PUBLIC  XMIT_8042

                                        EXTRN   CMOS_READ:NEAR
                                        EXTRN   DDS:NEAR
                                        EXTRN   DISK_BASE:NEAR
                                        EXTRN   E602:NEAR
                                        EXTRN   ERR_BEEP:NEAR
                                        EXTRN   E_MSG:NEAR
                                        EXTRN   F3A:NEAR
                                        EXTRN   PRT_SEG:NEAR

                                        ASSUME  CS:CODE,DS:DATA

0000                          POST6     PROC    NEAR
                              ;--------------------------------------------------------------
                              ; THIS SUBROUTINE PERFORMS A READ/WRITE STORAGE TEST ON A BLOCK :
                              ;         OF STORAGE.                                          :
                              ; ENTRY REQUIREMENTS:                                          :
                              ;         ES = ADDRESS OF STORAGE SEGMENT BEING TESTED         :
                              ;         DS = ADDRESS OF STORAGE SEGMENT BEING TESTED         :
                              ;         CX = WORD COUNT OF STORAGE BLOCK TO BE TESTED        :
                              ; EXIT PARAMETERS:                                             :
                              ;         ZERO FLAG = 0 IF STORAGE ERROR (DATA COMPARE OR PARITY :
                              ;         CHECK). AL=0 DENOTES A PARITY CHECK. ELSE AL=XOR'ED  :
                              ;         BIT PATTERN OF THE EXPECTED DATA PATTERN VS THE ACTUAL :
                              ;         DATA READ.                                           :
                              ; AX,BX,CX,DX,DI, AND SI ARE ALL DESTROYED.                    :
                              ;--------------------------------------------------------------
0000                          STGTST_CNT        PROC    NEAR
0000 8B D9                              MOV     BX,CX                   ; SAVE WORD COUNT OF BLOCK TO TEST
0002 E4 61                              IN      AL,PORT_B
0004 0C 0C                              OR      AL,RAM_PAR_OFF          ; TOGGLE PARITY CHECK LATCHES
0006 E6 61                              OUT     PORT_B,AL               ; TO RESET ANY PENDING ERROR
0008 24 F3                              AND     AL,RAM_PAR_ON
000A E6 61                              OUT     PORT_B,AL

                              ;-----    ROLL A BIT THROUGH THE FIRST WORD

000C 33 D2                              XOR     DX,DX                   ; CLEAR THE INITIAL DATA PATTERN
000E B9 0010                            MOV     CX,16                   ; ROLL 16 BIT POSITIONS
0011 2B FF                              SUB     DI,DI                   ; START AT BEGINNING OF BLOCK
0013 2B F6                              SUB     SI,SI                   ; INITIALIZE DESTINATION POINTER
0015 F9                                 STC                             ; SET CARRY FLAG ON FOR FIRST BIT
0016                          C1:
0016 D1 D2                              RCL     DX,1                    ; MOVE BIT OVER LEFT TO NEXT POSITION
0018 89 15                              MOV     [DI],DX                 ; STORE DATA PATTERN
001A 8B 05                              MOV     AX,[DI]                 ; GET THE DATA WRITTEN
001C 33 C2                              XOR     AX,DX                   ; INSURE DATA AS EXPECTED (CLEAR CARRY)
001E E1 F6                              LOOPZ   C1                      ; LOOP TILL DONE OR ERROR

0020 75 66                              JNZ     C13                     ; EXIT IF ERROR

                              ;-----    CHECK CAS LINES FOR HIGH BYTE LOW BYTE

0022 BA FF00                            MOV     DX,0FF00H               ; TEST DATA - AX= 0000H
0025 89 05                              MOV     [DI],AX                 ; STORE DATA PATTERN  = 0000H
0027 88 75 01                           MOV     [DI+1],DH               ; WRITE A BYTE OF FFH AT ODD LOCATION
002A 8B 05                              MOV     AX,[DI]                 ; GET THE DATA - SHOULD BE 0FF00H
002C 33 C2                              XOR     AX,DX                   ; CHECK THE FIRST WRITTEN
002E 75 58                              JNZ     C13                     ; ERROR EXIT IF NOT ZERO

0030 89 05                              MOV     [DI],AX                 ; STORE DATA PATTERN OF 0000H
0032 88 35                              MOV     [DI],DH                 ; WRITE A BYTE OF FFH AT EVEN LOCATION
0034 86 F2                              XCHG    DH,DL                   ; SET DX= 000FFH AND BUS SETTLE
0036 8B 05                              MOV     AX,[DI]                 ; GET THE DATA
0038 33 C2                              XOR     AX,DX                   ; CHECK THE FIRST WRITTEN
003A 75 4C                              JNZ     C13                     ; EXIT IF NOT

                              ;-----    CHECK FOR I/O OR BASE MEMORY ERROR

003C E4 61                              IN      AL,PORT_B               ; CHECK FOR I/O - PARITY CHECK
003E 86 C4                              XCHG    AL,AH                   ; SAVE ERROR
0040 E4 87                              IN      AL,DMA_PAGE+6           ; CHECK FOR R/W OR I/O ERROR
0042 22 E0                              AND     AH,AL                   ; MASK FOR ERROR EXPECTED

                              ;-----    PARITY ERROR EXIT

0044 B8 0000                            MOV     AX,0                    ; RESTORE AX TO 0000
0047 75 3F                              JNZ     C13                     ; EXIT IF PARITY ERROR

0049 BA AA55                            MOV     DX,0AA55H               ; WRITE THE INITIAL DATA PATTERN
004C                          C3:
004C 2B FF                              SUB     DI,DI                   ; START AT BEGINNING OF BLOCK
004E 2B F6                              SUB     SI,SI                   ; INITIALIZE DESTINATION POINTER
0050 8B CB                              MOV     CX,BX                   ; SETUP BYTE COUNT FOR LOOP
0052 8B C2                              MOV     AX,DX                   ; GET THE PATTERN
0054 F3/ AB                             REP     STOSW                   ; STORE 64K BYTES (32K WORDS)
0056 8B CB                              MOV     CX,BX                   ; SET COUNT
0058 2B F6                              SUB     SI,SI                   ; START AT BEGINNING
005A                          C6:
005A AD                                 LODSW                           ; GET THE FIRST WRITTEN
005B 33 C2                              XOR     AX,DX                   ; INSURE DATA AS EXPECTED
005D E1 FB                              LOOPZ   C6                      ; LOOP TILL DONE OR ERROR

005F 75 27                              JNZ     C13                     ; EXIT IF NOT EXPECTED (ERROR BITS ON)

                              ;-----    CHECK FOR I/O OR BASE MEMORY ERROR

0061 E4 61                              IN      AL,PORT_B               ; CHECK FOR I/O -PARITY CHECK
0063 86 C4                              XCHG    AL,AH                   ; SAVE ERROR
0065 E4 87                              IN      AL,DMA_PAGE+6           ; CHECK FOR R/W OR I/O ERROR
0067 22 E0                              AND     AH,AL
```

SECTION 5

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                                ;-----  PARITY ERROR EXIT

0069 B8 0000                            MOV     AX,0                    ; RESTORE AX TO 0000
006C 75 1A                              JNZ     C13                     ; GO IF YES

                                ;-----  CHECK FOR END OF 64K BLOCK

006E 23 D2                              AND     DX,DX                   ; ENDING ZERO PATTERN WRITTEN TO MEMORY?
0070 74 16                              JZ      C13                     ; YES - RETURN TO CALLER WITH AL=0

                                ;-----  SETUP NEXT PATTERN

0072 81 FA 55AA                         CMP     DX,055AAH               ; CHECK IF LAST PATTERN =55AA
0076 74 0B                              JZ      C9                      ; GO IF NOT
0078 81 FA 0101                         CMP     DX,0101H                ; LAST PATTERN 0101?
007C 74 0B                              JZ      C10                     ; GO IF YES
007E BA 55AA                            MOV     DX,055AAH               ; WRITE 55AA TO STORAGE
0081 EB C9                              JMP     C3

                                ;-----  INSURE PARITY BITS ARE NOT STUCK ON

0083 BA 0101                    C9:     MOV     DX,0101H                ; WRITE 0101 TO STORAGE
0086 EB C4                              JMP     C3

                                ;-----  EXIT STORAGE TEST
0088                            C13:
0088 C3                                 RET                             ; ERROR IF ZF NOT SET

                                ;-----  CHECKER BOARD TEST

0089 2B FF                      C10:    SUB     DI,DI                   ; POINT TO START OF BLOCK
008B 8B CB                              MOV     CX,BX                   ; GET THE BLOCK COUNT
008D D1 E9                              SHR     CX,1                    ; DIVIDE BY 2
008F B8 AAAA                            MOV     AX,1010101010101010B    ; SECOND CHECKER PATTERN
0092 BE 5555                            MOV     SI,0101010101010101B    ; FIRST CHECKER PATTERN
0095                            C11:
0095 96                                 XCHG    AX,SI                   ; FIRST CHECKER PATTERN TO AX
0096 AB                                 STOSW                           ; WRITE IT TO MEMORY
0097 96                                 XCHG    AX,SI                   ; SECOND CHECKER PATTERN TO AX
0098 AB                                 STOSW                           ; WRITE IT TO MEMORY
0099 E2 FA                              LOOP    C11                     ; DO IT FOR CX COUNT

009B 2B F6                              SUB     SI,SI                   ; POINT TO START OF BLOCK
009D 8B CB                              MOV     CX,BX                   ; GET THE BLOCK COUNT
009F D1 E9                              SHR     CX,1                    ; DIVIDE BY 2
00A1 BF 5555                            MOV     DI,0101010101010101B    ; CHECK CORRECT
00A4 BA AAAA                            MOV     DX,1010101010101010B
00A7                            C12:
00A7 AD                                 LODSW                           ; GET THE DATA
00A8 33 C7                              XOR     AX,DI                   ; CHECK CORRECT
00AA 75 DC                              JNZ     C13                     ; EXIT IF NOT

00AC AD                                 LODSW                           ; GET NEXT DATA
00AD 33 C2                              XOR     AX,DX                   ; CHECK SECOND PATTERN
00AF E1 F6                              LOOPZ   C12                     ; CONTINUE TILL DONE

00B1 75 D5                              JNZ     C13                     ; ERROR EXIT IF NOT CORRECT

                                ;-----  CHECK FOR I/O OR BASE MEMORY PARITY CHECK

00B3 E4 61                              IN      AL,PORT_B               ; CHECK FOR I/O-PARITY CHECK
00B5 86 C4                              XCHG    AL,AH                   ; SAVE ERROR
00B7 E4 87                              IN      AL,DMA_PAGE+6           ; CHECK FOR R/W OR I/O ERROR
00B9 22 E0                              AND     AH,AL

                                ;-----  CHECKPOINT 32 FOR ADDRESS LINE 0->15 FAILURE

00BB B0 32                              MOV     AL,32H                  ;       <><><><><><><><><><><><>
00BD E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  32 <><>
00BF B8 0000                            MOV     AX,0                    ; RESTORE AX (SET AX TO ZERO)
00C2 75 C4                              JNZ     C13                     ; EXIT IF PARITY ERROR

                                ;-----  64K ADDRESS TEST AND FILL WITH ZERO

00C4 48                                 DEC     AX                      ; WRITE FIRST AND LAST LOCATION=FFFF
00C5 2B FF                              SUB     DI,DI                   ; POINT TO START OF BLOCK
00C7 8B CB                              MOV     CX,BX                   ; GET THE BLOCK COUNT
00C9 83 E9 02                           SUB     CX,2                    ; DO ALL LOCATIONS BUT LAST
00CC AB                                 STOSW                           ; WRITE FIRST LOCATION AS FFFFH
00CD 40                                 INC     AX                      ; WRITE ZERO
00CE F3/ AB                             REP     STOSW                   ; WRITE IT
00D0 48                                 DEC     AX                      ; LAST WORD IS FFFF
00D1 AB                                 STOSW
00D2 2B F6                              SUB     SI,SI                   ; POINT TO START OF BLOCK
00D4 8B CB                              MOV     CX,BX                   ; GET THE BLOCK COUNT
00D6 83 E9 02                           SUB     CX,2
00D9 AD                                 LODSW                           ; GET THE DATA
00DA 35 FFFF                            XOR     AX,0FFFFH               ; CHECK CORRECT
00DD 75 A9                              JNZ     C13                     ; EXIT IF NOT
00DF                            C12A:
00DF AD                                 LODSW                           ; GET NEXT DATA
00E0 0B C0                              OR      AX,AX                   ; ANY BIT ON ?
00E2 E1 FB                              LOOPZ   C12A                    ; CONTINUE TILL LAST WORD
00E4 75 A2                              JNZ     C13                     ; GO IF NOT CORRECT
00E6 AD                                 LODSW                           ; GET LAST WORD
00E7 35 FFFF                            XOR     AX,0FFFFH               ; S/B FFFF
00EA 75 9C                              JNZ     C13                     ; EXIT IF NOT

                                ;-----  CLEAR WORD 0 AND FFFE

00EC 2B FF                              SUB     DI,DI                   ; CLEAR FIRST WORD
00EE AB                                 STOSW
00EF BF FFFE                            MOV     DI,0FFFEH               ; CLEAR TOP WORD
00F2 AB                                 STOSW

                                ;-----  CHECK FOR I/O OR BASE MEMORY

00F3 E4 61                              IN      AL,PORT_B               ; CHECK FOR I/O - PARITY CHECK
00F5 86 C4                              XCHG    AL,AH                   ; SAVE ERROR
00F7 E4 87                              IN      AL,DMA_PAGE+6           ; CHECK FOR R/W OR I/O ERROR
00F9 22 E0                              AND     AH,AL
00FB B8 0000                            MOV     AX,0                    ; SET AX EQUAL ZERO
00FE EB 88                              JMP     C13                     ; ERROR EXIT IF ZF NOT SET
0100                            STGTST_CNT      ENDP
```

```
                                  PAGE
                                  ;--------------------------------------------------------------------
                                  ;  PRINT ADDRESS AND ERROR MESSAGE FOR ROM CHECKSUM ERRORS         :
                                  ;--------------------------------------------------------------------
 0100                             ROM_ERR PROC    NEAR
 0100 52                                  PUSH    DX                      ; SAVE POINTER
 0101 06                                  PUSH    ES
 0102 50                                  PUSH    AX
 0103 B8 ---- R                           MOV     AX,DATA                 ; SET ES TO DATA SEGMENT
 0106 8E C0                               MOV     ES,AX
 0108 58                                  POP     AX                      ; RESTORE AX
 0109 50                                  PUSH    AX
 010A 8C DA                               MOV     DX,DS                   ; GET ADDRESS POINTER
 010C 26: 88 36 0015 R                    MOV     ES:@MFG_ERR_FLAG,DH     ;       <><><><><><><><><><><><><><><>
                                                                          ;       <><> CHECKPOINTS C0->F4 <><>
 0111 81 FA C800                          CMP     DX,0C800H               ; DISPLAY CARD IN ERROR?
 0115 7C 0D                               JL      ROM_ERR_BEEP            ; GIVE DISPLAY CARD FAIL BEEP
 0117 E8 0000 E                           CALL    PRT_SEG                 ; PRINT SEGMENT IN ERROR
 011A BE 0000 E                           MOV     SI,OFFSET F3A           ; DISPLAY ERROR MESSAGE
 011D E8 0000 E                           CALL    E_MSG
 0120                             ROM_ERR_END:
 0120 58                                  POP     AX
 0121 07                                  POP     ES
 0122 5A                                  POP     DX
 0123 C3                                  RET
 0124                             ROM_ERR_BEEP:
 0124 BA 0102                             MOV     DX,0102H                ; BEEP 1 LONG, 2 SHORT
 0127 E8 0000 E                           CALL    ERR_BEEP
 012A EB F4                               JMP     SHORT ROM_ERR_END
 012C                             ROM_ERR ENDP
                                  ;-----------------------------------------------------------------
                                  ; THIS SUBROUTINE SENDS AN OUTPUT COMMAND TO THE KEYBOARD AND     :
                                  ;       RECEIVES THE KEYBOARD RESPONSE.                           :
                                  ; ENTRY REQUIREMENTS:                                             :
                                  ;       AL = COMMAND/DATA TO BE SENT                              :
                                  ; EXIT PARAMETERS:                                                :
                                  ;       ZERO FLAG = 1 IF ACK RECEIVED FROM THE KEY BOARD          :
                                  ;       AL = RESPONSE                                             :
                                  ;-----------------------------------------------------------------
 012C                             XMIT_8042 PROC  NEAR

                                  ;-----  CHECK INPUT BUFFER FULL

 012C 86 E0                               XCHG    AH,AL                   ; SAVE COMMAND
 012E 2B C9                               SUB     CX,CX                   ; SET LOOP TIME-OUT
 0130                             XMITLOOP:
 0130 E4 64                               IN      AL,STATUS_PORT
 0132 A8 02                               TEST    AL,INPT_BUF_FULL        ; CHECK INPUT BUFFER FULL
 0134 E0 FA                               LOOPNZ  XMITLOOP
 0136 E3 34                               JCXZ    SHORT XMIT_EXIT
 0138 86 E0                               XCHG    AH,AL                   ; RESTORE COMMAND

                                  ;-----  ISSUE THE COMMAND

 013A E6 60                               OUT     PORT_A,AL               ; SEND THE COMMAND
 013C 2B C9                               SUB     CX,CX                   ; SET LOOP COUNT

                                  ;-----  CHECK OUTPUT BUFFER FULL

 013E E4 64                       XMIT_1: IN      AL,STATUS_PORT
 0140 8A E0                               MOV     AH,AL                   ; SAVE STATUS
 0142 A8 01                               TEST    AL,OUT_BUF_FULL         ; CHECK IF 8042 HAS DATA
 0144 74 02                               JZ      XMIT_2                  ; GO IF NOT
 0146 E4 60                               IN      AL,PORT_A               ; FLUSH DATA
 0148 F6 C4 02                    XMIT_2: TEST    AH,INPT_BUF_FULL        ; CHECK COMMAND ACCEPTED
 014B E0 F1                               LOOPNZ  XMIT_1
 014D 75 1D                               JNZ     SHORT XMIT_EXIT         ; NO FLUSH OR COMMAND NOT ACCEPTED

                                  ;-----  CHECK OUTPUT BUFFER FULL

 014F B3 06                               MOV     BL,6                    ; SET COUNT
 0151 2B C9                               SUB     CX,CX                   ; SET LOOP COUNT
 0153 E4 64                       XMIT_3: IN      AL,STATUS_PORT
 0155 A8 01                               TEST    AL,OUT_BUF_FULL         ; CHECK IF HAS DATA
 0157 E1 FA                               LOOPZ   XMIT_3                  ; WAIT TILL DONE
 0159 75 08                               JNZ     XMIT_4
 015B FE CB                               DEC     BL                      ; DECREMENT OUTER LOOP
 015D 75 F4                               JNZ     SHORT XMIT_3            ; TRY AGAIN
 015F FE C3                               INC     BL                      ; SET ERROR FLAG
 0161 EB 09                               JMP     SHORT XMIT_EXIT         ; 8042 STUCK BUSY

                                  ;-----  GET THE DATA

 0163 2B C9                       XMIT_4: SUB     CX,CX                   ; ALLOW TIME FOR POSSIBLE
                                                                          ; ERROR -> SYSTEM UNIT OR KEYBOARD
 0165 E2 FE                       XMIT_5: LOOP    XMIT_5
 0167 E4 60                               IN      AL,PORT_A
 0169 83 E9 01                            SUB     CX,01H                  ; SET CX OTHER THAN ZERO
 016C                             XMIT_EXIT:
 016C C3                                  RET
 016D                             XMIT_8042 ENDP

                                  ;--- BOOT_STRAP -- INT  19 H -------------------------
                                  ; BOOT STRAP LOADER                                  :
                                  ;       TRACK 0, SECTOR 1 IS READ INTO THE           :
                                  ;       BOOT LOCATION (SEGMENT 0 OFFSET 7C00)        :
                                  ;       AND CONTROL IS TRANSFERRED THERE.            :
                                  ;                                                    :
                                  ;       IF THERE IS A HARDWARE ERROR CONTROL IS      :
                                  ;       TRANSFERRED TO THE ROM BASIC ENTRY POINT     :
                                  ;-----------------------------------------------------
                                          ASSUME CS:CODE,DS:ABS0,ES:ABS0

 016D                             BOOT_STRAP_1    PROC    NEAR

 016D B8 ---- R                           MOV     AX,ABS0                 ; ESTABLISH ADDRESSING
 0170 8E D8                               MOV     DS,AX
 0172 8E C0                               MOV     ES,AX

                                  ;-----  RESET THE DISK PARAMETER TABLE VECTOR

 0174 C7 06 0078 R 0000 E                 MOV     WORD PTR @DISK_POINTER, OFFSET DISK_BASE
 017A 8C 0E 007A R                        MOV     WORD PTR @DISK_POINTER+2,CS
```

SECTION 5

```
                             ;----- CLEAR @BOOT_LOCN

 017E 33 C0                          XOR     AX,AX
 0180 B9 0100                        MOV     CX,256                  ; CLEAR 256 WORDS
 0183 BF 7C00 R                      MOV     DI,OFFSET @BOOT_LOCN
 0186 F3/ AB                         REP     STOSW

                             ;----- LOAD SYSTEM FROM DISKETTE -- CX HAS RETRY COUNT

 0188 FB                             STI
 0189 B9 0004                        MOV     CX,4                    ; SET RETRY COUNT
 018C 51                     H1:     PUSH    CX                      ; IPL SYSTEM
 018D B4 00                          MOV     AH,0                    ; RESET THE DISKETTE SYSTEM
 018F CD 13                          INT     13H                     ; DISKETTE_IO
 0191 72 0F                          JC      H2                      ; IF ERROR, TRY AGAIN

 0193 B8 0201                        MOV     AX,201H                 ; READ IN THE SINGLE SECTOR
 0196 2B D2                          SUB     DX,DX                   ; TO THE BOOT LOCATION
 0198 8E C2                          MOV     ES,DX
 019A BB 7C00 R                      MOV     BX,OFFSET @BOOT_LOCN    ; DRIVE 0, HEAD 0
 019D B9 0001                        MOV     CX,1                    ; SECTOR 1, TRACK 0
 01A0 CD 13                          INT     13H                     ; DISKETTE_IO
 01A2 59                     H2:     POP     CX                      ; RECOVER RETRY COUNT
 01A3 73 09                          JNC     H4                      ; CARRY FLAG SET BY UNSUCCESSFUL READ
 01A5 80 FC 80                       CMP     AH,80H                  ; IF TIME OUT, NO RETRY
 01A8 74 22                          JZ      H5                      ; TRY FIXED DISK
 01AA E2 E0                          LOOP    H1                      ; DO IT FOR RETRY TIMES
 01AC EB 1E                          JMP     SHORT H5                ; TRY FIXED DISK

                             ;----- BOOT RECORD READ SUCCESSFUL
                             ;----- INSURE FIRST BYTE OF LOADED BOOT RECORD IS VALID (NOT ZERO)

 01AE 80 3E 7C00 R 06        H4:     CMP     BYTE PTR @BOOT_LOCN,06H ; CHECK FOR FIRST INSTRUCTION INVALID
 01B3 72 71                          JB      H10                     ; IF BOOT NOT VALID PRINT MESSAGE HALT

                             ;----- INSURE DATA PATTERN FIRST 8 WORDS NOT ALL EQUAL

 01B5 BF 7C00 R                      MOV     DI,OFFSET @BOOT_LOCN    ; CHECK DATA PATTERN
 01B8 B9 0008                        MOV     CX,8                    ; CHECK THE NEXT 8 WORDS
 01BB A1 7C00 R                      MOV     AX,WORD PTR @BOOT_LOCN

 01BE 83 C7 02               H4A:    ADD     DI,2                    ; POINT TO NEXT LOCATION
 01C1 3B 05                          CMP     AX,[DI]                 ; CHECK DATA PATTERN FOR A FILL PATTERN
 01C3 E1 F9                          LOOPZ   H4A
 01C5 74 5F                          JZ      H10                     ; BOOT NOT VALID PRINT MESSAGE HALT

 01C7 EA 7C00 ---- R         H4_A:   JMP     @BOOT_LOCN

                             ;----- ATTEMPT BOOTSTRAP FROM FIXED DISK

 01CC B0 44                  H5:     MOV     AL,044H                 ;       <><><><><><><><><><><><>
 01CE E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  44 <><>
                                     ASSUME  DS:DATA
 01D0 E8 0000 E                      CALL    DDS
 01D3 F6 06 008B R 01                TEST    @LASTRATE,DUAL          ; FLOPPY/FIXED DISK CARD INSTALLED
                                     ASSUME  DS:ABS0
 01D8 B8 ---- R                      MOV     AX,ABS0                 ; ESTABLISH ADDRESSING
 01DB 8E D8                          MOV     DS,AX
 01DD 74 3D                          JZ      H9                      ; GO IF NOT

                             ;----- CHECK FOR FIXED DISK INITIALIZATION ERROR

 01DF B0 0E                          MOV     AL,CMOS_DIAG            ; GET POST POWER ON STATUS (NMI ENABLED)
 01E1 E8 0000 E                      CALL    CMOS_READ               ; FROM DIAGNOSTIC STATUS BYTE
 01E4 A8 08                          TEST    AL,HF_FAIL              ; DID WE HAVE A FIXED DISK FAILURE?
 01E6 75 34                          JNZ     H9                      ; GO IF YES

 01E8 2B C0                          SUB     AX,AX                   ; RESET DISKETTE
 01EA 2B D2                          SUB     DX,DX
 01EC CD 13                          INT     13H
 01EE B9 0003                        MOV     CX,3                    ; RETRY COUNT
 01F1                        H6:
 01F1 51                             PUSH    CX                      ; SAVE RETRY COUNT
 01F2 BA 0080                        MOV     DX,0080H                ; FIXED DISK ZERO
 01F5 B8 0201                        MOV     AX,0201H                ; READ IN A SINGLE SECTOR
 01F8 2B DB                          SUB     BX,BX
 01FA 8E C3                          MOV     ES,BX
 01FC BB 7C00 R                      MOV     BX,OFFSET @BOOT_LOCN    ; TO THE BOOT LOCATION
 01FF B9 0001                        MOV     CX,1                    ; SECTOR 1, TRACK 0
 0202 CD 13                          INT     13H                     ; FILE I/O CALL
 0204 59                             POP     CX                      ; RECOVER RETRY COUNT
 0205 72 08                          JC      H8
 0207 81 3E 7DFE R AA55              CMP     WORD PTR @BOOT_LOCN+510D,0AA55H ; TEST FOR GENERIC BOOT BLOCK
 020D 74 B8                          JZ      H4_A

 020F 51                     H8:     PUSH    CX
 0210 BA 0080                        MOV     DX,0080H                ; FIXED DISK ZERO
 0213 2B C0                          SUB     AX,AX                   ; RESET THE FIXED DISK
 0215 CD 13                          INT     13H                     ; FILE I/O CALL
 0217 59                             POP     CX                      ; RESTORE LOOP COUNT
 0218 72 08                          JC      H10A                    ; IF ERROR, TRY AGAIN
 021A E2 D5                          LOOP    H6                      ; DO IT FOR RETRY TIMES

                             ;----- UNABLE TO IPL FROM THE DISKETTE OR FIXED DISK

 021C B0 45                  H9:     MOV     AL,045H                 ;       <><><><><><><><><><><><>
 021E E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  45 <><>

 0220 CD 18                          INT     18H                     ; GO TO RESIDENT BASIC

                             ;----- HARD FILE RESET FAILURE

 0222 E2 EB                  H10A:   LOOP    H8                      ; TRY RESET AGAIN
 0224 EB F6                          JMP     H9                      ; GO TO RESIDENT BASIC

                             ;----- IF DISKETTE READ OK BUT BOOT RECORD IS NOT STOP SYSTEM ALLOW SOFT RESET

 0226 BE 0000 E              H10:    MOV     SI,OFFSET E602          ; PRINT DISKETTE BOOT
 0229 E8 0000 E                      CALL    E_MSG                   ; PRINT MESSAGE
 022C EB FE                  H11:    JMP     H11
 022E                        BOOT_STRAP_1    ENDP
 022E                        POST6       ENDP
 022E                        CODE        ENDS
                                         END
```

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                                        PAGE 118,121
                                        TITLE DSKETTE -- 06/10/85  DISKETTE BIOS
                                        .286C
                                        .LIST
 0000                                   CODE    SEGMENT BYTE PUBLIC

                                                PUBLIC  DISK_INT_1
                                                PUBLIC  SEEK
                                                PUBLIC  DSKETTE_SETUP
                                                PUBLIC  DISKETTE_IO_1

                                                EXTRN   CMOS_READ:NEAR          ; READ CMOS LOCATION ROUTINE
                                                EXTRN   DDS:NEAR                ; LOAD (DS) WITH DATA SEGMENT SELECTOR
                                                EXTRN   DISK_BASE:NEAR          ; DISKETTE PARAMETER TABLE LOCATION
                                                EXTRN   WAITF:NEAR              ; FIXED WAIT ROUTINE - (CX)*15.086 US

                                        ;-- INT 13H ---------------------------------------------------------------
                                        ; DISKETTE I/O
                                        ;       THIS INTERFACE PROVIDES ACCESS TO THE 5 1/4" DISKETTE DRIVES
                                        ;       320/360K DISKETTE DRIVES AND 1.2M DISKETTE DRIVES SUPPORTED
                                        ; INPUT
                                        ;       (AH)= 00H  RESET DISKETTE SYSTEM
                                        ;               HARD RESET TO NEC, PREPARE COMMAND, RECALIBRATE REQUIRED
                                        ;               ON ALL DRIVES
                                        ;--------------------------------------------------------------------------
                                        ;       (AH)= 01H  READ THE STATUS OF THE SYSTEM INTO (AH)
                                        ;               @DSKETTE_STATUS FROM LAST OPERATION IS USED
                                        ;--------------------------------------------------------------------------
                                        ;       REGISTERS FOR READ/WRITE/VERIFY/FORMAT
                                        ;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
                                        ;       (DH) - HEAD NUMBER (0-1 ALLOWED, NOT VALUE CHECKED)
                                        ;       (CH) - TRACK NUMBER (NOT VALUE CHECKED)
                                        ;               MEDIA     DRIVE         TRACK NUMBER
                                        ;              320/360   320/360          0-39
                                        ;              320/360    1.2M            0-39
                                        ;               1.2M      1.2M            0-79
                                        ;               720K      720K            0-79
                                        ;       (CL) - SECTOR NUMBER (NOT VALUE CHECKED, NOT USED FOR FORMAT)
                                        ;               MEDIA     DRIVE         SECTOR NUMBER
                                        ;              320/360   320/360          1-8/9
                                        ;              320/360    1.2M            1-8/9
                                        ;               1.2M      1.2M            1-15
                                        ;               720K      720K            1-9
                                        ;       (AL) - NUMBER OF SECTORS (NOT VALUE CHECKED)
                                        ;               MEDIA     DRIVE         MAX NUMBER OF SECTORS
                                        ;              320/360   320/360             8/9
                                        ;              320/360    1.2M               8/9
                                        ;               1.2M      1.2M               15
                                        ;               720K      720K               9
                                        ;
                                        ;       (ES:BX) - ADDRESS OF BUFFER ( REQUIRED FOR VERIFY)
                                        ;
                                        ;--------------------------------------------------------------------------
                                        ;       (AH)= 02H  READ THE DESIRED SECTORS INTO MEMORY
                                        ;--------------------------------------------------------------------------
                                        ;       (AH)= 03H  WRITE THE DESIRED SECTORS FROM MEMORY
                                        ;--------------------------------------------------------------------------
                                        ;       (AH)= 04H  VERIFY THE DESIRED SECTORS
                                        ;--------------------------------------------------------------------------
                                        ;       (AH)= 05H  FORMAT THE DESIRED TRACK
                                        ;               FOR THE FORMAT OPERATION, THE BUFFER POINTER (ES,BX) MUST
                                        ;               POINT TO THE COLLECTION OF DESIRED ADDRESS FIELDS FOR THE
                                        ;               TRACK.  EACH FIELD IS COMPOSED OF 4 BYTES, (C,H,R,N), WHERE
                                        ;               C = TRACK NUMBER, H=HEAD NUMBER, R = SECTOR NUMBER, N= NUMBER
                                        ;               OF BYTES PER SECTOR (00=128, 01=256, 02=512, 03=1024,)
                                        ;               THERE MUST BE ONE ENTRY FOR EVERY SECTOR ON THE TRACK.
                                        ;               THIS INFORMATION IS USED TO FIND THE REQUESTED SECTOR DURING
                                        ;               READ/WRITE ACCESS.
                                        ;               PRIOR TO FORMATTING A DISKETTE, IF THERE EXISTS MORE THAN
                                        ;               ONE SUPPORTED MEDIA FORMAT TYPE WITHIN THE DRIVE IN QUESTION,
                                        ;               THEN "SET DASD TYPE" (INT 13H, AH = 17H) MUST BE CALLED TO
                                        ;               SET THE DISKETTE TYPE THAT IS TO BE FORMATTED.  IF "SET DASD
                                        ;               TYPE" IS NOT CALLED, THE FORMAT ROUTINE WILL ASSUME THE
                                        ;               MEDIA FORMAT TO BE THE MAXIMUM CAPACITY OF THE DRIVE.
                                        ;               IN ORDER TO FORMAT 320/360K MEDIA IN EITHER A 320/360K OR
                                        ;               1.2M DISKETTE DRIVE THE GAP LENGTH FOR FORMAT PARAMETER
                                        ;               OF DISK_BASE MUST BE CHANGE TO 050H.  ALSO THE EOT
                                        ;               PARAMETER (LAST SECTOR ON TRACK) MUST BE SET TO THE
                                        ;               DESIRED NUMBER OF SECTORS/TRACK - 8 FOR 320K, 9 FOR 360K.
                                        ;               DISK_BASE IS POINTED TO BY DISK POINTER LOCATED AT
                                        ;               ABSOLUTE ADDRESS 0:78.
                                        ;               WHEN 320/360K FORMAT OPERATIONS ARE COMPLETE, THE PARAMETERS
                                        ;               SHOULD BE RESTORED TO THEIR RESPECTIVE INITIAL VALUES.
                                        ;--------------------------------------------------------------------------
                                        ;       (AH)= 08H  READ DRIVE PARAMETERS
                                        ;       REGISTERS
                                        ;         INPUT
                                        ;           (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
                                        ;         OUTPUT
                                        ;           (ES:DI) POINTS TO DISK BASE
                                        ;           (CH) - LOW ORDER 8 OF 10 BITS MAXIMUM NUMBER OF TRACKS
                                        ;           (CL) - BITS 7 & 6 - HIGH ORDER TWO BITS OF MAXIMUM TRACKS
                                        ;                - BITS 5 THRU 0 - MAXIMUM SECTORS PER TRACK
                                        ;           (DH) - MAXIMUM HEAD NUMBER
                                        ;           (DL) - NUMBER OF DISKETTE DRIVES INSTALLED
                                        ;           (BH) - 0
                                        ;           (BL) - BITS 7 THRU 4 - 0
                                        ;                  BITS 3 THRU 0 - VALID DRIVE TYPE VALUE IN CMOS
                                        ;           (AX) - 0
                                        ;        UNDER THE FOLLOWING CIRCUMSTANCES:
                                        ;          (1) THE DRIVE NUMBER IS INVALID,
                                        ;          (2) THE DRIVE TYPE IS UNKNOWN AND CMOS IS NOT PRESENT,
                                        ;          (3) THE DRIVE TYPE IS UNKNOWN AND CMOS IS BAD,
                                        ;          (4) OR THE DRIVE TYPE IS UNKNOWN AND THE CMOS DRIVE TYPE IS INVALID
                                        ;          THEN ES,AX,BX,CX,DH,DI=0 ; DL=NUMBER OF DRIVES.
                                        ;          IF NO DRIVES ARE PRESENT THEN: ES,AX,BX,CX,DX,DI=0.
                                        ;          @DSKETTE_STATUS = 0 AND CY IS RESET.
```

SECTION 5

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                        PAGE
                        ;----------------------------------------------------------------------------
                        ;       (AH)= 15H  READ DASD TYPE
                        ;       REGISTERS
                        ;       (AH) - ON RETURN IF CARRY FLAG NOT SET, OTHERWISE ERROR
                        ;               00 - DRIVE NOT PRESENT
                        ;               01 - DISKETTE, NO CHANGE LINE AVAILABLE
                        ;               02 - DISKETTE, CHANGE LINE AVAILABLE
                        ;               03 - FIXED DISK
                        ;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
                        ;
                        ;----------------------------------------------------------------------------
                        ;       (AH)= 16H  DISK CHANGE LINE STATUS
                        ;       REGISTERS
                        ;       (AH)=00 - DISK CHANGE LINE NOT ACTIVE
                        ;            06 - DISK CHANGE LINE ACTIVE & CARRY BIT ON
                        ;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
                        ;
                        ;----------------------------------------------------------------------------
                        ;       (AH)= 17H  SET DASD TYPE FOR FORMAT
                        ;       REGISTERS
                        ;       (AL) -   00 - NOT USED
                        ;               01 - DISKETTE 320/360K IN 360K DRIVE
                        ;               02 - DISKETTE 360K IN 1.2M DRIVE
                        ;               03 - DISKETTE 1.2M IN 1.2M DRIVE
                        ;               04 - DISKETTE 720K IN 720K DRIVE
                        ;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED;
                        ;              DO NOT USE WHEN DISKETTE ATTACH CARD USED)
                        ;----------------------------------------------------------------------------
                        ;       DISK CHANGE STATUS IS ONLY CHECKED WHEN A 1.2M BYTE DISKETTE
                        ;       DRIVE IS SPECIFIED.  IF THE DISK CHANGE LINE IS FOUND TO BE
                        ;       ACTIVE THE FOLLOWING ACTIONS TAKE PLACE:
                        ;               ATTEMPT TO RESET DISK CHANGE LINE TO INACTIVE STATE.
                        ;               IF ATTEMPT SUCCEEDS SET DASD TYPE FOR FORMAT AND RETURN DISK
                        ;               CHANGE ERROR CODE
                        ;               IF ATTEMPT FAILS RETURN TIMEOUT ERROR CODE AND SET DASD TYPE
                        ;               TO A PREDETERMINED STATE INDICATING MEDIA TYPE UNKNOWN.
                        ;       IF THE DISK CHANGE LINE IN INACTIVE PERFORM SET DASD TYPE FOR FORMAT.
                        ;
                        ; DATA VARIABLE -- @DISK_POINTER
                        ;       DOUBLE WORD POINTER TO THE CURRENT SET OF DISKETTE PARAMETERS
                        ;----------------------------------------------------------------------------
                        ; OUTPUT FOR ALL FUNCTIONS
                        ;       AH = STATUS OF OPERATION
                        ;               STATUS BITS ARE DEFINED IN THE EQUATES FOR @DSKETTE_STATUS
                        ;               VARIABLE IN THE DATA SEGMENT OF THIS MODULE
                        ;       CY = 0  SUCCESSFUL OPERATION (AH=0 ON RETURN, EXCEPT FOR READ DASD
                        ;               TYPE AH=(15)).
                        ;       CY = 1  FAILED OPERATION (AH HAS ERROR REASON)
                        ;       FOR READ/WRITE/VERIFY
                        ;               DS,BX,DX,CX PRESERVED
                        ;       NOTE: IF AN ERROR IS REPORTED BY THE DISKETTE CODE, THE APPROPRIATE
                        ;               ACTION IS TO RESET THE DISKETTE, THEN RETRY THE OPERATION.
                        ;               ON READ ACCESSES, NO MOTOR START DELAY IS TAKEN, SO THAT
                        ;               THREE RETRIES ARE REQUIRED ON READS TO ENSURE THAT THE
                        ;               PROBLEM IS NOT DUE TO MOTOR START-UP.
                        ;----------------------------------------------------------------------------
                        .LIST
                        ; DISKETTE STATE MACHINE - ABSOLUTE ADDRESS 40:90 (DRIVE A) & 91 (DRIVE B)
                        .LIST
                        ;     -------------------------------------------------------------
                        ;     I     I     I     I     I     I     I     I     I
                        ;     I  7  I  6  I  5  I  4  I  3  I  2  I  1  I  0  I
                        ;     I     I     I     I     I     I     I     I     I
                        ;     -------------------------------------------------------------
                        ;        I     I     I     I     I     I     I     I
                        ;        I     I     I     I     I     -----------------
                        ;        I     I     I     I     I           I
                        ;        I     I     I     I   RESERVED        I
                        ;        I     I     I     I                PRESENT STATE
                        ;        I     I     I     I       000: 360K IN 360K DRIVE UNESTABLISHED
                        ;        I     I     I     I       001: 360K IN 1.2M DRIVE UNESTABLISHED
                        ;        I     I     I     I       010: 1.2M IN 1.2M DRIVE UNESTABLISHED
                        ;        I     I     I     I       011: 360K IN 360K DRIVE ESTABLISHED
                        ;        I     I     I     I       100: 360K IN 1.2M DRIVE ESTABLISHED
                        ;        I     I     I     I       101: 1.2M IN 1.2M DRIVE ESTABLISHED
                        ;        I     I     I     I       110: RESERVED
                        ;        I     I     I     I       111: NONE OF THE ABOVE
                        ;        I     I     I     I
                        ;        I     I     I     ------> MEDIA/DRIVE ESTABLISHED
                        ;        I     I     I
                        ;        I     I     --------------> DOUBLE STEPPING REQUIRED (360K IN 1.2M
                        ;        I     I                      DRIVE)
                        ;        I     I
                        ;        ------------------------------> DATA TRANSFER RATE FOR THIS DRIVE:
                        ;
                        ;                                              00: 500 KBS
                        ;                                              01: 300 KBS
                        ;                                              10: 250 KBS
                        ;                                              11: RESERVED
                        ;
                        .LIST
                        ;----------------------------------------------------------------------------
                        ; STATE OPERATION STARTED - ABSOLUTE ADDRESS 40:92 (DRIVE A) & 93 (DRIVE B)
                        ;----------------------------------------------------------------------------
                        ; PRESENT CYLINDER NUMBER - ABSOLUTE ADDRESS 40:94 (DRIVE A) & 95 (DRIVE B)
                        ;----------------------------------------------------------------------------
```

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                                  PAGE
                                            ASSUME  CS:CODE,DS:DATA,ES:DATA
                                  .LIST
      0000                        DISKETTE_IO_1   PROC     FAR              ;>>> ENTRY POINT FOR ORG 0EC59H
      0000 FB                               STI                             ; INTERRUPTS BACK ON
      0001 55                               PUSH    BP                      ; USER REGISTER
      0002 57                               PUSH    DI                      ; USER REGISTER
      0003 52                               PUSH    DX                      ; HEAD #, DRIVE # OR USER REGISTER
      0004 53                               PUSH    BX                      ; BUFFER OFFSET PARAMETER OR REGISTER
      0005 51                               PUSH    CX                      ; TRACK #-SECTOR # OR USER REGISTER
      0006 8B EC                            MOV     BP,SP                   ; BP      => PARAMETER LIST DEP. ON AH
                                                                            ; [BP]    = SECTOR #
                                                                            ; [BP+1]  = TRACK #
                                                                            ; [BP+2]  = BUFFER OFFSET
                                                                            ; FOR RETURN OF DRIVE PARAMETERS:
                                                                            ; CL/[BP] = BITS 7&6 HI BITS OF MAX CYL
                                                                            ;           BITS 0-5 MAX SECTORS/TRACK
                                                                            ; CH/[BP+1] = LOW 8 BITS OF MAX CYL.
                                                                            ; BL/[BP+2] = BITS 7-4 = 0
                                                                            ;             BITS 3-0 = VALID CMOS TYPE
                                                                            ; BH/[BP+3] = 0
                                                                            ; DL/[BP+4] = # DRIVES INSTALLED
                                                                            ; DH/[BP+5] = MAX HEAD #
                                                                            ; DI/[BP+6] = OFFSET TO DISK BASE
      0008 1E                               PUSH    DS                      ; BUFFER SEGMENT PARM OR USER REGISTER
      0009 56                               PUSH    SI                      ; USER REGISTERS
      000A E8 0000 E                        CALL    DDS                     ; SEGMENT OF BIOS DATA AREA TO DS
      000D 80 FC 18                         CMP     AH,(FNC_TAE-FNC_TAB)/2  ; CHECK FOR > LARGEST FUNCTION
      0010 72 02                            JB      OK_FUNC                 ; FUNCTION OK

      0012 B4 14                            MOV     AH,14H                  ; REPLACE WITH KNOWN INVALID FUNCTION
      0014                        OK_FUNC:
      0014 80 FC 01                         CMP     AH,1                    ; RESET OR STATUS ?
      0017 76 0C                            JBE     OK_DRV                  ; IF RESET OR STATUS DRIVE ALWAYS OK
      0019 80 FC 08                         CMP     AH,8                    ; READ DRIVE PARMS ?
      001C 74 07                            JZ      OK_DRV                  ; IF SO DRIVE CHECKED LATER
      001E 80 FA 01                         CMP     DL,1                    ; DRIVES 0 AND 1 OK
      0021 76 02                            JBE     OK_DRV                  ; IF 0 OR 1 THEN JUMP
      0023 B4 14                            MOV     AH,14H                  ; REPLACE WITH KNOWN INVALID FUNCTION
      0025                        OK_DRV:
      0025 8A CC                            MOV     CL,AH                   ; CL = FUNCTION
      0027 32 ED                            XOR     CH,CH                   ; CX = FUNCTION
      0029 D0 E1                            SHL     CL,1                    ; FUNCTION TIMES 2
      002B BB 004E R                        MOV     BX,OFFSET FNC_TAB       ; LOAD START OF FUNCTION TABLE
      002E 03 D9                            ADD     BX,CX                   ; ADD OFFSET INTO TABLE => ROUTINE
      0030 8A E6                            MOV     AH,DH                   ; AX = HEAD #,# OF SECTORS OR DASD TYPE
      0032 32 F6                            XOR     DH,DH                   ; DX = DRIVE #
      0034 8B F0                            MOV     SI,AX                   ; SI = HEAD #,# OF SECTORS OR DASD TYPE
      0036 8B FA                            MOV     DI,DX                   ; DI = DRIVE #
      0038 8A 26 0041 R                     MOV     AH,@DSKETTE_STATUS      ; LOAD STATUS TO AH FOR STATUS FUNCTION
      003C C6 06 0041 R 00                  MOV     @DSKETTE_STATUS,0       ; INITIALIZE FOR ALL OTHERS

                                  ;         THROUGHOUT THE DISKETTE BIOS, THE FOLLOWING INFORMATION IS CONTAINED IN
                                  ;         THE FOLLOWING MEMORY LOCATIONS AND REGISTERS. NOT ALL DISKETTE BIOS
                                  ;         FUNCTIONS REQUIRE ALL OF THESE PARAMETERS.
                                  ;
                                  ;                 DI      : DRIVE #
                                  ;                 SI-HI   : HEAD #
                                  ;                 SI-LOW  : # OF SECTORS OR DASD TYPE FOR FORMAT
                                  ;                 ES      : BUFFER SEGMENT
                                  ;                 [BP]    : SECTOR #
                                  ;                 [BP+1]  : TRACK #
                                  ;                 [BP+2]  : BUFFER OFFSET
                                  ;
                                  ;         ACROSS CALLS TO SUBROUTINES THE CARRY FLAG (CY=1), WHERE INDICATED IN
                                  ;         SUBROUTINE PROLOGUES, REPRESENTS AN EXCEPTION RETURN (NORMALLY AN ERROR
                                  ;         CONDITION). IN MOST CASES, WHEN CY = 1, @DSKETTE_STATUS CONTAINS THE
                                  ;         SPECIFIC ERROR CODE.
                                                                            ; (AH) = @DSKETTE_STATUS
      0041 2E: FF 17                        CALL    WORD PTR CS:[BX]        ; CALL THE REQUESTED FUNCTION
      0044 5E                               POP     SI                      ; RESTORE ALL REGISTERS
      0045 1F                               POP     DS
      0046 59                               POP     CX
      0047 5B                               POP     BX
      0048 5A                               POP     DX
      0049 5F                               POP     DI
      004A 5D                               POP     BP
      004B CA 0002                          RET     2                       ; THROW AWAY SAVED FLAGS


                                  ;-----------------------------------------------------------------------------
      004E 007E R                 FNC_TAB DW        DISK_RESET              ; AH = 00; RESET
      0050 00E8 R                         DW        DISK_STATUS             ; AH = 01; STATUS
      0052 00F4 R                         DW        DISK_READ               ; AH = 02; READ
      0054 0100 R                         DW        DISK_WRITE              ; AH = 03; WRITE
      0056 010C R                         DW        DISK_VERF               ; AH = 04; VERIFY
      0058 0118 R                         DW        DISK_FORMAT             ; AH = 05; FORMAT
      005A 016A R                         DW        FNC_ERR                 ; AH = 06; INVALID
      005C 016A R                         DW        FNC_ERR                 ; AH = 07; INVALID
      005E 0174 R                         DW        DISK_PARMS              ; AH = 08; READ DRIVE PARAMETERS
      0060 016A R                         DW        FNC_ERR                 ; AH = 09; INVALID
      0062 016A R                         DW        FNC_ERR                 ; AH = 0A; INVALID
      0064 016A R                         DW        FNC_ERR                 ; AH = 0B; INVALID
      0066 016A R                         DW        FNC_ERR                 ; AH = 0C; INVALID
      0068 016A R                         DW        FNC_ERR                 ; AH = 0D; INVALID
      006A 016A R                         DW        FNC_ERR                 ; AH = 0E; INVALID
      006C 016A R                         DW        FNC_ERR                 ; AH = 0F; INVALID
      006E 016A R                         DW        FNC_ERR                 ; AH = 10; INVALID
      0070 016A R                         DW        FNC_ERR                 ; AH = 11; INVALID
      0072 016A R                         DW        FNC_ERR                 ; AH = 12; INVALID
      0074 016A R                         DW        FNC_ERR                 ; AH = 13; INVALID
      0076 016A R                         DW        FNC_ERR                 ; AH = 14; INVALID
      0078 021A R                         DW        DISK_TYPE               ; AH = 15; READ DASD TYPE
      007A 023C R                         DW        DISK_CHANGE             ; AH = 16; CHANGE STATUS
      007C 0267 R                         DW        FORMAT_SET              ; AH = 17; SET DASD TYPE
      = 007E                      FNC_TAE EQU       $                       ; END

      007E                        DISKETTE_IO_1   ENDP
```

SECTION 5

```
                              PAGE
                              ;------------------------------------------------------------------------
                              ; DISK_RESET:    RESET THE DISKETTE SYSTEM.
                              ;
                              ; ON EXIT:       @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                              ;------------------------------------------------------------------------
 007E                         DISK_RESET      PROC    NEAR
 007E BA 03F2                         MOV     DX,03F2H                ; ADAPTER CONTROL PORT
 0081 FA                              CLI                             ; NO INTERRUPTS
 0082 A0 003F R                       MOV     AL,@MOTOR_STATUS        ; GET DIGITAL OUTPUT REGISTER REFLECTION
 0085 24 3F                           AND     AL,00111111B            ; KEEP SELECTED AND MOTOR ON BITS
 0087 C0 C0 04                        ROL     AL,4                    ; MOTOR VALUE TO HIGH NIBBLE
                                                                      ; DRIVE SELECT TO LOW NIBBLE
 008A 0C 08                           OR      AL,00001000B            ; TURN ON INTERRUPT ENABLE
 008C EE                              OUT     DX,AL                   ; RESET THE ADAPTER
 008D C6 06 003E R 00                 MOV     @SEEK_STATUS,0          ; SET RECALIBRATE REQUIRED ON ALL DRIVES
 0092 EB 00                           JMP     $+2                     ; WAIT FOR I/O
 0094 0C 04                           OR      AL,00000100B            ; TURN OFF RESET BIT
 0096 EE                              OUT     DX,AL                   ; RESET THE ADAPTER
 0097 FB                              STI                             ; ENABLE THE INTERRUPTS
 0098 E8 087C R                       CALL    WAIT_INT                ; WAIT FOR THE INTERRUPT
 009B 72 44                           JC      DR_ERR                  ; IF ERROR, RETURN IT
 009D B9 00C0                         MOV     CX,11000000B            ; CL = EXPECTED @NEC_STATUS

 00A0                         NXT_DRV:
 00A0 51                              PUSH    CX                      ; SAVE FOR CALL
 00A1 B8 00E0 R                       MOV     AX,OFFSET DR_POP_ERR    ; LOAD NEC_OUTPUT ERROR ADDRESS
 00A4 50                              PUSH    AX                      ; "
 00A5 B4 08                           MOV     AH,08H                  ; SENSE INTERRUPT STATUS COMMAND
 00A7 E8 07BD R                       CALL    NEC_OUTPUT
 00AA 58                              POP     AX                      ; THROW AWAY ERROR RETURN
 00AB E8 08A4 R                       CALL    RESULTS                 ; READ IN THE RESULTS
 00AE 59                              POP     CX                      ; RESTORE AFTER CALL
 00AF 72 30                           JC      DR_ERR                  ; ERROR RETURN
 00B1 3A 0E 0042 R                    CMP     CL,@NEC_STATUS          ; TEST FOR DRIVE READY TRANSITION
 00B5 75 2A                           JNZ     DR_ERR                  ; EVERYTHING OK
 00B7 FE C1                           INC     CL                      ; NEXT EXPECTED @NEC_STATUS
 00B9 80 F9 C3                        CMP     CL,11000011B            ; ALL POSSIBLE DRIVES CLEARED
 00BC 76 E2                           JBE     NXT_DRV                 ; FALL THRU IF 11000100B OR >

                              ;-----  SEND SPECIFY COMMAND TO NEC

 00BE B8 00D8 R                       MOV     AX,OFFSET RESBAC        ; LOAD ERROR ADDRESS
 00C1 50                              PUSH    AX                      ; PUSH NEC_OUT ERROR RETURN
 00C2 B4 03                           MOV     AH,03H                  ; SPECIFY COMMAND
 00C4 E8 07BD R                       CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
 00C7 2A D2                           SUB     DL,DL                   ; FIRST SPECIFY BYTE
 00C9 E8 06CC R                       CALL    GET_PARM                ; GET PARAMETER TO AH
 00CC E8 07BD R                       CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
 00CF B2 01                           MOV     DL,1                    ; SECOND SPECIFY BYTE
 00D1 E8 06CC R                       CALL    GET_PARM                ; GET PARAMETER TO AH
 00D4 E8 07BD R                       CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
 00D7 58                              POP     AX                      ; POP ERROR RETURN
 00D8                         RESBAC:
 00D8 E8 0620 R                       CALL    SETUP_END               ; VARIOUS CLEANUPS
 00DB 8B DE                           MOV     BX,SI                   ; GET SAVED AL TO BL
 00DD 8A C3                           MOV     AL,BL                   ; PUT BACK FOR RETURN
 00DF C3                              RET

 00E0                         DR_POP_ERR:
 00E0 59                              POP     CX                      ; CLEAR STACK
 00E1                         DR_ERR:
 00E1 80 0E 0041 R 20                 OR      @DSKETTE_STATUS,BAD_NEC ; SET ERROR CODE
 00E6 EB F0                           JMP     SHORT RESBAC            ; RETURN FROM RESET
 00E8                         DISK_RESET      ENDP

                              ;------------------------------------------------------------------------
                              ; DISK_STATUS:   DISKETTE STATUS.
                              ;
                              ; ON ENTRY:      AH : STATUS OF PREVIOUS OPERATION
                              ;
                              ; ON EXIT:       AH, @DSKETTE_STATUS, CY REFLECT STATUS OF PREVIOUS OPERATION.
                              ;------------------------------------------------------------------------
 00E8                         DISK_STATUS     PROC    NEAR
 00E8 88 26 0041 R                    MOV     @DSKETTE_STATUS,AH      ; PUT BACK FOR SETUP_END
 00EC E8 0620 R                       CALL    SETUP_END               ; VARIOUS CLEANUPS
 00EF 8B DE                           MOV     BX,SI                   ; GET SAVED AL TO BL
 00F1 8A C3                           MOV     AL,BL                   ; PUT BACK FOR RETURN
 00F3 C3                              RET
 00F4                         DISK_STATUS     ENDP
                              ;------------------------------------------------------------------------
                              ; DISK_READ:     DISKETTE READ.
                              ;
                              ; ON ENTRY:      DI      : DRIVE #
                              ;                SI-HI   : HEAD #
                              ;                SI-LOW  : # OF SECTORS
                              ;                ES      : BUFFER SEGMENT
                              ;                [BP]    : SECTOR #
                              ;                [BP+1]  : TRACK #
                              ;                [BP+2]  : BUFFER OFFSET
                              ;
                              ; ON EXIT:       @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                              ;------------------------------------------------------------------------
 00F4                         DISK_READ       PROC    NEAR
 00F4 80 26 003F R 7F                 AND     @MOTOR_STATUS,01111111B ; INDICATE A READ OPERATION
 00F9 B8 E646                         MOV     AX,0E646H               ; AX = NEC COMMAND, DMA COMMAND
 00FC E8 035C R                       CALL    RD_WR_VF                ; COMMON READ/WRITE/VERIFY
 00FF C3                              RET
 0100                         DISK_READ       ENDP
                              ;------------------------------------------------------------------------
                              ; DISK_WRITE:    DISKETTE WRITE.
                              ;
                              ; ON ENTRY:      DI      : DRIVE #
                              ;                SI-HI   : HEAD #
                              ;                SI-LOW  : # OF SECTORS
                              ;                ES      : BUFFER SEGMENT
                              ;                [BP]    : SECTOR #
                              ;                [BP+1]  : TRACK #
                              ;                [BP+2]  : BUFFER OFFSET
                              ;
                              ; ON EXIT:       @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                              ;------------------------------------------------------------------------
 0100                         DISK_WRITE      PROC    NEAR
 0100 B8 C54A                         MOV     AX,0C54AH               ; AX = NEC COMMAND, DMA COMMAND
```

```
0103 80 0E 003F R 80                    OR      @MOTOR_STATUS,10000000B ; INDICATE WRITE OPERATION
0108 E8 035C R                          CALL    RD_WR_VF                ; COMMON READ/WRITE/VERIFY
010B C3                                 RET
010C                    DISK_WRITE      ENDP
                        ;------------------------------------------------------------------------
                        ; DISK_VERF:    DISKETTE VERIFY.
                        ;
                        ; ON ENTRY:     DI      : DRIVE #
                        ;               SI-HI   : HEAD #
                        ;               SI-LOW  : # OF SECTORS
                        ;               ES      : BUFFER SEGMENT
                        ;               [BP]    : SECTOR #
                        ;               [BP+1]  : TRACK #
                        ;               [BP+2]  : BUFFER OFFSET
                        ;
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;------------------------------------------------------------------------
010C                    DISK_VERF       PROC    NEAR
010C 80 26 003F R 7F                    AND     @MOTOR_STATUS,01111111B ; INDICATE A READ OPERATION
0111 B8 E642                            MOV     AX,0E642H               ; AX = NEC COMMAND, DMA COMMAND
0114 E8 035C R                          CALL    RD_WR_VF                ; COMMON READ/WRITE/VERIFY
0117 C3                                 RET
0118                    DISK_VERF       ENDP
                        ;------------------------------------------------------------------------
                        ; DISK_FORMAT:  DISKETTE FORMAT.
                        ;
                        ; ON ENTRY:     DI      : DRIVE #
                        ;               SI-HI   : HEAD #
                        ;               SI-LOW  : # OF SECTORS
                        ;               ES      : BUFFER SEGMENT
                        ;               [BP]    : SECTOR #
                        ;               [BP+1]  : TRACK #
                        ;               [BP+2]  : BUFFER OFFSET
                        ;
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;------------------------------------------------------------------------
0118                    DISK_FORMAT     PROC    NEAR
0118 E8 02C8 R                          CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
011B E8 03CE R                          CALL    FMT_INIT                ; ESTABLISH STATE IF UNESTABLISHED
011E 80 0E 003F R 80                    OR      @MOTOR_STATUS,10000000B ; INDICATE WRITE OPERATION
0123 E8 0416 R                          CALL    MED_CHANGE              ; CHECK MEDIA CHANGE AND RESET IF SO
0126 72 37                              JC      FM_DON                  ; MEDIA CHANGED, SKIP
0128 E8 0451 R                          CALL    SEND_RATE               ; SEND DATA RATE TO CONTROLLER
012B B0 4A                              MOV     AL,04AH                 ; WILL WRITE TO THE DISKETTE
012D E8 0471 R                          CALL    DMA_SETUP               ; SET UP THE DMA
0130 72 2D                              JC      FM_DON                  ; RETURN WITH ERROR
0132 B4 4D                              MOV     AH,04DH                 ; ESTABLISH THE FORMAT COMMAND
0134 E8 04C7 R                          CALL    NEC_INIT                ; INITIALIZE THE NEC
0137 B8 015F R                          MOV     AX,OFFSET FM_DON        ; LOAD ERROR ADDRESS
013A 50                                 PUSH    AX                      ; PUSH NEC_OUT ERROR RETURN
013B B2 03                              MOV     DL,3                    ; BYTES/SECTOR VALUE TO NEC
013D E8 06CC R                          CALL    GET_PARM
0140 E8 07BD R                          CALL    NEC_OUTPUT
0143 B2 04                              MOV     DL,4                    ; SECTORS/TRACK VALUE TO NEC
0145 E8 06CC R                          CALL    GET_PARM
0148 E8 07BD R                          CALL    NEC_OUTPUT
014B B2 07                              MOV     DL,7                    ; GAP LENGTH VALUE TO NEC
014D E8 06CC R                          CALL    GET_PARM
0150 E8 07BD R                          CALL    NEC_OUTPUT
0153 B2 08                              MOV     DL,8                    ; FILLER BYTE TO NEC
0155 E8 06CC R                          CALL    GET_PARM
0158 E8 07BD R                          CALL    NEC_OUTPUT
015B 58                                 POP     AX                      ; THROW AWAY ERROR
015C E8 0530 R                          CALL    NEC_TERM                ; TERMINATE, RECEIVE STATUS, ETC.
015F                    FM_DON:
015F E8 02EE R                          CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
0162 E8 0620 R                          CALL    SETUP_END               ; VARIOUS CLEANUPS
0165 8B DE                              MOV     BX,SI                   ; GET SAVED AL TO BL
0167 8A C3                              MOV     AL,BL                   ; PUT BACK FOR RETURN
0169 C3                                 RET
016A                    DISK_FORMAT     ENDP
                        ;------------------------------------------------------------------------
                        ; FNC_ERR :     INVALID FUNCTION REQUESTED OR INVALID DRIVE; SET BAD COMMAND IN
                        ;               STATUS.
                        ;
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;------------------------------------------------------------------------
016A                    FNC_ERR PROC    NEAR                            ; INVALID FUNCTION REQUEST
016A 8B C6                              MOV     AX,SI                   ; RESTORE AL
016C B4 01                              MOV     AH,BAD_CMD              ; SET BAD COMMAND ERROR
016E 88 26 0041 R                       MOV     @DSKETTE_STATUS,AH      ; STORE IN DATA AREA
0172 F9                                 STC                             ; SET CARRY INDICATING ERROR
0173 C3                                 RET
0174                    FNC_ERR ENDP
                        ;------------------------------------------------------------------------
                        ; DISK_PARMS:   READ DRIVE PARAMETERS.
                        ;
                        ; ON ENTRY:     DI : DRIVE #
                        ;
                        ; ON EXIT:      CL/[BP]   = BITS 7 & 6 HIGH 2 BITS OF MAX CYLINDER
                        ;                             BITS 0-5 MAX SECTORS/TRACK
                        ;               CH/[BP+1] = LOW 8 BITS OF MAX CYLINDER
                        ;               BL/[BP+2] = BITS 7-4 = 0
                        ;                             BITS 3-0 = VALID CMOS DRIVE TYPE
                        ;               BH/[BP+3] = 0
                        ;               DL/[BP+4] = # DRIVES INSTALLED  (VALUE CHECKED)
                        ;               DH/[BP+5] = MAX HEAD #
                        ;               DI/[BP+6] = OFFSET OF DISK_BASE
                        ;               ES        = SEGMENT OF DISK_BASE
                        ;               AX        = 0
                        ;
                        ;               NOTE : THE ABOVE INFORMATION IS STORED IN THE USERS STACK AT
                        ;                      THE LOCATIONS WHERE THE MAIN ROUTINE WILL POP THEM
                        ;                      INTO THE APPROPRIATE REGISTERS BEFORE RETURNING TO THE
                        ;                      CALLER.
                        ;------------------------------------------------------------------------
0174                    DISK_PARMS      PROC    NEAR
0174 81 FF 0080                         CMP     DI,80H                  ; CHECK FOR FIXED MEDIA TYPE REQUEST
0178 72 06                              JB      DISK_P2                 ; CONTINUE IF NOT REQUEST FALL THROUGH

                        ;----- FIXED DISK REQUEST FALL THROUGH ERROR

017A 8B C6                              MOV     AX,SI                   ; RESTORE AL WITH CALLERS VALUE
017C B4 01                              MOV     AH,BAD_CMD              ; SET BAD COMMAND ERROR IN (AH)
```

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017E F9                       STC                                     ; SET ERROR RETURN CODE
017F C3                       RET

0180                    DISK_P2:
0180 E8 02C8 R                CALL    XLAT_NEW                        ; TRANSLATE STATE TO PRESENT ARCH.
0183 C7 46 02 0000            MOV     WORD PTR [BP+2],0               ; DRIVE TYPE = 0
0188 A1 0010 R                MOV     AX,@EQUIP_FLAG                  ; LOAD EQUIPMENT FLAG FOR # DISKETTES
018B 24 C1                    AND     AL,11000001B                    ; KEEP DISKETTE DRIVE BITS
018D B2 02                    MOV     DL,2                            ; DISKETTE DRIVES = 2
018F 3C 41                    CMP     AL,01000001B                    ; 2 DRIVES INSTALLED ?
0191 74 06                    JZ      DISK_P3                         ; IF YES JUMP

0193 FE CA                    DEC     DL                              ; DISKETTE DRIVES = 1
0195 3C 01                    CMP     AL,00000001B                    ; 1 DRIVE INSTALLED ?
0197 75 6A                    JNZ     DISK_P8                         ; IF NO JUMP
0199                    DISK_P3:
0199 88 56 04                 MOV     [BP+4],DL                       ; STORE NUMBER OF DRIVES
019C 83 FF 01                 CMP     DI,1                            ; CHECK FOR VALID DRIVE
019F 77 66                    JA      DISK_P9                         ; DRIVE INVALID
01A1 C6 46 05 01              MOV     BYTE PTR[BP+5],1                ; MAXIMUM HEAD NUMBER = 1
01A5 E8 06B3 R                CALL    CMOS_TYPE                       ; RETURN DRIVE TYPE IN AL
01A8 72 18                    JC      DISK_P4                         ; IF CMOS BAD CHECKSUM ESTABLISHED
01AA 0A C0                    OR      AL,AL                           ; TEST FOR NO DRIVE TYPE
01AC 74 14                    JZ      DISK_P4                         ; JUMP IF SO
01AE 3C 03                    CMP     AL,(DR_PTE-DR_PT)/2             ; > MAXIMUM
01B0 77 10                    JA      DISK_P4                         ; IF SO JUMP

01B2 88 46 02                 MOV     [BP+2],AL                       ; STORE VALID CMOS DRIVE TYPE
01B5 FE C8                    DEC     AL                              ; MAKE 0 ORIGIN
01B7 D0 E0                    SHL     AL,1                            ; ACCOUNT FOR FIELD WIDTH
01B9 8A D8                    MOV     BL,AL                           ; FINISH MAKING INDEX POINTER
01BB 32 FF                    XOR     BH,BH                           ; CLEAR HIGH ORDER INDEX
01BD 2E: 8B 8F 0214 R         MOV     CX,CS:WORD PTR DR_PT[BX]; GET MAX TRACK AND SECTOR

01C2                    DISK_P4:
01C2 8A 85 0090 R             MOV     AL,@DSK_STATE[DI]               ; LOAD STATE FOR THIS DRIVE
01C6 A8 10                    TEST    AL,MED_DET                      ; CHECK FOR ESTABLISHED STATE
01C8 75 08                    JNZ     DISK_P5                         ; GO TO CMOS FOR DRIVE CHECK
01CA 80 7E 02 00              CMP     BYTE PTR [BP+2],0               ; CHECK FOR CMOS BAD/INVALID
01CE 74 37                    JZ      DISK_P9                         ; CMOS BAD/INVALID AND UNESTABLISHED
01D0 EB 1C                    JMP     SHORT DISK_P6                   ; CMOS GOOD AND UNESTABLISHED; USE CMOS

01D2                    DISK_P5:
01D2 24 C0                    AND     AL,RATE_MSK                     ; ISOLATE STATE
01D4 2E: 8B 0E 0216 R         MOV     CX,WORD PTR CS:DR_PT+2          ; GET DRIVE PARAMETERS FOR 1.2 M DRIVE
01D9 3C 80                    CMP     AL,RATE_250                     ; 1.2M DRIVE ?
01DB 75 11                    JNE     DISK_P6                         ; 300 OR 500 RATE IS 1.2M DRIVE

01DD 2E: 8B 0E 0214 R         MOV     CX,WORD PTR CS:DR_PT            ; GET DRIVE PARAMETERS 360K DRIVE
01E2 F6 85 0090 R 01          TEST    @DSK_STATE[DI],TRK_CAPA         ; 80 TRACK ?
01E7 74 05                    JZ      DISK_P6                         ; MUST BE 360

01E9 2E: 8B 0E 0218 R         MOV     CX,WORD PTR CS:DR_PT+4          ; GET DRIVE PARAMETERS
01EE                    DISK_P6:                                      ;
01EE 89 4E 00                 MOV     [BP],CX                         ; SAVE POINTER IN STACK FOR RETURN
01F1 8D 06 0000 E             LEA     AX,DISK_BASE                    ; ADDRESS OF DISK_BASE
01F5 89 46 06                 MOV     [BP+6],AX                       ; SAVE IN STACK
01F8 8C C8                    MOV     AX,CS                           ; SEGMENT DISK_BASE (SAME AS THIS ONE)
01FA                    DISK_P7:
01FA 8E C0                    MOV     ES,AX                           ; ES IS SEGMENT OF TABLE
01FC E8 02EE R                CALL    XLAT_OLD                        ; TRANSLATE STATE TO COMPATIBLE MODE
01FF 33 C0                    XOR     AX,AX                           ; CLEAR
0201 F8                       CLC
0202 C3                       RET

                        ;----- NO DRIVE PRESENT HANDLER

0203                    DISK_P8:
0203 C6 46 04 00              MOV     BYTE PTR [BP+4],0               ; CLEAR NUMBER OF DRIVES
0207                    DISK_P9:
0207 33 C0                    XOR     AX,AX                           ; CLEAR PARMS IF NO DRIVES OR CMOS BAD
0209 89 46 00                 MOV     [BP],AX                         ; TRACKS, SECTORS/TRACK = 0
020C 88 66 05                 MOV     [BP+5],AH                       ; HEAD = 0
020F 89 46 06                 MOV     [BP+6],AX                       ; OFFSET TO DISK_BASE = 0
0212 EB E6                    JMP     DISK_P7                         ; EXIT
0214                    DISK_PARMS      ENDP
                        ;--------------------------------------------------------------------------------
                        ;             DRIVE PARAMETER TABLE
                        ;--------------------------------------------------------------------------------
0214 09 27              DR_PT   DB      09H,027H                        ; MAX. TRACKS, SECTORS/TRACK 360K
0216 0F 4F                      DB      0FH,04FH                        ;          "             "    1.2M
0218 09 4F                      DB      09H,04FH                        ;          "             "    720K
= 021A                  DR_PTE  EQU     $
                        ;--------------------------------------------------------------------------------
                        ; DISK_TYPE:    THIS ROUTINE RETURNS THE TYPE OF MEDIA INSTALLED.
                        ;
                        ;  ON ENTRY:    DI      : DRIVE #
                        ;
                        ;  ON EXIT:     AH : DRIVE TYPE, CY=0
                        ;--------------------------------------------------------------------------------
021A                    DISK_TYPE       PROC    NEAR
021A E8 02C8 R                CALL    XLAT_NEW                        ; TRANSLATE STATE TO PRESENT ARCH.
021D 8A 85 0090 R             MOV     AL,@DSK_STATE[DI]               ; GET PRESENT STATE INFORMATION
0221 0A C0                    OR      AL,AL                           ; CHECK FOR NO DRIVE
0223 74 13                    JZ      NO_DRV                          ;
0225 B4 01                    MOV     AH,NOCHGLN                      ; NO CHANGE LINE FOR 40 TRACK DRIVE
0227 A8 01                    TEST    AL,TRK_CAPA                     ; IS THIS DRIVE AN 80 TRACK DRIVE?
0229 74 02                    JZ      DT_BACK                         ; IF NO JUMP
022B B4 02                    MOV     AH,CHGLN                        ; CHANGE LINE FOR 80 TRACK DRIVE

022D                    DT_BACK:
022D 50                       PUSH    AX                              ; SAVE RETURN VALUE
022E E8 02EE R                CALL    XLAT_OLD                        ; TRANSLATE STATE TO COMPATIBLE MODE
0231 58                       POP     AX                              ; RESTORE RETURN VALUE
0232 F8                       CLC                                     ; NO ERROR
0233 8B DE                    MOV     BX,SI                           ; GET SAVED AL TO BL
0235 8A C3                    MOV     AL,BL                           ; PUT BACK FOR RETURN
0237 C3                       RET
0238                    NO_DRV:
0238 32 E4                    XOR     AH,AH                           ; NO DRIVE PRESENT OR UNKNOWN
023A EB F1                    JMP     SHORT DT_BACK
023C                    DISK_TYPE ENDP
                        ;--------------------------------------------------------------------------------
                        ; DISK_CHANGE : THIS ROUTINE RETURNS THE STATE OF THE DISK CHANGE LINE.
```

```
                                ;
                                ; ON ENTRY:     DI : DRIVE #
                                ;
                                ; ON EXIT:      AH : @DSKETTE_STATUS
                                ;               00 - DISK CHANGE LINE INACTIVE, CY = 0
                                ;               06 - DISK CHANGE LINE ACTIVE, CY = 1
                                ;------------------------------------------------------------------------
 023C                           DISK_CHANGE     PROC    NEAR
 023C E8 02C8 R                         CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
 023F 8A 85 0090 R                      MOV     AL,@DSK_STATE[DI]       ; GET MEDIA STATE INFORMATION
 0243 0A C0                             OR      AL,AL                   ; DRIVE PRESENT ?
 0245 74 19                             JZ      DC_NON                  ; JUMP IF NO DRIVE
 0247 A8 01                             TEST    AL,TRK_CAPA             ; 80 TRACK DRIVE ?
 0249 74 05                             JZ      SETIT                   ; IF SO , CHECK CHANGE LINE

 024B E8 08E3 R                         CALL    READ_DSKCHNG            ; GO CHECK STATE OF DISK CHANGE LINE
 024E 74 05                             JZ      FINIS                   ; CHANGE LINE NOT ACTIVE

 0250 C6 06 0041 R 06           SETIT:  MOV     @DSKETTE_STATUS,MEDIA_CHANGE    ; INDICATE MEDIA REMOVED

 0255 E8 02EE R                 FINIS:  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
 0258 E8 0620 R                         CALL    SETUP_END               ; VARIOUS CLEANUPS
 025B 8B DE                             MOV     BX,SI                   ; GET SAVED AL TO BL
 025D 8A C3                             MOV     AL,BL                   ; PUT BACK FOR RETURN
 025F C3                                RET

 0260                           DC_NON:
 0260 80 0E 0041 R 80                   OR      @DSKETTE_STATUS,TIME_OUT        ; SET TIMEOUT, NO DRIVE
 0265 EB EE                             JMP     SHORT FINIS
 0267                           DISK_CHANGE     ENDP
                                ;------------------------------------------------------------------------
                                ; FORMAT_SET :  THIS ROUTINE IS USED TO ESTABLISH THE TYPE OF MEDIA TO BE USED
                                ;               FOR THE FOLLOWING FORMAT OPERATION.
                                ;
                                ; ON ENTRY:     SI LOW : DASD TYPE FOR FORMAT
                                ;               DI     : DRIVE #
                                ;
                                ; ON EXIT:      @DSKETTE_STATUS REFLECTS STATUS
                                ;               AH : @DSKETTE_STATUS
                                ;               CY = 1 IF ERROR
                                ;------------------------------------------------------------------------
 0267                           FORMAT_SET      PROC    NEAR
 0267 E8 02C8 R                         CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
 026A 56                                PUSH    SI                      ; SAVE DASD TYPE
 026B 8B C6                             MOV     AX,SI                   ; AH = ? , AL = DASD TYPE
 026D 32 E4                             XOR     AH,AH                   ; AH = 0 , AL = DASD TYPE
 026F 8B F0                             MOV     SI,AX                   ; SI = DASD TYPE
 0271 80 A5 0090 R 0F                   AND     @DSK_STATE[DI],NOT MED_DET+DBL_STEP+RATE_MSK    ; CLEAR STATE
 0276 4E                                DEC     SI                      ; CHECK FOR 320/360K MEDIA & DRIVE
 0277 75 07                             JNZ     NOT_320                 ; BYPASS IF NOT
 0279 80 8D 0090 R 90                   OR      @DSK_STATE[DI],MED_DET+RATE_250 ; SET TO 320/360
 027E EB 37                             JMP     SHORT S0

 0280                           NOT_320:
 0280 E8 0416 R                         CALL    MED_CHANGE              ; CHECK FOR TIME_OUT
 0283 80 3E 0041 R 80                   CMP     @DSKETTE_STATUS,TIME_OUT
 0288 74 2D                             JZ      S0                      ; IF TIME OUT TELL CALLER

 028A 4E                                DEC     SI                      ; CHECK FOR 320/360K IN 1.2M DRIVE
 028B 75 07                             JNZ     NOT_320_12              ; BYPASS IF NOT
 028D 80 8D 0090 R 70                   OR      @DSK_STATE[DI],MED_DET+DBL_STEP+RATE_300 ; SET STATE
 0292 EB 23                             JMP     SHORT S0

 0294                           NOT_320_12:
 0294 4E                                DEC     SI                      ; CHECK FOR 1.2M MEDIA IN 1.2M DRIVE
 0295 75 07                             JNZ     NOT_12                  ; BYPASS IF NOT
 0297 80 8D 0090 R 10                   OR      @DSK_STATE[DI],MED_DET+RATE_500   ; SET STATE VARIABLE
 029C EB 19                             JMP     SHORT S0                ; RETURN TO CALLER

 029E                           NOT_12:
 029E 4E                                DEC     SI                      ; CHECK FOR SET DASD TYPE 04
 029F 75 20                             JNZ     FS_ERR                  ; BAD COMMAND EXIT IF NOT VALID TYPE

 02A1 F6 85 0090 R 04                   TEST    @DSK_STATE[DI],DRV_DET  ; DRIVE DETERMINED ?
 02A6 74 09                             JZ      ASSUME                  ; IF STILL NOT DETERMINED ASSUME
 02A8 B0 50                             MOV     AL,MED_DET+RATE_300
 02AA F6 85 0090 R 02                   TEST    @DSK_STATE[DI],FMT_CAPA ; MULTIPLE FORMAT CAPABILITY ?
 02AF 75 02                             JNZ     OR_IT_IN                ; IF 1.2 M THEN DATA RATE 300

 02B1                           ASSUME:
 02B1 B0 90                             MOV     AL,MED_DET+RATE_250     ; SET UP

 02B3                           OR_IT_IN:
 02B3 08 85 0090 R                      OR      @DSK_STATE[DI],AL       ; OR IN THE CORRECT STATE

 02B7                           S0:
 02B7 E8 02EE R                         CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
 02BA E8 0620 R                         CALL    SETUP_END               ; VARIOUS CLEANUPS
 02BD 5B                                POP     BX                      ; GET SAVED AL TO BL
 02BE 8A C3                             MOV     AL,BL                   ; PUT BACK FOR RETURN
 02C0 C3                                RET

 02C1                           FS_ERR:
 02C1 C6 06 0041 R 01                   MOV     @DSKETTE_STATUS,BAD_CMD ; UNKNOWN STATE,BAD COMMAND
 02C6 EB EF                             JMP     SHORT S0

 02C8                           FORMAT_SET      ENDP
                                ;------------------------------------------------------------------------
                                ; XLAT_NEW:  TRANSLATES DISKETTE STATE LOCATIONS FROM COMPATIBLE MODE TO
                                ;            NEW ARCHITECTURE.
                                ;
                                ; ON ENTRY:     DI : DRIVE
                                ;------------------------------------------------------------------------
 02C8                           XLAT_NEW        PROC    NEAR            ;
 02C8 83 FF 01                          CMP     DI,1                    ; VALID DRIVE ?
 02CB 77 1C                             JA      XN_OUT                  ; IF INVALID BACK
 02CD 80 BD 0090 R 00                   CMP     @DSK_STATE[DI],0        ; NO DRIVE ?
 02D2 74 16                             JZ      DO_DET                  ; IF NO DRIVE ATTEMPT DETERMINE
 02D4 8B CF                             MOV     CX,DI                   ; CX = DRIVE NUMBER
 02D6 C0 E1 02                          SHL     CL,2                    ; CL = SHIFT COUNT, A=0, B=4
 02D9 A0 008F R                         MOV     AL,@HF_CNTRL            ; DRIVE INFORMATION
 02DC D2 C8                             ROR     AL,CL                   ; TO LOW NIBBLE
 02DE 24 07                             AND     AL,DRV_DET+FMT_CAPA+TRK_CAPA    ; KEEP DRIVE BITS
 02E0 80 A5 0090 R F8                   AND     @DSK_STATE[DI],NOT DRV_DET+FMT_CAPA+TRK_CAPA
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02E5 08 85 0090 R                   OR      @DSK_STATE[DI],AL       ; UPDATE DRIVE STATE
02E9                        XN_OUT:
02E9 C3                             RET

02EA                        DO_DET:
02EA E8 08ED R                      CALL    DRIVE_DET               ; TRY TO DETERMINE
02ED C3                             RET

02EE                        XLAT_NEW        ENDP
                            ;----------------------------------------------------------------
                            ; XLAT_OLD : TRANSLATES DISKETTE STATE LOCATIONS FROM NEW ARCHITECTURE TO
                            ;            COMPATIBLE MODE.
                            ;
                            ; ON ENTRY:      DI : DRIVE
                            ;----------------------------------------------------------------
02EE                        XLAT_OLD        PROC    NEAR
02EE 83 FF 01                       CMP     DI,1                    ; VALID DRIVE ?
02F1 77 68                          JA      XO_OUT                  ; IF INVALID BACK
02F3 80 BD 0090 R 00                CMP     @DSK_STATE[DI],0        ; NO DRIVE ?
02F8 74 61                          JZ      XO_OUT                  ; IF NO DRIVE TRANSLATE DONE

                            ;----- TEST FOR SAVED DRIVE INFORMATION ALREADY SET

02FA 8B CF                          MOV     CX,DI                   ; CX = DRIVE NUMBER
02FC C0 E1 02                       SHL     CL,2                    ; CL = SHIFT COUNT, A=0, B=4
02FF B4 02                          MOV     AH,FMT_CAPA             ; LOAD MULTIPLE DATA RATE BIT MASK
0301 D2 CC                          ROR     AH,CL                   ; ROTATE BY MASK
0303 84 26 008F R                   TEST    @HF_CNTRL,AH            ; MULTIPLE-DATA RATE DETERMINED ?
0307 75 16                          JNZ     SAVE_SET                ; IF SO, NO NEED TO RE-SAVE

                            ;----- ERASE DRIVE BITS IN @HF_CNTRL FOR THIS DRIVE

0309 B4 07                          MOV     AH,DRV_DET+FMT_CAPA+TRK_CAPA    ; MASK TO KEEP
030B D2 CC                          ROR     AH,CL                   ; FIX MASK TO KEEP
030D F6 D4                          NOT     AH                      ; TRANSLATE MASK
030F 20 26 008F R                   AND     @HF_CNTRL,AH            ; KEEP BITS FROM OTHER DRIVE INTACT

                            ;----- ACCESS CURRENT DRIVE BITS AND STORE IN @HF_CNTRL

0313 8A 85 0090 R                   MOV     AL,@DSK_STATE[DI]       ; ACCESS STATE
0317 24 07                          AND     AL,DRV_DET+FMT_CAPA+TRK_CAPA    ; KEEP DRIVE BITS
0319 D2 C8                          ROR     AL,CL                   ; FIX FOR THIS DRIVE
031B 08 06 008F R                   OR      @HF_CNTRL,AL            ; UPDATE SAVED DRIVE STATE

                            ;----- TRANSLATE TO COMPATIBILITY MODE

031F                        SAVE_SET:
031F 8A A5 0090 R                   MOV     AH,@DSK_STATE[DI]       ; ACCESS STATE
0323 8A FC                          MOV     BH,AH                   ; TO BH FOR LATER
0325 80 E4 C0                       AND     AH,RATE_MSK             ; KEEP ONLY RATE
0328 B0 02                          MOV     AL,MIDIU                ; AL = 1.2 IN 1.2 UNESTABLISHED
032A 80 FC 00                       CMP     AH,RATE_500             ; RATE 500 ?
032D 74 1C                          JZ      TST_DET                 ; JUMP IF 1.2 IN 1.2
032F B0 01                          MOV     AL,M3DIU                ; AL = 360 IN 1.2 UNESTABLISHED
0331 80 FC 40                       CMP     AH,RATE_300             ; RATE 300 ?
0334 75 09                          JNZ     CHK_250                 ; IF SO FALL THRU
0336 F6 C7 20                       TEST    BH,DBL_STEP             ; CHECK FOR DOUBLE STEP
0339 75 10                          JNZ     TST_DET                 ; MUST BE 360 IN 1.2

033B                        UNKNO:
033B B0 07                          MOV     AL,MED_UNK              ; NONE OF THE ABOVE
033D EB 13                          JMP     SHORT AL_SET            ; PROCESS COMPLETE

033F                        CHK_250:
033F B0 00                          MOV     AL,M3D3U                ; AL = 360 IN 360 UNESTABLISHED
0341 80 FC 80                       CMP     AH,RATE_250             ; RATE 250 ?
0344 75 F5                          JNZ     UNKNO                   ; IF SO FALL THRU
0346 F6 C7 01                       TEST    BH,TRK_CAPA             ; 80 TRACK CAPABILITY ?
0349 75 F0                          JNZ     UNKNO                   ; IF SO JUMP, FALL THRU TEST DET

034B                        TST_DET:
034B F6 C7 10                       TEST    BH,MED_DET              ; DETERMINED ?
034E 74 02                          JZ      AL_SET                  ; IF NOT THEN SET
0350 04 03                          ADD     AL,3                    ; MAKE DETERMINED/ESTABLISHED

0352                        AL_SET:
0352 80 A5 0090 R F8                AND     @DSK_STATE[DI],NOT DRV_DET+FMT_CAPA+TRK_CAPA  ; CLEAR DRIVE
0357 08 85 0090 R                   OR      @DSK_STATE[DI],AL       ; REPLACE WITH COMPATIBLE MODE
035B                        XO_OUT:
035B C3                             RET
035C                        XLAT_OLD        ENDP
                            ;----------------------------------------------------------------
                            ; RD_WR_VF : COMMON READ, WRITE AND VERIFY; MAIN LOOP FOR STATE RETRIES.
                            ;
                            ; ON ENTRY:      AH : READ/WRITE/VERIFY DMA PARAMETER
                            ;                AL : READ/WRITE/VERIFY NEC PARAMETER
                            ;
                            ; ON EXIT:       @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                            ;----------------------------------------------------------------
035C                        RD_WR_VF        PROC    NEAR
035C 50                             PUSH    AX                      ; SAVE DMA, NEC PARAMETERS
035D E8 02C8 R                      CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
0360 E8 039B R                      CALL    SETUP_STATE             ; STATE INITIALIZATIONS
0363 58                             POP     AX                      ; RESTORE DMA,NEC PARAMETERS

0364                        DO_AGAIN:
0364 50                             PUSH    AX                      ; SAVE READ/WRITE/VERIFY PARAMETER
0365 E8 0416 R                      CALL    MED_CHANGE              ; MEDIA CHANGE AND RESET IF CHANGED
0368 58                             POP     AX                      ; RESTORE READ/WRITE/VERIFY
0369 72 21                          JC      RWV_END                 ; MEDIA CHANGE ERROR OR TIME-OUT
036B 50                             PUSH    AX                      ; SAVE READ/WRITE/VERIFY PARAMETER
036C E8 0451 R                      CALL    SEND_RATE               ; SEND DATA RATE TO NEC
036F E8 063A R                      CALL    SETUP_DBL               ; CHECK FOR DOUBLE STEP
0372 72 12                          JC      CHK_RET                 ; ERROR FROM READ ID, POSSIBLE RETRY
0374 58                             POP     AX                      ; RESTORE NEC,DMA COMMAND
0375 50                             PUSH    AX                      ; SAVE NEC COMMAND
0376 E8 0471 R                      CALL    DMA_SETUP               ; SET UP THE DMA
0379 58                             POP     AX                      ; RESTORE NEC COMMAND
037A 72 16                          JC      RWV_BAC                 ; CHECK FOR DMA BOUNDARY ERROR
037C 50                             PUSH    AX                      ; SAVE NEC COMMAND
037D E8 04C7 R                      CALL    NEC_INIT                ; INITIALIZE NEC
0380 E8 04EC R                      CALL    RWV_COM                 ; OP CODE COMMON TO READ/WRITE/VERIFY
0383 E8 0530 R                      CALL    NEC_TERM                ; TERMINATE, GET STATUS, ETC.
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0386                          CHK_RET:
0386 E8 05B1 R                        CALL    RETRY                   ; CHECK FOR, SETUP RETRY
0389 58                               POP     AX                      ; RESTORE READ/WRITE/VERIFY PARAMETER
038A 72 D8                            JC      DO_AGAIN                ; CY = 1 MEANS RETRY

038C                          RWV_END:
038C E8 0582 R                        CALL    DSTATE                  ; ESTABLISH STATE IF SUCCESSFUL
038F E8 05F3 R                        CALL    NUM_TRANS               ; AL = NUMBER TRANSFERRED

0392                          RWV_BAC:                                ; BAD DMA ERROR ENTRY
0392 50                               PUSH    AX                      ; SAVE NUMBER TRANSFERRED
0393 E8 02EE R                        CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
0396 58                               POP     AX                      ; RESTORE NUMBER TRANSFERRED
0397 E8 0620 R                        CALL    SETUP_END               ; VARIOUS CLEANUPS
039A C3                               RET
039B                          RD_WR_VF        ENDP
                              ;-------------------------------------------------------------------------
                              ; SETUP_STATE:  INITIALIZES START AND END RATES.
                              ;-------------------------------------------------------------------------
039B                          SETUP_STATE     PROC    NEAR            ;
039B F6 85 0090 R 10                  TEST    @DSK_STATE[DI],MED_DET  ; MEDIA DETERMINED ?
03A0 75 2B                            JNZ     J1C                     ; NO STATES IF DETERMINED
03A2 B8 4080                          MOV     AX,RATE_300*H+RATE_250  ; AH = START RATE,  AL = END RATE
03A5 F6 85 0090 R 04                  TEST    @DSK_STATE[DI],DRV_DET  ; DRIVE ?
03AA 74 0C                            JZ      AX_SET                  ; DO NOT KNOW DRIVE
03AC B0 00                            MOV     AL,RATE_500             ; SET UP FOR 1.2 M END RATE
03AE F6 85 0090 R 02                  TEST    @DSK_STATE[DI],FMT_CAPA ; 1.2 M ?
03B3 75 03                            JNZ     AX_SET                  ; JUMP WITH FIXED END RATE
03B5 B8 8080                          MOV     AX,RATE_250*X           ; START & EMD RATE = 250 FOR 360 DRIVE

03B8                          AX_SET:
03B8 80 A5 0090 R 1F                  AND     @DSK_STATE[DI],NOT RATE_MSK+DBL_STEP ; TURN OFF THE RATE
03BD 08 A5 0090 R                     OR      @DSK_STATE[DI],AH       ; RATE FIRST TO TRY
03C1 80 26 008B R F3                  AND     @LASTRATE,NOT STRT_MSK  ; ERASE LAST TO TRY RATE BITS
03C6 C0 C8 04                         ROR     AL,4                    ; TO OPERATION LAST RATE LOCATION
03C9 08 06 008B R                     OR      @LASTRATE,AL            ; LAST RATE
03CD                          J1C:
03CD C3                               RET
03CE                          SETUP_STATE     ENDP
                              ;-------------------------------------------------------------------------
                              ; FMT_INIT: ESTABLISH STATE IF UNESTABLISHED AT FORMAT TIME.
                              ;-------------------------------------------------------------------------
03CE                          FMT_INIT        PROC    NEAR
03CE F6 85 0090 R 10                  TEST    @DSK_STATE[DI],MED_DET  ; IS MEDIA ESTABLISHED
03D3 75 3C                            JNZ     F1_OUT                  ; IF SO RETURN
03D5 E8 06B3 R                        CALL    CMOS_TYPE               ; RETURN DRIVE TYPE IN AL
03D8 72 38                            JC      CL_DRV                  ; ERROR IN CMOS ASSUME NO DRIVE
03DA FE C8                            DEC     AL                      ; MAKE ZERO ORIGIN
03DC 78 34                            JS      CL_DRV                  ; NO DRIVE IF AL 0
03DE 8A A5 0090 R                     MOV     AH,@DSK_STATE[DI]       ; AH = CURRENT STATE
03E2 80 E4 0F                         AND     AH,NOT MED_DET+DBL_STEP+RATE_MSK        ; CLEAR
03E5 0A C0                            OR      AL,AL                   ; CHECK FOR 360
03E7 75 05                            JNZ     N_360                   ; IF 360 WILL BE 0
03E9 80 CC 90                         OR      AH,MED_DET+RATE_250     ; ESTABLISH MEDIA
03EC EB 1F                            JMP     SHORT SKP_STATE         ; SKIP OTHER STATE PROCESSING

03EE                          N_360:
03EE FE C8                            DEC     AL                      ; 1.2 M DRIVE
03F0 75 05                            JNZ     N_12                    ; JUMP IF NOT
03F2 80 CC 10                         OR      AH,MED_DET+RATE_500     ; DEFAULT TO 1.2M FORMAT
03F5 EB 16                            JMP     SHORT SKP_STATE         ; SKIP OTHER STATE PROCESSING

03F7                          N_12:
03F7 FE C8                            DEC     AL                      ; CHECK FOR TYPE 3
03F9 75 17                            JNZ     CL_DRV                  ; NO DRIVE, CMOS BAD
03FB F6 C4 04                         TEST    AH,DRV_DET              ; IS DRIVE DETERMINED
03FE 74 0A                            JZ      ISNT_12                 ; TREAT AS NON 1.2 DRIVE
0400 F6 C4 02                         TEST    AH,FMT_CAPA             ; IS 1.2M
0403 74 05                            JZ      ISNT_12                 ; JUMP IF NOT
0405 80 CC 50                         OR      AH,MED_DET+RATE_300     ; RATE 300
0408 EB 03                            JMP     SHORT SKP_STATE         ; CONTINUE

040A                          ISNT_12:
040A 80 CC 90                         OR      AH,MED_DET+RATE_250     ; MUST BE RATE 250

040D                          SKP_STATE:
040D 88 A5 0090 R                     MOV     @DSK_STATE[DI],AH       ; STORE AWAY

0411                          F1_OUT:
0411 C3                               RET

0412                          CL_DRV:
0412 32 E4                            XOR     AH,AH                   ; CLEAR STATE
0414 EB F7                            JMP     SHORT SKP_STATE         ; SAVE IT
0416                          FMT_INIT        ENDP
                              ;-------------------------------------------------------------------------
                              ; MED_CHANGE:   CHECKS FOR MEDIA CHANGE, RESETS MEDIA CHANGE, CHECKS MEDIA
                              ;               CHANGE AGAIN.
                              ;
                              ; ON EXIT:      CY = 1 MEANS MEDIA CHANGE OR TIMEOUT
                              ;               @DSKETTE_STATUS = ERROR CODE
                              ;-------------------------------------------------------------------------
0416                          MED_CHANGE      PROC    NEAR
0416 E8 08E3 R                        CALL    READ_DSKCHNG            ; READ DISK CHANGE LINE STATE
0419 74 34                            JZ      MED_C9                  ; BYPASS HANDLING DISK CHANGE LINE
041B 80 A5 0090 R EF                  AND     @DSK_STATE[DI],NOT MED_DET      ; CLEAR STATE FOR THIS DRIVE

                              ;       THIS SEQUENCE ENSURES WHENEVER A DISKETTE IS CHANGED THAT
                              ;       ON THE NEXT OPERATION THE REQUIRED MOTOR START UP TIME WILL
                              ;       BE WAITED. (DRIVE MOTOR MAY GO OFF UPON DOOR OPENING).

0420 8B CF                            MOV     CX,DI                   ; CL = DRIVE #
0422 B0 01                            MOV     AL,1                    ; MOTOR ON BIT MASK
0424 D2 E0                            SHL     AL,CL                   ; TO APPROPRIATE POSITION
0426 F6 D0                            NOT     AL                      ; KEEP ALL BUT MOTOR ON
0428 FA                               CLI                             ; NO INTERRUPTS
0429 20 06 003F R                     AND     @MOTOR_STATUS,AL        ; TURN MOTOR OFF INDICATOR
042D FB                               STI                             ; INTERRUPTS ENABLED
042E E8 06E1 R                        CALL    MOTOR_ON                ; TURN MOTOR ON

                              ;-----  THIS SEQUENCE OF SEEKS IS USED TO RESET DISKETTE CHANGE SIGNAL

0431 E8 007E R                        CALL    DISK_RESET              ; RESET NEC
0434 B5 01                            MOV     CH,01H                  ; MOVE TO CYLINDER 1
```

SECTION 5

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0436 E8 07DE R                    CALL    SEEK                    ; ISSUE SEEK
0439 32 ED                        XOR     CH,CH                   ; MOVE TO CYLINDER 0
043B E8 07DE R                    CALL    SEEK                    ; ISSUE SEEK
043E C6 06 0041 R 06              MOV     @DSKETTE_STATUS,MEDIA_CHANGE    ; STORE IN STATUS
0443 E8 08E3 R                    CALL    READ_DSKCHNG            ; CHECK MEDIA CHANGED AGAIN
0446 74 05                        JZ      MED_C8                  ; IF ACTIVE, NO DISKETTE, TIMEOUT
0448 C6 06 0041 R 80              MOV     @DSKETTE_STATUS,TIME_OUT; TIMEOUT IF DRIVE EMPTY
044D                      MED_C8:
044D F9                           STC                             ; MEDIA CHANGED, SET CY
044E C3                           RET
044F                      MED_C9:
044F F8                           CLC                             ; NO MEDIA CHANGED, CLEAR CY
0450 C3                           RET
0451                      MED_CHANGE      ENDP
                          ;-------------------------------------------------------------------------------
                          ; SEND_RATE:      SENDS DATA RATE COMMAND TO NEC IF PREVIOUS RATE WAS DIFFERENT.
                          ;-------------------------------------------------------------------------------
0451                      SEND_RATE       PROC    NEAR
0451 8A 26 008B R                 MOV     AH,@LASTRATE            ; GET LAST DATA RATE SELECTED
0455 8A 85 0090 R                 MOV     AL,@DSK_STATE[DI]       ; GET RATE STATE OF THIS DRIVE
0459 25 C0C0                      AND     AX,SEND_MSK*X           ; KEEP ONLY RATE BITS OF BOTH
045C 3A C4                        CMP     AL,AH                   ; COMPARE TO PREVIOUSLY TRIED
045E 74 10                        JE      C_S_OUT                 ; IF SAME, NO NEW TRANSFER RATE
0460 80 26 008B R 3F              AND     @LASTRATE,NOT SEND_MSK  ; ELSE CLEAR LAST RATE ATTEMPTED
0465 08 06 008B R                 OR      @LASTRATE,AL            ; SAVE NEW RATE FOR NEXT CHECK
0469 C0 C0 02                     ROL     AL,2                    ; MOVE TO BIT OUTPUT POSITIONS
046C BA 03F7                      MOV     DX,03F7H                ; OUTPUT NEW DATA RATE
046F EE                           OUT     DX,AL
0470                      C_S_OUT:
0470 C3                           RET
0471                      SEND_RATE       ENDP
                          ;-------------------------------------------------------------------------------
                          ; DMA_SETUP:      THIS ROUTINE SETS UP THE DMA FOR READ/WRITE/VERIFY OPERATIONS.
                          ;
                          ; ON ENTRY:       AL = DMA COMMAND
                          ;
                          ; ON EXIT:        @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                          ;-------------------------------------------------------------------------------
0471                      DMA_SETUP       PROC    NEAR
0471 FA                           CLI                             ; DISABLE INTERRUPTS DURING DMA SET-UP
0472 E6 0C                        OUT     DMA+12,AL               ; SET THE FIRST/LAST F/F
0474 EB 00                        JMP     $+2                     ; WAIT FOR I/O
0476 E6 0B                        OUT     DMA+11,AL               ; OUTPUT THE MODE BYTE
0478 8C C0                        MOV     AX,ES                   ; GET THE ES VALUE
047A C1 C0 04                     ROL     AX,4                    ; ROTATE LEFT
047D 8A E8                        MOV     CH,AL                   ; GET HIGHEST NIBBLE OF ES TO CH
047F 24 F0                        AND     AL,11110000B            ; ZERO THE LOW NIBBLE FROM SEGMENT
0481 03 46 02                     ADD     AX,[BP+2]               ; TEST FOR CARRY FROM ADDITION
0484 73 02                        JNC     J33
0486 FE C5                        INC     CH                      ; CARRY MEANS HIGH 4 BITS MUST BE INC
0488                      J33:
0488 50                           PUSH    AX                      ; SAVE START ADDRESS
0489 E6 04                        OUT     DMA+4,AL                ; OUTPUT LOW ADDRESS
048B EB 00                        JMP     $+2                     ; WAIT FOR I/O
048D 8A C4                        MOV     AL,AH
048F E6 04                        OUT     DMA+4,AL                ; OUTPUT HIGH ADDRESS
0491 8A C5                        MOV     AL,CH                   ; GET HIGH 4 BITS
0493 EB 00                        JMP     $+2                     ; I/O WAIT STATE
0495 24 0F                        AND     AL,00001111B
0497 E6 81                        OUT     081H,AL                 ; OUTPUT HIGH 4 BITS TO PAGE REGISTER

                          ;-----  DETERMINE COUNT

0499 8B C6                        MOV     AX,SI                   ; AL = # OF SECTORS
049B 86 C4                        XCHG    AL,AH                   ; AH = # OF SECTORS
049D 2A C0                        SUB     AL,AL                   ; AL = 0, AX = # OF SECTORS * 256
049F D1 E8                        SHR     AX,1                    ; AX = # SECTORS * 128
04A1 50                           PUSH    AX                      ; SAVE # OF SECTORS * 128
04A2 B2 03                        MOV     DL,3                    ; GET BYTES/SECTOR PARAMETER
04A4 E8 06CC R                    CALL    GET_PARM                ; "
04A7 8A CC                        MOV     CL,AH                   ; SHIFT COUNT (0=128, 1=256 ETC)
04A9 58                           POP     AX                      ; AX = # OF SECTORS * 128
04AA D3 E0                        SHL     AX,CL                   ; SHIFT BY PARAMETER VALUE
04AC 48                           DEC     AX                      ;-1 FOR DMA VALUE
04AD 50                           PUSH    AX                      ; SAVE COUNT VALUE
04AE E6 05                        OUT     DMA+5,AL                ; LOW BYTE OF COUNT
04B0 EB 00                        JMP     $+2                     ; WAIT FOR I/O
04B2 8A C4                        MOV     AL,AH
04B4 E6 05                        OUT     DMA+5,AL                ; HIGH BYTE OF COUNT
04B6 FB                           STI                             ; RE-ENABLE INTERRUPTS
04B7 59                           POP     CX                      ; RECOVER COUNT VALUE
04B8 58                           POP     AX                      ; RECOVER ADDRESS VALUE
04B9 03 C1                        ADD     AX,CX                   ; ADD, TEST FOR 64K OVERFLOW
04BB B0 02                        MOV     AL,2                    ; MODE FOR 8237
04BD E6 0A                        OUT     DMA+10,AL               ; INITIALIZE THE DISKETTE CHANNEL
04BF 73 05                        JNC     NO_BAD                  ; CHECK FOR ERROR
04C1 C6 06 0041 R 09              MOV     @DSKETTE_STATUS,DMA_BOUNDARY    ; SET ERROR
04C6                      NO_BAD:
04C6 C3                           RET                             ; CY SET BY ABOVE IF ERROR
04C7                      DMA_SETUP       ENDP
                          ;-------------------------------------------------------------------------------
                          ; NEC_INIT:       THIS ROUTINE SEEKS TO THE REQUESTED TRACK AND INITIALIZES THE
                          ;                 NEC FOR THE READ/WRITE/VERIFY/FORMAT OPERATION.
                          ;
                          ; ON ENTRY:       AH : NEC COMMAND TO BE PERFORMED
                          ;
                          ; ON EXIT:        @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                          ;-------------------------------------------------------------------------------
04C7                      NEC_INIT        PROC    NEAR
04C7 50                           PUSH    AX                      ; SAVE NEC COMMAND
04C8 E8 06E1 R                    CALL    MOTOR_ON                ; TURN MOTOR ON FOR SPECIFIC DRIVE

                          ;-----  DO THE SEEK OPERATION

04CB 8A 6E 01                     MOV     CH,[BP+1]               ; CH = TRACK #
04CE E8 07DE R                    CALL    SEEK                    ; MOVE TO CORRECT TRACK
04D1 58                           POP     AX                      ; RECOVER COMMAND
04D2 72 17                        JC      ER_1                    ; ERROR ON SEEK
04D4 BB 04EB R                    MOV     BX,OFFSET ER_1          ; LOAD ERROR ADDRESS
04D7 53                           PUSH    BX                      ; PUSH NEC_OUT ERROR RETURN
```

```
                            ;----- SEND OUT THE PARAMETERS TO THE CONTROLLER

04D8 E8 07BD R                      CALL    NEC_OUTPUT              ; OUTPUT THE OPERATION COMMAND
04DB 8B C6                          MOV     AX,SI                   ; AH = HEAD #
04DD 8B DF                          MOV     BX,DI                   ; BL = DRIVE #
04DF C0 E4 02                       SAL     AH,2                    ; MOVE IT TO BIT 2
04E2 80 E4 04                       AND     AH,00000100B            ; ISOLATE THAT BIT
04E5 0A E3                          OR      AH,BL                   ; OR IN THE DRIVE NUMBER
04E7 E8 07BD R                      CALL    NEC_OUTPUT              ; FALL THRU CY SET IF ERROR
04EA 5B                             POP     BX                      ; THROW AWAY ERROR RETURN
04EB                        ER_1:
04EB C3                             RET
04EC                        NEC_INIT        ENDP

                            ;-------------------------------------------------------------------------
                            ; RWV_COM:      THIS ROUTINE SENDS PARAMETERS TO THE NEC SPECIFIC TO THE
                            ;               READ/WRITE/VERIFY OPERATIONS.
                            ;
                            ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                            ;-------------------------------------------------------------------------
04EC                        RWV_COM PROC    NEAR
04EC B8 052F R                      MOV     AX,OFFSET ER_2          ; LOAD ERROR ADDRESS
04EF 50                             PUSH    AX                      ; PUSH NEC_OUT ERROR RETURN
04F0 8A 66 01                       MOV     AH,[BP+1]               ; OUTPUT TRACK #
04F3 E8 07BD R                      CALL    NEC_OUTPUT
04F6 8B C6                          MOV     AX,SI                   ; OUTPUT HEAD #
04F8 E8 07BD R                      CALL    NEC_OUTPUT
04FB 8A 66 00                       MOV     AH,[BP]                 ; OUTPUT SECTOR #
04FE E8 07BD R                      CALL    NEC_OUTPUT
0501 B2 03                          MOV     DL,3                    ; BYTES/SECTOR PARAMETER FROM BLOCK
0503 E8 06CC R                      CALL    GET_PARM                ; . TO THE NEC
0506 E8 07BD R                      CALL    NEC_OUTPUT              ; OUTPUT TO CONTROLLER
0509 B2 04                          MOV     DL,4                    ; EOT PARAMETER FROM BLOCK
050B E8 06CC R                      CALL    GET_PARM                ; . TO THE NEC
050E E8 07BD R                      CALL    NEC_OUTPUT              ; OUTPUT TO CONTROLLER
0511 8A 85 0090 R                   MOV     AL,@DSK_STATE[DI]       ; GET DRIVE STATE VALUE
0515 B4 1B                          MOV     AH,01BH                 ; 1.2/1.2 DRIVE GAP LENGTH
0517 24 C0                          AND     AL,RATE_MSK             ; STRIP OFF HIGH BITS
0519 74 08                          JZ      R15                     ; IF SO JUMP
051B B4 23                          MOV     AH,023H                 ; 320,360/1.2 DRIVE GAP LENGTH
051D FE C8                          DEC     AL                      ; CHECK FOR 320 MEDIA IN 1.2 DRIVE
051F 74 02                          JZ      R15                     ; IF SO JUMP

0521 B4 2A                          MOV     AH,02AH                 ; 360/360 DRIVE GAP LENGTH
0523                        R15:
0523 E8 07BD R                      CALL    NEC_OUTPUT
0526 B2 06                          MOV     DL,6                    ; DTL PARAMETER FROM BLOCK
0528 E8 06CC R                      CALL    GET_PARM                ;  TO THE NEC
052B E8 07BD R                      CALL    NEC_OUTPUT              ; OUTPUT TO CONTROLLER
052E 58                             POP     AX                      ; THROW AWAY ERROR EXIT
052F                        ER_2:
052F C3                             RET
0530                        RWV_COM ENDP

                            ;-------------------------------------------------------------------------
                            ; NEC_TERM:     THIS ROUTINE WAITS FOR THE OPERATION THEN ACCEPTS THE STATUS
                            ;               FROM THE NEC FOR THE READ/WRITE/VERIFY/FORMAT OPERATION.
                            ;
                            ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                            ;-------------------------------------------------------------------------
0530                        NEC_TERM        PROC    NEAR

                            ;----- LET THE OPERATION HAPPEN

0530 56                             PUSH    SI                      ; SAVE HEAD #, # OF SECTORS
0531 E8 087C R                      CALL    WAIT_INT                ; WAIT FOR THE INTERRUPT
0534 9C                             PUSHF
0535 E8 08A4 R                      CALL    RESULTS                 ; GET THE NEC STATUS
0538 72 45                          JC      SET_END_POP
053A 9D                             POPF
053B 72 3A                          JC      SET_END                 ; LOOK FOR ERROR

                            ;----- CHECK THE RESULTS RETURNED BY THE CONTROLLER

053D FC                             CLD                             ; SET THE CORRECT DIRECTION
053E BE 0042 R                      MOV     SI,OFFSET @NEC_STATUS   ; POINT TO STATUS FIELD
0541 AC                             LODS    @NEC_STATUS             ; GET ST0
0542 24 C0                          AND     AL,11000000B            ; TEST FOR NORMAL TERMINATION
0544 74 31                          JZ      SET_END                 ;
0546 3C 40                          CMP     AL,01000000B            ; TEST FOR ABNORMAL TERMINATION
0548 75 27                          JNZ     J18                     ; NOT ABNORMAL, BAD NEC

                            ;----- ABNORMAL TERMINATION, FIND OUT WHY

054A AC                             LODS    @NEC_STATUS             ; GET ST1
054B D0 E0                          SAL     AL,1                    ; TEST FOR EOT FOUND
054D B4 04                          MOV     AH,RECORD_NOT_FND
054F 72 22                          JC      J19
0551 C0 E0 02                       SAL     AL,2
0554 B4 10                          MOV     AH,BAD_CRC
0556 72 1B                          JC      J19
0558 D0 E0                          SAL     AL,1                    ; TEST FOR DMA OVERRUN
055A B4 08                          MOV     AH,BAD_DMA
055C 72 15                          JC      J19
055E C0 E0 02                       SAL     AL,2                    ; TEST FOR RECORD NOT FOUND
0561 B4 04                          MOV     AH,RECORD_NOT_FND
0563 72 0E                          JC      J19
0565 D0 E0                          SAL     AL,1
0567 B4 03                          MOV     AH,WRITE_PROTECT        ; TEST FOR WRITE_PROTECT
0569 72 08                          JC      J19
056B D0 E0                          SAL     AL,1                    ; TEST MISSING ADDRESS MARK
056D B4 02                          MOV     AH,BAD_ADDR_MARK
056F 72 02                          JC      J19

                            ;----- NEC MUST HAVE FAILED
0571                        J18:
0571 B4 20                          MOV     AH,BAD_NEC
0573                        J19:
0573 08 26 0041 R                   OR      @DSKETTE_STATUS,AH
0577                        SET_END:
0577 80 3E 0041 R 01                CMP     @DSKETTE_STATUS,1       ; SET ERROR CONDITION
057C F5                             CMC                             ;
057D 5E                             POP     SI                      ; RESTORE HEAD #, # OF SECTORS
057E C3                             RET
```

SECTION 5

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057F                          SET_END_POP:
057F 9D                               POPF
0580 EB F5                            JMP     SHORT SET_END
0582                          NEC_TERM        ENDP

                              ;------------------------------------------------------------------------
                              ; DSTATE:         ESTABLISH STATE UPON SUCCESSFUL OPERATION.
                              ;------------------------------------------------------------------------
0582                          DSTATE  PROC    NEAR
0582 80 3E 0041 R 00                  CMP     @DSKETTE_STATUS,0         ; CHECK FOR ERROR
0587 75 27                            JNZ     SETBAC                    ; IF ERROR JUMP
0589 80 8D 0090 R 10                  OR      @DSK_STATE[DI],MED_DET    ; NO ERROR, MARK MEDIA AS DETERMINED
058E F6 85 0090 R 04                  TEST    @DSK_STATE[DI],DRV_DET    ; DRIVE DETERMINED ?
0593 75 1B                            JNZ     SETBAC                    ; IF DETERMINED NO TRY TO DETERMINE
0595 8A 85 0090 R                     MOV     AL,@DSK_STATE[DI]         ; LOAD STATE
0599 24 C0                            AND     AL,RATE_MSK               ; KEEP ONLY RATE
059B 3C 80                            CMP     AL,RATE_250               ; CHECK FOR 1.2M
059D 75 0C                            JNE     M_12                      ; MUST BE 1.2
059F 80 A5 0090 R FD                  AND     @DSK_STATE[DI],NOT FMT_CAPA      ; TURN OFF FORMAT CAPABILITY
05A4 80 8D 0090 R 04                  OR      @DSK_STATE[DI],DRV_DET    ; MARK DRIVE DETERMINED
05A9 EB 05                            JMP     SHORT SETBAC              ; BACK

05AB                          M_12:
05AB 80 8D 0090 R 06                  OR      @DSK_STATE[DI],DRV_DET+FMT_CAPA ; TURN ON DETERMINED & FMT CAPA

05B0                          SETBAC:
05B0 C3                               RET
05B1                          DSTATE  ENDP
                              ;------------------------------------------------------------------------
                              ; RETRY:          DETERMINES WHETHER A RETRY IS NECESSARY. IF RETRY IS REQUIRED
                              ;                 THEN STATE INFORMATION IS UPDATED FOR RETRY.
                              ;
                              ; ON EXIT:        CY = 1 FOR RETRY, CY = 0 FOR NO RETRY
                              ;------------------------------------------------------------------------
05B1                          RETRY   PROC    NEAR
05B1 80 3E 0041 R 00                  CMP     @DSKETTE_STATUS,0         ; GET STATUS OF OPERATION
05B6 74 39                            JZ      NO_RETRY                  ; SUCCESSFUL OPERATION
05B8 80 3E 0041 R 80                  CMP     @DSKETTE_STATUS,TIME_OUT          ; IF TIME OUT NO RETRY
05BD 74 32                            JZ      NO_RETRY                  ;
05BF 8A A5 0090 R                     MOV     AH,@DSK_STATE[DI]         ; GET MEDIA STATE OF DRIVE
05C3 F6 C4 10                         TEST    AH,MED_DET                ; ESTABLISHED/DETERMINED ?
05C6 75 29                            JNZ     NO_RETRY                  ; IF ESTABLISHED STATE THEN TRUE ERROR
05C8 80 E4 C0                         AND     AH,RATE_MSK               ; ISOLATE RATE
05CB 8A 2E 008B R                     MOV     CH,@LASTRATE              ; GET START OPERATION STATE
05CF C0 C5 04                         ROL     CH,4                      ; TO CORRESPONDING BITS
05D2 80 E5 C0                         AND     CH,RATE_MSK               ; ISOLATE RATE BITS
05D5 3A EC                            CMP     CH,AH                     ; ALL RATES TRIED
05D7 74 18                            JE      NO_RETRY                  ; IF YES, THEN TRUE ERROR

                              ;       SETUP STATE INDICATOR FOR RETRY ATTEMPT TO NEXT RATE
                              ;         00000000B (500) -> 10000000B (250)
                              ;         10000000B (250) -> 01000000B (300)
                              ;         01000000B (300) -> 00000000B (500)

05D9 80 FC 01                         CMP     AH,RATE_500+1             ; SET CY FOR RATE 500
05DC D0 DC                            RCR     AH,1                      ; TO NEXT STATE
05DE 80 E4 C0                         AND     AH,RATE_MSK               ; KEEP ONLY RATE BITS
05E1 80 A5 0090 R 1F                  AND     @DSK_STATE[DI],NOT RATE_MSK+DBL_STEP     ; RATE, DBL STEP OFF
05E6 08 A5 0090 R                     OR      @DSK_STATE[DI],AH         ; TURN ON NEW RATE
05EA C6 06 0041 R 00                  MOV     @DSKETTE_STATUS,0         ; RESET STATUS FOR RETRY
05EF F9                               STC                               ; SET CARRY FOR RETRY
05F0 C3                               RET                               ; RETRY RETURN

05F1                          NO_RETRY:
05F1 F8                               CLC                               ; CLEAR CARRY NO RETRY
05F2 C3                               RET                               ; NO RETRY RETURN
05F3                          RETRY   ENDP
                              ;------------------------------------------------------------------------
                              ; NUM_TRANS:      THIS ROUTINE CALCULATES THE NUMBER OF SECTORS THAT WERE
                              ;                 ACTUALLY TRANSFERRED TO/FROM THE DISKETTE.
                              ;
                              ; ON ENTRY:       [BP+1] = TRACK
                              ;                 SI-HI  = HEAD
                              ;                 [BP]   = START SECTOR
                              ;
                              ; ON EXIT:        AL = NUMBER ACTUALLY TRANSFERRED
                              ;------------------------------------------------------------------------
05F3                          NUM_TRANS       PROC    NEAR
05F3 32 C0                            XOR     AL,AL                     ; CLEAR FOR ERROR
05F5 80 3E 0041 R 00                  CMP     @DSKETTE_STATUS,0         ; CHECK FOR ERROR
05FA 75 23                            JNZ     NT_OUT                    ; IF ERROR 0 TRANSFERRED
05FC B2 04                            MOV     DL,4                      ; SECTORS/TRACK OFFSET TO DL
05FE E8 06CC R                        CALL    GET_PARM                  ; AH = SECTORS/TRACK
0601 8A 1E 0047 R                     MOV     BL,@NEC_STATUS+5          ; GET ENDING SECTOR
0605 8B CE                            MOV     CX,SI                     ; CH = HEAD # STARTED
0607 3A 2E 0046 R                     CMP     CH,@NEC_STATUS+4          ; GET HEAD ENDED UP ON
060B 75 0B                            JNZ     DIF_HD                    ; IF ON SAME HEAD, THEN NO ADJUST

060D 8A 2E 0045 R                     MOV     CH,@NEC_STATUS+3          ; GET TRACK ENDED UP ON
0611 3A 6E 01                         CMP     CH,[BP+1]                 ; IS IT ASKED FOR TRACK
0614 74 04                            JZ      SAME_TRK                  ; IF SAME TRACK NO INCREASE

0616 02 DC                            ADD     BL,AH                     ; ADD SECTORS/TRACK
0618                          DIF_HD:
0618 02 DC                            ADD     BL,AH                     ; ADD SECTORS/TRACK
061A                          SAME_TRK:
061A 2A 5E 00                         SUB     BL,[BP]                   ; SUBTRACT START FROM END
061D 8A C3                            MOV     AL,BL                     ; TO AL

061F                          NT_OUT:
061F C3                               RET
0620                          NUM_TRANS       ENDP
                              ;------------------------------------------------------------------------
                              ; SETUP_END:      RESTORES @MOTOR_COUNT TO PARAMETER PROVIDED IN TABLE AND LOADS
                              ;                 @DSKETTE_STATUS TO AH, AND SETS CY.
                              ;
                              ; ON EXIT:        AH, @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                              ;------------------------------------------------------------------------
0620                          SETUP_END       PROC    NEAR
0620 B2 02                            MOV     DL,2                      ; GET THE MOTOR WAIT PARAMETER
0622 50                               PUSH    AX                        ; SAVE NUMBER TRANSFERRED
0623 E8 06CC R                        CALL    GET_PARM
0626 88 26 0040 R                     MOV     @MOTOR_COUNT,AH           ; STORE UPON RETURN
062A 58                               POP     AX                        ; RESTORE NUMBER TRANSFERRED
062B 8A 26 0041 R                     MOV     AH,@DSKETTE_STATUS        ; GET STATUS OF OPERATION
```

```
062F 0A E4                      OR      AH,AH                   ; CHECK FOR ERROR
0631 74 02                      JZ      NUN_ERR                 ; NO ERROR
0633 32 C0                      XOR     AL,AL                   ; CLEAR NUMBER RETURNED

0635                    NUN_ERR:
0635 80 FC 01                   CMP     AH,1                    ; SET THE CARRY FLAG TO INDICATE
0638 F5                         CMC                             ; SUCCESS OR FAILURE
0639 C3                         RET
063A                    SETUP_END       ENDP
                        ;-------------------------------------------------------------------------
                        ; SETUP_DBL:    CHECK DOUBLE STEP.
                        ;
                        ; ON ENTRY :    AH = RATE; DI = DRIVE
                        ;
                        ; ON EXIT :     CY = 1 MEANS ERROR
                        ;-------------------------------------------------------------------------
063A                    SETUP_DBL       PROC    NEAR
063A 8A A5 0090 R               MOV     AH,@DSK_STATE[DI]       ; ACCESS STATE
063E F6 C4 10                   TEST    AH,MED_DET              ; ESTABLISHED STATE ?
0641 75 59                      JNZ     NO_DBL                  ; IF ESTABLISHED THEN DOUBLE DONE

                        ;----- CHECK FOR TRACK 0 TO SPEED UP ACKNOWLEDGE OF UNFORMATTED DISKETTE

0643 C6 06 003E R 00            MOV     @SEEK_STATUS,0          ; SET RECALIBRATE REQUIRED ON ALL DRIVES
0648 E8 06E1 R                  CALL    MOTOR_ON                ; ENSURE MOTOR STAY ON
064B B5 00                      MOV     CH,0                    ; LOAD TRACK 0
064D E8 07DE R                  CALL    SEEK                    ; SEEK TO TRACK 0
0650 E8 069E R                  CALL    READ_ID                 ; READ ID FUNCTION
0653 72 32                      JC      SD_ERR                  ; IF ERROR NO TRACK 0

                        ;----- INITIALIZE START AND MAX TRACKS (TIMES 2 FOR BOTH HEADS)

0655 B9 0450                    MOV     CX,0450H                ; START, MAX TRACKS
0658 F6 85 0090 R 01            TEST    @DSK_STATE[DI],TRK_CAPA ; TEST FOR 80 TRACK CAPABILITY
065D 74 02                      JZ      CNT_OK                  ; IF NOT COUNT IS SETUP
065F B1 A0                      MOV     CL,0A0H                 ; MAXIMUM TRACK 1.2 MB

                        ;       ATTEMPT READ ID OF ALL TRACKS, ALL HEADS UNTIL SUCCESS; UPON SUCCESS,
                        ;       MUST SEE IF ASKED FOR TRACK IN SINGLE STEP MODE = TRACK ID READ; IF NOT
                        ;       THEN SET DOUBLE STEP ON.

0661                    CNT_OK:
0661 51                         PUSH    CX                      ; SAVE TRACK, COUNT
0662 C6 06 0041 R 00            MOV     @DISKETTE_STATUS,0      ; CLEAR STATUS, EXPECT ERRORS
0667 33 C0                      XOR     AX,AX                   ; CLEAR AX
0669 D0 ED                      SHR     CH,1                    ; HALVE TRACK, CY = HEAD
066B C0 D0 03                   RCL     AL,3                    ; AX = HEAD IN CORRECT BIT
066E 50                         PUSH    AX                      ; SAVE HEAD
066F E8 07DE R                  CALL    SEEK                    ; SEEK TO TRACK
0672 58                         POP     AX                      ; RESTORE HEAD
0673 0B F8                      OR      DI,AX                   ; DI = HEAD OR'ED DRIVE
0675 E8 069E R                  CALL    READ_ID                 ; READ ID HEAD 0
0678 9C                         PUSHF                           ; SAVE RETURN FROM READ_ID
0679 81 E7 00FB                 AND     DI,11111011B            ; TURN OFF HEAD 1 BIT
067D 9D                         POPF                            ; RESTORE ERROR RETURN
067E 59                         POP     CX                      ; RESTORE COUNT
067F 73 08                      JNC     DO_CHK                  ; IF OK, ASKED = RETURNED TRACK ?
0681 FE C5                      INC     CH                      ; INC FOR NEXT TRACK
0683 3A E9                      CMP     CH,CL                   ; REACHED MAXIMUM YET
0685 75 DA                      JNZ     CNT_OK                  ; CONTINUE TILL ALL TRIED

                        ;----- FALL THRU, READ ID FAILED FOR ALL TRACKS

0687                    SD_ERR:
0687 F9                         STC                             ; SET CARRY FOR ERROR
0688 C3                         RET                             ; SETUP_DBL ERROR EXIT

0689                    DO_CHK:
0689 8A 0E 0045 R               MOV     CL,@NEC_STATUS+3        ; LOAD RETURNED TRACK
068D 88 8D 0094 R               MOV     @DSK_TRK[DI],CL         ; STORE TRACK NUMBER
0691 D0 ED                      SHR     CH,1                    ; HALVE TRACK
0693 3A E9                      CMP     CH,CL                   ; IS IT THE SAME AS ASKED FOR TRACK
0695 74 05                      JZ      NO_DBL                  ; IF SAME THEN NO DOUBLE STEP
0697 80 8D 0090 R 20            OR      @DSK_STATE[DI],DBL_STEP ; TURN ON DOUBLE STEP REQUIRED

069C                    NO_DBL:
069C F8                         CLC                             ; CLEAR ERROR FLAG
069D C3                         RET
069E                    SETUP_DBL       ENDP
                        ;-------------------------------------------------------------------------
                        ; READ_ID :     READ ID FUNCTION.
                        ;
                        ; ON ENTRY:     DI : BIT 2 = HEAD; BITS 1,0 = DRIVE
                        ;
                        ; ON EXIT:      DI : BIT 2 IS RESET, BITS 1,0 = DRIVE
                        ;               @DISKETTE_STATUS, CY REFLECT STATUS OF OPERATION
                        ;-------------------------------------------------------------------------
069E                    READ_ID PROC    NEAR
069E B8 06B2 R                  MOV     AX,OFFSET ER_3          ; MOVE NEC OUTPUT ERROR ADDRESS
06A1 50                         PUSH    AX
06A2 B4 4A                      MOV     AH,4AH                  ; READ ID COMMAND
06A4 E8 07BD R                  CALL    NEC_OUTPUT              ; TO CONTROLLER
06A7 8B C7                      MOV     AX,DI                   ; DRIVE # TO AH, HEAD 0
06A9 8A E0                      MOV     AH,AL
06AB E8 07BD R                  CALL    NEC_OUTPUT              ; TO CONTROLLER
06AE E8 0530 R                  CALL    NEC_TERM                ; WAIT FOR OPERATION, GET STATUS
06B1 58                         POP     AX                      ; THROW AWAY ERROR ADDRESS
06B2                    ER_3:
06B2 C3                         RET
06B3                    READ_ID ENDP
                        ;-------------------------------------------------------------------------
                        ; CMOS_TYPE:    RETURNS DISKETTE TYPE FROM CMOS
                        ;
                        ; ON ENTRY:     DI : DRIVE #
                        ;
                        ; ON EXIT:      AL = TYPE (IF VALID)    ; CY REFLECTS STATUS
                        ;-------------------------------------------------------------------------
06B3                    CMOS_TYPE       PROC    NEAR
06B3 B0 0E                      MOV     AL,CMOS_DIAG            ; CMOS DIAGNOSTIC STATUS BYTE ADDRESS
06B5 E8 0000 E                  CALL    CMOS_READ               ; GET CMOS STATUS
06B8 A8 C0                      TEST    AL,BAD_BAT+BAD_CKSUM    ; BATTERY GOOD AND CHECKSUM VALID ?
06BA F9                         STC                             ; SET CY = 1 INDICATING ERROR FOR RETURN
06BB 75 0E                      JNZ     CMOS_T9                 ; ERROR EXIT IF EITHER ERROR BIT WAS ON
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SECTION 5

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06BD B0 10                          MOV     AL,CMOS_DISKETTE        ; ADDRESS OF DISKETTE BYTE IN CMOS
06BF E8 0000 E                      CALL    CMOS_READ               ; GET DISKETTE BYTE
06C2 0B FF                          OR      DI,DI                   ; SEE WHICH DRIVE IN QUESTION
06C4 75 03                          JNZ     CMOS_T5                 ; IF DRIVE 1, DATA IN LOW NIBBLE

06C6 C0 C8 04                       ROR     AL,4                    ; EXCHANGE NIBBLES IF SECOND DRIVE
06C9                        CMOS_T5:
06C9 24 0F                          AND     AL,00FH                 ; KEEP ONLY DRIVE DATA, RESET CY = 0
06CB                        CMOS_T9:
06CB C3                             RET                             ; CY = STATUS OF READ
06CC                        CMOS_TYPE       ENDP

                            ;----------------------------------------------------------------------
                            ; GET_PARM:     THIS ROUTINE FETCHES THE INDEXED POINTER FROM THE DISK_BASE
                            ;               BLOCK POINTED TO BY THE DATA VARIABLE @DISK_POINTER. A BYTE FROM
                            ;               THAT TABLE IS THEN MOVED INTO AH, THE INDEX OF THAT BYTE BEING
                            ;               THE PARAMETER IN DL.
                            ;
                            ; ON ENTRY:     DL = INDEX OF BYTE TO BE FETCHED
                            ;
                            ; ON EXIT:      AH = THAT BYTE FROM BLOCK
                            ;               AL,DH DESTROYED
                            ;----------------------------------------------------------------------
06CC                        GET_PARM        PROC    NEAR
06CC 1E                             PUSH    DS
06CD 56                             PUSH    SI
06CE 2B C0                          SUB     AX,AX                   ; DS = 0 , BIOS DATA AREA
06D0 8E D8                          MOV     DS,AX
06D2 87 D3                          XCHG    DX,BX                   ; BL = INDEX
06D4 2A FF                          SUB     BH,BH                   ; BX = INDEX
                                    ASSUME  DS:ABS0
06D6 C5 36 0078 R                   LDS     SI,@DISK_POINTER        ; POINT TO BLOCK
06DA 8A 20                          MOV     AH,[SI+BX]              ; GET THE WORD
06DC 87 D3                          XCHG    DX,BX                   ; RESTORE BX
06DE 5E                             POP     SI
06DF 1F                             POP     DS
06E0 C3                             RET
                                    ASSUME  DS:DATA
06E1                        GET_PARM        ENDP
                            ;----------------------------------------------------------------------
                            ; MOTOR_ON :    TURN MOTOR ON AND WAIT FOR MOTOR START UP TIME. THE @MOTOR_COUNT
                            ;               IS REPLACED WITH A SUFFICIENTLY HIGH NUMBER (0FFH) TO ENSURE
                            ;               THAT THE MOTOR DOES NOT GO OFF DURING THE OPERATION. IF THE
                            ;               MOTOR NEEDED TO BE TURNED ON, THE MULTI-TASKING HOOK FUNCTION
                            ;               (AX=90FDH, INT 15H) IS CALLED TELLING THE OPERATING SYSTEM
                            ;               THAT THE BIOS IS ABOUT TO WAIT FOR MOTOR START UP. IF THIS
                            ;               FUNCTION RETURNS WITH CY = 1, IT MEANS THAT THE MINIMUM WAIT
                            ;               HAS BEEN COMPLETED. AT THIS POINT A CHECK IS MADE TO ENSURE
                            ;               THAT THE MOTOR WASN'T TURNED OFF BY THE TIMER. IF THE HOOK DID
                            ;               NOT WAIT, THE WAIT FUNCTION (AH=086H) IS CALLED TO WAIT THE
                            ;               PRESCRIBED AMOUNT OF TIME. IF THE CARRY FLAG IS SET ON RETURN,
                            ;               IT MEANS THAT THE FUNCTION IS IN USE AND DID NOT PERFORM THE
                            ;               WAIT. A TIMER 1 WAIT LOOP WILL THEN DO THE WAIT.
                            ;
                            ; ON ENTRY:     DI = DRIVE #
                            ;
                            ; ON EXIT:      AX,BX,CX,DX DESTROYED
                            ;----------------------------------------------------------------------
06E1                        MOTOR_ON        PROC    NEAR
06E1 E8 072A R                      CALL    TURN_ON                 ; TURN ON MOTOR
06E4 72 43                          JC      MOT_IS_ON               ; IF CY=1 NO WAIT
06E6 E8 02EE R                      CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
06E9 B8 90FD                        MOV     AX,090FDH               ; LOAD WAIT CODE & TYPE
06EC CD 15                          INT     15H                     ; TELL OPERATING SYSTEM ABOUT TO DO WAIT
06EE 9C                             PUSHF                           ; SAVE CY FOR TEST
06EF E8 02C8 R                      CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
06F2 9D                             POPF                            ; RESTORE CY FOR TEST
06F3 73 05                          JNC     M_WAIT                  ; BYPASS LOOP IF OP SYSTEM HANDLED WAIT
06F5 E8 072A R                      CALL    TURN_ON                 ; CHECK AGAIN IF MOTOR ON
06F8 72 2F                          JC      MOT_IS_ON               ; IF NO WAIT MEANS IT IS ON

06FA                        M_WAIT:
06FA B2 0A                          MOV     DL,10                   ; GET THE MOTOR WAIT PARAMETER
06FC E8 06CC R                      CALL    GET_PARM
06FF 8A C4                          MOV     AL,AH                   ; AL = MOTOR WAIT PARAMETER
0701 32 E4                          XOR     AH,AH                   ; AX = MOTOR WAIT PARAMETER
0703 3C 08                          CMP     AL,8                    ; SEE IF AT LEAST A SECOND IS SPECIFIED
0705 73 02                          JAE     GP2                     ; IF YES, CONTINUE
0707 B0 08                          MOV     AL,8                    ; ONE SECOND WAIT FOR MOTOR START UP

                            ;-----  AX CONTAINS NUMBER OF 1/8 SECONDS (125000 MICROSECONDS) TO WAIT

0709 50                     GP2:    PUSH    AX                      ; SAVE WAIT PARAMETER
070A BA F424                        MOV     DX,62500                ; LOAD LARGEST POSSIBLE MULTIPLIER
070D F7 E2                          MUL     DX                      ; MULTIPLY BY HALF OF WHAT'S NECESSARY
070F 8B CA                          MOV     CX,DX                   ; CX = HIGH WORD
0711 8B D0                          MOV     DX,AX                   ; CX,DX = 1/2 * (# OF MICROSECONDS)
0713 F8                             CLC                             ; CLEAR CARRY FOR ROTATE
0714 D1 D2                          RCL     DX,1                    ; DOUBLE LOW WORD, CY CONTAINS OVERFLOW
0716 D1 D1                          RCL     CX,1                    ; DOUBLE HI, INCLUDING LOW WORD OVERFLOW
0718 B4 86                          MOV     AH,86H                  ; LOAD WAIT CODE
071A CD 15                          INT     15H                     ; PERFORM WAIT
071C 58                             POP     AX                      ; RESTORE WAIT PARAMETER
071D 73 0A                          JNC     MOT_IS_ON               ; CY MEANS WAIT COULD NOT BE DONE

                            ;-----  FOLLOWING LOOPS REQUIRED WHEN RTC WAIT FUNCTION IS ALREADY IN USE

071F                        J13:                                    ;       WAIT FOR 1/8 SECOND PER (AL)
071F B9 205E                        MOV     CX,8286                 ; COUNT FOR 1/8 SECOND AT 15.085737 US
0722 E8 0000 E                      CALL    WAITF                   ; GO TO FIXED WAIT ROUTINE
0725 FE C8                          DEC     AL                      ; DECREMENT TIME VALUE
0727 75 F6                          JNZ     J13                     ; ARE WE DONE YET

0729                        MOT_IS_ON:
0729 C3                             RET
072A                        MOTOR_ON        ENDP
                            ;----------------------------------------------------------------------
                            ; TURN_ON :     TURN MOTOR ON AND RETURN WAIT STATE.
                            ;
                            ; ON ENTRY:     DI = DRIVE #
                            ;
                            ; ON EXIT:      CY = 0 MEANS WAIT REQUIRED
                            ;               CY = 1 MEANS NO WAIT REQUIRED
                            ;               AX,BX,CX,DX DESTROYED
                            ;----------------------------------------------------------------------
```

```
072A                     TURN_ON PROC   NEAR
072A 8B DF                      MOV     BX,DI                   ; BX = DRIVE #
072C 8A CB                      MOV     CL,BL                   ; CL = DRIVE #
072E C0 C3 04                   ROL     BL,4                    ; BL = DRIVE SELECT
0731 FA                         CLI                             ; NO INTERRUPTS WHILE DETERMINING STATUS
0732 C6 06 0040 R FF            MOV     @MOTOR_COUNT,0FFH       ; ENSURE MOTOR STAYS ON FOR OPERATION
0737 A0 003F R                  MOV     AL,@MOTOR_STATUS        ; GET DIGITAL OUTPUT REGISTER REFLECTION
073A 24 30                      AND     AL,00110000B            ; KEEP ONLY DRIVE SELECT BITS
073C B4 01                      MOV     AH,1                    ; MASK FOR DETERMINING MOTOR BIT
073E D2 E4                      SHL     AH,CL                   ; AH = MOTOR ON, A=00000001, B=00000010

                         ;  AL = DRIVE SELECT FROM @MOTOR_STATUS
                         ;  BL = DRIVE SELECT DESIRED
                         ;  AH = MOTOR ON MASK DESIRED

0740 3A C3                      CMP     AL,BL                   ; REQUESTED DRIVE ALREADY SELECTED ?
0742 75 06                      JNZ     TURN_IT_ON              ; IF NOT SELECTED JUMP
0744 84 26 003F R               TEST    AH,@MOTOR_STATUS        ; TEST MOTOR ON BIT
0748 75 2C                      JNZ     NO_MOT_WAIT             ; JUMP IF MOTOR ON AND SELECTED

074A                     TURN_IT_ON:
074A 0A E3                      OR      AH,BL                   ; AH = DRIVE SELECT AND MOTOR ON
074C 8A 3E 003F R               MOV     BH,@MOTOR_STATUS        ; SAVE COPY OF @MOTOR_STATUS BEFORE
0750 80 E7 0F                   AND     BH,00001111B            ; KEEP ONLY MOTOR BITS
0753 80 26 003F R CF            AND     @MOTOR_STATUS,11001111B ; CLEAR OUT DRIVE SELECT
0758 08 26 003F R               OR      @MOTOR_STATUS,AH        ; OR IN DRIVE SELECTED AND MOTOR ON
075C A0 003F R                  MOV     AL,@MOTOR_STATUS        ; GET DIGITAL OUTPUT REGISTER REFLECTION
075F 8A D8                      MOV     BL,AL                   ; BL=@MOTOR_STATUS AFTER, BH=BEFORE
0761 80 E3 0F                   AND     BL,00001111B            ; KEEP ONLY MOTOR BITS
0764 FB                         STI                             ; ENABLE INTERRUPTS AGAIN
0765 24 3F                      AND     AL,00111111B            ; STRIP AWAY UNWANTED BITS
0767 C0 C0 04                   ROL     AL,4                    ; PUT BITS IN DESIRED POSITIONS
076A 0C 0C                      OR      AL,00001100B            ; NO RESET, ENABLE DMA/INTERRUPT
076C BA 03F2                    MOV     DX,03F2H                ; SELECT DRIVE AND TURN ON MOTOR
076F EE                         OUT     DX,AL                   ; "
0770 3A DF                      CMP     BL,BH                   ; NEW MOTOR TURNED ON ?
0772 74 02                      JZ      NO_MOT_WAIT             ; NO WAIT REQUIRED IF JUST SELECT
0774 F8                         CLC                             ; SET CARRY MEANING WAIT
0775 C3                         RET

0776                     NO_MOT_WAIT:
0776 F9                         STC                             ; SET NO WAIT REQUIRED
0777 FB                         STI                             ; INTERRUPTS BACK ON
0778 C3                         RET
0779                     TURN_ON ENDP
                         ;-------------------------------------------------------------------------------
                         ; HD_WAIT :       WAIT FOR HEAD SETTLE TIME.
                         ;
                         ; ON ENTRY:       DI : DRIVE #
                         ;
                         ; ON EXIT:        AX,BX,CX,DX DESTROYED
                         ;-------------------------------------------------------------------------------
0779                     HD_WAIT        PROC    NEAR
0779 B2 09                      MOV     DL,9                    ; GET HEAD SETTLE PARAMETER
077B E8 06CC R                  CALL    GET_PARM                ; "
077E F6 06 003F R 80            TEST    @MOTOR_STATUS,10000000B ; SEE IF A WRITE OPERATION
0783 74 14                      JZ      ISNT_WRITE              ; IF NOT, DO NOT ENFORCE ANY VALUES
0785 0A E4                      OR      AH,AH                   ; CHECK FOR ANY WAIT?
0787 75 14                      JNZ     DO_WAT                  ; IF THERE DO NOT ENFORCE
0789 B4 0F                      MOV     AH,HD12_SETTLE          ; LOAD 1.2M HEAD SETTLE MINIMUM
078B 8A 85 0090 R               MOV     AL,@DSK_STATE[DI]       ; LOAD STATE
078F 24 C0                      AND     AL,RATE_MSK             ; KEEP ONLY RATE
0791 3C 80                      CMP     AL,RATE_250             ; 1.2 M DRIVE ?
0793 75 08                      JNZ     DO_WAT                  ; DEFAULT HEAD SETTLE LOADED

0795 B4 14                      MOV     AH,HD320_SETTLE         ; USE 320/360 HEAD SETTLE
0797 EB 04                      JMP     SHORT DO_WAT            ; "

0799                     ISNT_WRITE:
0799 0A E4                      OR      AH,AH                   ; CHECK FOR NO WAIT
079B 74 1F                      JZ      HW_DONE                 ; IF NOT WRITE AND 0 ITS OK

                         ;-----  AH CONTAINS NUMBER OF MILLISECONDS TO WAIT

079D                     DO_WAT:
079D 8A C4                      MOV     AL,AH                   ; AL = # MILLISECONDS
079F 32 E4                      XOR     AH,AH                   ; AX = # MILLISECONDS
07A1 50                         PUSH    AX                      ; SAVE HEAD SETTLE PARAMETER
07A2 BA 03E8                    MOV     DX,1000                 ; SET UP FOR MULTIPLY TO MICROSECONDS
07A5 F7 E2                      MUL     DX                      ; DX,AX = # MICROSECONDS
07A7 8B CA                      MOV     CX,DX                   ; CX,AX = # MICROSECONDS
07A9 8B D0                      MOV     DX,AX                   ; CX,DX = # MICROSECONDS
07AB B4 86                      MOV     AH,86H                  ; LOAD WAIT CODE
07AD CD 15                      INT     15H                     ; PERFORM WAIT
07AF 58                         POP     AX                      ; RESTORE HEAD SETTLE PARAMETER
07B0 73 0A                      JNC     HW_DONE                 ; CHECK FOR EVENT WAIT ACTIVE

07B2                     J29:                                   ;       1 MILLISECOND LOOP
07B2 B9 0042                    MOV     CX,66                   ; COUNT AT 15.085737 US PER COUNT
07B5 E8 0000 E                  CALL    WAITF                   ; DELAY FOR 1 MILLISECOND
07B8 FE C8                      DEC     AL                      ; DECREMENT THE COUNT
07BA 75 F6                      JNZ     J29                     ; DO AL MILLISECOND # OF TIMES
07BC                     HW_DONE:
07BC C3                         RET
07BD                     HD_WAIT        ENDP
                         ;-------------------------------------------------------------------------------
                         ; NEC_OUTPUT:    THIS ROUTINE SENDS A BYTE TO THE NEC CONTROLLER AFTER TESTING
                         ;                FOR CORRECT DIRECTION AND CONTROLLER READY THIS ROUTINE WILL
                         ;                TIME OUT IF THE BYTE IS NOT ACCEPTED WITHIN A REASONABLE AMOUNT
                         ;                OF TIME, SETTING THE DISKETTE STATUS ON COMPLETION.
                         ;
                         ; ON ENTRY:      AH = BYTE TO BE OUTPUT
                         ;
                         ; ON EXIT:       CY = 0  SUCCESS
                         ;                CY = 1  FAILURE -- DISKETTE STATUS UPDATED
                         ;                        IF A FAILURE HAS OCCURRED, THE RETURN IS MADE ONE LEVEL
                         ;                        HIGHER THAN THE CALLER OF NEC_OUTPUT. THIS REMOVES THE
                         ;                        REQUIREMENT OF TESTING AFTER EVERY CALL OF NEC_OUTPUT.
                         ;                AX,BX,CX,DX DESTROYED
                         ;-------------------------------------------------------------------------------
07BD                     NEC_OUTPUT     PROC    NEAR
07BD BA 03F4                    MOV     DX,03F4H                ; STATUS PORT
07C0 B3 02                      MOV     BL,2                    ; HIGH ORDER COUNTER
07C2 33 C9                      XOR     CX,CX                   ; COUNT FOR TIME OUT
```

SECTION 5

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07C4 EC                    J23:    IN      AL,DX                   ; GET STATUS
07C5 24 C0                         AND     AL,11000000B            ; KEEP STATUS AND DIRECTION
07C7 3C 80                         CMP     AL,10000000B            ; STATUS 1 AND DIRECTION 0 ?
07C9 74 0E                         JZ      J27                     ; STATUS AND DIRECTION OK
07CB E2 F7                         LOOP    J23                     ; CONTINUE TILL CX EXHAUSTED

07CD FE CB                         DEC     BL                      ; DECREMENT COUNTER
07CF 75 F3                         JNZ     J23                     ; REPEAT TILL DELAY FINISHED, CX = 0

                           ;-----  FALL THRU TO ERROR RETURN

07D1 80 0E 0041 R 80               OR      @DSKETTE_STATUS,TIME_OUT
07D6 58                            POP     AX                      ; DISCARD THE RETURN ADDRESS
07D7 F9                            STC                             ; INDICATE ERROR TO CALLER
07D8 C3                            RET

                           ;-----  DIRECTION AND STATUS OK; OUTPUT BYTE

07D9 8A C4                 J27:    MOV     AL,AH                   ; GET BYTE TO OUTPUT
07DB 42                            INC     DX                      ; DATA PORT = STATUS PORT + 1
07DC EE                            OUT     DX,AL                   ; OUTPUT THE BYTE
07DD C3                            RET                             ; CY = 0 FROM TEST INSTRUCTION
07DE                       NEC_OUTPUT      ENDP
                           ;---------------------------------------------------------------------
                           ; SEEK:         THIS ROUTINE WILL MOVE THE HEAD ON THE NAMED DRIVE TO THE NAMED
                           ;               TRACK.  IF THE DRIVE HAS NOT BEEN ACCESSED SINCE THE DRIVE
                           ;               RESET COMMAND WAS ISSUED, THE DRIVE WILL BE RECALIBRATED.
                           ;
                           ; ON ENTRY:     DI : DRIVE #
                           ;               CH : TRACK #
                           ;
                           ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.
                           ;               AX,BX,CX,DX DESTROYED
                           ;---------------------------------------------------------------------
07DE                       SEEK    PROC    NEAR
07DE 8B DF                         MOV     BX,DI                   ; BX = DRIVE #
07E0 BA 083D R                     MOV     DX,OFFSET NEC_ERR       ; LOAD RETURN ADDRESS
07E3 52                            PUSH    DX                      ; ON STACK FOR NEC_OUTPUT ERROR
07E4 B0 01                         MOV     AL,1                    ; ESTABLISH MASK FOR RECALIBRATE TEST
07E6 86 CB                         XCHG    CL,BL                   ; GET DRIVE VALUE INTO CL
07E8 D2 C0                         ROL     AL,CL                   ; SHIFT MASK BY THE DRIVE VALUE
07EA 86 CB                         XCHG    CL,BL                   ; RECOVER TRACK VALUE
07EC 84 06 003E R                  TEST    AL,@SEEK_STATUS         ; TEST FOR RECALIBRATE REQUIRED
07F0 75 1C                         JNZ     J28A                    ; JUMP IF RECALIBRATE NOT REQUIRED

07F2 08 06 003E R                  OR      @SEEK_STATUS,AL         ; TURN ON THE NO RECALIBRATE BIT IN FLAG
07F6 E8 083E R                     CALL    RECAL                   ; RECALIBRATE DRIVE
07F9 73 0A                         JNC     AFT_RECAL               ; RECALIBRATE DONE

                           ;-----  ISSUE RECALIBRATE FOR 80 TRACK DISKETTES

07FB C6 06 0041 R 00               MOV     @DSKETTE_STATUS,0       ; CLEAR OUT INVALID STATUS
0800 E8 083E R                     CALL    RECAL                   ; RECALIBRATE DRIVE
0803 72 37                         JC      RB                      ; IF RECALIBRATE FAILS TWICE THEN ERROR
                           ;
0805                       AFT_RECAL:
0805 C6 85 0094 R 00               MOV     @DSK_TRK[DI],0          ; SAVE NEW CYLINDER AS PRESENT POSITION
080A 0A ED                         OR      CH,CH                   ; CHECK FOR SEEK TO TRACK 0
080C 74 29                         JZ      DO_WAIT                 ; HEAD SETTLE, CY = 0 IF JUMP

                           ;-----  DRIVE IS IN SYNCHRONIZATION WITH CONTROLLER, SEEK TO TRACK

080E F6 85 0090 R 20       J28A:   TEST    @DSK_STATE[DI],DBL_STEP ; CHECK FOR DOUBLE STEP REQUIRED
0813 74 02                         JZ      R7                      ; SINGLE STEP REQUIRED BYPASS DOUBLE
0815 D0 E5                         SHL     CH,1                    ; DOUBLE NUMBER OF STEP TO TAKE

0817 3A AD 0094 R          R7:     CMP     CH,@DSK_TRK[DI]         ; SEE IF ALREADY AT THE DESIRED TRACK
081B 74 1F                         JE      RB                      ; IF YES, DO NOT NEED TO SEEK

081D 88 AD 0094 R                  MOV     @DSK_TRK[DI],CH         ; SAVE NEW CYLINDER AS PRESENT POSITION
0821 B4 0F                         MOV     AH,0FH                  ; SEEK COMMAND TO NEC
0823 E8 07BD R                     CALL    NEC_OUTPUT
0826 8B DF                         MOV     BX,DI                   ; BX = DRIVE #
0828 8A E3                         MOV     AH,BL                   ; OUTPUT DRIVE NUMBER
082A E8 07BD R                     CALL    NEC_OUTPUT
082D 8A A5 0094 R                  MOV     AH,@DSK_TRK[DI]         ; GET CYLINDER NUMBER
0831 E8 07BD R                     CALL    NEC_OUTPUT
0834 E8 0855 R                     CALL    CHK_STAT_2              ; ENDING INTERRUPT AND SENSE STATUS

                           ;-----  WAIT FOR HEAD SETTLE

0837                       DO_WAIT:
0837 9C                            PUSHF                           ; SAVE STATUS
0838 E8 0779 R                     CALL    HD_WAIT                 ; WAIT FOR HEAD SETTLE TIME
083B 9D                            POPF                            ; RESTORE STATUS
083C                       RB:
083C 58                            POP     AX                      ; CLEAR ERROR RETURN FROM NEC_OUTPUT
083D                       NEC_ERR:
083D C3                            RET                             ; RETURN TO CALLER
083E                       SEEK    ENDP
                           ;---------------------------------------------------------------------
                           ; RECAL :       RECALIBRATE DRIVE
                           ;
                           ; ON ENTRY      DI = DRIVE #
                           ;
                           ; ON EXIT:      CY  REFLECTS STATUS OF OPERATION.
                           ;---------------------------------------------------------------------
083E                       RECAL   PROC    NEAR
083E 51                            PUSH    CX
083F B8 0853 R                     MOV     AX,OFFSET RC_BACK       ; LOAD NEC_OUTPUT ERROR
0842 50                            PUSH    AX
0843 B4 07                         MOV     AH,07H                  ; RECALIBRATE COMMAND
0845 E8 07BD R                     CALL    NEC_OUTPUT
0848 8B DF                         MOV     BX,DI                   ; BX = DRIVE #
084A 8A E3                         MOV     AH,BL
084C E8 07BD R                     CALL    NEC_OUTPUT              ; OUTPUT THE DRIVE NUMBER
084F E8 0855 R                     CALL    CHK_STAT_2              ; GET THE INTERRUPT AND SENSE INT STATUS
0852 58                            POP     AX                      ; THROW AWAY ERROR
0853                       RC_BACK:
0853 59                            POP     CX
0854 C3                            RET
0855                       RECAL   ENDP
                           ;---------------------------------------------------------------------
```

```
                                ; CHK_STAT_2:   THIS ROUTINE HANDLES THE INTERRUPT RECEIVED AFTER RECALIBRATE,
                                ;               SEEK, OR RESET TO THE ADAPTER. THE INTERRUPT IS WAITED FOR, THE
                                ;               INTERRUPT STATUS SENSED, AND THE RESULT RETURNED TO THE CALLER.
                                ;
                                ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.
                                ;-------------------------------------------------------------------------------
0855                            CHK_STAT_2      PROC    NEAR
0855 B8 0873 R                          MOV     AX,OFFSET CS_BACK       ; LOAD NEC_OUTPUT ERROR ADDRESS
0858 50                                 PUSH    AX
0859 E8 087C R                          CALL    WAIT_INT                ; WAIT FOR THE INTERRUPT
085C 72 14                              JC      J34                     ; IF ERROR, RETURN IT
085E B4 08                              MOV     AH,08H                  ; SENSE INTERRUPT STATUS COMMAND
0860 E8 07BD R                          CALL    NEC_OUTPUT
0863 E8 08A4 R                          CALL    RESULTS                 ; READ IN THE RESULTS
0866 72 0A                              JC      J34
0868 A0 0042 R                          MOV     AL,@NEC_STATUS          ; GET THE FIRST STATUS BYTE
086B 24 60                              AND     AL,01100000B            ; ISOLATE THE BITS
086D 3C 60                              CMP     AL,01100000B            ; TEST FOR CORRECT VALUE
086F 74 03                              JZ      J35                     ; IF ERROR, GO MARK IT
0871 F8                                 CLC                             ; GOOD RETURN
0872                            J34:
0872 58                                 POP     AX                      ; THROW AWAY ERROR RETURN
0873                            CS_BACK:
0873 C3                                 RET

0874                            J35:
0874 80 0E 0041 R 40                    OR      @DSKETTE_STATUS,BAD_SEEK
0879 F9                                 STC                             ; ERROR RETURN CODE
087A EB F6                              JMP     SHORT J34
087C                            CHK_STAT_2      ENDP
                                ;-------------------------------------------------------------------------------
                                ; WAIT_INT:     THIS ROUTINE WAITS FOR AN INTERRUPT TO OCCUR A TIME OUT ROUTINE
                                ;               TAKES PLACE DURING THE WAIT, SO THAT AN ERROR MAY BE RETURNED
                                ;               IF THE DRIVE IS NOT READY.
                                ;
                                ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.
                                ;-------------------------------------------------------------------------------
087C                            WAIT_INT        PROC    NEAR
087C FB                                 STI                             ; TURN ON INTERRUPTS, JUST IN CASE
087D F8                                 CLC                             ; CLEAR TIMEOUT INDICATOR
087E B8 9001                            MOV     AX,09001H               ; LOAD WAIT CODE AND TYPE
0881 CD 15                              INT     15H                     ; PERFORM OTHER FUNCTION
0883 72 11                              JC      J36A                    ; BYPASS TIMING LOOP IF TIMEOUT DONE

0885 B3 04                              MOV     BL,4                    ; CLEAR THE COUNTERS
0887 33 C9                              XOR     CX,CX                   ; FOR 2 SECOND WAIT
0889                            J36:
0889 F6 06 003E R 80                    TEST    @SEEK_STATUS,INT_FLAG   ; TEST FOR INTERRUPT OCCURRING
088E 75 0C                              JNZ     J37
0890 E2 F7                              LOOP    J36                     ; COUNT DOWN WHILE WAITING
0892 FE CB                              DEC     BL                      ; SECOND LEVEL COUNTER
0894 75 F3                              JNZ     J36

0896 80 0E 0041 R 80            J36A:   OR      @DSKETTE_STATUS,TIME_OUT        ; NOTHING HAPPENED
089B F9                                 STC                             ; ERROR RETURN
089C                            J37:
089C 9C                                 PUSHF                           ; SAVE CURRENT CARRY
089D 80 26 003E R 7F                    AND     @SEEK_STATUS,NOT INT_FLAG       ; TURN OFF INTERRUPT FLAG
08A2 9D                                 POPF                            ; RECOVER CARRY
08A3 C3                                 RET                             ; GOOD RETURN CODE
08A4                            WAIT_INT        ENDP
                                ;-------------------------------------------------------------------------------
                                ; RESULTS:      THIS ROUTINE WILL READ ANYTHING THAT THE NEC CONTROLLER RETURNS
                                ;               FOLLOWING AN INTERRUPT.
                                ;
                                ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.
                                ;               AX,BX,CX,DX DESTROYED
                                ;-------------------------------------------------------------------------------
08A4                            RESULTS PROC    NEAR
08A4 57                                 PUSH    DI
08A5 BF 0042 R                          MOV     DI,OFFSET @NEC_STATUS   ; POINTER TO DATA AREA
08A8 B3 07                              MOV     BL,7                    ; MAX STATUS BYTES
08AA BA 03F4                            MOV     DX,03F4H                ; STATUS PORT

                                ;-----  WAIT FOR REQUEST FOR MASTER

08AD B7 02                      R10:    MOV     BH,2                    ; HIGH ORDER COUNTER
08AF 33 C9                              XOR     CX,CX                   ; COUNTER
08B1                            J39:                                    ; WAIT FOR MASTER
08B1 EC                                 IN      AL,DX                   ; GET STATUS
08B2 24 C0                              AND     AL,11000000B            ; KEEP ONLY STATUS AND DIRECTION
08B4 3C C0                              CMP     AL,11000000B            ; STATUS 1 AND DIRECTION 0 ?
08B6 74 0E                              JZ      J42                     ; STATUS AND DIRECTION OK
08B8 E2 F7                              LOOP    J39                     ; LOOP TILL TIMEOUT

08BA FE CF                              DEC     BH                      ; DECREMENT HIGH ORDER COUNTER
08BC 75 F3                              JNZ     J39                     ; REPEAT TILL DELAY DONE

08BE 80 0E 0041 R 80                    OR      @DSKETTE_STATUS,TIME_OUT
08C3 F9                                 STC                             ; SET ERROR RETURN
08C4 EB 1B                              JMP     SHORT POPRES            ; POP REGISTERS AND RETURN

                                ;-----  READ IN THE STATUS

08C6                            J42:
08C6 42                                 INC     DX                      ; POINT AT DATA PORT
08C7 EC                                 IN      AL,DX                   ; GET THE DATA
08C8 88 05                              MOV     [DI],AL                 ; STORE THE BYTE
08CA 47                                 INC     DI                      ; INCREMENT THE POINTER

08CB B9 0002                            MOV     CX,2                    ; MINIMUM 12 MICROSECONDS FOR NEC
08CE E8 0000 E                          CALL    WAITF                   ; WAIT 15 TO 30 MICROSECONDS
08D1 4A                                 DEC     DX                      ; POINT AT STATUS PORT
08D2 EC                                 IN      AL,DX                   ; GET STATUS
08D3 A8 10                              TEST    AL,00010000B            ; TEST FOR NEC STILL BUSY
08D5 74 0A                              JZ      POPRES                  ; RESULTS DONE ?

08D7 FE CB                              DEC     BL                      ; DECREMENT THE STATUS COUNTER
08D9 75 D2                              JNZ     R10                     ; GO BACK FOR MORE
08DB 80 0E 0041 R 20                    OR      @DSKETTE_STATUS,BAD_NEC ; TOO MANY STATUS BYTES
08E0 F9                                 STC                             ; SET ERROR FLAG

                                ;-----  RESULT OPERATION IS DONE

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SECTION 5

```
08E1                       POPRES:
08E1 5F                            POP     DI
08E2 C3                            RET                             ; RETURN WITH CARRY SET
08E3                       RESULTS ENDP

                           ;-----------------------------------------------------------------------
                           ; READ_DSKCHNG: READS THE STATE OF THE DISK CHANGE LINE.
                           ;
                           ; ON ENTRY:     DI = DRIVE #
                           ;
                           ; ON EXIT:      DI = DRIVE #
                           ;               ZERO FLAG = 0 : DISK CHANGE LINE INACTIVE
                           ;               ZERO FLAG = 1 : DISK CHANGE LINE ACTIVE
                           ;               AX,CX,DX DESTROYED
                           ;-----------------------------------------------------------------------
08E3                       READ_DSKCHNG    PROC    NEAR
08E3 E8 06E1 R                     CALL    MOTOR_ON                ; TURN ON THE MOTOR IF OFF
08E6 BA 03F7                       MOV     DX,03F7H                ; ADDRESS DIGITAL INPUT REGISTER
08E9 EC                            IN      AL,DX                   ; INPUT DIGITAL INPUT REGISTER
08EA A8 80                         TEST    AL,DSK_CHG              ; CHECK FOR DISK CHANGE LINE ACTIVE
08EC C3                            RET                             ; RETURN TO CALLER WITH ZERO FLAG SET
08ED                       READ_DSKCHNG    ENDP

                           ;-----------------------------------------------------------------------
                           ; DRIVE_DET:    DETERMINES WHETHER DRIVE IS 80 OR 40 TRACKS AND UPDATES STATE
                           ;               INFORMATION ACCORDINGLY.
                           ;
                           ; ON ENTRY:     DI = DRIVE #
                           ;-----------------------------------------------------------------------
08ED                       DRIVE_DET       PROC    NEAR
08ED E8 06E1 R                     CALL    MOTOR_ON                ; TURN ON MOTOR IF NOT ALREADY ON
08F0 E8 083E R                     CALL    RECAL                   ; RECALIBRATE DRIVE
08F3 72 3C                         JC      DD_BAC                  ; ASSUME NO DRIVE PRESENT
08F5 B5 30                         MOV     CH,TRK_SLAP             ; SEEK TO TRACK 48
08F7 E8 07DE R                     CALL    SEEK                    ; "
08FA 72 35                         JC      DD_BAC                  ; ERROR NO DRIVE
08FC B5 0B                         MOV     CH,QUIET_SEEK+1         ; SEEK TO TRACK 10
08FE                       SK_GIN:
08FE FE CD                         DEC     CH                      ; DECREMENT TO NEXT TRACK
0900 51                            PUSH    CX                      ; SAVE TRACK
0901 E8 07DE R                     CALL    SEEK                    ; "
0904 72 2C                         JC      POP_BAC                 ; POP AND RETURN
0906 B8 0931 R                     MOV     AX,OFFSET DD_BAC        ; LOAD NEC OUTPUT ERROR ADDRESS
0909 50                            PUSH    AX                      ; "
090A B4 04                         MOV     AH,SENSE_DRV_ST         ; SENSE DRIVE STATUS COMMAND BYTE
090C E8 07BD R                     CALL    NEC_OUTPUT              ; OUTPUT TO NEC
090F 8B C7                         MOV     AX,DI                   ; AL = DRIVE
0911 8A E0                         MOV     AH,AL                   ; AH = DRIVE
0913 E8 07BD R                     CALL    NEC_OUTPUT              ; OUTPUT TO NEC
0916 E8 08A4 R                     CALL    RESULTS                 ; GO GET STATUS
0919 58                            POP     AX                      ; THROW AWAY ERROR ADDRESS
091A 59                            POP     CX                      ; RESTORE TRACK
091B F6 06 0042 R 10               TEST    @NEC_STATUS,HOME        ; TRACK 0 ?
0920 74 DC                         JZ      SK_GIN                  ; GO TILL TRACK 0
0922 0A ED                         OR      CH,CH                   ; IS HOME AT TRACK 0 ?
0924 74 06                         JZ      IS_80                   ; MUST BE 80 TRACK DRIVE

                           ;       DRIVE IS A 360; SET DRIVE TO DETERMINED;
                           ;       SET MEDIA TO DETERMINED AT RATE 250.

0926 80 8D 0090 R 94               OR      @DSK_STATE[DI],DRV_DET+MED_DET+RATE_250
092B C3                            RET                             ; ALL INFORMATION SET

092C                       IS_80:
092C 80 8D 0090 R 01               OR      @DSK_STATE[DI],TRK_CAPA ; SETUP 80 TRACK CAPABILITY
0931                       DD_BAC:
0931 C3                            RET

0932                       POP_BAC:
0932 59                            POP     CX                      ; THROW AWAY
0933 C3                            RET

0934                       DRIVE_DET       ENDP
```

```
                              PAGE
                              ;--- HARDWARE INT  08 H -- ( IRQ LEVEL  6 ) ---------------------------------
                              ;
                              ; DISK_INT      THIS ROUTINE HANDLES THE DISKETTE INTERRUPT.
                              ;
                              ; ON EXIT:      THE INTERRUPT FLAG IS SET IN @SEEK_STATUS.
                              ;
                              ;-----------------------------------------------------------------------------

0934                          DISK_INT_1      PROC     FAR                  ; ENTRY POINT FOR ORG 0EF57H
0934 FB                               STI                                   ; RE-ENABLE INTERRUPTS
0935 50                               PUSH    AX                            ; SAVE WORK REGISTER
0936 1E                               PUSH    DS                            ; SAVE REGISTERS
0937 E8 0000 E                        CALL    DDS                           ; SETUP DATA ADDRESSING
093A 80 0E 003E R 80                  OR      @SEEK_STATUS,INT_FLAG         ; TURN ON INTERRUPT OCCURRED
093F 1F                               POP     DS                            ; RESTORE USER (DS)
0940 B0 20                            MOV     AL,EOI                        ; END OF INTERRUPT MARKER
0942 E6 20                            OUT     INTA00,AL                     ; INTERRUPT CONTROL PORT
0944 B8 9101                          MOV     AX,09101H                     ; INTERRUPT POST CODE AND TYPE
0947 CD 15                            INT     15H                           ; GO PERFORM OTHER TASK
0949 58                               POP     AX                            ; RECOVER REGISTER
094A CF                               IRET                                  ; RETURN FROM INTERRUPT

094B                          DISK_INT_1      ENDP



                              ;-----------------------------------------------------------------------------
                              ; DSKETTE_SETUP: THIS ROUTINE DOES A PRELIMINARY CHECK TO SEE WHAT TYPE OF
                              ;                DISKETTE DRIVES ARE ATTACH TO THE SYSTEM.
                              ;-----------------------------------------------------------------------------

094B                          DSKETTE_SETUP PROC       NEAR
094B 50                               PUSH    AX                            ; SAVE REGISTERS
094C 53                               PUSH    BX
094D 51                               PUSH    CX
094E 52                               PUSH    DX
094F 57                               PUSH    DI
0950 1E                               PUSH    DS
0951 E8 0000 E                        CALL    DDS                           ; POINT DATA SEGMENT TO BIOS DATA AREA
0954 80 0E 00A0 R 01                  OR      @RTC_WAIT_FLAG,01             ; NO RTC WAIT, FORCE USE OF LOOP
0959 33 FF                            XOR     DI,DI                         ; INITIALIZE DRIVE POINTER
095B C7 06 0090 R 0000                MOV     WORD PTR @DSK_STATE,0         ; INITIALIZE STATES
0961 80 26 008B R 33                  AND     @LASTRATE,NOT STRT_MSK+SEND_MSK ; CLEAR START & SEND
0966 80 0E 008B R C0                  OR      @LASTRATE,SEND_MSK            ; INITIALIZE SENT TO IMPOSSIBLE
096B C6 06 003E R 00                  MOV     @SEEK_STATUS,0                ; INDICATE RECALIBRATE NEEDED
0970 C6 06 0040 R 00                  MOV     @MOTOR_COUNT,0                ; INITIALIZE MOTOR COUNT
0975 C6 06 003F R 00                  MOV     @MOTOR_STATUS,0               ; INITIALIZE DRIVES TO OFF STATE
097A C6 06 0041 R 00                  MOV     @DSKETTE_STATUS,0             ; NO ERRORS

097F                          SUP0:
097F E8 08ED R                        CALL    DRIVE_DET                     ; DETERMINE DRIVE
0982 E8 02EE R                        CALL    XLAT_OLD                      ; TRANSLATE STATE TO COMPATIBLE MODE
0985 47                               INC     DI                            ; POINT TO NEXT DRIVE
0986 83 FF 02                         CMP     DI,MAX_DRV                    ; SEE IF DONE
0989 75 F4                            JNZ     SUP0                          ; REPEAT FOR EACH DRIVE
098B C6 06 003E R 00                  MOV     @SEEK_STATUS,0                ; FORCE RECALIBRATE
0990 80 26 00A0 R FE                  AND     @RTC_WAIT_FLAG,0FEH           ; ALLOW FOR RTC WAIT
0995 E8 0620 R                        CALL    SETUP_END                     ; VARIOUS CLEANUPS
0998 1F                               POP     DS                            ; RESTORE CALLERS RESISTERS
0999 5F                               POP     DI
099A 5A                               POP     DX
099B 59                               POP     CX
099C 5B                               POP     BX
099D 58                               POP     AX
099E C3                               RET

099F                          DSKETTE_SETUP ENDP

099F                          CODE    ENDS
                                      END
```

SECTION 5

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                                PAGE 118,121
                                TITLE DISK ----- 06/10/85  FIXED DISK BIOS
                                .286C
                                .LIST
 0000                           CODE    SEGMENT BYTE PUBLIC

                                        PUBLIC  DISK_IO
                                        PUBLIC  DISK_SETUP
                                        PUBLIC  HD_INT

                                        EXTRN   CMOS_READ:NEAR
                                        EXTRN   CMOS_WRITE:NEAR
                                        EXTRN   DDS:NEAR
                                        EXTRN   E_MSG:NEAR
                                        EXTRN   F1780:NEAR
                                        EXTRN   F1781:NEAR
                                        EXTRN   F1782:NEAR
                                        EXTRN   F1790:NEAR
                                        EXTRN   F1791:NEAR
                                        EXTRN   FD_TBL:NEAR

                                ;--- INT 13H -------------------------------------------------------------------
                                ;                                                                             :
                                ; FIXED DISK I/O INTERFACE                                                    :
                                ;                                                                             :
                                ;       THIS INTERFACE PROVIDES ACCESS TO 5 1/4" FIXED DISKS THROUGH          :
                                ;       THE IBM FIXED DISK CONTROLLER.                                        :
                                ;                                                                             :
                                ;       THE  BIOS  ROUTINES  ARE  MEANT  TO  BE  ACCESSED  THROUGH            :
                                ;       SOFTWARE  INTERRUPTS  ONLY.    ANY  ADDRESSES  PRESENT  IN            :
                                ;       THESE  LISTINGS  ARE  INCLUDED  ONLY  FOR  COMPLETENESS,              :
                                ;       NOT  FOR  REFERENCE.   APPLICATIONS  WHICH  REFERENCE  ANY            :
                                ;       ABSOLUTE  ADDRESSES  WITHIN  THE  CODE  SEGMENTS  OF  BIOS            :
                                ;       VIOLATE  THE  STRUCTURE  AND  DESIGN  OF  BIOS.                       :
                                ;                                                                             :
                                ;------------------------------------------------------------------------------
                                ;                                                                             :
                                ; INPUT  (AH)= HEX COMMAND VALUE                                              :
                                ;                                                                             :
                                ;       (AH)= 00H  RESET DISK (DL = 80H,81H) / DISKETTE                       :
                                ;       (AH)= 01H  READ THE STATUS OF THE LAST DISK OPERATION INTO (AL)       :
                                ;                   NOTE: DL < 80H - DISKETTE                                 :
                                ;                         DL > 80H - DISK                                     :
                                ;       (AH)= 02H  READ THE DESIRED SECTORS INTO MEMORY                       :
                                ;       (AH)= 03H  WRITE THE DESIRED SECTORS FROM MEMORY                      :
                                ;       (AH)= 04H  VERIFY THE DESIRED SECTORS                                 :
                                ;       (AH)= 05H  FORMAT THE DESIRED TRACK                                   :
                                ;       (AH)= 06H  UNUSED                                                     :
                                ;       (AH)= 07H  UNUSED                                                     :
                                ;       (AH)= 08H  RETURN THE CURRENT DRIVE PARAMETERS                        :
                                ;       (AH)= 09H  INITIALIZE DRIVE PAIR CHARACTERISTICS                      :
                                ;                   INTERRUPT 41 POINTS TO DATA BLOCK FOR DRIVE 0             :
                                ;                   INTERRUPT 46 POINTS TO DATA BLOCK FOR DRIVE 1             :
                                ;       (AH)= 0AH  READ LONG                                                  :
                                ;       (AH)= 0BH  WRITE LONG  (READ & WRITE LONG ENCOMPASS 512 + 4 BYTES ECC) :
                                ;       (AH)= 0CH  SEEK                                                       :
                                ;       (AH)= 0DH  ALTERNATE DISK RESET (SEE DL)                              :
                                ;       (AH)= 0EH  UNUSED                                                     :
                                ;       (AH)= 0FH  UNUSED                                                     :
                                ;       (AH)= 10H  TEST DRIVE READY                                           :
                                ;       (AH)= 11H  RECALIBRATE                                                :
                                ;       (AH)= 12H  UNUSED                                                     :
                                ;       (AH)= 13H  UNUSED                                                     :
                                ;       (AH)= 14H  CONTROLLER INTERNAL DIAGNOSTIC                             :
                                ;       (AH)= 15H  READ DASD TYPE                                             :
                                ;                                                                             :
                                ;-----------------------------------------------------------------------------:
                                ;                                                                             :
                                ;       REGISTERS USED FOR FIXED DISK OPERATIONS                              :
                                ;                                                                             :
                                ;               (DL)    -  DRIVE NUMBER     (80H-81H FOR DISK, VALUE CHECKED) :
                                ;               (DH)    -  HEAD NUMBER      (0-15 ALLOWED, NOT VALUE CHECKED) :
                                ;               (CH)    -  CYLINDER NUMBER  (0-1023, NOT VALUE CHECKED)(SEE CL):
                                ;               (CL)    -  SECTOR NUMBER    (1-17, NOT VALUE CHECKED)         :
                                ;                                                                             :
                                ;                          NOTE: HIGH 2 BITS OF CYLINDER NUMBER ARE PLACED    :
                                ;                                IN THE HIGH 2 BITS OF THE CL REGISTER        :
                                ;                                (10 BITS TOTAL)                              :
                                ;                                                                             :
                                ;               (AL)    -  NUMBER OF SECTORS (MAXIMUM POSSIBLE RANGE 1-80H,   :
                                ;                                             FOR READ/WRITE LONG 1-79H)      :
                                ;                                                                             :
                                ;               (ES:BX) -  ADDRESS OF BUFFER FOR READS AND WRITES,            :
                                ;                          (NOT REQUIRED FOR VERIFY)                          :
                                ;                                                                             :
                                ;               FORMAT (AH=5) ES:BX POINTS TO A 512 BYTE BUFFER.  THE FIRST   :
                                ;                          2*(SECTORS/TRACK) BYTES CONTAIN F,N FOR EACH SECTOR.:
                                ;                          F = 00H FOR A GOOD SECTOR                          :
                                ;                              80H FOR A BAD SECTOR                           :
                                ;                          N = SECTOR NUMBER                                  :
                                ;                          FOR AN INTERLEAVE OF 2 AND 17 SECTORS/TRACK        :
                                ;                          THE TABLE SHOULD BE:                               :
                                ;                                                                             :
                                ;                  DB      00H,01H,00H,0AH,00H,02H,00H,0BH,00H,03H,00H,0CH    :
                                ;                  DB      00H,04H,00H,0DH,00H,05H,00H,0EH,00H,06H,00H,0FH    :
                                ;                  DB      00H,07H,00H,10H,00H,08H,00H,11H,00H,09H            :
                                ;                                                                             :
                                ;-----------------------------------------------------------------------------:
```

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                        PAGE
                        ;---------------------------------------------------------------------;
                        ; OUTPUT                                                              :
                        ;       AH = STATUS OF CURRENT OPERATION                              :
                        ;            STATUS BITS ARE DEFINED IN THE EQUATES BELOW             :
                        ;       CY = 0  SUCCESSFUL OPERATION (AH=0 ON RETURN)                 :
                        ;       CY = 1  FAILED OPERATION (AH HAS ERROR REASON)                :
                        ;                                                                     :
                        ;       NOTE:    ERROR 11H  INDICATES THAT THE DATA READ HAD A RECOVERABLE  :
                        ;                ERROR WHICH WAS CORRECTED BY THE ECC ALGORITHM.  THE DATA  :
                        ;                IS PROBABLY GOOD,   HOWEVER THE BIOS ROUTINE INDICATES AN  :
                        ;                ERROR TO ALLOW THE CONTROLLING PROGRAM A CHANCE TO DECIDE  :
                        ;                FOR  ITSELF.  THE  ERROR  MAY  NOT  RECUR  IF THE DATA IS  :
                        ;                REWRITTEN.                                           :
                        ;                                                                     :
                        ;       IF DRIVE PARAMETERS WERE REQUESTED (DL >= 80H),               :
                        ;          INPUT:                                                     :
                        ;            (DL) = DRIVE NUMBER                                      :
                        ;          OUTPUT:                                                    :
                        ;            (DL) = NUMBER OF CONSECUTIVE ACKNOWLEDGING DRIVES ATTACHED (1-2)  :
                        ;                   (CONTROLLER CARD ZERO TALLY ONLY)                 :
                        ;            (DH) = MAXIMUM USEABLE VALUE FOR HEAD NUMBER             :
                        ;            (CH) = MAXIMUM USEABLE VALUE FOR CYLINDER NUMBER         :
                        ;            (CL) = MAXIMUM USEABLE VALUE FOR SECTOR NUMBER           :
                        ;                   AND CYLINDER NUMBER HIGH BITS                     :
                        ;                                                                     :
                        ;       IF READ DASD TYPE WAS REQUESTED,                              :
                        ;                                                                     :
                        ;       AH = 0 - NOT PRESENT                                          :
                        ;            1 - DISKETTE - NO CHANGE LINE AVAILABLE                  :
                        ;            2 - DISKETTE - CHANGE LINE AVAILABLE                     :
                        ;            3 - FIXED DISK                                           :
                        ;       CX,DX = NUMBER OF 512 BYTE BLOCKS WHEN AH = 3                 :
                        ;                                                                     :
                        ;       REGISTERS WILL BE PRESERVED EXCEPT WHEN THEY ARE USED TO RETURN  :
                        ;       INFORMATION.                                                  :
                        ;                                                                     :
                        ;       NOTE: IF AN ERROR IS REPORTED BY THE DISK CODE, THE APPROPRIATE  :
                        ;             ACTION IS TO RESET THE DISK, THEN RETRY THE OPERATION.  :
                        ;                                                                     :
                        ;---------------------------------------------------------------------

 = 00FF                 SENSE_FAIL      EQU     0FFH            ; NOT IMPLEMENTED
 = 00E0                 NO_ERR          EQU     0E0H            ; STATUS ERROR/ERROR REGISTER=0
 = 00CC                 WRITE_FAULT     EQU     0CCH            ; WRITE FAULT ON SELECTED DRIVE
 = 00BB                 UNDEF_ERR       EQU     0BBH            ; UNDEFINED ERROR OCCURRED
 = 00AA                 NOT_RDY         EQU     0AAH            ; DRIVE NOT READY
 = 0080                 TIME_OUT        EQU     80H             ; ATTACHMENT FAILED TO RESPOND
 = 0040                 BAD_SEEK        EQU     40H             ; SEEK OPERATION FAILED
 = 0020                 BAD_CNTLR       EQU     20H             ; CONTROLLER HAS FAILED
 = 0011                 DATA_CORRECTED  EQU     11H             ; ECC CORRECTED DATA ERROR
 = 0010                 BAD_ECC         EQU     10H             ; BAD ECC ON DISK READ
 = 000B                 BAD_TRACK       EQU     0BH             ; NOT IMPLEMENTED
 = 000A                 BAD_SECTOR      EQU     0AH             ; BAD SECTOR FLAG DETECTED
 = 0009                 DMA_BOUNDARY    EQU     09H             ; DATA EXTENDS TOO FAR
 = 0007                 INIT_FAIL       EQU     07H             ; DRIVE PARAMETER ACTIVITY FAILED
 = 0005                 BAD_RESET       EQU     05H             ; RESET FAILED
 = 0004                 RECORD_NOT_FND  EQU     04H             ; REQUESTED SECTOR NOT FOUND
 = 0002                 BAD_ADDR_MARK   EQU     02H             ; ADDRESS MARK NOT FOUND
 = 0001                 BAD_CMD         EQU     01H             ; BAD COMMAND PASSED TO DISK I/O


                        ;----------------------------------------------------
                        ;                                                   :
                        ; FIXED DISK PARAMETER TABLE                        :
                        ;                                                   :
                        ;  -  THE TABLE IS COMPOSED OF A BLOCK DEFINED AS:  :
                        ;                                                   :
                        ;  +0    (1 WORD) - MAXIMUM NUMBER OF CYLINDERS     :
                        ;  +2    (1 BYTE) - MAXIMUM NUMBER OF HEADS         :
                        ;  +3    (1 WORD) - NOT USED/SEE PC-XT              :
                        ;  +5    (1 WORD) - STARTING WRITE PRECOMPENSATION CYL  :
                        ;  +7    (1 BYTE) - MAXIMUM ECC DATA BURST LENGTH   :
                        ;  +8    (1 BYTE) - CONTROL BYTE                    :
                        ;                   BIT    7 DISABLE RETRIES -OR-   :
                        ;                   BIT    6 DISABLE RETRIES        :
                        ;                   BIT    3 MORE THAN 8 HEADS      :
                        ;  +9    (3 BYTES)- NOT USED/SEE PC-XT              :
                        ; +12    (1 WORD) - LANDING ZONE                    :
                        ; +14    (1 BYTE) - NUMBER OF SECTORS/TRACK         :
                        ; +15    (1 BYTE) - RESERVED FOR FUTURE USE         :
                        ;                                                   :
                        ;        - TO DYNAMICALLY DEFINE A SET OF PARAMETERS  :
                        ;          BUILD A TABLE FOR UP TO 15 TYPES AND PLACE  :
                        ;          THE CORRESPONDING VECTOR INTO INTERRUPT 41  :
                        ;          FOR DRIVE 0 AND INTERRUPT 46 FOR DRIVE 1.  :
                        ;                                                   :
                        ;----------------------------------------------------
```

SECTION 5

```
                                PAGE
                                ;----------------------------------------------------
                                ;                                                    :
                                ; HARDWARE SPECIFIC VALUES                           :
                                ;                                                    :
                                ;  -  CONTROLLER I/O PORT                            :
                                ;                                                    :
                                ;     > WHEN READ FROM:                              :
                                ;       HF_PORT+0 - READ DATA (FROM CONTROLLER TO CPU) :
                                ;       HF_PORT+1 - GET ERROR REGISTER               :
                                ;       HF_PORT+2 - GET SECTOR COUNT                 :
                                ;       HF_PORT+3 - GET SECTOR NUMBER                :
                                ;       HF_PORT+4 - GET CYLINDER LOW                 :
                                ;       HF_PORT+5 - GET CYLINDER HIGH (2 BITS)       :
                                ;       HF_PORT+6 - GET SIZE/DRIVE/HEAD              :
                                ;       HF_PORT+7 - GET STATUS REGISTER              :
                                ;                                                    :
                                ;     > WHEN WRITTEN TO:                             :
                                ;       HF_PORT+0 - WRITE DATA (FROM CPU TO CONTROLLER) :
                                ;       HF_PORT+1 - SET PRECOMPENSATION CYLINDER     :
                                ;       HF_PORT+2 - SET SECTOR COUNT                 :
                                ;       HF_PORT+3 - SET SECTOR NUMBER                :
                                ;       HF_PORT+4 - SET CYLINDER LOW                 :
                                ;       HF_PORT+5 - SET CYLINDER HIGH (2 BITS)       :
                                ;       HF_PORT+6 - SET SIZE/DRIVE/HEAD              :
                                ;       HF_PORT+7 - SET COMMAND REGISTER             :
                                ;                                                    :
                                ;----------------------------------------------------

 = 01F0                         HF_PORT         EQU     01F0H           ; DISK PORT
 = 03F6                         HF_REG_PORT     EQU     03F6H

                                ;-----          STATUS REGISTER

 = 0001                         ST_ERROR        EQU     00000001B       ;
 = 0002                         ST_INDEX        EQU     00000010B       ;
 = 0004                         ST_CORRCTD      EQU     00000100B       ; ECC CORRECTION SUCCESSFUL
 = 0008                         ST_DRQ          EQU     00001000B       ;
 = 0010                         ST_SEEK_COMPL   EQU     00010000B       ; SEEK COMPLETE
 = 0020                         ST_WRT_FLT      EQU     00100000B       ; WRITE FAULT
 = 0040                         ST_READY        EQU     01000000B       ;
 = 0080                         ST_BUSY         EQU     10000000B       ;

                                ;-----          ERROR REGISTER

 = 0001                         ERR_DAM         EQU     00000001B       ; DATA ADDRESS MARK NOT FOUND
 = 0002                         ERR_TRK_0       EQU     00000010B       ; TRACK 0 NOT FOUND ON RECAL
 = 0004                         ERR_ABORT       EQU     00000100B       ; ABORTED COMMAND
                                ;               EQU     00001000B       ; NOT USED
 = 0010                         ERR_ID          EQU     00010000B       ; ID NOT FOUND
                                ;               EQU     00100000B       ; NOT USED
 = 0040                         ERR_DATA_ECC    EQU     01000000B
 = 0080                         ERR_BAD_BLOCK   EQU     10000000B


 = 0010                         RECAL_CMD       EQU     00010000B       ; DRIVE RECAL   (10H)
 = 0020                         READ_CMD        EQU     00100000B       ;       READ    (20H)
 = 0030                         WRITE_CMD       EQU     00110000B       ;       WRITE   (30H)
 = 0040                         VERIFY_CMD      EQU     01000000B       ;       VERIFY  (40H)
 = 0050                         FMTTRK_CMD      EQU     01010000B       ; FORMAT TRACK  (50H)
 = 0060                         INIT_CMD        EQU     01100000B       ;   INITIALIZE  (60H)
 = 0070                         SEEK_CMD        EQU     01110000B       ;       SEEK    (70H)
 = 0090                         DIAG_CMD        EQU     10010000B       ; DIAGNOSTIC    (90H)
 = 0091                         SET_PARM_CMD    EQU     10010001B       ; DRIVE PARMS   (91H)
 = 0001                         NO_RETRIES      EQU     00000001B       ; CMD MODIFIER  (01H)
 = 0002                         ECC_MODE        EQU     00000010B       ; CMD MODIFIER  (02H)
 = 0008                         BUFFER_MODE     EQU     00001000B       ; CMD MODIFIER  (08H)

 = 0002                         MAX_FILE        EQU     2
 = 0002                         S_MAX_FILE      EQU     2

 = 0025                         DELAY_1         EQU     25H             ; DELAY FOR OPERATION COMPLETE
 = 0600                         DELAY_2         EQU     0600H           ; DELAY FOR READY
 = 0100                         DELAY_3         EQU     0100H           ; DELAY FOR DATA REQUEST

 = 0008                         HF_FAIL         EQU     08H             ; CMOS FLAG IN BYTE 0EH

                                ;-----          COMMAND BLOCK REFERENCE

 =                              @CMD_BLOCK      EQU     BYTE PTR [BP]-8 ; @CMD_BLOCK REFERENCES BLOCK HEAD IN SS
                                                                        ;  (BP) POINTS TO COMMAND BLOCK TAIL
                                                                        ;       AS DEFINED BY THE "ENTER" PARMS
```

```
                                PAGE
                                ;----------------------------------------------------------------
                                ; FIXED DISK I/O SETUP                                          :
                                ;                                                               :
                                ;  -  ESTABLISH TRANSFER VECTORS FOR THE FIXED DISK             :
                                ;  -  PERFORM POWER ON DIAGNOSTICS                              :
                                ;     SHOULD AN ERROR OCCUR A "1701" MESSAGE IS DISPLAYED       :
                                ;                                                               :
                                ;----------------------------------------------------------------
                                        ASSUME  CS:CODE,DS:ABS0                         ; WORK OFF DS REGISTER

 0000                           DISK_SETUP      PROC    NEAR
 0000 FA                                CLI
 0001 B8 ---- R                         MOV     AX,ABS0                                 ; GET ABSOLUTE SEGMENT
 0004 8E D8                             MOV     DS,AX                                   ; SET SEGMENT REGISTER
 0006 A1 004C R                         MOV     AX,WORD PTR @ORG_VECTOR                 ; GET DISKETTE VECTOR
 0009 A3 0100 R                         MOV     WORD PTR @DISK_VECTOR,AX                ;  INTO INT 40H
 000C A1 004E R                         MOV     AX,WORD PTR @ORG_VECTOR+2
 000F A3 0102 R                         MOV     WORD PTR @DISK_VECTOR+2,AX
 0012 C7 06 004C R 01A9 R               MOV     WORD PTR @ORG_VECTOR,OFFSET DISK_IO     ; FIXED DISK HANDLER
 0018 8C 0E 004E R                      MOV     WORD PTR @ORG_VECTOR+2,CS
 001C C7 06 01D8 R 06CD R               MOV     WORD PTR @HDISK_INT,OFFSET HD_INT       ; FIXED DISK INTERRUPT
 0022 8C 0E 01DA R                      MOV     WORD PTR @HDISK_INT+2,CS
 0026 C7 06 0104 R 0000 E               MOV     WORD PTR @HF_TBL_VEC,OFFSET FD_TBL      ; PARM TABLE DRIVE 80
 002C 8C 0E 0106 R                      MOV     WORD PTR @HF_TBL_VEC+2,CS
 0030 C7 06 0118 R 0000 E               MOV     WORD PTR @HF1_TBL_VEC,OFFSET FD_TBL     ; PARM TABLE DRIVE 81
 0036 8C 0E 011A R                      MOV     WORD PTR @HF1_TBL_VEC+2,CS
 003A E4 A1                             IN      AL,INTB01                       ; TURN ON SECOND INTERRUPT CHIP
 003C 24 BF                             AND     AL,0BFH
 003E EB 00                             JMP     $+2
 0040 E6 A1                             OUT     INTB01,AL
 0042 E4 21                             IN      AL,INTA01               ; LET INTERRUPTS PASS THRU TO
 0044 24 FB                             AND     AL,0FBH                 ;  SECOND CHIP
 0046 EB 00                             JMP     $+2
 0048 E6 21                             OUT     INTA01,AL

 004A FB                                STI
                                        ASSUME  DS:DATA,ES:ABS0
 004B 1E                                PUSH    DS                      ; MOVE ABS0 POINTER TO
 004C 07                                POP     ES                      ; EXTRA SEGMENT POINTER
 004D E8 0000 E                         CALL    DDS                     ; ESTABLISH DATA SEGMENT
 0050 C6 06 0074 R 00                   MOV     @DISK_STATUS1,0         ; RESET THE STATUS INDICATOR
 0055 C6 06 0075 R 00                   MOV     @HF_NUM,0               ; ZERO NUMBER OF FIXED DISKS
 005A C6 06 0076 R 00                   MOV     @CONTROL_BYTE,0
 005F B0 8E                             MOV     AL,CMOS_DIAG+NMI
 0061 E8 0000 E                         CALL    CMOS_READ               ; CHECK CMOS VALIDITY
 0064 8A E0                             MOV     AH,AL                   ; SAVE CMOS FLAG
 0066 24 C0                             AND     AL,BAD_BAT+BAD_CKSUM    ; CHECK FOR VALID CMOS
 0068 74 03                             JZ      L1
 006A E9 00F8 R                         JMP     POD_DONE                ; CMOS NOT VALID -- NO FIXED DISKS
 006D                           L1:
 006D 80 E4 F7                          AND     AH,NOT HF_FAIL          ; ALLOW FIXED DISK IPL
 0070 B0 8E                             MOV     AL,CMOS_DIAG+NMI        ; WRITE IT BACK
 0072 E8 0000 E                         CALL    CMOS_WRITE
 0075 B0 92                             MOV     AL,CMOS_DISK+NMI
 0077 E8 0000 E                         CALL    CMOS_READ
 007A C6 06 0077 R 00                   MOV     @PORT_OFF,0             ; ZERO CARD OFFSET
 007F 8A D8                             MOV     BL,AL                   ; SAVE FIXED DISK BYTE
 0081 25 00F0                           AND     AX,000F0H               ; GET FIRST DRIVE TYPE AS OFFSET
 0084 74 72                             JZ      POD_DONE                ; NO FIXED DISKS

 0086 3C F0                             CMP     AL,0F0H                 ; CHECK FOR EXTENDED DRIVE TYPE BYTE USE
 0088 75 10                             JNE     L2                      ; USE DRIVE TYPE 1 --> 14 IF NOT IN USE

 008A B0 99                             MOV     AL,CMOS_DISK_1+NMI      ; GET EXTENDED TYPE FOR DRIVE C:
 008C E8 0000 E                         CALL    CMOS_READ               ; FROM CMOS
 008F 3C 00                             CMP     AL,0                    ; IS TYPE SET TO ZERO
 0091 74 65                             JE      POD_DONE                ; EXIT IF NOT VALID AND NO FIXED DISKS
 0093 3C 2F                             CMP     AL,47                   ; IS TYPE WITHIN VALID RANGE
 0095 77 61                             JA      POD_DONE                ; EXIT WITH NO FIXED DISKS IF NOT VALID
 0097 C1 E0 04                          SHL     AX,4                    ; ADJUST TYPE TO HIGH NIBBLE
 009A                           L2:
 009A 05 FFF0 E                         ADD     AX,OFFSET FD_TBL-16D    ; COMPUTE OFFSET OF FIRST DRIVE TABLE
 009D 26: A3 0104 R                     MOV     WORD PTR @HF_TBL_VEC,AX ; SAVE IN VECTOR POINTER
 00A1 C6 06 0075 R 01                   MOV     @HF_NUM,1               ; AT LEAST ONE DRIVE
 00A6 8A C3                             MOV     AL,BL
 00A8 C0 E0 04                          SHL     AL,4                    ; GET SECOND DRIVE TYPE
 00AB 74 2A                             JZ      SHORT L4                ; ONLY ONE DRIVE
 00AD B4 00                             MOV     AH,0

 00AF 3C F0                             CMP     AL,0F0H                 ; CHECK FOR EXTENDED DRIVE TYPE BYTE USE
 00B1 75 10                             JNE     L3                      ; USE DRIVE TYPE 1 --> 14 IF NOT IN USE

 00B3 B0 9A                             MOV     AL,CMOS_DISK_2+NMI      ; GET EXTENDED TYPE FOR DRIVE D:
 00B5 E8 0000 E                         CALL    CMOS_READ               ; FROM CMOS
 00B8 3C 00                             CMP     AL,0                    ; IS TYPE SET TO ZERO
 00BA 74 1B                             JE      L4                      ; SKIP IF SECOND FIXED DISK NOT VALID
 00BC 3C 2F                             CMP     AL,47                   ; IS TYPE WITHIN VALID RANGE
 00BE 77 17                             JA      L4                      ; SKIP IF NOT VALID
 00C0 C1 E0 04                          SHL     AX,4                    ; ADJUST TYPE TO HIGH NIBBLE
 00C3                           L3:
 00C3 05 FFF0 E                         ADD     AX,OFFSET FD_TBL-16D    ; COMPUTE OFFSET FOR SECOND FIXED DISK
 00C6 8B D8                             MOV     BX,AX
 00C8 2E: 83 3F 00                      CMP     WORD PTR CS:[BX],0      ; CHECK FOR ZERO CYLINDERS IN TABLE
 00CC 74 09                             JE      L4                      ; SKIP DRIVE IF NOT A VALID TABLE ENTRY
 00CE 26: A3 0118 R                     MOV     WORD PTR @HF1_TBL_VEC,AX
 00D2 C6 06 0075 R 02                   MOV     @HF_NUM,2               ; TWO DRIVES
 00D7                           L4:
 00D7 B2 80                             MOV     DL,80H                  ; CHECK THE CONTROLLER
 00D9 B4 14                             MOV     AH,14H                  ; USE CONTROLLER DIAGNOSTIC COMMAND
 00DB CD 13                             INT     13H                     ; CALL BIOS WITH DIAGNOSTIC COMMAND
 00DD 72 1A                             JC      CTL_ERRX                ;  DISPLAY ERROR MESSAGE IF BAD RETURN
 00DF A1 006C R                         MOV     AX,@TIMER_LOW           ; GET START TIMER COUNTS
 00E2 8B D8                             MOV     BX,AX
 00E4 05 0444                           ADD     AX,6*182                ; 60 SECONDS* 18.2
 00E7 8B C8                             MOV     CX,AX
 00E9 E8 0104 R                         CALL    HD_RESET_1              ; SET UP DRIVE 0
 00EC 80 3E 0075 R 01                   CMP     @HF_NUM,1               ; WERE THERE TWO DRIVES?
 00F1 76 05                             JBE     POD_DONE                ; NO-ALL DONE
 00F3 B2 81                             MOV     DL,81H                  ; SET UP DRIVE 1
 00F5 E8 0104 R                         CALL    HD_RESET_1
 00F8                           POD_DONE:
 00F8 C3                                RET
```

SECTION 5

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                            ;----- POD ERROR

00F9                        CTL_ERRX:
00F9 BE 0000 E                      MOV     SI,OFFSET F1782         ; CONTROLLER ERROR
00FC E8 017C R                      CALL    SET_FAIL                ; DO NOT IPL FROM DISK
00FF E8 0000 E                      CALL    E_MSG                   ; DISPLAY ERROR AND SET (BP) ERROR FLAG
0102 EB F4                          JMP     POD_DONE


0104                        HD_RESET_1      PROC    NEAR
0104 53                             PUSH    BX                      ; SAVE TIMER LIMITS
0105 51                             PUSH    CX
0106 B4 09                  RES_1:  MOV     AH,09H                  ; SET DRIVE PARAMETERS
0108 CD 13                          INT     13H
010A 72 06                          JC      RES_2
010C B4 11                          MOV     AH,11H                  ; RECALIBRATE DRIVE
010E CD 13                          INT     13H
0110 73 19                          JNC     RES_CK                  ; DRIVE OK
0112 E8 018A R              RES_2:  CALL    POD_TCHK                ; CHECK TIME OUT
0115 73 EF                          JNC     RES_1
0117 BE 0000 E              RES_FL: MOV     SI,OFFSET F1781         ; INDICATE DISK 1 FAILURE
011A F6 C2 01                       TEST    DL,1
011D 75 57                          JNZ     RES_E1
011F BE 0000 E                      MOV     SI,OFFSET F1780         ; INDICATE DISK 0 FAILURE
0122 E8 017C R                      CALL    SET_FAIL                ; DO NOT TRY TO IPL DISK 0
0125 EB 4F                          JMP     SHORT RES_E1
0127 B4 00                  RES_RS: MOV     AH,00H                  ; RESET THE DRIVE
0129 CD 13                          INT     13H
012B B4 08                  RES_CK: MOV     AH,08H                  ; GET MAX CYLINDER,HEAD,SECTOR
012D 8A DA                          MOV     BL,DL                   ; SAVE DRIVE CODE
012F CD 13                          INT     13H
0131 72 38                          JC      RES_ER
0133 89 0E 0042 R                   MOV     WORD PTR @NEC_STATUS,CX ; SAVE MAX CYLINDER, SECTOR
0137 8A D3                          MOV     DL,BL                   ; RESTORE DRIVE CODE
0139 B8 0401                RES_3:  MOV     AX,0401H                ; VERIFY THE LAST SECTOR
013C CD 13                          INT     13H
013E 73 39                          JNC     RES_OK                  ; VERIFY OK
0140 80 FC 0A                       CMP     AH,BAD_SECTOR           ; OK ALSO IF JUST ID READ
0143 74 34                          JE      RES_OK
0145 80 FC 11                       CMP     AH,DATA_CORRECTED
0148 74 2F                          JE      RES_OK
014A 80 FC 10                       CMP     AH,BAD_ECC
014D 74 2A                          JE      RES_OK
014F E8 018A R                      CALL    POD_TCHK                ; CHECK FOR TIME OUT
0152 72 17                          JC      RES_ER                  ; FAILED
0154 8B 0E 0042 R                   MOV     CX,WORD PTR @NEC_STATUS ; GET SECTOR ADDRESS, AND CYLINDER
0158 8A C1                          MOV     AL,CL                   ; SEPARATE OUT SECTOR NUMBER
015A 24 3F                          AND     AL,3FH
015C FE C8                          DEC     AL                      ; TRY PREVIOUS ONE
015E 74 C7                          JZ      RES_RS                  ; WE'VE TRIED ALL SECTORS ON TRACK
0160 80 E1 C0                       AND     CL,0C0H                 ; KEEP CYLINDER BITS
0163 0A C8                          OR      CL,AL                   ; MERGE SECTOR WITH CYLINDER BITS
0165 89 0E 0042 R                   MOV     WORD PTR @NEC_STATUS,CX ; SAVE CYLINDER, NEW SECTOR NUMBER
0169 EB CE                          JMP     RES_3                   ; TRY AGAIN
016B BE 0000 E              RES_ER: MOV     SI,OFFSET F1791         ; INDICATE DISK 1 ERROR
016E F6 C2 01                       TEST    DL,1
0171 75 03                          JNZ     RES_E1
0173 BE 0000 E                      MOV     SI,OFFSET F1790         ; INDICATE DISK 0 ERROR
0176                        RES_E1:
0176 E8 0000 E                      CALL    E_MSG                   ; DISPLAY ERROR AND SET (BP) ERROR FLAG
0179                        RES_OK:
0179 59                             POP     CX                      ; RESTORE TIMER LIMITS
017A 5B                             POP     BX
017B C3                             RET
017C                        HD_RESET_1      ENDP

017C                        SET_FAIL        PROC    NEAR
017C B8 8E8E                        MOV     AX,X*(CMOS_DIAG+NMI)    ; GET CMOS ERROR BYTE
017F E8 0000 E                      CALL    CMOS_READ
0182 0C 08                          OR      AL,HF_FAIL              ; SET DO NOT IPL FROM DISK FLAG
0184 86 E0                          XCHG    AH,AL                   ; SAVE IT
0186 E8 0000 E                      CALL    CMOS_WRITE              ; PUT IT OUT
0189 C3                             RET
018A                        SET_FAIL        ENDP

018A                        POD_TCHK        PROC NEAR               ; CHECK FOR 30 SECOND TIME OUT
018A 58                             POP     AX                      ; SAVE RETURN
018B 59                             POP     CX                      ; GET TIME OUT LIMITS
018C 5B                             POP     BX
018D 53                             PUSH    BX                      ; AND SAVE THEM AGAIN
018E 51                             PUSH    CX
018F 50                             PUSH    AX                      ; RESTORE RETURN
0190 A1 006C R                      MOV     AX,@TIMER_LOW           ; AX = CURRENT TIME
                                                                    ; BX = START TIME
                                                                    ; CX = END TIME
0193 3B D9                          CMP     BX,CX
0195 72 06                          JB      TCHK1                   ; START < END
0197 3B D8                          CMP     BX,AX
0199 72 0C                          JB      TCHKG                   ; END < START < CURRENT
019B EB 04                          JMP     SHORT TCHK2             ; END, CURRENT < START
019D 3B C3                  TCHK1:  CMP     AX,BX
019F 72 04                          JB      TCHKNG                  ; CURRENT < START < END
01A1 3B C1                  TCHK2:  CMP     AX,CX
01A3 72 02                          JB      TCHKG                   ; START < CURRENT < END
                                                                    ; OR CURRENT < END < START
01A5 F9                     TCHKNG: STC                             ; CARRY SET INDICATES TIME OUT
01A6 C3                             RET
01A7 F8                     TCHKG:  CLC                             ; INDICATE STILL TIME
01A8 C3                             RET
01A9                        POD_TCHK        ENDP

01A9                        DISK_SETUP      ENDP
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                                PAGE
                                ;----------------------------------------
                                ;       FIXED DISK BIOS ENTRY POINT     :
                                ;----------------------------------------

 01A9                           DISK_IO PROC    FAR
                                        ASSUME  DS:DATA,ES:NOTHING
 01A9 80 FA 80                          CMP     DL,80H                  ; TEST FOR FIXED DISK DRIVE
 01AC 73 05                             JAE     A1                      ; YES, HANDLE HERE
 01AE CD 40                             INT     40H                     ; DISKETTE HANDLER
 01B0                           RET_2:
 01B0 CA 0002                           RET     2                       ; BACK TO CALLER

 01B3                           A1:
 01B3 FB                                STI                             ; ENABLE INTERRUPTS
 01B4 0A E4                             OR      AH,AH
 01B6 75 09                             JNZ     A2
 01B8 CD 40                             INT     40H                     ; RESET NEC WHEN AH=0
 01BA 2A E4                             SUB     AH,AH
 01BC 80 FA 81                          CMP     DL,(80H + S_MAX_FILE - 1)
 01BF 77 EF                             JA      RET_2
 01C1                           A2:
 01C1 80 FC 08                          CMP     AH,08H                  ; GET PARAMETERS IS A SPECIAL CASE
 01C4 75 03                             JNZ     A3
 01C6 E9 0393 R                         JMP     GET_PARM_N
 01C9 80 FC 15                  A3:     CMP     AH,15H                  ; READ DASD TYPE IS ALSO
 01CC 75 03                             JNZ     A4
 01CE E9 0353 R                         JMP     READ_DASD_TYPE

 01D1                           A4:                                     ;       SAVE REGISTERS DURING OPERATION
 01D1 C8 0008 00                        ENTER   8,0                     ; SAVE (BP) AND MAKE ROOM FOR @CMD_BLOCK
 01D5 53                                PUSH    BX                      ;  IN THE STACK. THE COMMAND BLOCK IS:
 01D6 51                                PUSH    CX                      ;   @CMD_BLOCK == BYTE PTR [BP]-8
 01D7 52                                PUSH    DX
 01D8 1E                                PUSH    DS
 01D9 06                                PUSH    ES
 01DA 56                                PUSH    SI
 01DB 57                                PUSH    DI
 01DC 0A E4                             OR      AH,AH                   ; CHECK FOR RESET
 01DE 75 02                             JNZ     A5
 01E0 B2 80                             MOV     DL,80H                  ; FORCE DRIVE 80 FOR RESET
 01E2 E8 0225 R                 A5:     CALL    DISK_IO_CONT            ; PERFORM THE OPERATION
 01E5 E8 0000 E                         CALL    DDS                     ; ESTABLISH SEGMENT
 01E8 8A 26 0074 R                      MOV     AH,@DISK_STATUS1        ; GET STATUS FROM OPERATION
 01EC 80 FC 01                          CMP     AH,1                    ; SET THE CARRY FLAG TO INDICATE
 01EF F5                                CMC                             ;  SUCCESS OR FAILURE
 01F0 5F                                POP     DI                      ; RESTORE REGISTERS
 01F1 5E                                POP     SI
 01F2 07                                POP     ES
 01F3 1F                                POP     DS
 01F4 5A                                POP     DX
 01F5 59                                POP     CX
 01F6 5B                                POP     BX
 01F7 C9                                LEAVE                           ; ADJUST (SP) AND RESTORE (BP)
 01F8 CA 0002                           RET     2                       ; THROW AWAY SAVED FLAGS
 01FB                           DISK_IO ENDP

 01FB                           M1      LABEL   WORD                    ; FUNCTION TRANSFER TABLE
 01FB 02C1 R                            DW      DISK_RESET              ; 000H
 01FD 0315 R                            DW      RETURN_STATUS           ; 001H
 01FF 031E R                            DW      DISK_READ               ; 002H
 0201 0325 R                            DW      DISK_WRITE              ; 003H
 0203 032C R                            DW      DISK_VERF               ; 004H
 0205 033E R                            DW      FMT_TRK                 ; 005H
 0207 02B9 R                            DW      BAD_COMMAND             ; 006H  FORMAT BAD SECTORS
 0209 02B9 R                            DW      BAD_COMMAND             ; 007H  FORMAT DRIVE
 020B 02B9 R                            DW      BAD_COMMAND             ; 008H  RETURN PARAMETERS
 020D 03F1 R                            DW      INIT_DRV                ; 009H
 020F 0423 R                            DW      RD_LONG                 ; 00AH
 0211 042A R                            DW      WR_LONG                 ; 00BH
 0213 0431 R                            DW      DISK_SEEK               ; 00CH
 0215 02C1 R                            DW      DISK_RESET              ; 00DH
 0217 02B9 R                            DW      BAD_COMMAND             ; 00EH  READ BUFFER
 0219 02B9 R                            DW      BAD_COMMAND             ; 00FH  WRITE BUFFER
 021B 044F R                            DW      TST_RDY                 ; 010H
 021D 0466 R                            DW      HDISK_RECAL             ; 011H
 021F 02B9 R                            DW      BAD_COMMAND             ; 012H  MEMORY DIAGNOSTIC
 0221 02B9 R                            DW      BAD_COMMAND             ; 013H  DRIVE DIAGNOSTIC
 0223 048E R                            DW      CTLR_DIAGNOSTIC         ; 014H  CONTROLLER DIAGNOSTIC
 = 002A                         M1L     EQU     $-M1

 0225                           DISK_IO_CONT    PROC    NEAR
 0225 E8 0000 E                         CALL    DDS                     ; ESTABLISH SEGMENT
 0228 80 FC 01                          CMP     AH,01H                  ; RETURN STATUS
 022B 75 03                             JNZ     SU0
 022D E9 0315 R                         JMP     RETURN_STATUS
 0230                           SU0:
 0230 C6 06 0074 R 00                   MOV     @DISK_STATUS1,0         ; RESET THE STATUS INDICATOR
 0235 53                                PUSH    BX                      ; SAVE DATA ADDRESS
 0236 8A 1E 0075 R                      MOV     BL,@HF_NUM              ; GET NUMBER OF DRIVES
 023A 50                                PUSH    AX
 023B 80 E2 7F                          AND     DL,7FH                  ; GET DRIVE AS 0 OR 1
 023E 3A DA                             CMP     BL,DL
 0240 76 75                             JBE     BAD_COMMAND_POP         ; INVALID DRIVE
 0242 06                                PUSH    ES
 0243 E8 06B7 R                         CALL    GET_VEC                 ; GET DISK PARAMETERS
 0246 26: 8B 47 05                      MOV     AX,WORD PTR ES:[BX][5]  ; GET WRITE PRE-COMPENSATION CYLINDER
 024A C1 E8 02                          SHR     AX,2
 024D 88 46 F8                          MOV     @CMD_BLOCK,AL
 0250 26: 8A 47 08                      MOV     AL,BYTE PTR ES:[BX][8]  ; GET CONTROL BYTE MODIFIER
 0254 52                                PUSH    DX
 0255 BA 03F6                           MOV     DX,HF_REG_PORT
 0258 EE                                OUT     DX,AL                   ; SET EXTRA HEAD OPTION
 0259 5A                                POP     DX
 025A 07                                POP     ES
 025B 8A 26 0076 R                      MOV     AH,@CONTROL_BYTE        ; SET EXTRA HEAD OPTION IN
 025F 80 E4 C0                          AND     AH,0C0H                 ; CONTROL BYTE
 0262 0A E0                             OR      AH,AL
 0264 88 26 0076 R                      MOV     @CONTROL_BYTE,AH
 0268 58                                POP     AX
 0269 88 46 F9                          MOV     @CMD_BLOCK+1,AL         ; SECTOR COUNT
 026C 50                                PUSH    AX
 026D 8A C1                             MOV     AL,CL                   ; GET SECTOR NUMBER
 026F 24 3F                             AND     AL,3FH
```

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0271 88 46 FA                  MOV     @CMD_BLOCK+2,AL
0274 88 6E FB                  MOV     @CMD_BLOCK+3,CH          ; GET CYLINDER NUMBER
0277 8A C1                     MOV     AL,CL
0279 C0 E8 06                  SHR     AL,6
027C 88 46 FC                  MOV     @CMD_BLOCK+4,AL          ; CYLINDER HIGH ORDER 2 BITS
027F 8A C2                     MOV     AL,DL                    ; DRIVE NUMBER
0281 C0 E0 04                  SHL     AL,4
0284 80 E6 0F                  AND     DH,0FH                   ; HEAD NUMBER
0287 0A C6                     OR      AL,DH
0289 0C A0                     OR      AL,80H OR 20H            ; ECC AND 512 BYTE SECTORS
028B 88 46 FD                  MOV     @CMD_BLOCK+5,AL          ; ECC/SIZE/DRIVE/HEAD
028E 58                        POP     AX
028F 50                        PUSH    AX
0290 8A C4                     MOV     AL,AH                    ; GET INTO LOW BYTE
0292 32 E4                     XOR     AH,AH                    ; ZERO HIGH BYTE
0294 D1 E0                     SAL     AX,1                     ; *2 FOR TABLE LOOKUP
0296 8B F0                     MOV     SI,AX                    ; PUT INTO SI FOR BRANCH
0298 3D 002A                   CMP     AX,M1L                   ; TEST WITHIN RANGE
029B 73 1A                     JNB     BAD_COMMAND_POP
029D 58                        POP     AX                       ; RESTORE AX
029E 5B                        POP     BX                       ; AND DATA ADDRESS
029F 51                        PUSH    CX
02A0 50                        PUSH    AX                       ; ADJUST ES:BX
02A1 8B CB                     MOV     CX,BX                    ; GET 3 HIGH ORDER NIBBLES OF BX
02A3 C1 E9 04                  SHR     CX,4
02A6 8C C0                     MOV     AX,ES
02A8 03 C1                     ADD     AX,CX
02AA 8E C0                     MOV     ES,AX
02AC 81 E3 000F                AND     BX,000FH                 ; ES:BX CHANGED TO ES:000X
02B0 58                        POP     AX
02B1 59                        POP     CX
02B2 2E: FF A4 01FB R          JMP     WORD PTR CS:[SI + OFFSET M1]
02B7                   BAD_COMMAND_POP:
02B7 58                        POP     AX
02B8 5B                        POP     BX
02B9                   BAD_COMMAND:
02B9 C6 06 0074 R 01           MOV     @DISK_STATUS1,BAD_CMD    ; COMMAND ERROR
02BE B0 00                     MOV     AL,0
02C0 C3                        RET
02C1                   DISK_IO_CONT    ENDP

                       ;----------------------------------------
                       ;       RESET THE DISK SYSTEM  (AH=00H) :
                       ;----------------------------------------

02C1                   DISK_RESET      PROC    NEAR
02C1 FA                        CLI
02C2 E4 A1                     IN      AL,INTB01                ; GET THE MASK REGISTER
02C4 EB 00                     JMP     $+2
02C6 24 BF                     AND     AL,0BFH                  ; ENABLE FIXED DISK INTERRUPT
02C8 E6 A1                     OUT     INTB01,AL
02CA FB                        STI                              ; START INTERRUPTS
02CB B0 04                     MOV     AL,04H
02CD BA 03F6                   MOV     DX,HF_REG_PORT
02D0 EE                        OUT     DX,AL                    ; RESET
02D1 B9 000A                   MOV     CX,10                    ; DELAY COUNT
02D4 49                DRD:    DEC     CX
02D5 75 FD                     JNZ     DRD                      ; WAIT 4.8 MICRO-SEC
02D7 A0 0076 R                 MOV     AL,@CONTROL_BYTE
02DA 24 0F                     AND     AL,0FH                   ; SET HEAD OPTION
02DC EE                        OUT     DX,AL                    ; TURN RESET OFF
02DD E8 05E6 R                 CALL    NOT_BUSY
02E0 75 2D                     JNZ     DRERR                    ; TIME OUT ON RESET
02E2 BA 01F1                   MOV     DX,HF_PORT+1
02E5 EC                        IN      AL,DX                    ; GET RESET STATUS
02E6 3C 01                     CMP     AL,1
02E8 75 25                     JNZ     DRERR                    ; BAD RESET STATUS
02EA 80 66 FD EF               AND     @CMD_BLOCK+5,0EFH        ; SET TO DRIVE 0
02EE 2A D2                     SUB     DL,DL
02F0 E8 03F1 R                 CALL    INIT_DRV                 ; SET MAX HEADS
02F3 E8 0466 R                 CALL    HDISK_RECAL              ; RECAL TO RESET SEEK SPEED
02F6 80 3E 0075 R 01           CMP     @HF_NUM,1                ; CHECK FOR DRIVE 1
02FB 76 0C                     JBE     DRE
02FD 80 4E FD 10               OR      @CMD_BLOCK+5,010H        ; SET TO DRIVE 1
0301 B2 01                     MOV     DL,1
0303 E8 03F1 R                 CALL    INIT_DRV                 ; SET MAX HEADS
0306 E8 0466 R                 CALL    HDISK_RECAL              ; RECAL TO RESET SEEK SPEED
0309 C6 06 0074 R 00   DRE:    MOV     @DISK_STATUS1,0          ; IGNORE ANY SET UP ERRORS
030E C3                        RET
030F C6 06 0074 R 05   DRERR:  MOV     @DISK_STATUS1,BAD_RESET  ; CARD FAILED
0314 C3                        RET
0315                   DISK_RESET      ENDP

                       ;----------------------------------------
                       ;       DISK STATUS ROUTINE  (AH = 01H) :
                       ;----------------------------------------

0315                   RETURN_STATUS   PROC    NEAR
0315 A0 0074 R                 MOV     AL,@DISK_STATUS1         ; OBTAIN PREVIOUS STATUS
0318 C6 06 0074 R 00           MOV     @DISK_STATUS1,0          ; RESET STATUS
031D C3                        RET
031E                   RETURN_STATUS   ENDP
```

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                                  PAGE
                                  ;----------------------------------------
                                  ;       DISK READ ROUTINE    (AH = 02H) :
                                  ;----------------------------------------

 031E                             DISK_READ       PROC    NEAR
 031E C6 46 FE 20                         MOV     @CMD_BLOCK+6,READ_CMD
 0322 E9 04C6 R                           JMP     COMMANDI
 0325                             DISK_READ       ENDP

                                  ;----------------------------------------
                                  ;       DISK WRITE ROUTINE   (AH = 03H) :
                                  ;----------------------------------------

 0325                             DISK_WRITE      PROC    NEAR
 0325 C6 46 FE 30                         MOV     @CMD_BLOCK+6,WRITE_CMD
 0329 E9 0505 R                           JMP     COMMANDO
 032C                             DISK_WRITE      ENDP

                                  ;----------------------------------------
                                  ;       DISK VERIFY          (AH = 04H) :
                                  ;----------------------------------------

 032C                             DISK_VERF       PROC    NEAR
 032C C6 46 FE 40                         MOV     @CMD_BLOCK+6,VERIFY_CMD
 0330 E8 054F R                           CALL    COMMAND
 0333 75 08                               JNZ     VERF_EXIT               ; CONTROLLER STILL BUSY
 0335 E8 05B5 R                           CALL    WAIT
 0338 75 03                               JNZ     VERF_EXIT               ; TIME OUT
 033A E8 0623 R                           CALL    CHECK_STATUS
 033D                             VERF_EXIT:
 033D C3                                  RET
 033E                             DISK_VERF       ENDP

                                  ;----------------------------------------
                                  ;       FORMATTING           (AH = 05H) :
                                  ;----------------------------------------

 033E                             FMT_TRK PROC    NEAR                    ; FORMAT TRACK  (AH = 005H)
 033E C6 46 FE 50                         MOV     @CMD_BLOCK+6,FMTTRK_CMD
 0342 06                                  PUSH    ES
 0343 53                                  PUSH    BX
 0344 E8 06B7 R                           CALL    GET_VEC                 ; GET DISK PARAMETERS ADDRESS
 0347 26: 8A 47 0E                        MOV     AL,ES:[BX][14]          ; GET SECTORS/TRACK
 034B 88 46 F9                            MOV     @CMD_BLOCK+1,AL         ; SET SECTOR COUNT IN COMMAND
 034E 5B                                  POP     BX
 034F 07                                  POP     ES
 0350 E9 050A R                           JMP     CMD_OF                  ; GO EXECUTE THE COMMAND
 0353                             FMT_TRK ENDP


                                  ;----------------------------------------
                                  ;       READ DASD TYPE       (AH = 15H) :
                                  ;----------------------------------------

 0353                             READ_DASD_TYPE  LABEL   NEAR
 0353                             READ_D_T        PROC    FAR             ; GET DRIVE PARAMETERS
 0353 1E                                  PUSH    DS                      ; SAVE REGISTERS
 0354 06                                  PUSH    ES
 0355 53                                  PUSH    BX
                                          ASSUME  DS:DATA
 0356 E8 0000 E                           CALL    DDS                     ; ESTABLISH ADDRESSING
 0359 C6 06 0074 R 00                     MOV     @DISK_STATUS1,0
 035E 8A 1E 0075 R                        MOV     BL,@HF_NUM              ; GET NUMBER OF DRIVES
 0362 80 E2 7F                            AND     DL,7FH                  ; GET DRIVE NUMBER
 0365 3A DA                               CMP     BL,DL
 0367 76 22                               JBE     RDT_NOT_PRESENT         ; RETURN DRIVE NOT PRESENT
 0369 E8 06B7 R                           CALL    GET_VEC                 ; GET DISK PARAMETER ADDRESS
 036C 26: 8A 47 02                        MOV     AL,ES:[BX][2]           ; HEADS
 0370 26: 8A 4F 0E                        MOV     CL,ES:[BX][14]
 0374 F6 E9                               IMUL    CL                      ; * NUMBER OF SECTORS
 0376 26: 8B 0F                           MOV     CX,ES:[BX]              ; MAX NUMBER OF CYLINDERS
 0379 49                                  DEC     CX                      ; LEAVE ONE FOR DIAGNOSTICS
 037A F7 E9                               IMUL    CX                      ; NUMBER OF SECTORS
 037C 8B CA                               MOV     CX,DX                   ; HIGH ORDER HALF
 037E 8B D0                               MOV     DX,AX                   ; LOW ORDER HALF
 0380 2B C0                               SUB     AX,AX
 0382 B4 03                               MOV     AH,03H                  ; INDICATE FIXED DISK
 0384 5B                          RDT2:   POP     BX                      ; RESTORE REGISTERS
 0385 07                                  POP     ES
 0386 1F                                  POP     DS
 0387 F8                                  CLC                             ; CLEAR CARRY
 0388 CA 0002                             RET     2
 038B                             RDT_NOT_PRESENT:
 038B 2B C0                               SUB     AX,AX                   ; DRIVE NOT PRESENT RETURN
 038D 8B C8                               MOV     CX,AX                   ; ZERO BLOCK COUNT
 038F 8B D0                               MOV     DX,AX
 0391 EB F1                               JMP     RDT2
 0393                             READ_D_T        ENDP
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                                PAGE
                                ;----------------------------------------
                                ;      GET PARAMETERS         (AH = 08H) :
                                ;----------------------------------------

 0393                           GET_PARM_N      LABEL   NEAR
 0393                           GET_PARM        PROC    FAR             ; GET DRIVE PARAMETERS
 0393 1E                                PUSH    DS                      ; SAVE REGISTERS
 0394 06                                PUSH    ES
 0395 53                                PUSH    BX
                                        ASSUME  DS:ABS0
 0396 B8 ---- R                         MOV     AX,ABS0                 ; ESTABLISH ADDRESSING
 0399 8E D8                             MOV     DS,AX
 039B F6 C2 01                          TEST    DL,1                    ; CHECK FOR DRIVE 1
 039E 74 06                             JZ      G0
 03A0 C4 1E 0118 R                      LES     BX,@HF1_TBL_VEC
 03A4 EB 04                             JMP     SHORT G1
 03A6 C4 1E 0104 R              G0:     LES     BX,@HF_TBL_VEC
                                        ASSUME  DS:DATA
 03AA                           G1:
 03AA E8 0000 E                         CALL    DDS                     ; ESTABLISH SEGMENT
 03AD 80 EA 80                          SUB     DL,80H
 03B0 80 FA 02                          CMP     DL,MAX_FILE             ; TEST WITHIN RANGE
 03B3 73 2C                             JAE     G4
 03B5 C6 06 0074 R 00                   MOV     @DISK_STATUS1,0
 03BA 26: 8B 07                         MOV     AX,ES:[BX]              ; MAX NUMBER OF CYLINDERS
 03BD 2D 0002                           SUB     AX,2                    ; ADJUST FOR 0-N
 03C0 8A E8                             MOV     CH,AL
 03C2 25 0300                           AND     AX,0300H                ; HIGH TWO BITS OF CYLINDER
 03C5 D1 E8                             SHR     AX,1
 03C7 D1 E8                             SHR     AX,1
 03C9 26: 0A 47 0E                      OR      AL,ES:[BX][14]          ; SECTORS
 03CD 8A C8                             MOV     CL,AL
 03CF 26: 8A 77 02                      MOV     DH,ES:[BX][2]           ; HEADS
 03D3 FE CE                             DEC     DH                      ; 0-N RANGE
 03D5 8A 16 0075 R                      MOV     DL,@HF_NUM              ; DRIVE COUNT
 03D9 2B C0                             SUB     AX,AX
 03DB                           G5:
 03DB 5B                                POP     BX                      ; RESTORE REGISTERS
 03DC 07                                POP     ES
 03DD 1F                                POP     DS
 03DE CA 0002                           RET     2
 03E1                           G4:
 03E1 C6 06 0074 R 07                   MOV     @DISK_STATUS1,INIT_FAIL ; OPERATION FAILED
 03E6 B4 07                             MOV     AH,INIT_FAIL
 03E8 2A C0                             SUB     AL,AL
 03EA 2B D2                             SUB     DX,DX
 03EC 2B C9                             SUB     CX,CX
 03EE F9                                STC                             ; SET ERROR FLAG
 03EF EB EA                             JMP     G5
 03F1                           GET_PARM        ENDP

                                ;----------------------------------------
                                ;      INITIALIZE DRIVE       (AH = 09H) :
                                ;----------------------------------------
 03F1                           INIT_DRV        PROC    NEAR
 03F1 C6 46 FE 91                       MOV     @CMD_BLOCK+6,SET_PARM_CMD
 03F5 E8 06B7 R                         CALL    GET_VEC                 ; ES:BX -> PARAMETER BLOCK
 03F8 26: 8A 47 02                      MOV     AL,ES:[BX][2]           ; GET NUMBER OF HEADS
 03FC FE C8                             DEC     AL                      ; CONVERT TO 0-INDEX
 03FE 8A 66 FD                          MOV     AH,@CMD_BLOCK+5         ; GET SDH REGISTER
 0401 80 E4 F0                          AND     AH,0F0H                 ; CHANGE HEAD NUMBER
 0404 0A E0                             OR      AH,AL                   ;  TO MAX HEAD
 0406 88 66 FD                          MOV     @CMD_BLOCK+5,AH
 0409 26: 8A 47 0E                      MOV     AL,ES:[BX][14]          ; MAX SECTOR NUMBER
 040D 88 46 F9                          MOV     @CMD_BLOCK+1,AL
 0410 2B C0                             SUB     AX,AX
 0412 88 46 FB                          MOV     @CMD_BLOCK+3,AL         ; ZERO FLAGS
 0415 E8 054F R                         CALL    COMMAND                 ; TELL CONTROLLER
 0418 75 08                             JNZ     INIT_EXIT               ; CONTROLLER BUSY ERROR
 041A E8 05E6 R                         CALL    NOT_BUSY                ; WAIT FOR IT TO BE DONE
 041D 75 03                             JNZ     INIT_EXIT               ; TIME OUT
 041F E8 0623 R                         CALL    CHECK_STATUS
 0422                           INIT_EXIT:
 0422 C3                                RET
 0423                           INIT_DRV        ENDP

                                ;----------------------------------------
                                ;      READ LONG              (AH = 0AH) :
                                ;----------------------------------------

 0423                           RD_LONG         PROC    NEAR
 0423 C6 46 FE 22                       MOV     @CMD_BLOCK+6,READ_CMD OR ECC_MODE
 0427 E9 04C6 R                         JMP     COMMANDI
 042A                           RD_LONG         ENDP

                                ;----------------------------------------
                                ;      WRITE LONG             (AH = 0BH) :
                                ;----------------------------------------

 042A                           WR_LONG         PROC    NEAR
 042A C6 46 FE 32                       MOV     @CMD_BLOCK+6,WRITE_CMD OR ECC_MODE
 042E E9 0505 R                         JMP     COMMANDO
 0431                           WR_LONG         ENDP

                                ;----------------------------------------
                                ;      SEEK                   (AH = 0CH) :
                                ;----------------------------------------

 0431                           DISK_SEEK       PROC    NEAR
 0431 C6 46 FE 70                       MOV     @CMD_BLOCK+6,SEEK_CMD
 0435 E8 054F R                         CALL    COMMAND
 0438 75 14                             JNZ     DS_EXIT                 ; CONTROLLER BUSY ERROR
 043A E8 05B5 R                         CALL    WAIT
 043D 75 0F                             JNZ     DS_EXIT                 ; TIME OUT ON SEEK
 043F E8 0623 R                         CALL    CHECK_STATUS
 0442 80 3E 0074 R 40                   CMP     @DISK_STATUS1,BAD_SEEK
 0447 75 05                             JNE     DS_EXIT
 0449 C6 06 0074 R 00                   MOV     @DISK_STATUS1,0
 044E                           DS_EXIT:
 044E C3                                RET

 044F                           DISK_SEEK       ENDP
```

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                              PAGE
                              ;---------------------------------------
                              ;      TEST DISK READY       (AH = 10H) :
                              ;---------------------------------------

044F                          TST_RDY PROC    NEAR
044F E8 05E6 R                        CALL    NOT_BUSY                ; WAIT FOR CONTROLLER
0452 75 11                            JNZ     TR_EX
0454 8A 46 FD                         MOV     AL,@CMD_BLOCK+5         ; SELECT DRIVE
0457 BA 01F6                          MOV     DX,HF_PORT+6
045A EE                               OUT     DX,AL
045B E8 0635 R                        CALL    CHECK_ST                ; CHECK STATUS ONLY
045E 75 05                            JNZ     TR_EX
0460 C6 06 0074 R 00                  MOV     @DISK_STATUS1,0         ; WIPE OUT DATA CORRECTED ERROR
0465 C3                       TR_EX:  RET
0466                          TST_RDY ENDP

                              ;---------------------------------------
                              ;      RECALIBRATE           (AH = 11H) :
                              ;---------------------------------------

0466                          HDISK_RECAL     PROC    NEAR
0466 C6 46 FE 10                      MOV     @CMD_BLOCK+6,RECAL_CMD
046A E8 054F R                        CALL    COMMAND                 ; START THE OPERATION
046D 75 19                            JNZ     RECAL_EXIT              ; ERROR
046F E8 05B5 R                        CALL    WAIT                    ; WAIT FOR COMPLETION
0472 74 05                            JZ      RECAL_X                 ; TIME OUT ONE OK ?
0474 E8 05B5 R                        CALL    WAIT                    ; WAIT FOR COMPLETION LONGER
0477 75 0F                            JNZ     RECAL_EXIT              ; TIME OUT TWO TIMES IS ERROR
0479                          RECAL_X:
0479 E8 0623 R                        CALL    CHECK_STATUS
047C 80 3E 0074 R 40                  CMP     @DISK_STATUS1,BAD_SEEK  ; SEEK NOT COMPLETE
0481 75 05                            JNE     RECAL_EXIT              ; IS OK
0483 C6 06 0074 R 00                  MOV     @DISK_STATUS1,0
0488                          RECAL_EXIT:
0488 80 3E 0074 R 00                  CMP     @DISK_STATUS1,0
048D C3                               RET
048E                          HDISK_RECAL     ENDP

                              ;---------------------------------------
                              ;   CONTROLLER DIAGNOSTIC (AH = 14H)  :
                              ;---------------------------------------

048E                          CTLR_DIAGNOSTIC PROC    NEAR
048E FA                               CLI                     ; DISABLE INTERRUPTS WHILE CHANGING MASK
048F E4 A1                            IN      AL,INTB01       ; TURN ON SECOND INTERRUPT CHIP
0491 24 BF                            AND     AL,0BFH
0493 EB 00                            JMP     $+2
0495 E6 A1                            OUT     INTB01,AL
0497 E4 21                            IN      AL,INTA01       ; LET INTERRUPTS PASS THRU TO
0499 24 FB                            AND     AL,0FBH         ;  SECOND CHIP
049B EB 00                            JMP     $+2
049D E6 21                            OUT     INTA01,AL
049F FB                               STI
04A0 E8 05E6 R                        CALL    NOT_BUSY        ; WAIT FOR CARD
04A3 75 1A                            JNZ     CD_ERR          ; BAD CARD
04A5 BA 01F7                          MOV     DX,HF_PORT+7
04A8 B0 90                            MOV     AL,DIAG_CMD     ; START DIAGNOSE
04AA EE                               OUT     DX,AL
04AB E8 05E6 R                        CALL    NOT_BUSY        ; WAIT FOR IT TO COMPLETE
04AE B4 80                            MOV     AH,TIME_OUT
04B0 75 0F                            JNZ     CD_EXIT         ; TIME OUT ON DIAGNOSTIC
04B2 BA 01F1                          MOV     DX,HF_PORT+1    ; GET ERROR REGISTER
04B5 EC                               IN      AL,DX
04B6 A2 008D R                        MOV     @HF_ERROR,AL    ; SAVE IT
04B9 B4 00                            MOV     AH,0
04BB 3C 01                            CMP     AL,1            ; CHECK FOR ALL OK
04BD 74 02                            JE      SHORT CD_EXIT
04BF B4 20                    CD_ERR: MOV     AH,BAD_CNTLR
04C1                          CD_EXIT:
04C1 88 26 0074 R                     MOV     @DISK_STATUS1,AH
04C5 C3                               RET
04C6                          CTLR_DIAGNOSTIC ENDP

                              ;---------------------------------------
                              ; COMMANDI                              :
                              ;       REPEATEDLY INPUTS DATA TILL     :
                              ;       NSECTOR RETURNS ZERO            :
                              ;---------------------------------------
04C6                          COMMANDI:
04C6 E8 0694 R                        CALL    CHECK_DMA               ; CHECK 64K BOUNDARY ERROR
04C9 72 39                            JC      CMD_ABORT
04CB 8B FB                            MOV     DI,BX
04CD E8 054F R                        CALL    COMMAND                 ; OUTPUT COMMAND
04D0 75 32                            JNZ     CMD_ABORT
04D2                          CMD_I1:
04D2 E8 05B5 R                        CALL    WAIT                    ; WAIT FOR DATA REQUEST INTERRUPT
04D5 75 2D                            JNZ     TM_OUT                  ; TIME OUT
04D7 B9 0100                          MOV     CX,256D                 ; SECTOR SIZE IN WORDS
04DA BA 01F0                          MOV     DX,HF_PORT
04DD FA                               CLI
04DE FC                               CLD
04DF F3/ 6D                           REP     INSW                    ; GET THE SECTOR
04E1 FB                               STI
04E2 F6 46 FE 02                      TEST    @CMD_BLOCK+6,ECC_MODE   ; CHECK FOR NORMAL INPUT
04E6 74 12                            JZ      CMD_I3
04E8 E8 060D R                        CALL    WAIT_DRQ                ; WAIT FOR DATA REQUEST
04EB 72 17                            JC      TM_OUT
04ED BA 01F0                          MOV     DX,HF_PORT
04F0 B9 0004                          MOV     CX,4                    ; GET ECC BYTES
04F3 EC                       CMD_I2: IN      AL,DX
04F4 26: 88 05                        MOV     ES:BYTE PTR [DI],AL     ; GO SLOW FOR BOARD
04F7 47                               INC     DI
04F8 E2 F9                            LOOP    CMD_I2
04FA E8 0623 R                CMD_I3: CALL    CHECK_STATUS
04FD 75 05                            JNZ     CMD_ABORT               ; ERROR RETURNED
04FF FE 4E F9                         DEC     @CMD_BLOCK+1            ; CHECK FOR MORE
0502 75 CE                            JNZ     SHORT CMD_I1
0504                          CMD_ABORT:
0504                          TM_OUT:
0504 C3                               RET
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                              PAGE
                              ;--------------------------------------
                              ; COMMANDO                            :
                              ;       REPEATEDLY OUTPUTS DATA TILL    :
                              ;       NSECTOR RETURNS ZERO            :
                              ;--------------------------------------
0505                          COMMANDO:
0505 E8 0694 R                        CALL    CHECK_DMA               ; CHECK 64K BOUNDARY ERROR
0508 72 FA                            JC      CMD_ABORT
050A 8B F3                    CMD_OF: MOV     SI,BX
050C E8 054F R                        CALL    COMMAND                 ; OUTPUT COMMAND
050F 75 F3                            JNZ     CMD_ABORT
0511 E8 060D R                        CALL    WAIT_DRQ                ; WAIT FOR DATA REQUEST
0514 72 EE                            JC      TM_OUT                  ; TOO LONG
0516 1E                       CMD_01: PUSH    DS
0517 06                               PUSH    ES                      ; MOVE ES TO DS
0518 1F                               POP     DS
0519 B9 0100                          MOV     CX,256D                 ; PUT THE DATA OUT TO THE CARD
051C BA 01F0                          MOV     DX,HF_PORT
051F FA                               CLI
0520 FC                               CLD
0521 F3/ 6F                           REP     OUTSW
0523 FB                               STI
0524 1F                               POP     DS                      ; RESTORE DS
0525 F6 46 FE 02                      TEST    @CMD_BLOCK+6,ECC_MODE   ; CHECK FOR NORMAL OUTPUT
0529 74 12                            JZ      CMD_03
052B E8 060D R                        CALL    WAIT_DRQ                ; WAIT FOR DATA REQUEST
052E 72 D4                            JC      TM_OUT
0530 BA 01F0                          MOV     DX,HF_PORT
0533 B9 0004                          MOV     CX,4                    ; OUTPUT THE ECC BYTES
0536 26: 8A 04                CMD_02: MOV     AL,ES:BYTE PTR [SI]
0539 EE                               OUT     DX,AL
053A 46                               INC     SI
053B E2 F9                            LOOP    CMD_02
053D                          CMD_03:
053D E8 05B5 R                        CALL    WAIT                    ; WAIT FOR SECTOR COMPLETE INTERRUPT
0540 75 C2                            JNZ     TM_OUT                  ; ERROR RETURNED
0542 E8 0623 R                        CALL    CHECK_STATUS
0545 75 BD                            JNZ     CMD_ABORT
0547 F6 06 008C R 08                  TEST    @HF_STATUS,ST_DRQ       ; CHECK FOR MORE
054C 75 C8                            JNZ     SHORT CMD_01
054E C3                               RET


                              ;-----------------------------------------------------
                              ; COMMAND                                            :
                              ;       THIS ROUTINE OUTPUTS THE COMMAND BLOCK       :
                              ; OUTPUT                                             :
                              ;       BL = STATUS                                  :
                              ;       BH = ERROR REGISTER                          :
                              ;-----------------------------------------------------

054F                          COMMAND PROC    NEAR
054F 53                               PUSH    BX                      ; WAIT FOR SEEK COMPLETE AND READY
0550 B9 0600                          MOV     CX,DELAY_2              ; SET INITIAL DELAY BEFORE TEST
0553                          COMMAND1:
0553 51                               PUSH    CX                      ; SAVE LOOP COUNT
0554 E8 044F R                        CALL    TST_RDY                 ; CHECK DRIVE READY
0557 59                               POP     CX
0558 74 0B                            JZ      COMMAND2                ; DRIVE IS READY
055A 80 3E 0074 R 80                  CMP     @DISK_STATUS1,TIME_OUT  ; TST_RDY TIMED OUT--GIVE UP
055F 74 48                            JZ      CMD_TIMEOUT
0561 E2 F0                            LOOP    COMMAND1                ; KEEP TRYING FOR A WHILE
0563 EB 49                            JMP     SHORT COMMAND4          ; ITS NOT GOING TO GET READY
0565                          COMMAND2:
0565 5B                               POP     BX
0566 57                               PUSH    DI
0567 C6 06 008E R 00                  MOV     @HF_INT_FLAG,0          ; RESET INTERRUPT FLAG
056C FA                               CLI                             ; INHIBIT INTERRUPTS WHILE CHANGING MASK
056D E4 A1                            IN      AL,INTB01               ; TURN ON SECOND INTERRUPT CHIP
056F 24 BF                            AND     AL,0BFH
0571 EB 00                            JMP     $+2
0573 E6 A1                            OUT     INTB01,AL
0575 E4 21                            IN      AL,INTA01               ; LET INTERRUPTS PASS THRU TO
0577 24 FB                            AND     AL,0FBH                 ;  SECOND CHIP
0579 EB 00                            JMP     $+2
057B E6 21                            OUT     INTA01,AL
057D FB                               STI
057E 33 FF                            XOR     DI,DI                   ; INDEX THE COMMAND TABLE
0580 BA 01F1                          MOV     DX,HF_PORT+1            ; DISK ADDRESS
0583 F6 06 0076 R C0                  TEST    @CONTROL_BYTE,0C0H      ; CHECK FOR RETRY SUPPRESSION
0588 74 11                            JZ      COMMAND3
058A 8A 46 FE                         MOV     AL,@CMD_BLOCK+6         ; YES-GET OPERATION CODE
058D 24 F0                            AND     AL,0F0H                 ; GET RID OF MODIFIERS
058F 3C 20                            CMP     AL,20H                  ; 20H-40H IS READ, WRITE, VERIFY
0591 72 08                            JB      COMMAND3
0593 3C 40                            CMP     AL,40H
0595 77 04                            JA      COMMAND3
0597 80 4E FE 01                      OR      @CMD_BLOCK+6,NO_RETRIES ; VALID OPERATION FOR RETRY SUPPRESS
059B                          COMMAND3:
059B 8A 43 F8                         MOV     AL,[@CMD_BLOCK+DI]      ; GET THE COMMAND STRING BYTE
059E EE                               OUT     DX,AL                   ; GIVE IT TO CONTROLLER
059F 47                               INC     DI                      ; NEXT BYTE IN COMMAND BLOCK
05A0 42                               INC     DX                      ; NEXT DISK ADAPTER REGISTER
05A1 81 FA 01F8                       CMP     DX,HF_PORT+8            ; ALL DONE?
05A5 75 F4                            JNZ     COMMAND3                ; NO--GO DO NEXT ONE
05A7 5F                               POP     DI
05A8 C3                               RET                             ; ZERO FLAG IS SET
05A9                          CMD_TIMEOUT:
05A9 C6 06 0074 R 20                  MOV     @DISK_STATUS1,BAD_CNTLR
05AE                          COMMAND4:
05AE 5B                               POP     BX
05AF 80 3E 0074 R 00                  CMP     @DISK_STATUS1,0         ; SET CONDITION CODE FOR CALLER
05B4 C3                               RET
05B5                          COMMAND ENDP
```

```
                                PAGE
                                ;----------------------------------------
                                ;       WAIT FOR INTERRUPT              :
                                ;----------------------------------------
05B5                            WAIT    PROC    NEAR
05B5 FB                                 STI                             ; MAKE SURE INTERRUPTS ARE ON
05B6 2B C9                              SUB     CX,CX                   ; SET INITIAL DELAY BEFORE TEST
05B8 F8                                 CLC
05B9 B8 9000                            MOV     AX,9000H                ; DEVICE WAIT INTERRUPT
05BC CD 15                              INT     15H
05BE 72 0F                              JC      WT2                     ; DEVICE TIMED OUT

05C0 B3 25                              MOV     BL,DELAY_1              ; SET DELAY COUNT

                                ;-----  WAIT LOOP

05C2 F6 06 008E R 80            WT1:    TEST    @HF_INT_FLAG,80H        ; TEST FOR INTERRUPT
05C7 E1 F9                              LOOPZ   WT1
05C9 75 0B                              JNZ     WT3                     ; INTERRUPT--LETS GO
05CB FE CB                              DEC     BL
05CD 75 F3                              JNZ     WT1                     ; KEEP TRYING FOR A WHILE

05CF C6 06 0074 R 80            WT2:    MOV     @DISK_STATUS1,TIME_OUT  ; REPORT TIME OUT ERROR
05D4 EB 0A                              JMP     SHORT WT4
05D6 C6 06 0074 R 00            WT3:    MOV     @DISK_STATUS1,0
05DB C6 06 008E R 00                    MOV     @HF_INT_FLAG,0
05E0 80 3E 0074 R 00            WT4:    CMP     @DISK_STATUS1,0         ; SET CONDITION CODE FOR CALLER
05E5 C3                                 RET
05E6                            WAIT    ENDP

                                ;----------------------------------------
                                ;       WAIT FOR CONTROLLER NOT BUSY    :
                                ;----------------------------------------
05E6                            NOT_BUSY        PROC    NEAR
05E6 FB                                 STI                             ; MAKE SURE INTERRUPTS ARE ON
05E7 53                                 PUSH    BX
05E8 B3 25                              MOV     BL,DELAY_1
05EA 2B C9                              SUB     CX,CX                   ; SET INITIAL DELAY BEFORE TEST
05EC BA 01F7                            MOV     DX,HF_PORT+7
05EF EC                         NB1:    IN      AL,DX                   ; CHECK STATUS
05F0 A8 80                              TEST    AL,ST_BUSY
05F2 E0 FB                              LOOPNZ  NB1
05F4 74 0B                              JZ      NB2                     ; NOT BUSY--LETS GO
05F6 FE CB                              DEC     BL
05F8 75 F5                              JNZ     NB1                     ; KEEP TRYING FOR A WHILE

05FA C6 06 0074 R 80                    MOV     @DISK_STATUS1,TIME_OUT  ; REPORT TIME OUT ERROR
05FF EB 05                              JMP     SHORT NB3
0601 C6 06 0074 R 00            NB2:    MOV     @DISK_STATUS1,0
0606 5B                         NB3:    POP     BX
0607 80 3E 0074 R 00                    CMP     @DISK_STATUS1,0         ; SET CONDITION CODE FOR CALLER
060C C3                                 RET
060D                            NOT_BUSY        ENDP

                                ;----------------------------------------
                                ;       WAIT FOR DATA REQUEST           :
                                ;----------------------------------------
060D                            WAIT_DRQ        PROC    NEAR
060D B9 0100                            MOV     CX,DELAY_3
0610 BA 01F7                            MOV     DX,HF_PORT+7
0613 EC                         WQ_1:   IN      AL,DX                   ; GET STATUS
0614 A8 08                              TEST    AL,ST_DRQ               ; WAIT FOR DRQ
0616 75 09                              JNZ     WQ_OK
0618 E2 F9                              LOOP    WQ_1                    ; KEEP TRYING FOR A SHORT WHILE
061A C6 06 0074 R 80                    MOV     @DISK_STATUS1,TIME_OUT  ; ERROR
061F F9                                 STC
0620 C3                                 RET
0621 F8                         WQ_OK:  CLC
0622 C3                                 RET
0623                            WAIT_DRQ        ENDP
                                ;----------------------------------------
                                ;       CHECK FIXED DISK STATUS         :
                                ;----------------------------------------
0623                            CHECK_STATUS    PROC    NEAR
0623 E8 0635 R                          CALL    CHECK_ST                ; CHECK THE STATUS BYTE
0626 75 07                              JNZ     CHECK_S1                ; AN ERROR WAS FOUND
0628 A8 01                              TEST    AL,ST_ERROR             ; WERE THERE ANY OTHER ERRORS
062A 74 03                              JZ      CHECK_S1                ; NO ERROR REPORTED
062C E8 0669 R                          CALL    CHECK_ER                ; ERROR REPORTED
062F                            CHECK_S1:
062F 80 3E 0074 R 00                    CMP     @DISK_STATUS1,0         ; SET STATUS FOR CALLER
0634 C3                                 RET
0635                            CHECK_STATUS    ENDP
                                ;----------------------------------------
                                ;       CHECK FIXED DISK STATUS BYTE    :
                                ;----------------------------------------
0635                            CHECK_ST        PROC    NEAR
0635 BA 01F7                            MOV     DX,HF_PORT+7            ; GET THE STATUS
0638 EC                                 IN      AL,DX
0639 A2 008C R                          MOV     @HF_STATUS,AL
063C B4 00                              MOV     AH,0
063E A8 80                              TEST    AL,ST_BUSY              ; IF STILL BUSY
0640 75 1A                              JNZ     CKST_EXIT               ;  REPORT OK
0642 B4 CC                              MOV     AH,WRITE_FAULT
0644 A8 20                              TEST    AL,ST_WRT_FLT           ; CHECK FOR WRITE FAULT
0646 75 14                              JNZ     CKST_EXIT
0648 B4 AA                              MOV     AH,NOT_RDY
064A A8 40                              TEST    AL,ST_READY             ; CHECK FOR NOT READY
064C 74 0E                              JZ      CKST_EXIT
064E B4 40                              MOV     AH,BAD_SEEK
0650 A8 10                              TEST    AL,ST_SEEK_COMPL        ; CHECK FOR SEEK NOT COMPLETE
0652 74 08                              JZ      CKST_EXIT
0654 B4 11                              MOV     AH,DATA_CORRECTED
0656 A8 04                              TEST    AL,ST_CORRCTD           ; CHECK FOR CORRECTED ECC
0658 75 02                              JNZ     CKST_EXIT
065A B4 00                              MOV     AH,0
065C                            CKST_EXIT:
065C 88 26 0074 R                       MOV     @DISK_STATUS1,AH        ; SET ERROR FLAG
0660 80 FC 11                           CMP     AH,DATA_CORRECTED       ; KEEP GOING WITH DATA CORRECTED
0663 74 03                              JZ      CKST_EX1
0665 80 FC 00                           CMP     AH,0
0668                            CKST_EX1:
0668 C3                                 RET
0669                            CHECK_ST        ENDP
```

SECTION 5

```
                                PAGE
                                ;---------------------------------------
                                ;       CHECK FIXED DISK ERROR REGISTER :
                                ;---------------------------------------
0669                            CHECK_ER        PROC    NEAR
0669 BA 01F1                            MOV     DX,HF_PORT+1            ; GET THE ERROR REGISTER
066C EC                                 IN      AL,DX
066D A2 008D R                          MOV     @HF_ERROR,AL
0670 53                                 PUSH    BX
0671 B9 0008                            MOV     CX,8                    ; TEST ALL 8 BITS
0674 D0 E0                      CK1:    SHL     AL,1                    ; MOVE NEXT ERROR BIT TO CARRY
0676 72 02                              JC      CK2                     ; FOUND THE ERROR
0678 E2 FA                              LOOP    CK1                     ; KEEP TRYING
067A BB 068B R                  CK2:    MOV     BX,OFFSET ERR_TBL       ; COMPUTE ADDRESS OF
067D 03 D9                              ADD     BX,CX                   ; ERROR CODE
067F 2E: 8A 27                          MOV     AH,BYTE PTR CS:[BX]     ; GET ERROR CODE
0682 88 26 0074 R               CKEX:   MOV     @DISK_STATUS1,AH        ; SAVE ERROR CODE
0686 5B                                 POP     BX
0687 80 FC 00                           CMP     AH,0
068A C3                                 RET
068B E0                         ERR_TBL DB      NO_ERR
068C 02 40 01 BB                        DB      BAD_ADDR_MARK,BAD_SEEK,BAD_CMD,UNDEF_ERR
0690 04 BB 10 0A                        DB      RECORD_NOT_FND,UNDEF_ERR,BAD_ECC,BAD_SECTOR
0694                            CHECK_ER        ENDP

                                ;-----------------------------------------------------
                                ; CHECK_DMA                                          :
                                ;  -CHECK ES:BX AND # SECTORS TO MAKE SURE THAT IT WILL :
                                ;   FIT WITHOUT SEGMENT OVERFLOW.                    :
                                ;  -ES:BX HAS BEEN REVISED TO THE FORMAT SSSS:000X   :
                                ;  -OK IF # SECTORS < 80H (7FH IF LONG READ OR WRITE) :
                                ;  -OK IF # SECTORS = 80H (7FH) AND BX <= 00H (04H)  :
                                ;  -ERROR OTHERWISE                                  :
                                ;-----------------------------------------------------
0694                            CHECK_DMA       PROC    NEAR
0694 50                                 PUSH    AX                      ; SAVE REGISTERS
0695 B8 8000                            MOV     AX,8000H                ; AH = MAX # SECTORS   AL = MAX OFFSET
0698 F6 46 FE 02                        TEST    @CMD_BLOCK+6,ECC_MODE
069C 74 03                              JZ      CKD1
069E B8 7F04                            MOV     AX,7F04H                ; ECC IS 4 MORE BYTES
06A1 3A 66 F9                   CKD1:   CMP     AH,@CMD_BLOCK+1         ; NUMBER OF SECTORS
06A4 77 06                              JA      CKDOK                   ; IT WILL FIT
06A6 72 07                              JB      CKDERR                  ; TOO MANY
06A8 3A C3                              CMP     AL,BL                   ; CHECK OFFSET ON MAX SECTORS
06AA 72 03                              JB      CKDERR                  ; ERROR
06AC F8                         CKDOK:  CLC                             ; CLEAR CARRY
06AD 58                                 POP     AX
06AE C3                                 RET                             ; NORMAL RETURN
06AF F9                         CKDERR: STC                             ; INDICATE ERROR
06B0 C6 06 0074 R 09                    MOV     @DISK_STATUS1,DMA_BOUNDARY
06B5 58                                 POP     AX
06B6 C3                                 RET
06B7                            CHECK_DMA       ENDP

                                ;---------------------------------------
                                ;       SET UP  ES:BX-> DISK PARMS      :
                                ;---------------------------------------
06B7                            GET_VEC PROC    NEAR
06B7 2B C0                              SUB     AX,AX                   ; GET DISK PARAMETER ADDRESS
06B9 8E C0                              MOV     ES,AX
                                        ASSUME  ES:ABS0
06BB F6 C2 01                           TEST    DL,1
06BE 74 07                              JZ      GV_0
06C0 26: C4 1E 0118 R                   LES     BX,@HF1_TBL_VEC         ; ES:BX -> DRIVE PARAMETERS
06C5 EB 05                              JMP     SHORT GV_EXIT
06C7                            GV_0:
06C7 26: C4 1E 0104 R                   LES     BX,@HF_TBL_VEC          ; ES:BX -> DRIVE PARAMETERS
06CC                            GV_EXIT:
06CC C3                                 RET
06CD                            GET_VEC ENDP

                                ;--- HARDWARE INT  76H -- ( IRQ LEVEL  14 ) ----------------------------------
                                ;                                                                           :
                                ;       FIXED DISK INTERRUPT ROUTINE                                        :
                                ;                                                                           :
                                ;----------------------------------------------------------------------------

06CD                            HD_INT  PROC    NEAR
06CD 50                                 PUSH    AX
06CE 1E                                 PUSH    DS
06CF E8 0000 E                          CALL    DDS
06D2 C6 06 008E R FF                    MOV     @HF_INT_FLAG,0FFH       ; ALL DONE
06D7 B0 20                              MOV     AL,EOI                  ; NON-SPECIFIC END OF INTERRUPT
06D9 E6 A0                              OUT     INTB00,AL               ; FOR CONTROLLER #2
06DB EB 00                              JMP     $+2                     ; WAIT
06DD E6 20                              OUT     INTA00,AL               ; FOR CONTROLLER #1
06DF 1F                                 POP     DS
06E0 FB                                 STI                             ; RE-ENABLE INTERRUPTS
06E1 B8 9100                            MOV     AX,9100H                ; DEVICE POST
06E4 CD 15                              INT     15H                     ;  INTERRUPT
06E6 58                                 POP     AX
06E7 CF                                 IRET                            ; RETURN FROM INTERRUPT

06E8                            HD_INT  ENDP

06E8 30 36 2F 31 30 2F                  DB      '06/10/85'              ; RELEASE MARKER
     38 35
06F0                            CODE    ENDS
                                        END
```

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                              PAGE 118,121
                              TITLE KYBD ----- 06/10/85  KEYBOARD BIOS
                              .LIST
 0000                         CODE      SEGMENT BYTE PUBLIC

                                        PUBLIC  K16
                                        PUBLIC  KEYBOARD_IO_1
                                        PUBLIC  KB_INT_1
                                        PUBLIC  SND_DATA

                                        EXTRN   BEEP:NEAR
                                        EXTRN   DDS:NEAR
                                        EXTRN   START_1:NEAR
                                        EXTRN   K10:BYTE
                                        EXTRN   K11:BYTE
                                        EXTRN   K12:BYTE
                                        EXTRN   K13:BYTE
                                        EXTRN   K14:BYTE
                                        EXTRN   K15:BYTE
                                        EXTRN   K6:BYTE
                                        EXTRN   K6L:ABS
                                        EXTRN   K7:BYTE
                                        EXTRN   K8:BYTE
                                        EXTRN   K9:BYTE

                              ;--- INT 16 H ------------------------------------------------------------------
                              ; KEYBOARD I/O                                                                 :
                              ;         THESE ROUTINES PROVIDE READ KEYBOARD SUPPORT                          :
                              ; INPUT                                                                        :
                              ;         (AH)= 00H  READ THE NEXT ASCII CHARACTER ENTERED FROM THE KEYBOARD,  :
                              ;                    RETURN THE RESULT IN (AL), SCAN CODE IN (AH).             :
                              ;         (AH)= 01H  SET THE ZERO FLAG TO INDICATE IF AN ASCII CHARACTER IS    :
                              ;                    AVAILABLE TO BE READ FROM THE KEYBOARD BUFFER.            :
                              ;                    (ZF)= 1 -- NO CODE AVAILABLE                              :
                              ;                    (ZF)= 0 -- CODE IS AVAILABLE  (AX)= CHARACTER             :
                              ;                    IF (ZF)= 0, THE NEXT CHARACTER IN THE BUFFER TO BE READ IS :
                              ;                    IN (AX), AND THE ENTRY REMAINS IN THE BUFFER.             :
                              ;         (AH)= 02H  RETURN THE CURRENT SHIFT STATUS IN (AL) REGISTER          :
                              ;                    THE BIT SETTINGS FOR THIS CODE ARE INDICATED IN THE       :
                              ;                    THE EQUATES FOR @KB_FLAG                                  :
                              ; OUTPUT                                                                       :
                              ;         AS NOTED ABOVE, ONLY (AX) AND FLAGS CHANGED                          :
                              ;         ALL REGISTERS RETAINED                                               :
                              ;-------------------------------------------------------------------------------
                                        ASSUME  CS:CODE,DS:DATA

 0000                         KEYBOARD_IO_1     PROC      FAR           ;>>> ENTRY POINT FOR ORG 0E82EH
 0000 FB                                STI                             ; INTERRUPTS BACK ON
 0001 1E                                PUSH    DS                      ; SAVE CURRENT DS
 0002 53                                PUSH    BX                      ; SAVE BX TEMPORARILY
 0003 E8 0000 E                         CALL    DDS                     ; ESTABLISH POINTER TO DATA REGION
 0006 0A E4                             OR      AH,AH                   ; CHECK FOR (AH)= 00H
 0008 74 0B                             JZ      K1B                     ; ASCII_READ
 000A FE CC                             DEC     AH                      ; CHECK FOR (AH)= 01H
 000C 74 45                             JZ      K2                      ; ASCII_STATUS
 000E FE CC                             DEC     AH                      ; CHECK FOR (AH)= 02H
 0010 74 67                             JZ      K3                      ; SHIFT_STATUS
 0012 5B                                POP     BX                      ; RECOVER REGISTER
 0013 1F                                POP     DS
 0014 CF                                IRET                            ; INVALID COMMAND EXIT

                              ;-----    READ THE KEY TO FIGURE OUT WHAT TO DO

 0015 8B 1E 001A R            K1B:      MOV     BX,@BUFFER_HEAD         ; GET POINTER TO HEAD OF BUFFER
 0019 3B 1E 001C R                      CMP     BX,@BUFFER_TAIL         ; TEST END OF BUFFER
 001D 75 07                             JNE     K1C                     ; IF ANYTHING IN BUFFER SKIP INTERRUPT

 001F B8 9002                           MOV     AX,09002H               ; MOVE IN WAIT CODE & TYPE
 0022 CD 15                             INT     15H                     ; PERFORM OTHER FUNCTION
 0024                         K1:                                       ; ASCII READ
 0024 FB                                STI                             ; INTERRUPTS BACK ON DURING LOOP
 0025 90                                NOP                             ; ALLOW AN INTERRUPT TO OCCUR
 0026 FA                      K1C:      CLI                             ; INTERRUPTS BACK OFF
 0027 8B 1E 001A R                      MOV     BX,@BUFFER_HEAD         ; GET POINTER TO HEAD OF BUFFER
 002B 3B 1E 001C R                      CMP     BX,@BUFFER_TAIL         ; TEST END OF BUFFER
 002F 53                                PUSH    BX                      ; SAVE ADDRESS
 0030 9C                                PUSHF                           ; SAVE FLAG
 0031 E8 0587 R                         CALL    MAKE_LED                ; GO GET MODE INDICATOR DATA BYTE
 0034 8A 1E 0097 R                      MOV     BL,@KB_FLAG_2           ; GET PREVIOUS BITS
 0038 32 D8                             XOR     BL,AL                   ; SEE IF ANY DIFFERENT
 003A 80 E3 07                          AND     BL,KB_LEDS              ; ISOLATE INDICATOR BITS
 003D 74 04                             JZ      K1A                     ; IF NO CHANGE BYPASS UPDATE

 003F E8 0549 R                         CALL    SND_LED1                ; GO TURN ON MODE INDICATORS
 0042 FA                                CLI                             ; DISABLE INTERRUPTS
 0043 9D                      K1A:      POPF                            ; RESTORE FLAGS
 0044 5B                                POP     BX                      ; RESTORE ADDRESS
 0045 74 DD                             JZ      K1                      ; LOOP UNTIL SOMETHING IN BUFFER

 0047 8B 07                             MOV     AX,[BX]                 ; GET SCAN CODE AND ASCII CODE
 0049 E8 007F R                         CALL    K4                      ; MOVE POINTER TO NEXT POSITION
 004C 89 1E 001A R                      MOV     @BUFFER_HEAD,BX         ; STORE VALUE IN VARIABLE

 0050 5B                                POP     BX                      ; RECOVER REGISTER
 0051 1F                                POP     DS                      ; RECOVER SEGMENT
 0052 CF                                IRET                            ; RETURN TO CALLER

                              ;-----    ASCII STATUS

 0053                         K2:
 0053 FA                                CLI                             ; INTERRUPTS OFF
 0054 8B 1E 001A R                      MOV     BX,@BUFFER_HEAD         ; GET HEAD POINTER
 0058 3B 1E 001C R                      CMP     BX,@BUFFER_TAIL         ; IF EQUAL (Z=1) THEN NOTHING THERE
 005C 8B 07                             MOV     AX,[BX]
 005E 9C                                PUSHF                           ; SAVE FLAGS
 005F 50                                PUSH    AX                      ; SAVE CODE
 0060 E8 0587 R                         CALL    MAKE_LED                ; GO GET MODE INDICATOR DATA BYTE
 0063 8A 1E 0097 R                      MOV     BL,@KB_FLAG_2           ; GET PREVIOUS BITS
 0067 32 D8                             XOR     BL,AL                   ; SEE IF ANY DIFFERENT
 0069 80 E3 07                          AND     BL,KB_LEDS              ; ISOLATE INDICATOR BITS
 006C 74 03                             JZ      SK2                     ; IF NO CHANGE BYPASS UPDATE

 006E E8 0549 R                         CALL    SND_LED1                ; GO TURN ON MODE INDICATORS
 0071 58                      SK2:      POP     AX                      ; RESTORE CODE
```

SECTION 5

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0072 9D                           POPF                          ; RESTORE FLAGS
0073 FB                           STI                           ; INTERRUPTS BACK ON
0074 5B                           POP     BX                    ; RECOVER REGISTER
0075 1F                           POP     DS                    ; RECOVER SEGMENT
0076 CA 0002                      RET     2                     ; THROW AWAY FLAGS

                          ;-----  SHIFT STATUS

0079                      K3:
0079 A0 0017 R                    MOV     AL,@KB_FLAG           ; GET THE SHIFT STATUS FLAGS
007C 5B                           POP     BX                    ; RECOVER REGISTER
007D 1F                           POP     DS                    ; RECOVER REGISTERS
007E CF                           IRET                          ; RETURN TO CALLER
007F                      KEYBOARD_IO_1   ENDP

                          ;-----  INCREMENT A BUFFER POINTER

007F                      K4      PROC    NEAR
007F 43                           INC     BX                    ; MOVE TO NEXT WORD IN LIST
0080 43                           INC     BX
0081 3B 1E 0082 R                 CMP     BX,@BUFFER_END        ; AT END OF BUFFER?
0085 75 04                        JNE     K5                    ; NO, CONTINUE
0087 8B 1E 0080 R                 MOV     BX,@BUFFER_START      ; YES, RESET TO BUFFER BEGINNING
008B                      K5:
008B C3                           RET
008C                      K4      ENDP

                          ;--- HARDWARE INT  09 H -- ( IRQ LEVEL  1 ) ----------------------------------
                          ;                                                                           :
                          ;       KEYBOARD INTERRUPT ROUTINE                                          :
                          ;                                                                           :
                          ;----------------------------------------------------------------------------

008C                      KB_INT_1 PROC   FAR
008C FB                           STI                           ; ENABLE INTERRUPTS
008D 55                           PUSH    BP
008E 50                           PUSH    AX
008F 53                           PUSH    BX
0090 51                           PUSH    CX
0091 52                           PUSH    DX
0092 56                           PUSH    SI
0093 57                           PUSH    DI
0094 1E                           PUSH    DS
0095 06                           PUSH    ES
0096 FC                           CLD                           ; FORWARD DIRECTION
0097 E8 0000 E                    CALL    DDS                   ; SET UP ADDRESSING

                          ;-----  WAIT FOR KEYBOARD DISABLE COMMAND TO BE ACCEPTED

009A B0 AD                        MOV     AL,DIS_KBD            ; DISABLE THE KEYBOARD COMMAND
009C E8 0595 R                    CALL    SHIP_IT               ; EXECUTE DISABLE
009F FA                           CLI                           ; DISABLE INTERRUPTS
00A0 2B C9                        SUB     CX,CX                 ; SET MAXIMUM TIMEOUT
00A2                      KB_INT_01:
00A2 E4 64                        IN      AL,STATUS_PORT        ; READ ADAPTER STATUS
00A4 A8 02                        TEST    AL,INPT_BUF_FULL      ; CHECK INPUT BUFFER FULL STATUS BIT
00A6 E0 FA                        LOOPNZ  KB_INT_01             ; WAIT FOR COMMAND TO BE ACCEPTED

                          ;-----  READ CHARACTER FROM KEYBOARD INTERFACE

00A8 E4 60                        IN      AL,PORT_A             ; READ IN THE CHARACTER

                          ;-----  SYSTEM HOOK  INT 15H - FUNCTION 4FH  (ON HARDWARE INTERRUPT LEVEL 9H)

00AA B4 4F                        MOV     AH,04FH               ; SYSTEM INTERCEPT - KEY CODE FUNCTION
00AC F9                           STC                           ; SET CY= 1 (IN CASE OF IRET)
00AD CD 15                        INT     15H                   ; CASSETTE CALL    (AL)= KEY SCAN CODE
                                                                ;  RETURNS CY= 1 FOR INVALID FUNCTION
00AF 72 03                        JC      KB_INT_02             ; CONTINUE IF CARRY FLAG SET ((AL)=CODE)

00B1 E9 02EE R                    JMP     K26                   ; EXIT IF SYSTEM HANDLED SCAN CODE
                                                                ;  EXIT HANDLES HARDWARE EOI AND ENABLE

                          ;-----  CHECK FOR A RESEND COMMAND TO KEYBOARD

00B4                      KB_INT_02:                            ;         (AL)= SCAN CODE
00B4 FB                           STI                           ; ENABLE INTERRUPTS AGAIN
00B5 3C FE                        CMP     AL,KB_RESEND          ; IS THE INPUT A RESEND
00B7 74 0D                        JE      KB_INT_4              ; GO IF RESEND

                          ;-----  CHECK FOR RESPONSE TO A COMMAND TO KEYBOARD

00B9 3C FA                        CMP     AL,KB_ACK             ; IS THE INPUT AN ACKNOWLEDGE
00BB 75 12                        JNZ     KB_INT_2              ; GO IF NOT

                          ;-----  A COMMAND TO THE KEYBOARD WAS ISSUED

00BD FA                           CLI                           ; DISABLE INTERRUPTS
00BE 80 0E 0097 R 10              OR      @KB_FLAG_2,KB_FA      ; INDICATE ACK RECEIVED
00C3 E9 02EE R                    JMP     K26                   ; RETURN IF NOT (ACK RETURNED FOR DATA)

                          ;-----  RESEND THE LAST BYTE

00C6                      KB_INT_4:
00C6 FA                           CLI                           ; DISABLE INTERRUPTS
00C7 80 0E 0097 R 20              OR      @KB_FLAG_2,KB_FE      ; INDICATE RESEND RECEIVED
00CC E9 02EE R                    JMP     K26                   ; RETURN IF NOT (ACK RETURNED FOR DATA)

00CF                      KB_INT_2:

                          ;-----  UPDATE MODE INDICATORS IF CHANGE IN STATE

00CF 50                           PUSH    AX                    ; SAVE DATA IN
00D0 E8 0587 R                    CALL    MAKE_LED              ; GO GET MODE INDICATOR DATA BYTE
00D3 8A 1E 0097 R                 MOV     BL,@KB_FLAG_2         ; GET PREVIOUS BITS
00D7 32 D8                        XOR     BL,AL                 ; SEE IF ANY DIFFERENT
00D9 80 E3 07                     AND     BL,KB_LEDS            ; ISOLATE INDICATOR BITS
00DC 74 03                        JZ      UP0                   ; IF NO CHANGE BYPASS UPDATE

00DE E8 0536 R                    CALL    SND_LED               ; GO TURN ON MODE INDICATORS
00E1 58                   UP0:    POP     AX                    ; RESTORE DATA IN
00E2 8A E0                        MOV     AH,AL                 ; SAVE SCAN CODE IN AH ALSO

                          ;-----  TEST FOR OVERRUN SCAN CODE FROM KEYBOARD
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0 0E4 3C FF                       CMP     AL,KB_OVER_RUN          ; IS THIS AN OVERRUN CHAR
00E6 75 0D                        JNZ     K16                     ; NO, TEST FOR SHIFT KEY
00E8 E9 04EB R                    JMP     K62                     ; BUFFER_FULL_BEEP

                           ;----- THIS CODE CONTAINS THE KBX SUPPORT FOR INT 09H

                           ;       EQUATES
= 00D9                     F11_M   EQU     217                     ; FUNC 11 MAKE
= 00D7                     F11_B   EQU     215                     ; FUNC 11 BREAK
= 00DA                     F12_M   EQU     218                     ; FUNC 12 MAKE
= 00D8                     F12_B   EQU     216                     ; FUNC 12 BREAK
= 0056                     K102_M  EQU     86                      ; KEY 102 MAKE
= 00D6                     K102_B  EQU     214                     ; KEY 102 BREAK

= 0052                     INS_M   EQU     82                      ; INSERT KEY MAKE
= 0053                     DEL_M   EQU     83                      ; DELETE KEY MAKE
= 004B                     LEFT_M  EQU     75                      ; CURSOR LEFT MAKE
= 004D                     RIGHT_M EQU     77                      ; CURSOR RIGHT MAKE
= 0048                     UP_M    EQU     72                      ; CURSOR UP MAKE
= 0050                     DN_M    EQU     80                      ; CURSOR DOWN MAKE
= 0049                     PGUP_M  EQU     73                      ; PG UP MAKE
= 0051                     PGDN_M  EQU     81                      ; PG DN MAKE
= 0047                     HOME_M  EQU     71                      ; HOME MAKE
= 004F                     END_M   EQU     79                      ; END MAKE

= 0085                     FUNC11  EQU     133                     ; FUNCTION 11 KEY
= 00E0                     HC      EQU     224                     ; HIDDEN CODE

                           ;----- TABLE OF KEYPAD CURSOR & CONTROL KEYS

00EB 48 50 52 53 4B 4D     K_TAB1  DB      UP_M,DN_M,INS_M,DEL_M,LEFT_M,RIGHT_M
00F1 49 51 47 4F                   DB      PGUP_M,PGDN_M,HOME_M,END_M
= 000A                     L_TAB1  EQU     $-K_TAB1

00F5                       K16:
00F5 24 7F                         AND     AL,07FH                 ; REMOVE BREAK BIT
00F7 0E                            PUSH    CS
00F8 07                            POP     ES                      ; ESTABLISH ADDRESS OF TABLES

00F9 F6 06 0096 R C0               TEST    @KB_FLAG_3,RD_ID+LC_AB  ; ARE WE DOING A READ ID?
00FE 74 33                         JZ      NOT_ID                  ; CONTINUE IF NOT
0100 79 11                         JNS     TST_ID_2                ; IS THE RD_ID FLAG ON?
0102 80 FC AB                      CMP     AH,ID_1                 ; IS THIS THE 1ST ID CHARACTER?
0105 75 05                         JNE     RST_RD_ID
0107 80 0E 0096 R 40               OR      @KB_FLAG_3,LC_AB        ; INDICATE 1ST ID WAS OK
010C                       RST_RD_ID:
010C 80 26 0096 R 7F               AND     @KB_FLAG_3,NOT RD_ID    ; RESET THE READ ID FLAG
0111 EB 4B                         JMP     SHORT DO_EXT

0113                       TST_ID_2:
0113 80 26 0096 R BF               AND     @KB_FLAG_3,NOT LC_AB    ; RESET FLAG
0118 80 FC 41                      CMP     AH,ID_2                 ; IS THIS THE 2ND ID CHARACTER?
011B 75 41                         JNE     DO_EXT                  ; LEAVE IF NOT

                           ;----- A READ ID SAID THAT IT WAS KBX

011D 80 0E 0096 R 01               OR      @KB_FLAG_3,KBX          ; INDICATE KBX WAS FOUND
0122 F6 06 0096 R 20               TEST    @KB_FLAG_3,SET_NUM_LK   ; SHOULD WE SET NUM LOCK?
0127 74 35                         JZ      DO_EXT                  ; EXIT IF NOT
0129 80 0E 0017 R 20               OR      @KB_FLAG,NUM_STATE      ; FORCE NUM LOCK ON
012E E8 0536 R                     CALL    SND_LED                 ; GO SET THE NUM LOCK INDICATOR
0131 EB 70                         JMP     SHORT EXIT
0133                       NOT_ID:
0133 F6 06 0096 R 02               TEST    @KB_FLAG_3,LC_HC        ; WAS THE LAST CHARACTER A HIDDEN CODE
0138 74 5F                         JZ      NOT_LC_HC               ; JUMP IF NOT

                           ;----- THE LAST CHARACTER WAS A HIDDEN CODE

013A 80 26 0096 R FD               AND     @KB_FLAG_3,NOT LC_HC    ; RESET LAST CHAR HIDDEN CODE FLAG
013F 3C 52                         CMP     AL,INS_M                ; WAS IT THE INSERT KEY?
0141 74 05                         JE      NOT_I
0143 F6 C4 80                      TEST    AH,80H                  ; IS THIS A BREAK CODE
0146 75 5B                         JNZ     EXIT                    ; IGNORE BREAK ON REST OF THESE KEYS
0148                       NOT_I:
0148 BF 00EB R                     MOV     DI,OFFSET K_TAB1        ; TEST FOR ONE OF THE KEYPAD CURSOR FUNC
014B B9 000A                       MOV     CX,L_TAB1               ;
014E F2/ AE                        REPNE   SCASB                   ; SCAN FOR THE KEY
0150 75 54                         JNE     NOT_CUR                 ; GO ON IF NOT FOUND
0152 F6 06 0018 R 08               TEST    @KB_FLAG_1,HOLD_STATE   ; ARE WE IN HOLD STATE?
0157 74 07                         JZ      N_HLD
0159 80 26 0018 R F7               AND     @KB_FLAG_1,NOT HOLD_STATE       ; EXIT HOLD STATE
015E                       DO_EXT:
015E EB 43                         JMP     SHORT EXIT              ; IGNORE THIS KEY
0160                       N_HLD:
0160 F6 06 0017 R 08               TEST    @KB_FLAG,ALT_SHIFT      ; IS ALT DOWN?
0165 74 0E                         JZ      NOT_ALT
0167 F6 06 0017 R 04               TEST    @KB_FLAG,CTL_SHIFT      ; HOW ABOUT CTRL?
016C 74 35                         JZ      EXIT                    ; IGNORE ALL IF ONLY ALT DOWN
016E 3C 53                         CMP     AL,DEL_M                ; WAS IT THE DELETE KEY?
0170 75 31                         JNE     EXIT                    ; IGNORE IF NOT
0172 E9 030D R                     JMP     K29                     ; GO DO THE CTL, ALT, DEL RESET

0175                       NOT_ALT:
0175 F6 06 0017 R 04               TEST    @KB_FLAG,CTL_SHIFT      ; IS CTL DOWN?
017A 75 15                         JNZ     CTL_ON                  ; SPECIAL CASE IF SO
017C 3C 52                         CMP     AL,INS_M                ; IS THIS THE INSERT KEY?
017E 75 0E                         JNE     N_INS

                           ;----- SPECIAL HANDLING FOR INSERT KEY

0180 8A C4                         MOV     AL,AH                   ; RECOVER SCAN CODE
0182 B4 80                         MOV     AH,INS_SHIFT            ; AH = MASK FOR INSERT
0184 A8 80                         TEST    AL,80H                  ; WAS THIS A BREAK CODE?
0186 75 03                         JNZ     B_C
0188 E9 028F R                     JMP     K22                     ; GO HANDLE INSERT SHIFT
018B                       B_C:
018B E9 02D2 R                     JMP     K24                     ; HANDLE BREAK
018E                       N_INS:
018E E9 0453 R                     JMP     K49                     ; HANDLE & IGNORE NUMLOCK
0191                       CTL_ON:
0191 80 F9 05                      CMP     CL,5                    ; WAS IT INS, DEL, UP OR DOWN?
0194 77 0D                         JA      EXIT                    ; IGNORE IF SO
0196 E9 0401 R                     JMP     K42                     ; GO HANDLE CTRL CASE
```

SECTION 5

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0199                          NOT_LC_HC:                                       ; LAST CHARACTER WAS NOT A HIDDEN CODE
0199 80 FC E0                         CMP     AH,HC                            ; IS THIS CHARACTER A HIDDEN CODE?
019C 75 08                            JNE     NOT_CUR
019E 80 0E 0096 R 03                  OR      @KB_FLAG_3,LC_HC+KBX             ; SET LAST CHAR WAS A HIDDEN CODE & KBX
01A3                          EXIT:
01A3 E9 02EE R                        JMP     K26                              ; THROW AWAY THIS CODE
01A6                          NOT_CUR:
01A6 80 FC D9                         CMP     AH,F11_M                         ; WAS IT F11?
01A9 75 04                            JNE     T_F12                            ; HANDLE IF SO
01AB B1 85                            MOV     CL,FUNC11                        ; SET BASE FUNCTION 11
01AD EB 07                            JMP     SHORT DO_FN
01AF                          T_F12:
01AF 80 FC DA                         CMP     AH,F12_M                         ; WAS IT F12?
01B2 75 43                            JNE     T_SYS_KEY                        ; GO TEST FOR SYSTEM KEY
01B4 B1 86                            MOV     CL,FUNC11+1                      ; SET BASE FUNCTION 12
01B6                          DO_FN:
01B6 80 FC D7                         CMP     AH,F11_B                         ; IS THIS A BREAK CODE
01B9 74 E8                            JE      EXIT                             ; IGNORE BREAK CODES
01BB 80 FC D8                         CMP     AH,F12_B                         ; IS THIS A BREAK CODE
01BE 74 E3                            JE      EXIT                             ; IGNORE BREAK CODES
01C0 F6 06 0018 R 08                  TEST    @KB_FLAG_1,HOLD_STATE            ; ARE WE IN HOLD STATE?
01C5 74 07                            JZ      N_HLD1
01C7 80 26 0018 R F7                  AND     @KB_FLAG_1,NOT HOLD_STATE                ; EXIT HOLD STATE
01CC EB D5                            JMP     SHORT EXIT                       ; IGNORE THIS KEY
01CE                          N_HLD1:
01CE 8A E1                            MOV     AH,CL
01D0 F6 06 0017 R 08                  TEST    @KB_FLAG,ALT_SHIFT               ; ARE WE IN ALT
01D5 74 05                            JZ      T_CTL
01D7 80 C4 06                         ADD     AH,6                             ; CNVT TO ALT FN 11-12
01DA EB 16                            JMP     SHORT SET_FN
01DC                          T_CTL:
01DC F6 06 0017 R 04                  TEST    @KB_FLAG,CTL_SHIFT               ; ARE WE IN CTRL
01E1 74 05                            JZ      T_SHF
01E3 80 C4 04                         ADD     AH,4                             ; CNVT TO CTRL FN 11-12
01E6 EB 0A                            JMP     SHORT SET_FN
01E8                          T_SHF:
01E8 F6 06 0017 R 03                  TEST    @KB_FLAG,LEFT_SHIFT+RIGHT_SHIFT ; IS EITHER SHIFT ON?
01ED 74 03                            JZ      SET_FN
01EF 80 C4 02                         ADD     AH,2                             ; CNVT TO SHIFT FN 11-12
01F2                          SET_FN:
01F2 2A C0                            SUB     AL,AL                            ; FORCE PSEUDO SCAN CODE
01F4 E9 04BA R                        JMP     K61                              ; PUT IT INTO BUFFER
                              ;-----  TEST FOR SYSTEM KEY
01F7                          T_SYS_KEY:
01F7 3C 54                            CMP     AL,SYS_KEY                       ; IS IT THE SYSTEM KEY?
01F9 75 3D                            JNZ     K16A                             ; CONTINUE IF NOT
01FB F6 C4 80                         TEST    AH,080H                          ; CHECK IF THIS A BREAK CODE
01FE 75 21                            JNZ     K16C                             ; DO NOT TOUCH SYSTEM INDICATOR IF TRUE
0200 F6 06 0018 R 04                  TEST    @KB_FLAG_1,SYS_SHIFT             ; SEE IF IN SYSTEM KEY HELD DOWN
0205 75 17                            JNZ     K16B                             ; IF YES, DON'T PROCESS SYSTEM INDICATOR
0207 80 0E 0018 R 04                  OR      @KB_FLAG_1,SYS_SHIFT             ; INDICATE SYSTEM KEY DEPRESSED
020C B0 20                            MOV     AL,EOI                           ; END OF INTERRUPT COMMAND
020E E6 20                            OUT     INTA00,AL                        ; SEND COMMAND TO INTERRUPT CONTROL PORT
                                                                               ; INTERRUPT-RETURN-NO-EOI
0210 B0 AE                            MOV     AL,ENA_KBD                       ; INSURE KEYBOARD IS ENABLED
0212 E8 0595 R                        CALL    SHIP_IT                          ; EXECUTE ENABLE
0215 B8 8500                          MOV     AX,08500H                        ; FUNCTION VALUE FOR MAKE OF SYSTEM KEY
0218 FB                               STI                                      ; MAKE SURE INTERRUPTS ENABLED
0219 CD 15                            INT     15H                              ; USER INTERRUPT
021B E9 02F8 R                        JMP     K27A                             ; END PROCESSING
021E                          K16B:
021E E9 02EE R                        JMP     K26                              ; IGNORE SYSTEM KEY
0221                          K16C:
0221 80 26 0018 R FB                  AND     @KB_FLAG_1,NOT SYS_SHIFT; TURN OFF SHIFT KEY HELD DOWN
0226 B0 20                            MOV     AL,EOI                           ; END OF INTERRUPT COMMAND
0228 E6 20                            OUT     INTA00,AL                        ; SEND COMMAND TO INTERRUPT CONTROL PORT
                                                                               ; INTERRUPT-RETURN-NO-EOI
022A B0 AE                            MOV     AL,ENA_KBD                       ; INSURE KEYBOARD IS ENABLED
022C E8 0595 R                        CALL    SHIP_IT                          ; EXECUTE ENABLE
022F B8 8501                          MOV     AX,08501H                        ; FUNCTION VALUE FOR BREAK OF SYSTEM KEY
0232 FB                               STI                                      ; MAKE SURE INTERRUPTS ENABLED
0233 CD 15                            INT     15H                              ; USER INTERRUPT
0235 E9 02F8 R                        JMP     K27A                             ; IGNORE SYSTEM KEY
0238                          K16A:
0238 BF 0000 E                        MOV     DI,OFFSET K6                     ; SHIFT KEY TABLE
023B B9 0000 E                        MOV     CX,OFFSET K6L                    ; LENGTH
023E F2/ AE                           REPNE   SCASB                            ; LOOK THROUGH THE TABLE FOR A MATCH
0240 8A C4                            MOV     AL,AH                            ; RECOVER SCAN CODE
0242 74 03                            JE      K17                              ; JUMP IF MATCH FOUND
0244 E9 02DA R                        JMP     K25                              ; IF NO MATCH, THEN SHIFT NOT FOUND
                              ;-----  SHIFT KEY FOUND
0247                          K17:
0247 81 EF 0001 E                     SUB     DI,OFFSET K6+1                   ; ADJUST PTR TO SCAN CODE MATCH
024B 2E: 8A A5 0000 E                 MOV     AH,CS:K7[DI]                     ; GET MASK INTO AH
0250 A8 80                            TEST    AL,80H                           ; TEST FOR BREAK KEY
0252 74 02                            JZ      K17C                             ; BREAK_SHIFT_FOUND
0254 EB 5D                            JMP     SHORT K23                        ; CONTINUE
                              ;-----  DETERMINE SET OR TOGGLE
0256                          K17C:
0256 80 FC 10                         CMP     AH,SCROLL_SHIFT
0259 73 07                            JAE     K18                              ; IF SCROLL SHIFT OR ABOVE, TOGGLE KEY
                              ;-----  PLAIN SHIFT KEY, SET SHIFT ON
025B 08 26 0017 R                     OR      @KB_FLAG,AH                      ; TURN ON SHIFT BIT
025F E9 02EE R                        JMP     K26                              ; INTERRUPT_RETURN
                              ;-----  TOGGLED SHIFT KEY, TEST FOR 1ST MAKE OR NOT
0262                          K18:                                             ; SHIFT-TOGGLE
0262 F6 06 0017 R 04                  TEST    @KB_FLAG, CTL_SHIFT              ; CHECK CTL SHIFT STATE
0267 75 71                            JNZ     K25                              ; JUMP IF CTL STATE
0269 3C 52                            CMP     AL, INS_KEY                      ; CHECK FOR INSERT KEY
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0268 75 22                         JNZ     K22                     ; JUMP IF NOT INSERT KEY
026D F6 06 0017 R 08               TEST    @KB_FLAG, ALT_SHIFT     ; CHECK FOR ALTERNATE SHIFT
0272 75 66                         JNZ     K25                     ; JUMP IF ALTERNATE SHIFT

0274 F6 06 0017 R 20               TEST    @KB_FLAG, NUM_STATE     ; CHECK FOR BASE STATE
0279 75 0D                         JNZ     K21                     ; JUMP IF NUM LOCK IS ON
027B F6 06 0017 R 03               TEST    @KB_FLAG, LEFT_SHIFT+ RIGHT_SHIFT
0280 74 0D                         JZ      K22                     ; JUMP IF BASE STATE

0282                       K20:                                    ; NUMERIC ZERO, NOT INSERT KEY
0282 B8 5230                       MOV     AX, 5230H               ; PUT OUT AN ASCII ZERO
0285 E9 048A R                     JMP     K57                     ; BUFFER_FILL
0288                       K21:                                    ; MIGHT BE NUMERIC
0288 F6 06 0017 R 03               TEST    @KB_FLAG, LEFT_SHIFT+ RIGHT_SHIFT
028D 74 F3                         JZ      K20                     ; JUMP NUMERIC, NOT INSERT

028F                       K22:                                    ; SHIFT TOGGLE KEY HIT; PROCESS IT
028F 84 26 0018 R                  TEST    AH,@KB_FLAG_1           ; IS KEY ALREADY DEPRESSED
0293 74 02                         JZ      K22A0                   ; GO IF NOT
0295 EB 57                         JMP     SHORT K26               ; JUMP IF KEY ALREADY DEPRESSED
0297                       K22A0:
0297 08 26 0018 R                  OR      @KB_FLAG_1,AH           ; INDICATE THAT THE KEY IS DEPRESSED
029B 30 26 0017 R                  XOR     @KB_FLAG,AH             ; TOGGLE THE SHIFT STATE

                           ;-----  TOGGLE LED IF CAPS OR NUM KEY DEPRESSED

029F F6 C4 70                      TEST    AH,CAPS_SHIFT+NUM_SHIFT+SCROLL_SHIFT ; SHIFT TOGGLE?
02A2 74 05                         JZ      K22B                    ; GO IF NOT

02A4 50                            PUSH    AX                      ; SAVE SCAN CODE AND SHIFT MASK
02A5 E8 0536 R                     CALL    SND_LED                 ; GO TURN MODE INDICATORS ON
02A8 58                            POP     AX                      ; RESTORE SCAN CODE
02A9                       K22B:
02A9 3C 52                         CMP     AL,INS_KEY              ; TEST FOR 1ST MAKE OF INSERT KEY
02AB 75 41                         JNE     K26                     ; JUMP IF NOT INSERT KEY
02AD B8 5200                       MOV     AX,INS_KEY*H            ; SET SCAN CODE INTO AH, 0 INTO AL
02B0 E9 048A R                     JMP     K57                     ; PUT INTO OUTPUT BUFFER

                           ;-----  BREAK SHIFT FOUND

02B3                       K23:                                    ; BREAK-SHIFT-FOUND
02B3 80 FC 10                      CMP     AH,SCROLL_SHIFT         ; IS THIS A TOGGLE KEY
02B6 73 1A                         JAE     K24                     ; YES, HANDLE BREAK TOGGLE
02B8 F6 D4                         NOT     AH                      ; INVERT MASK
02BA 20 26 0017 R                  AND     @KB_FLAG,AH             ; TURN OFF SHIFT BIT
02BE 3C B8                         CMP     AL,ALT_KEY+80H          ; IS THIS ALTERNATE SHIFT RELEASE
02C0 75 2C                         JNE     K26                     ; INTERRUPT_RETURN

                           ;-----  ALTERNATE SHIFT KEY RELEASED, GET THE VALUE INTO BUFFER

02C2 A0 0019 R                     MOV     AL,@ALT_INPUT
02C5 B4 00                         MOV     AH,0                    ; SCAN CODE OF 0
02C7 88 26 0019 R                  MOV     @ALT_INPUT,AH           ; ZERO OUT THE FIELD
02CB 3C 00                         CMP     AL,0                    ; WAS THE INPUT=0
02CD 74 1F                         JE      K26                     ; INTERRUPT_RETURN
02CF E9 0493 R                     JMP     K58                     ; IT WASN'T, SO PUT IN BUFFER

02D2                       K24:                                    ; BREAK-TOGGLE
02D2 F6 D4                         NOT     AH                      ; INVERT MASK
02D4 20 26 0018 R                  AND     @KB_FLAG_1,AH           ; INDICATE NO LONGER DEPRESSED
02D8 EB 14                         JMP     SHORT K26               ; INTERRUPT_RETURN

                           ;-----  TEST FOR HOLD STATE

02DA                       K25:                                    ; NO-SHIFT-FOUND
02DA 3C 80                         CMP     AL,80H                  ; TEST FOR BREAK KEY
02DC 73 10                         JAE     K26                     ; NOTHING FOR BREAK CHARS FROM HERE ON
02DE F6 06 0018 R 08               TEST    @KB_FLAG_1,HOLD_STATE   ; ARE WE IN HOLD STATE
02E3 74 1E                         JZ      K28                     ; BRANCH AROUND TEST IF NOT
02E5 3C 45                         CMP     AL,NUM_KEY
02E7 74 05                         JE      K26                     ; CAN'T END HOLD ON NUM_LOCK
02E9 80 26 0018 R F7               AND     @KB_FLAG_1,NOT HOLD_STATE        ; TURN OFF THE HOLD STATE BIT

02EE                       K26:                                    ; INTERRUPT-RETURN
02EE FA                            CLI                             ; TURN OFF INTERRUPTS
02EF B0 20                         MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
02F1 E6 20                         OUT     INTA00,AL               ; SEND COMMAND TO INTERRUPT CONTROL PORT
02F3                       K27:                                    ; INTERRUPT-RETURN-NO-EOI
02F3 B0 AE                         MOV     AL,ENA_KBD              ; INSURE KEYBOARD IS ENABLED
02F5 E8 0595 R                     CALL    SHIP_IT                 ; EXECUTE ENABLE
02F8                       K27A:
02F8 FA                            CLI                             ; DISABLE INTERRUPTS
02F9 07                            POP     ES                      ; RESTORE REGISTERS
02FA 1F                            POP     DS
02FB 5F                            POP     DI
02FC 5E                            POP     SI
02FD 5A                            POP     DX
02FE 59                            POP     CX
02FF 5B                            POP     BX
0300 58                            POP     AX
0301 5D                            POP     BP
0302 CF                            IRET                            ; RETURN, INTERRUPTS ON WITH FLAG CHANGE

                           ;-----  NOT IN  HOLD STATE

0303                       K28:                                    ; NO-HOLD-STATE
0303 F6 06 0017 R 08               TEST    @KB_FLAG,ALT_SHIFT      ; ARE WE IN ALTERNATE SHIFT
0308 75 03                         JNZ     K29                     ; JUMP IF ALTERNATE SHIFT
030A E9 03A5 R                     JMP     K38                     ; JUMP IF NOT ALTERNATE

                           ;-----  TEST FOR CONTROL KEY AND RESET KEY SEQUENCE (CTL ALT DEL)

030D                       K29:                                    ; TEST-RESET
030D F6 06 0017 R 04               TEST    @KB_FLAG,CTL_SHIFT      ; ARE WE IN CONTROL SHIFT ALSO
0312 74 39                         JZ      K31                     ; NO_RESET
0314 3C 45                         CMP     AL,NUM_KEY              ; CHECK FOR INVALID NUM_LOCK KEY
0316 74 D6                         JE      K26                     ; THROW AWAY IF (ALT-CTL)+NUM_LOCK
0318 3C 46                         CMP     AL,SCROLL_KEY           ; CHECK FOR INVALID SCROLL_LOCK KEY
031A 74 D2                         JE      K26                     ; THROW AWAY IF (ALT-CTL)+SCROLL_LOCK
031C 3C 53                         CMP     AL,DEL_KEY              ; CTL-ALT STATE, TEST FOR DELETE KEY
031E 75 2D                         JNE     K31                     ; NO_RESET

                           ;-----  CTL-ALT-DEL HAS BEEN FOUND
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SECTION 5

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0320 C7 06 0072 R 1234              MOV     @RESET_FLAG,1234H       ; SET FLAG FOR RESET FUNCTION
0326 E9 0000 E                      JMP     START_1                 ; JUMP TO POWER ON DIAGNOSTICS

                            ;-----  ALT-INPUT-TABLE
0329                        K30     LABEL   BYTE
0329 52 4F 50 51 4B 4C              DB      82,79,80,81,75,76
032F 4D 47 48 49                    DB      77,71,72,73             ; 10 NUMBERS ON KEYPAD
                            ;-----  SUPER-SHIFT-TABLE
0333 10 11 12 13 14 15              DB      16,17,18,19,20,21       ; A-Z TYPEWRITER CHARS
0339 16 17 18 19 1E 1F              DB      22,23,24,25,30,31
033F 20 21 22 23 24 25              DB      32,33,34,35,36,37
0345 26 2C 2D 2E 2F 30              DB      38,44,45,46,47,48
034B 31 32                          DB      49,50

                            ;-----  IN ALTERNATE SHIFT, RESET NOT FOUND

034D                        K31:                                    ; NO-RESET
034D 3C 39                          CMP     AL,57                   ; TEST FOR SPACE KEY
034F 75 05                          JNE     K32                     ; NOT THERE
0351 B0 20                          MOV     AL,' '                  ; SET SPACE CHAR
0353 E9 048A R                      JMP     K57                     ; BUFFER_FILL

                            ;-----  LOOK FOR KEY PAD ENTRY

0356                        K32:                                    ; ALT-KEY-PAD
0356 BF 0329 R                      MOV     DI,OFFSET K30           ; ALT-INPUT-TABLE
0359 B9 000A                        MOV     CX,10                   ; LOOK FOR ENTRY USING KEYPAD
035C F2/ AE                         REPNE   SCASB                   ; LOOK FOR MATCH
035E 75 13                          JNE     K33                     ; NO_ALT_KEYPAD
0360 81 EF 032A R                   SUB     DI,OFFSET K30+1         ; DI NOW HAS ENTRY VALUE
0364 A0 0019 R                      MOV     AL,@ALT_INPUT           ; GET THE CURRENT BYTE
0367 B4 0A                          MOV     AH,10                   ; MULTIPLY BY 10
0369 F6 E4                          MUL     AH
036B 03 C7                          ADD     AX,DI                   ; ADD IN THE LATEST ENTRY
036D A2 0019 R                      MOV     @ALT_INPUT,AL           ; STORE IT AWAY
0370 E9 02EE R                      JMP     K26                     ; THROW AWAY THAT KEYSTROKE

                            ;-----  LOOK FOR SUPERSHIFT ENTRY

0373                        K33:                                    ; NO-ALT-KEYPAD
0373 C6 06 0019 R 00                MOV     @ALT_INPUT,0            ; ZERO ANY PREVIOUS ENTRY INTO INPUT
0378 B9 001A                        MOV     CX,26                   ; (DI),(ES) ALREADY POINTING
037B F2/ AE                         REPNE   SCASB                   ; LOOK FOR MATCH IN ALPHABET
037D 75 05                          JNE     K34                     ; NOT FOUND, FUNCTION KEY OR OTHER
037F B0 00                          MOV     AL,0                    ; ASCII CODE OF ZERO
0381 E9 048A R                      JMP     K57                     ; PUT IT IN THE BUFFER

                            ;-----  LOOK FOR TOP ROW OF ALTERNATE SHIFT

0384                        K34:                                    ; ALT-TOP-ROW
0384 3C 02                          CMP     AL,2                    ; KEY WITH '1' ON IT
0386 72 0C                          JB      K35                     ;  NOT ONE OF INTERESTING KEYS
0388 3C 0E                          CMP     AL,14                   ;  IS IT IN THE REGION
038A 73 08                          JAE     K35                     ;  ALT-FUNCTION
038C 80 C4 76                       ADD     AH,118                  ;  CONVERT PSEUDO SCAN CODE TO RANGE
038F B0 00                          MOV     AL,0                    ;  INDICATE AS SUCH
0391 E9 048A R                      JMP     K57                     ;  BUFFER_FILL

                            ;-----  TRANSLATE ALTERNATE SHIFT PSEUDO SCAN CODES

0394                        K35:                                    ; ALT-FUNCTION
0394 3C 3B                          CMP     AL,59                   ; TEST FOR IN TABLE
0396 73 03                          JAE     K37                     ; ALT-CONTINUE
0398                        K36:                                    ; CLOSE-RETURN
0398 E9 02EE R                      JMP     K26                     ; IGNORE THE KEY
039B                        K37:                                    ; ALT-CONTINUE
039B 3C 47                          CMP     AL,71                   ; IN KEYPAD REGION
039D 73 F9                          JAE     K36                     ; IF SO, IGNORE
039F BB 0000 E                      MOV     BX,OFFSET K13           ; ALT SHIFT PSEUDO SCAN TABLE
03A2 E9 04E1 R                      JMP     K63                     ; TRANSLATE THAT

                            ;-----  NOT IN ALTERNATE SHIFT

03A5                        K38:                                    ; NOT-ALT-SHIFT
03A5 F6 06 0017 R 04                TEST    @KB_FLAG,CTL_SHIFT      ; ARE WE IN CONTROL SHIFT
03AA 74 62                          JZ      K44                     ; NOT-CTL-SHIFT

                            ;-----  CONTROL SHIFT, TEST SPECIAL CHARACTERS
                            ;-----  TEST FOR BREAK AND PAUSE KEYS

03AC 3C 46                          CMP     AL,SCROLL_KEY           ; TEST FOR BREAK
03AE 75 1D                          JNE     K39                     ; NO-BREAK
03B0 8B 1E 0080 R                   MOV     BX,@BUFFER_START        ; RESET BUFFER TO EMPTY
03B4 89 1E 001A R                   MOV     @BUFFER_HEAD,BX
03B8 89 1E 001C R                   MOV     @BUFFER_TAIL,BX
03BC C6 06 0071 R 80                MOV     @BIOS_BREAK,80H         ; TURN ON @BIOS_BREAK BIT

                            ;-----  ENABLE KEYBOARD

03C1 B0 AE                          MOV     AL,ENA_KBD              ; ENABLE KEYBOARD
03C3 E8 0595 R                      CALL    SHIP_IT                 ; EXECUTE ENABLE
03C6 CD 1B                          INT     1BH                     ; BREAK INTERRUPT VECTOR
03C8 2B C0                          SUB     AX,AX                   ; PUT OUT DUMMY CHARACTER
03CA E9 048A R                      JMP     K57                     ; BUFFER_FILL

03CD                        K39:                                    ; NO-BREAK
03CD 3C 45                          CMP     AL,NUM_KEY              ; LOOK FOR PAUSE KEY
03CF 75 26                          JNE     K41                     ; NO-PAUSE
03D1 80 0E 0018 R 08                OR      @KB_FLAG_1,HOLD_STATE   ; TURN ON THE HOLD FLAG

                            ;-----  ENABLE KEYBOARD

03D6 B0 AE                          MOV     AL,ENA_KBD              ; ENABLE KEYBOARD
03D8 E8 0595 R                      CALL    SHIP_IT                 ; EXECUTE ENABLE
03DB B0 20                          MOV     AL,EOI                  ; END OF INTERRUPT TO CONTROL PORT
03DD E6 20                          OUT     INTA00,AL               ; ALLOW FURTHER KEYSTROKE INTERRUPTS

                            ;-----  DURING PAUSE INTERVAL, TURN COLOR CRT BACK ON

03DF 80 3E 0049 R 07                CMP     @CRT_MODE,7             ; IS THIS THE MONOCHROME CARD
03E4 74 07                          JE      K40                     ; YES, NOTHING TO DO
03E6 BA 03D8                        MOV     DX,03D8H                ; PORT FOR COLOR CARD
03E9 A0 0065 R                      MOV     AL,@CRT_MODE_SET        ; GET THE VALUE OF THE CURRENT MODE
03EC EE                             OUT     DX,AL                   ; SET THE CRT MODE, SO THAT CRT IS ON
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                              ;-----  SUSPEND SYSTEM OPERATION (LOOP) TILL NEXT KEY CLEARS HOLD STATE FLAG

 03ED                         K40:                                      ; PAUSE-LOOP
 03ED F6 06 0018 R 08                 TEST    @KB_FLAG_1,HOLD_STATE     ; CHECK HOLD STATE FLAG
 03F2 75 F9                           JNZ     K40                       ; LOOP UNTIL FLAG TURNED OFF

 03F4 E9 02F8 R                       JMP     K27A                      ; INTERRUPT_RETURN_NO_EOI

                              ;-----  TEST SPECIAL CASE KEY 55

 03F7                         K41:                                      ; NO-PAUSE
 03F7 3C 37                           CMP     AL,55
 03F9 75 06                           JNE     K42                       ; NOT-KEY-55
 03FB B8 7200                         MOV     AX,114*H                  ; START/STOP PRINTING SWITCH
 03FE E9 048A R                       JMP     K57                       ; BUFFER_FILL

                              ;-----  SET UP TO TRANSLATE CONTROL SHIFT

 0401                         K42:                                      ; NOT-KEY-55
 0401 BB 0000 E                       MOV     BX,OFFSET K8              ; SET UP TO TRANSLATE CTL
 0404 3C 3B                           CMP     AL,59                     ; IS IT IN TABLE
 0406 72 7E                           JB      K56                       ; YES, GO TRANSLATE CHAR
                                                                        ; CTL-TABLE-TRANSLATE
 0408 BB 0000 E                       MOV     BX,OFFSET K9              ; CTL TABLE SCAN
 040B E9 04E1 R                       JMP     K63                       ; TRANSLATE_SCAN

                              ;-----  NOT IN CONTROL SHIFT

 040E                         K44:                                      ; NOT-CTL-SHIFT
 040E 3C 47                           CMP     AL,71                     ; TEST FOR KEYPAD REGION
 0410 73 33                           JAE     K48                       ; HANDLE KEYPAD REGION
 0412 F6 06 0017 R 03                 TEST    @KB_FLAG,LEFT_SHIFT+RIGHT_SHIFT
 0417 74 62                           JZ      K54                       ; TEST FOR SHIFT STATE

                              ;-----  UPPER CASE, HANDLE SPECIAL CASES

 0419 3C 0F                           CMP     AL,15                     ; BACK TAB KEY
 041B 75 05                           JNE     K45                       ; NOT-BACK-TAB
 041D B8 0F00                         MOV     AX,15*H                   ; SET PSEUDO SCAN CODE
 0420 EB 68                           JMP     SHORT K57                 ; BUFFER_FILL

 0422                         K45:                                      ; NOT-BACK-TAB
 0422 3C 37                           CMP     AL,55                     ; PRINT SCREEN KEY
 0424 75 10                           JNE     K46                       ; NOT-PRINT-SCREEN

                              ;-----  ISSUE INTERRUPT TO INDICATE PRINT SCREEN FUNCTION

 0426 B0 AE                           MOV     AL,ENA_KBD                ; INSURE KEYBOARD IS ENABLED
 0428 E8 0595 R                       CALL    SHIP_IT                   ; EXECUTE ENABLE
 042B B0 20                           MOV     AL,EOI                    ; END OF CURRENT INTERRUPT
 042D E6 20                           OUT     INTA00,AL                 ;  SO FURTHER THINGS CAN HAPPEN
 042F 55                              PUSH    BP                        ; SAVE POINTER
 0430 CD 05                           INT     05H                       ; ISSUE PRINT SCREEN INTERRUPT
 0432 5D                              POP     BP                        ; RESTORE POINTER
 0433 E9 02F3 R                       JMP     K27                       ; GO BACK WITHOUT EOI OCCURRING

 0436                         K46:                                      ; NOT-PRINT-SCREEN
 0436 3C 3B                           CMP     AL,59                     ; FUNCTION KEYS
 0438 72 06                           JB      K47                       ; NOT-UPPER-FUNCTION
 043A BB 0000 E                       MOV     BX,OFFSET K12             ; UPPER CASE PSEUDO SCAN CODES
 043D E9 04E1 R                       JMP     K63                       ; TRANSLATE_SCAN

 0440                         K47:                                      ; NOT-UPPER-FUNCTION
 0440 BB 0000 E                       MOV     BX,OFFSET K11             ; POINT TO UPPER CASE TABLE
 0443 EB 41                           JMP     SHORT K56                 ; OK, TRANSLATE THE CHAR

                              ;-----  KEYPAD KEYS, MUST TEST NUM LOCK FOR DETERMINATION

 0445                         K48:                                      ; KEYPAD-REGION
 0445 F6 06 0017 R 20                 TEST    @KB_FLAG,NUM_STATE        ; ARE WE IN NUM_LOCK
 044A 75 21                           JNZ     K52                       ; TEST FOR SURE
 044C F6 06 0017 R 03                 TEST    @KB_FLAG,LEFT_SHIFT+RIGHT_SHIFT ; ARE WE IN SHIFT STATE
 0451 75 21                           JNZ     K53                       ; IF SHIFTED, REALLY NUM STATE

                              ;-----  BASE CASE FOR KEYPAD

 0453                         K49:                                      ; BASE-CASE

 0453 3C 4A                           CMP     AL,74                     ; SPECIAL CASE FOR A COUPLE OF KEYS
 0455 74 0C                           JE      K50                       ; MINUS
 0457 3C 4E                           CMP     AL,78
 0459 74 0D                           JE      K51
 045B 2C 47                           SUB     AL,71                     ; CONVERT ORIGIN
 045D BB 0000 E                       MOV     BX,OFFSET K15             ; BASE CASE TABLE
 0460 E9 04E3 R                       JMP     K64                       ; CONVERT TO PSEUDO SCAN
 0463                         K50:
 0463 B8 4A2D                         MOV     AX,74*H+'-'               ; MINUS
 0466 EB 22                           JMP     SHORT K57                 ; BUFFER_FILL
 0468                         K51:
 0468 B8 4E2B                         MOV     AX,78*H+'+'               ; PLUS
 046B EB 1D                           JMP     SHORT K57                 ; BUFFER_FILL

                              ;-----  MIGHT BE NUM LOCK, TEST SHIFT STATUS

 046D                         K52:                                      ; ALMOST-NUM-STATE
 046D F6 06 0017 R 03                 TEST    @KB_FLAG,LEFT_SHIFT+RIGHT_SHIFT
 0472 75 DF                           JNZ     K49                       ; SHIFTED TEMP OUT OF NUM STATE

 0474                         K53:                                      ; REALLY_NUM_STATE
 0474 2C 46                           SUB     AL,70                     ; CONVERT ORIGIN
 0476 BB 0000 E                       MOV     BX,OFFSET K14             ; NUM STATE TABLE
 0479 EB 0B                           JMP     SHORT K56                 ; TRANSLATE_CHAR

                              ;-----  PLAIN OLD LOWER CASE

 047B                         K54:                                      ; NOT-SHIFT
 047B 3C 3B                           CMP     AL,59                     ; TEST FOR FUNCTION KEYS
 047D 72 04                           JB      K55                       ; NOT-LOWER-FUNCTION
 047F B0 00                           MOV     AL,0                      ; SCAN CODE IN AH ALREADY
 0481 EB 07                           JMP     SHORT K57                 ; BUFFER_FILL

 0483                         K55:                                      ; NOT-LOWER-FUNCTION
 0483 BB 0000 E                       MOV     BX,OFFSET K10             ; LC TABLE
```

SECTION 5

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                                ;-----  TRANSLATE THE CHARACTER
0486                            K56:                                    ; TRANSLATE-CHAR
0486 FE C8                              DEC     AL                      ; CONVERT ORIGIN
0488 2E: D7                             XLAT    CS:K11                  ; CONVERT THE SCAN CODE TO ASCII
                                ;-----  PUT CHARACTER INTO BUFFER
048A                            K57:                                    ; BUFFER-FILL
048A 3C FF                              CMP     AL,-1                   ; IS THIS AN IGNORE CHAR
048C 74 1F                              JE      K59                     ; YES, DO NOTHING WITH IT
048E 80 FC FF                           CMP     AH,-1                   ; LOOK FOR -1 PSEUDO SCAN
0491 74 1A                              JE      K59                     ; NEAR_INTERRUPT_RETURN
                                ;-----  HANDLE THE CAPS LOCK PROBLEM
0493                            K58:                                    ; BUFFER-FILL-NOTEST
0493 F6 06 0017 R 40                    TEST    @KB_FLAG,CAPS_STATE     ; ARE WE IN CAPS LOCK STATE
0498 74 20                              JZ      K61                     ; SKIP IF NOT
                                ;-----  IN CAPS LOCK STATE
049A F6 06 0017 R 03                    TEST    @KB_FLAG,LEFT_SHIFT+RIGHT_SHIFT ; TEST FOR SHIFT STATE
049F 74 0F                              JZ      K60                     ; IF NOT SHIFT, CONVERT LOWER TO UPPER
                                ;-----  CONVERT ANY UPPER CASE TO LOWER CASE
04A1 3C 41                              CMP     AL,'A'                  ; FIND OUT IF ALPHABETIC
04A3 72 15                              JB      K61                     ; NOT_CAPS_STATE
04A5 3C 5A                              CMP     AL,'Z'
04A7 77 11                              JA      K61                     ; NOT_CAPS_STATE
04A9 04 20                              ADD     AL,'a'-'A'              ; CONVERT TO LOWER CASE
04AB EB 0D                              JMP     SHORT K61               ; NOT_CAPS_STATE
04AD                            K59:                                    ; NEAR-INTERRUPT-RETURN
04AD E9 02EE R                          JMP     K26                     ; INTERRUPT_RETURN
                                ;-----  CONVERT ANY LOWER CASE TO UPPER CASE
04B0                            K60:                                    ; LOWER-TO-UPPER
04B0 3C 61                              CMP     AL,'a'                  ; FIND OUT IF ALPHABETIC
04B2 72 06                              JB      K61                     ; NOT_CAPS_STATE
04B4 3C 7A                              CMP     AL,'z'
04B6 77 02                              JA      K61                     ; NOT_CAPS_STATE
04B8 2C 20                              SUB     AL,'a'-'A'              ; CONVERT TO UPPER CASE
04BA                            K61:                                    ; NOT-CAPS-STATE
04BA 8B 1E 001C R                       MOV     BX,@BUFFER_TAIL         ; GET THE END POINTER TO THE BUFFER
04BE 8B F3                              MOV     SI,BX                   ; SAVE THE VALUE
04C0 E8 007F R                          CALL    K4                      ; ADVANCE THE TAIL
04C3 3B 1E 001A R                       CMP     BX,@BUFFER_HEAD         ; HAS THE BUFFER WRAPPED AROUND
04C7 74 22                              JE      K62                     ; BUFFER_FULL_BEEP
04C9 89 04                              MOV     [SI],AX                 ; STORE THE VALUE
04CB 89 1E 001C R                       MOV     @BUFFER_TAIL,BX         ; MOVE THE POINTER UP
04CF FA                                 CLI                             ; TURN OFF INTERRUPTS
04D0 B0 20                              MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
04D2 E6 20                              OUT     INTA00,AL               ; SEND COMMAND TO INTERRUPT CONTROL PORT
04D4 B0 AE                              MOV     AL,ENA_KBD              ; INSURE KEYBOARD IS ENABLED
04D6 E8 0595 R                          CALL    SHIP_IT                 ; EXECUTE ENABLE
04D9 B8 9102                            MOV     AX,09102H               ; MOVE IN POST CODE & TYPE
04DC CD 15                              INT     15H                     ; PERFORM OTHER FUNCTION
04DE E9 02F8 R                          JMP     K27A                    ; INTERRUPT_RETURN

                                ;-----  TRANSLATE SCAN FOR PSEUDO SCAN CODES
04E1                            K63:                                    ; TRANSLATE-SCAN
04E1 2C 3B                              SUB     AL,59                   ; CONVERT ORIGIN TO FUNCTION KEYS
04E3                            K64:                                    ; TRANSLATE-SCAN-ORGD
04E3 2E: D7                             XLAT    CS:K9                   ; CTL TABLE SCAN
04E5 8A E0                              MOV     AH,AL                   ; PUT VALUE INTO AH
04E7 B0 00                              MOV     AL,0                    ; ZERO ASCII CODE
04E9 EB 9F                              JMP     K57                     ; PUT IT INTO THE BUFFER
04EB                            KB_INT_1        ENDP
04EB                            K62:
04EB B0 20                              MOV     AL,EOI                  ; ENABLE INTERRUPT CONTROLLER CHIP
04ED E6 20                              OUT     INTA00,AL               ;
04EF B9 02A6                            MOV     CX,678                  ; DIVISOR FOR 1760 HZ
04F2 B3 04                              MOV     BL,4                    ; SHORT BEEP COUNT (1/16 + 1/64 DELAY)
04F4 E8 0000 E                          CALL    BEEP                    ; GO TO COMMON BEEP HANDLER
04F7 E9 02F3 R                          JMP     K27                     ; EXIT

                                ;---------------------------------------------------------------------
                                ;  SND_DATA                                                          :
                                ;                                                                    :
                                ;       THIS ROUTINES HANDLES TRANSMISSION OF COMMAND AND DATA BYTES :
                                ;       TO THE KEYBOARD AND RECEIPT OF ACKNOWLEDGEMENTS.  IT ALSO    :
                                ;       HANDLES ANY RETRIES IF REQUIRED                              :
                                ;                                                                    :
                                ;---------------------------------------------------------------------
04FA                            SND_DATA PROC   NEAR
04FA 50                                 PUSH    AX                      ; SAVE REGISTERS
04FB 53                                 PUSH    BX
04FC 51                                 PUSH    CX
04FD 8A F8                              MOV     BH,AL                   ; SAVE TRANSMITTED BYTE FOR RETRIES
04FF B3 03                              MOV     BL,3                    ; LOAD RETRY COUNT
0501                            SD0:
0501 FA                                 CLI                             ; DISABLE INTERRUPTS
0502 80 26 0097 R CF                    AND     @KB_FLAG_2,NOT (KB_FE+KB_FA) ; CLEAR ACK AND RESEND FLAGS
                                ;-----  WAIT FOR ANY PENDING COMMAND TO BE ACCEPTED
0507 2B C9                              SUB     CX,CX                   ; MAXIMUM WAIT COUNT
0509                            SD1:
0509 E4 64                              IN      AL,STATUS_PORT          ; READ KEYBOARD PROCESSOR STATUS PORT
050B A8 02                              TEST    AL,INPT_BUF_FULL        ; CHECK FOR ANY PENDING COMMAND
050D E0 FA                              LOOPNZ  SD1                     ; WAIT FOR COMMAND TO BE ACCEPTED
050F 8A C7                              MOV     AL,BH                   ; REESTABLISH BYTE TO TRANSMIT
0511 E6 60                              OUT     PORT_A,AL               ; SEND BYTE
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0513 FB                          STI                             ; ENABLE INTERRUPTS
0514 B9 1A00                     MOV     CX,01A00H               ; LOAD COUNT FOR 10 ms+
0517                     SD3:
0517 F6 06 0097 R 30             TEST    @KB_FLAG_2,KB_FE+KB_FA  ; SEE IF EITHER BIT SET
051C 75 0D                       JNZ     SD7                     ; IF SET, SOMETHING RECEIVED GO PROCESS

051E E2 F7                       LOOP    SD3                     ; OTHERWISE WAIT
0520                     SD5:
0520 FE CB                       DEC     BL                      ; DECREMENT RETRY COUNT
0522 75 DD                       JNZ     SD0                     ; RETRY TRANSMISSION

0524 80 0E 0097 R 80             OR      @KB_FLAG_2,KB_ERR       ; TURN ON TRANSMIT ERROR FLAG
0529 EB 07                       JMP     SHORT SD9               ; RETRIES EXHAUSTED FORGET TRANSMISSION
052B                     SD7:
052B F6 06 0097 R 10             TEST    @KB_FLAG_2,KB_FA        ; SEE IF THIS IS AN ACKNOWLEDGE
0530 74 EE                       JZ      SD5                     ; IF NOT, GO RESEND
0532                     SD9:
0532 59                          POP     CX                      ; RESTORE REGISTERS
0533 5B                          POP     BX
0534 58                          POP     AX
0535 C3                          RET                             ; RETURN, GOOD TRANSMISSION
0536                     SND_DATA ENDP

                         ;---------------------------------------------------------------------
                         ;   SND_LED                                                          :
                         ;   SND_LED1                                                         :
                         ;                                                                    :
                         ;         THIS ROUTINES TURNS ON THE MODE INDICATORS.                :
                         ;                                                                    :
                         ;---------------------------------------------------------------------
0536                     SND_LED PROC    NEAR
0536 FA                          CLI                             ; TURN OFF INTERRUPTS
0537 F6 06 0097 R 40             TEST    @KB_FLAG_2,KB_PR_LED    ; CHECK FOR MODE INDICATOR UPDATE
053C 75 47                       JNZ     SL9                     ; DON'T UPDATE AGAIN IF UPDATE UNDERWAY

053E 80 0E 0097 R 40             OR      @KB_FLAG_2,KB_PR_LED    ; TURN ON UPDATE IN PROCESS
0543 B0 20                       MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
0545 E6 20                       OUT     INTA00,AL               ; SEND COMMAND TO INTERRUPT CONTROL PORT
0547 EB 0D                       JMP     SHORT SL3               ; GO SEND MODE INDICATOR COMMAND

0549                     SND_LED1:
0549 FA                          CLI                             ; TURN OFF INTERRUPTS
054A F6 06 0097 R 40             TEST    @KB_FLAG_2,KB_PR_LED    ; CHECK FOR MODE INDICATOR UPDATE
054F 75 34                       JNZ     SL9                     ; DON'T UPDATE AGAIN IF UPDATE UNDERWAY

0551 80 0E 0097 R 40             OR      @KB_FLAG_2,KB_PR_LED    ; TURN ON UPDATE IN PROCESS
0556                     SL3:
0556 B0 ED                       MOV     AL,LED_CMD              ; LED CMD BYTE
0558 E8 04FA R                   CALL    SND_DATA                ; SEND DATA TO KEYBOARD
055B FA                          CLI                             ;
055C E8 0587 R                   CALL    MAKE_LED                ; GO FORM INDICATOR DATA BYTE
055F 80 26 0097 R F8             AND     @KB_FLAG_2,NOT KB_LEDS  ; CLEAR MODE INDICATOR BITS
0564 08 06 0097 R                OR      @KB_FLAG_2,AL           ; SAVE INDICATORS STATES FOR NEXT TIME
0568 F6 06 0097 R 80             TEST    @KB_FLAG_2,KB_ERR       ; TRANSMIT ERROR DETECTED
056D 75 0B                       JNZ     SL5                     ; IF SO, BYPASS SECOND BYTE TRANSMISSION

056F E8 04FA R                   CALL    SND_DATA                ; SEND DATA TO KEYBOARD
0572 FA                          CLI                             ; TURN OFF INTERRUPTS
0573 F6 06 0097 R 80             TEST    @KB_FLAG_2,KB_ERR       ; TRANSMIT ERROR DETECTED
0578 74 06                       JZ      SL7                     ; IF NOT, DON'T SEND AN ENABLE COMMAND
057A                     SL5:
057A B0 F4                       MOV     AL,KB_ENABLE            ; GET KEYBOARD CSA ENABLE COMMAND
057C E8 04FA R                   CALL    SND_DATA                ; SEND DATA TO KEYBOARD
057F FA                          CLI                             ; TURN OFF INTERRUPTS
0580                     SL7:
0580 80 26 0097 R 3F             AND     @KB_FLAG_2,NOT(KB_PR_LED+KB_ERR) ; TURN OFF MODE INDICATOR
0585                     SL9:                                    ; UPDATE AND TRANSMIT ERROR FLAG
0585 FB                          STI                             ; ENABLE INTERRUPTS
0586 C3                          RET                             ; RETURN TO CALLER
0587                     SND_LED ENDP

                         ;---------------------------------------------------------------------
                         ;   MAKE_LED                                                         :
                         ;                                                                    :
                         ;         THIS ROUTINES FORMS THE DATA BYTE NECESSARY TO TURN ON/OFF :
                         ;         THE MODE INDICATORS                                        :
                         ;                                                                    :
                         ;---------------------------------------------------------------------
0587                     MAKE_LED PROC   NEAR
0587 51                          PUSH    CX                      ; SAVE CX
0588 A0 0017 R                   MOV     AL,@KB_FLAG             ; GET CAPS & NUM LOCK INDICATORS
058B 24 70                       AND     AL,CAPS_STATE+NUM_STATE+SCROLL_STATE ; ISOLATE INDICATORS
058D B1 04                       MOV     CL,4                    ; SHIFT COUNT
058F D2 C0                       ROL     AL,CL                   ; SHIFT BITS OVER TO TURN ON INDICATORS
0591 24 07                       AND     AL,07H                  ; MAKE SURE ONLY MODE BITS ON
0593 59                          POP     CX
0594 C3                          RET                             ; RETURN TO CALLER
0595                     MAKE_LED ENDP
                         ;---------------------------------------------------------------------
                         ;   SHIP_IT                                                          :
                         ;                                                                    :
                         ;         THIS ROUTINES HANDLES TRANSMISSION OF COMMAND AND DATA BYTES :
                         ;         TO THE KEYBOARD CONTROLLER.                                :
                         ;                                                                    :
                         ;---------------------------------------------------------------------
0595                     SHIP_IT PROC    NEAR
0595 50                          PUSH    AX                      ; SAVE DATA TO SEND
                         ;-----  WAIT FOR COMMAND TO ACCEPTED

0596 FA                          CLI                             ; DISABLE INTERRUPTS TILL DATA SENT
0597 2B C9                       SUB     CX,CX                   ; CLEAR TIMEOUT COUNTER
0599                     S10:
0599 E4 64                       IN      AL,STATUS_PORT          ; READ KYBOARD CONTROLLER STATUS
059B A8 02                       TEST    AL,INPT_BUF_FULL        ; CHECK FOR ITS INPUT BUFFER BUSY
059D E0 FA                       LOOPNZ  S10                     ; WAIT FOR COMMAND TO BE ACCEPTED

059F 58                          POP     AX                      ; GET DATA TO SEND
05A0 E6 64                       OUT     STATUS_PORT,AL          ; SEND TO KEYBOARD CONTROLLER
05A2 FB                          STI                             ; ENABLE INTERRUPTS AGAIN
05A3 C3                          RET                             ; RETURN TO CALLER
05A4                     SHIP_IT ENDP
05A4                     CODE    ENDS
                                 END
```

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                              PAGE 118,121
                              TITLE PRT ------ 06/10/85  PRINTER ADAPTER BIOS
                              .286C
                              .LIST
0000                          CODE     SEGMENT BYTE PUBLIC

                                       PUBLIC  PRINTER_IO_1
                                       EXTRN   DDS:NEAR

                              ;--- INT  17 H -----------------------------------------------------------------
                              ; PRINTER_IO                                                                   :
                              ;        THIS ROUTINE PROVIDES COMMUNICATION WITH THE PRINTER                  :
                              ; INPUT                                                                        :
                              ;        (AH)= 00H  PRINT THE CHARACTER IN (AL)                                :
                              ;                     ON RETURN, (AH)= 1 IF CHARACTER NOT BE PRINTED (TIME OUT) :
                              ;                     OTHER BITS SET AS ON NORMAL STATUS CALL                  :
                              ;        (AH)= 01H  INITIALIZE THE PRINTER PORT                                :
                              ;                     RETURNS WITH (AH) SET WITH PRINTER STATUS                :
                              ;        (AH)= 02H  READ THE PRINTER STATUS INTO (AH)                          :
                              ;                   7       6       5       4       3       2-1     0          :
                              ;                   |       |       |       |       |       |       |_ TIME OUT :
                              ;                   |       |       |       |       |       |                  :
                              ;                   |       |       |       |       |       |_ UNUSED          :
                              ;                   |       |       |       |       |                          :
                              ;                   |       |       |       |       |_ 1 = I/O ERROR           :
                              ;                   |       |       |       |                                  :
                              ;                   |       |       |       |_ 1 = SELECTED                    :
                              ;                   |       |       |                                          :
                              ;                   |       |       |_ 1 = OUT OF PAPER                        :
                              ;                   |       |                                                  :
                              ;                   |       |_ 1 = ACKNOWLEDGE                                 :
                              ;                   |                                                          :
                              ;                   |_ 1 = NOT BUSY                                            :
                              ;                                                                              :
                              ;        (DX) = PRINTER TO BE USED (0,1,2) CORRESPONDING TO ACTUAL VALUES      :
                              ;               IN @PRINTER_BASE AREA                                          :
                              ; DATA AREA @PRINTER_BASE CONTAINS THE BASE ADDRESS OF THE PRINTER CARD(S)     :
                              ; AVAILABLE (LOCATED AT BEGINNING OF DATA SEGMENT, 408H ABSOLUTE, 3 WORDS)      :
                              ;                                                                              :
                              ; DATA AREA @PRINT_TIM_OUT (BYTE) MAY BE CHANGE TO CAUSE DIFFERENT             :
                              ; TIME OUT WAITS. DEFAULT=20 * 4                                               :
                              ;                                                                              :
                              ; REGISTERS      (AH) IS MODIFIED WITH STATUS INFORMATION                      :
                              ;                ALL OTHERS UNCHANGED                                          :
                              ;-------------------------------------------------------------------------------
                                       ASSUME  CS:CODE,DS:DATA

0000                          PRINTER_IO_1     PROC    FAR             ; ENTRY POINT FOR ORG 0EFD2H
0000 FB                                STI                             ; INTERRUPTS BACK ON
0001 1E                                PUSH    DS                      ; SAVE SEGMENT
0002 56                                PUSH    SI
0003 52                                PUSH    DX
0004 51                                PUSH    CX
0005 53                                PUSH    BX
0006 E8 0000 E                         CALL    DDS                     ; ADDRESS DATA SEGMENT
0009 8B F2                             MOV     SI,DX                   ; GET PRINTER PARAMETER
000B 8A 9C 0078 R                      MOV     BL,@PRINT_TIM_OUT[SI]   ; LOAD TIMEOUT VALUE
000F D1 E6                             SHL     SI,1                    ; WORD OFFSET INTO TABLE INTO (SI)
0011 8B 94 0008 R                      MOV     DX,@PRINTER_BASE[SI]    ; GET BASE ADDRESS FOR PRINTER CARD
0015 0B D2                             OR      DX,DX                   ; TEST DX = ZERO, INDICATING NO PRINTER
0017 74 0C                             JZ      B10                     ; EXIT,  NO PRINTER ADAPTER AT OFFSET
0019 0A E4                             OR      AH,AH                   ; TEST FOR (AH)= 00H
001B 74 0E                             JZ      B20                     ;  PRINT CHARACTER IN (AL)
001D FE CC                             DEC     AH                      ; TEST FOR (AH)= 01H
001F 74 58                             JZ      B80                     ;  INITIALIZE PRINTER
0021 FE CC                             DEC     AH                      ; TEST FOR (AH)= 02H
0023 74 3F                             JZ      B50                     ;  GET PRINTER STATUS
0025                          B10:
0025 5B                                POP     BX                      ; RETURN
0026 59                                POP     CX
0027 5A                                POP     DX
0028 5E                                POP     SI                      ; RECOVER REGISTERS
0029 1F                                POP     DS
002A CF                                IRET                            ; RETURN TO CALLING PROGRAM

                              ;-----   PRINT THE CHARACTER IN (AL)

002B                          B20:
002B 50                                PUSH    AX                      ; SAVE VALUE TO PRINT
002C EE                                OUT     DX,AL                   ; OUTPUT CHARACTER TO DATA PORT
002D 42                                INC     DX                      ; POINT TO STATUS PORT

                              ;-----   CHECK FOR PRINTER BUSY

002E 53                                PUSH    BX                      ; SAVE TIMEOUT BASE COUNT
002F EC                                IN      AL,DX                   ; GET STATUS PORT VALUE
0030 A8 80                             TEST    AL,80H                  ; IS THE PRINTER CURRENTLY BUSY
0032 75 05                             JNZ     B25                     ; SKIP SYSTEM DEVICE BUSY CALL IF NOT

                              ;-----   INT 15 H -- DEVICE BUSY

0034 B8 90FE                           MOV     AX,90FEH                ; FUNCTION 90 PRINTER ID
0037 CD 15                             INT     15H                     ; SYSTEM CALL

                              ;-----   WAIT BUSY

0039                          B25:                                     ; ADJUST OUTER LOOP COUNT
0039 2A FF                             SUB     BH,BH                   ; CLEAR (BH)
003B C1 D3 02                          RCL     BX,2                    ; MULTIPLY BY 4
003E                          B30:
003E 2B C9                             SUB     CX,CX                   ; INNER LOOP (64K)
0040                          B35:
0040 EC                                IN      AL,DX                   ; GET STATUS
0041 8A E0                             MOV     AH,AL                   ; STATUS TO (AH) ALSO
0043 A8 80                             TEST    AL,80H                  ; IS THE PRINTER CURRENTLY BUSY
0045 75 0E                             JNZ     B40                     ; GO TO OUTPUT STROBE
0047 E2 F7                             LOOP    B35                     ; LOOP IF NOT
0049 4B                                DEC     BX                      ; DECREMENT OUTER LOOP COUNT
004A 75 F2                             JNZ     B30                     ; MAKE ANOTHER PASS IF NOT ZERO

004C 5B                                POP     BX                      ; CLEAR (BX) FROM STACK
004D 80 CC 01                          OR      AH,1                    ; SET ERROR FLAG
0050 80 E4 F9                          AND     AH,0F9H                 ; TURN OFF THE UNUSED BITS
0053 EB 1C                             JMP     SHORT B70               ; RETURN WITH ERROR FLAG SET
```

```
0055                    B40:                                    ;         SEND STROBE PULSE
0055 5B                         POP     BX                      ; RESTORE (BX) WITH TIMEOUT COUNT
0056 B0 0D                      MOV     AL,0DH                  ; SET THE STROBE LOW (BIT ON)
0058 42                         INC     DX                      ; OUTPUT STROBE TO CONTROL PORT
0059 FA                         CLI                             ; PREVENT INTERRUPT PULSE STRETCHING
005A EE                         OUT     DX,AL                   ; OUTPUT STROBE BIT   > 1us  < 5us
005B EB 00                      JMP     $+2                     ; I/O DELAY TO ALLOW FOR LINE LOADING
005D EB 00                      JMP     $+2                     ;  AND FOR CORRECT PULSE WIDTH
005F B0 0C                      MOV     AL,0CH                  ; SET THE -STROBE HIGH
0061 EE                         OUT     DX,AL
0062 FB                         STI                             ; INTERRUPTS BACK ON
0063 58                         POP     AX                      ; RECOVER THE OUTPUT CHAR

                        ;-----  PRINTER STATUS

0064                    B50:
0064 50                         PUSH    AX                      ; SAVE (AL) REGISTER
0065                    B60:
0065 8B 94 0008 R               MOV     DX,@PRINTER_BASE[SI]    ; GET PRINTER ATTACHMENT BASE ADDRESS
0069 42                         INC     DX                      ; POINT TO CONTROL PORT
006A EC                         IN      AL,DX                   ; PRE-CHARGE +BUSY LINE IF FLOATING
006B EC                         IN      AL,DX                   ; GET PRINTER STATUS HARDWARE BITS
006C 8A E0                      MOV     AH,AL                   ; SAVE
006E 80 E4 F8                   AND     AH,0F8H                 ; TURN OFF UNUSED BITS
0071                    B70:
0071 5A                         POP     DX                      ; RECOVER (AL) REGISTER
0072 8A C2                      MOV     AL,DL                   ; MOVE CHARACTER INTO (AL)
0074 80 F4 48                   XOR     AH,48H                  ; FLIP A COUPLE OF BITS
0077 EB AC                      JMP     B10                     ; RETURN FROM ROUTINE WITH STATUS IN AH

                        ;-----  INITIALIZE THE PRINTER PORT

0079                    B80:
0079 50                         PUSH    AX                      ; SAVE (AL)
007A 42                         INC     DX                      ; POINT TO OUTPUT PORT
007B 42                         INC     DX
007C B0 08                      MOV     AL,8                    ; SET INIT LINE LOW
007E EE                         OUT     DX,AL
007F B8 0FA0                    MOV     AX,1000*4               ; ADJUST FOR INITIALIZATION DELAY LOOP
0082                    B90:                                    ; INIT_LOOP
0082 48                         DEC     AX                      ; LOOP FOR RESET TO TAKE
0083 75 FD                      JNZ     B90                     ; INIT_LOOP
0085 B0 0C                      MOV     AL,0CH                  ; NO INTERRUPTS, NON AUTO LF, INIT HIGH
0087 EE                         OUT     DX,AL
0088 EB DB                      JMP     B60                     ; EXIT THROUGH STATUS ROUTINE

008A                    PRINTER_IO_1    ENDP

008A                            CODE    ENDS
                                END
```

```
                                PAGE 118,121
                                TITLE RS232 ---- 06/10/85  COMMUNICATIONS BIOS (RS232)
                                .LIST
 0000                           CODE    SEGMENT BYTE PUBLIC

                                        PUBLIC  RS232_IO_1
                                        EXTRN   A1:NEAR
                                        EXTRN   DDS:NEAR

                                ;--- INT 14 H ---------------------------------------------------------------
                                ;RS232_IO                                                                   :
                                ;       THIS ROUTINE PROVIDES BYTE STREAM I/O TO THE COMMUNICATIONS          :
                                ;       PORT ACCORDING TO THE PARAMETERS:                                    :
                                ;                                                                            :
                                ;       (AH)= 00H  INITIALIZE THE COMMUNICATIONS PORT                        :
                                ;                  (AL) HAS PARAMETERS FOR INITIALIZATION                    :
                                ;                                                                            :
                                ;               7     6     5       4     3       2       1      0           :
                                ;               ----- BAUD RATE --   -PARITY--   STOPBIT   --WORD LENGTH--:
                                ;                                                                            :
                                ;               000 - 110           X0 - NONE    0 - 1    10 - 7 BITS     :
                                ;               001 - 150           01 - ODD     1 - 2    11 - 8 BITS     :
                                ;               010 - 300           11 - EVEN                              :
                                ;               011 - 600                                                  :
                                ;               100 - 1200                                                 :
                                ;               101 - 2400                                                 :
                                ;               110 - 4800                                                 :
                                ;               111 - 9600                                                 :
                                ;               ON RETURN, CONDITIONS SET AS IN CALL TO COMMO STATUS (AH=03H) :
                                ;                                                                            :
                                ;       (AH)= 01H  SEND THE CHARACTER IN (AL) OVER THE COMMO LINE            :
                                ;                  (AL) REGISTER IS PRESERVED                                :
                                ;                  ON EXIT, BIT 7 OF AH IS SET IF THE ROUTINE WAS UNABLE TO  :
                                ;                       TO TRANSMIT THE BYTE OF DATA OVER THE LINE.          :
                                ;                       IF BIT 7 OF AH IS NOT SET, THE                       :
                                ;                       REMAINDER OF (AH) IS SET AS IN A STATUS REQUEST,     :
                                ;                       REFLECTING THE CURRENT STATUS OF THE LINE.           :
                                ;       (AH)= 02H  RECEIVE A CHARACTER IN (AL) FROM COMMO LINE BEFORE        :
                                ;                       RETURNING TO CALLER                                  :
                                ;                  ON EXIT, (AH) HAS THE CURRENT LINE STATUS, AS SET BY THE  :
                                ;                       THE STATUS ROUTINE, EXCEPT THAT THE ONLY BITS         :
                                ;                       LEFT ON ARE THE ERROR BITS (7,4,3,2,1)               :
                                ;                       IF (AH) HAS BIT 7 ON (TIME OUT) THE REMAINING        :
                                ;                       BITS ARE NOT PREDICTABLE.                            :
                                ;                       THUS, (AH) IS NON ZERO ONLY WHEN AN ERROR OCCURRED.  :
                                ;       (AH)= 03H  RETURN THE COMMO PORT STATUS IN (AX)                      :
                                ;                   (AH) CONTAINS THE LINE CONTROL STATUS                    :
                                ;                        BIT 7 = TIME OUT                                    :
                                ;                        BIT 6 = TRANSMIT SHIFT REGISTER EMPTY               :
                                ;                        BIT 5 = TRANSMIT HOLDING REGISTER EMPTY             :
                                ;                        BIT 4 = BREAK DETECT                                :
                                ;                        BIT 3 = FRAMING ERROR                               :
                                ;                        BIT 2 = PARITY ERROR                                :
                                ;                        BIT 1 = OVERRUN ERROR                               :
                                ;                        BIT 0 = DATA READY                                  :
                                ;                   (AL) CONTAINS THE MODEM STATUS                           :
                                ;                        BIT 7 = RECEIVE LINE SIGNAL DETECT                  :
                                ;                        BIT 6 = RING INDICATOR                              :
                                ;                        BIT 5 = DATA SET READY                              :
                                ;                        BIT 4 = CLEAR TO SEND                               :
                                ;                        BIT 3 = DELTA RECEIVE LINE SIGNAL DETECT            :
                                ;                        BIT 2 = TRAILING EDGE RING DETECTOR                 :
                                ;                        BIT 1 = DELTA DATA SET READY                        :
                                ;                        BIT 0 = DELTA CLEAR TO SEND                         :
                                ;                                                                            :
                                ;       (DX) = PARAMETER INDICATING WHICH RS232 CARD (0,1 ALLOWED)           :
                                ;                                                                            :
                                ; DATA AREA @RS232_BASE CONTAINS THE BASE ADDRESS OF THE 8250 ON THE CARD   :
                                ;       LOCATION 400H CONTAINS UP TO 4 RS232 ADDRESSES POSSIBLE              :
                                ;       DATA AREA LABEL @RS232_TIM_OUT (BYTE) CONTAINS OUTER LOOP COUNT      :
                                ;       VALUE FOR TIMEOUT (DEFAULT=1)                                        :
                                ;OUTPUT                                                                      :
                                ;               AX MODIFIED ACCORDING TO PARAMETERS OF CALL                  :
                                ;               ALL OTHERS UNCHANGED                                         :
                                ;----------------------------------------------------------------------------
                                        ASSUME  CS:CODE,DS:DATA

 0000                           RS232_IO_1      PROC    FAR

                                ;-----  VECTOR TO APPROPRIATE ROUTINE

 0000 FB                                STI                             ; INTERRUPTS BACK ON
 0001 1E                                PUSH    DS                      ; SAVE SEGMENT
 0002 52                                PUSH    DX
 0003 56                                PUSH    SI
 0004 57                                PUSH    DI
 0005 51                                PUSH    CX
 0006 53                                PUSH    BX
 0007 8B F2                             MOV     SI,DX                   ; RS232 VALUE TO (SI)
 0009 8B FA                             MOV     DI,DX                   ; AND TO (DI) (FOR TIMEOUTS)
 000B D1 E6                             SHL     SI,1                    ; WORD OFFSET
 000D E8 0000 E                         CALL    DDS
 0010 8B 94 0000 R                      MOV     DX,@RS232_BASE[SI]      ; GET BASE ADDRESS
 0014 0B D2                             OR      DX,DX                   ; TEST FOR 0 BASE ADDRESS
 0016 74 13                             JZ      A3                      ; RETURN
 0018 0A E4                             OR      AH,AH                   ; TEST FOR (AH)= 00H
 001A 74 16                             JZ      A4                      ; COMMO INITIALIZATION
 001C FE CC                             DEC     AH                      ; TEST FOR (AH)= 01H
 001E 74 4B                             JZ      A5                      ; SEND (AL)
 0020 FE CC                             DEC     AH                      ; TEST FOR (AH)= 02H
 0022 74 70                             JZ      A12                     ; RECEIVE INTO (AL)
 0024                           A2:
 0024 FE CC                             DEC     AH                      ; TEST FOR (AH)= 03H
 0026 75 03                             JNZ     A3
 0028 E9 00B6 R                         JMP     A18                     ; COMMUNICATION STATUS
 002B                           A3:                                     ; RETURN FROM RS232
 002B 5B                                POP     BX
 002C 59                                POP     CX
 002D 5F                                POP     DI
 002E 5E                                POP     SI
 002F 5A                                POP     DX
 0030 1F                                POP     DS
 0031 CF                                IRET                            ; RETURN TO CALLER, NO ACTION
```

```
                                   PAGE
                                   ;-----  INITIALIZE THE COMMUNICATIONS PORT

 0032                              A4:
 0032  8A E0                               MOV     AH,AL                   ; SAVE INITIALIZATION PARAMETERS IN (AH)
 0034  83 C2 03                            ADD     DX,3                    ; POINT TO 8250 CONTROL REGISTER
 0037  B0 80                               MOV     AL,80H
 0039  EE                                  OUT     DX,AL                   ; SET DLAB=1

                                   ;-----  DETERMINE BAUD RATE DIVISOR

 003A  8A D4                               MOV     DL,AH                   ; GET PARAMETERS TO (DL)
 003C  B1 04                               MOV     CL,4
 003E  D2 C2                               ROL     DL,CL
 0040  81 E2 000E                          AND     DX,0EH                  ; ISOLATE THEM
 0044  BF 0000 E                           MOV     DI,OFFSET A1            ; BASE OF TABLE
 0047  03 FA                               ADD     DI,DX                   ; PUT INTO INDEX REGISTER
 0049  8B 94 0000 R                        MOV     DX,@RS232_BASE[SI]      ; POINT TO HIGH ORDER OF DIVISOR
 004D  42                                  INC     DX
 004E  2E: 8A 45 01                        MOV     AL,CS:[DI]+1            ; GET HIGH ORDER OF DIVISOR
 0052  EE                                  OUT     DX,AL                   ; SET ms OF DIVISOR TO 0
 0053  4A                                  DEC     DX
 0054  EB 00                               JMP     $+2                     ; I/O DELAY
 0056  2E: 8A 05                           MOV     AL,CS:[DI]              ; GET LOW ORDER OF DIVISOR
 0059  EE                                  OUT     DX,AL                   ; SET LOW OF DIVISOR
 005A  83 C2 03                            ADD     DX,3
 005D  8A C4                               MOV     AL,AH                   ; GET PARAMETERS BACK
 005F  24 1F                               AND     AL,01FH                 ; STRIP OFF THE BAUD BITS
 0061  EE                                  OUT     DX,AL                   ; LINE CONTROL TO 8 BITS
 0062  4A                                  DEC     DX
 0063  4A                                  DEC     DX
 0064  EB 00                               JMP     $+2                     ; I/O DELAY
 0066  B0 00                               MOV     AL,0
 0068  EE                                  OUT     DX,AL                   ; INTERRUPT ENABLES ALL OFF
 0069  EB 4B                               JMP     SHORT A18               ; COM_STATUS

                                   ;-----  SEND CHARACTER IN (AL) OVER COMMO LINE

 006B                              A5:
 006B  50                                  PUSH    AX                      ; SAVE CHAR TO SEND
 006C  83 C2 04                            ADD     DX,4                    ; MODEM CONTROL REGISTER
 006F  B0 03                               MOV     AL,3                    ; DTR AND RTS
 0071  EE                                  OUT     DX,AL                   ; DATA TERMINAL READY, REQUEST TO SEND
 0072  42                                  INC     DX                      ; MODEM STATUS REGISTER
 0073  42                                  INC     DX
 0074  B7 30                               MOV     BH,30H                  ; DATA SET READY & CLEAR TO SEND
 0076  E8 00C5 R                           CALL    WAIT_FOR_STATUS         ; ARE BOTH TRUE
 0079  74 08                               JE      A9                      ; YES, READY TO TRANSMIT CHAR
 007B                              A7:
 007B  59                                  POP     CX
 007C  8A C1                               MOV     AL,CL                   ; RELOAD DATA BYTE
 007E                              A8:
 007E  80 CC 80                            OR      AH,80H                  ; INDICATE TIME OUT
 0081  EB A8                               JMP     A3                      ; RETURN

 0083                              A9:                                     ; CLEAR_TO_SEND
 0083  4A                                  DEC     DX                      ; LINE STATUS REGISTER
 0084                              A10:                                    ; WAIT_SEND
 0084  B7 20                               MOV     BH,20H                  ; IS TRANSMITTER READY
 0086  E8 00C5 R                           CALL    WAIT_FOR_STATUS         ; TEST FOR TRANSMITTER READY
 0089  75 F0                               JNZ     A7                      ; RETURN WITH TIME OUT SET
 008B                              A11:                                    ; OUT_CHAR
 008B  83 EA 05                            SUB     DX,5                    ; DATA PORT
 008E  59                                  POP     CX                      ; RECOVER IN CX TEMPORARILY
 008F  8A C1                               MOV     AL,CL                   ; MOVE CHAR TO AL FOR OUT, STATUS IN AH
 0091  EE                                  OUT     DX,AL                   ; OUTPUT CHARACTER
 0092  EB 97                               JMP     A3                      ; RETURN

                                   ;-----  RECEIVE CHARACTER FROM COMMO LINE

 0094                              A12:
 0094  83 C2 04                            ADD     DX,4                    ; MODEM CONTROL REGISTER
 0097  B0 01                               MOV     AL,1                    ; DATA TERMINAL READY
 0099  EE                                  OUT     DX,AL
 009A  42                                  INC     DX                      ; MODEM STATUS REGISTER
 009B  42                                  INC     DX
 009C                              A13:                                    ; WAIT_DSR
 009C  B7 20                               MOV     BH,20H                  ; DATA_SET READY
 009E  E8 00C5 R                           CALL    WAIT_FOR_STATUS         ; TEST FOR DSR
 00A1  75 DB                               JNZ     A8                      ; RETURN WITH ERROR
 00A3                              A15:                                    ; WAIT_DSR_END
 00A3  4A                                  DEC     DX                      ; LINE_STATUS REGISTER
 00A4                              A16:                                    ; WAIT_RECV
 00A4  B7 01                               MOV     BH,1                    ; RECEIVE BUFFER FULL
 00A6  E8 00C5 R                           CALL    WAIT_FOR_STATUS         ; TEST FOR RECEIVE BUFFER FULL
 00A9  75 D3                               JNZ     A8                      ; SET TIME OUT ERROR
 00AB                              A17:                                    ; GET_CHAR
 00AB  80 E4 1E                            AND     AH,00011110B            ; TEST FOR ERROR CONDITIONS ON RECEIVE

 00AE  8B 94 0000 R                        MOV     DX,@RS232_BASE[SI]      ; DATA PORT
 00B2  EC                                  IN      AL,DX                   ; GET CHARACTER FROM LINE
 00B3  E9 002B R                           JMP     A3                      ; RETURN

                                   ;-----  COMMO PORT STATUS ROUTINE

 00B6                              A18:
 00B6  8B 94 0000 R                        MOV     DX,@RS232_BASE[SI]
 00BA  83 C2 05                            ADD     DX,5                    ; CONTROL PORT
 00BD  EC                                  IN      AL,DX                   ; GET LINE CONTROL STATUS
 00BE  8A E0                               MOV     AH,AL                   ; PUT IN (AH) FOR RETURN
 00C0  42                                  INC     DX                      ; POINT TO MODEM STATUS REGISTER
 00C1  EC                                  IN      AL,DX                   ; GET MODEM CONTROL STATUS
 00C2  E9 002B R                           JMP     A3                      ; RETURN
```

SECTION 5

```
                                PAGE
                                ;----------------------------------------
                                ;       WAIT FOR STATUS ROUTINE         :
                                ;ENTRY: (BH)= STATUS BIT(S) TO LOOK FOR :
                                ;       (DX)= ADDRESS OF STATUS REG     :
                                ;EXIT:  ZERO FLAG ON = STATUS FOUND     :
                                ;       ZERO FLAG OFF = TIMEOUT.        :
                                ;       (AH)= LAST STATUS READ          :
                                ;----------------------------------------

 00C5                           WAIT_FOR_STATUS PROC    NEAR
 00C5 8A 9D 007C R                      MOV     BL,@RS232_TIM_OUT[DI]   ; LOAD OUTER LOOP COUNT

                                ;-----  ADJUST OUTER LOOP COUNT

 00C9 55                                PUSH    BP                      ; SAVE (BP)
 00CA 53                                PUSH    BX                      ; SAVE (BX)
 00CB 5D                                POP     BP                      ; USE BP FOR OUTER LOOP COUNT
 00CC 81 E5 00FF                        AND     BP,00FFH                ; STRIP HIGH BITS
 00D0 D1 D5                             RCL     BP,1                    ; MULTIPLY OUTER COUNT BY 4
 00D2 D1 D5                             RCL     BP,1
 00D4                           WFS0:
 00D4 2B C9                             SUB     CX,CX
 00D6                           WFS1:
 00D6 EC                                IN      AL,DX                   ; GET STATUS
 00D7 8A E0                             MOV     AH,AL                   ; MOVE TO (AH)
 00D9 22 C7                             AND     AL,BH                   ; ISOLATE BITS TO TEST
 00DB 3A C7                             CMP     AL,BH                   ; EXACTLY = TO MASK
 00DD 74 07                             JE      WFS_END                 ; RETURN WITH ZERO FLAG ON

 00DF E2 F5                             LOOP    WFS1                    ; TRY AGAIN

 00E1 4D                                DEC     BP
 00E2 75 F0                             JNZ     WFS0

 00E4 0A FF                             OR      BH,BH                   ; SET ZERO FLAG OFF
 00E6                           WFS_END:
 00E6 5D                                POP     BP                      ; RESTORE (BP)
 00E7 C3                                RET

 00E8                           WAIT_FOR_STATUS ENDP

 00E8                           RS232_IO_1      ENDP

 00E8                           CODE    ENDS
                                        END
```

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                                PAGE 118,121
                                TITLE VIDEO1 --- 06/10/85  VIDEO DISPLAY BIOS
                                .286C
                                .LIST
 0000                           CODE    SEGMENT BYTE PUBLIC

                                        PUBLIC  ACT_DISP_PAGE
                                        PUBLIC  READ_AC_CURRENT
                                        PUBLIC  READ_CURSOR
                                        PUBLIC  READ_DOT
                                        PUBLIC  READ_LPEN
                                        PUBLIC  SCROLL_DOWN
                                        PUBLIC  SCROLL_UP
                                        PUBLIC  SET_COLOR
                                        PUBLIC  SET_CPOS
                                        PUBLIC  SET_CTYPE
                                        PUBLIC  SET_MODE
                                        PUBLIC  WRITE_AC_CURRENT
                                        PUBLIC  WRITE_C_CURRENT
                                        PUBLIC  WRITE_DOT
                                        PUBLIC  WRITE_TTY
                                        PUBLIC  VIDEO_IO_1
                                        PUBLIC  VIDEO_STATE

                                        EXTRN   BEEP:NEAR               ; SPEAKER BEEP ROUTINE
                                        EXTRN   CRT_CHAR_GEN:NEAR       ; CHARACTER GENERATOR GRAPHICS TABLE
                                        EXTRN   DDS:NEAR                ; LOAD (DS) WITH DATA SEGMENT SELECTOR
                                        EXTRN   M5:WORD                 ; REGEN BUFFER LENGTH TABLE
                                        EXTRN   M6:BYTE                 ; COLUMNS PER MODE TABLE
                                        EXTRN   M7:BYTE                 ; MODE SET VALUE PER MODE TABLE

                                ;--- INT 10 H -------------------------------------------------------------------
                                ; VIDEO_IO                                                                     :
                                ;       THESE ROUTINES PROVIDE THE CRT DISPLAY INTERFACE                      :
                                ;       THE FOLLOWING FUNCTIONS ARE PROVIDED:                                 :
                                ;                                                                              :
                                ;    (AH)= 00H  SET MODE (AL) CONTAINS MODE VALUE                              :
                                ;                 (AL) = 00H  40X25 BW MODE (POWER ON DEFAULT)                 :
                                ;                 (AL) = 01H  40X25 COLOR                                      :
                                ;                 (AL) = 02H  80X25 BW                                         :
                                ;                 (AL) = 03H  80X25 COLOR                                      :
                                ;                             GRAPHICS MODES                                   :
                                ;                 (AL) = 04H  320X200 COLOR                                    :
                                ;                 (AL) = 05H  320X200 BW MODE                                  :
                                ;                 (AL) = 06H  640X200 BW MODE                                  :
                                ;                 (AL) = 07H   80X25 MONOCHROME (USED INTERNAL TO VIDEO ONLY)  :
                                ;                 *** NOTES -BW MODES OPERATE SAME AS COLOR MODES, BUT COLOR   :
                                ;                            BURST IS NOT ENABLED                              :
                                ;                           -CURSOR IS NOT DISPLAYED IN GRAPHICS MODE          :
                                ;    (AH)= 01H  SET CURSOR TYPE                                                :
                                ;                 (CH) =  BITS 4-0 = START LINE FOR CURSOR                     :
                                ;                         ** HARDWARE WILL ALWAYS CAUSE BLINK                  :
                                ;                         ** SETTING BIT 5 OR 6 WILL CAUSE ERRATIC BLINKING    :
                                ;                            OR NO CURSOR AT ALL                               :
                                ;                 (CL) =  BITS 4-0 = END LINE FOR CURSOR                       :
                                ;    (AH)= 02H  SET CURSOR POSITION                                            :
                                ;                 (DH,DL) = ROW,COLUMN  (00H,00H) IS UPPER LEFT                :
                                ;                 (BH) = PAGE NUMBER (MUST BE 00H FOR GRAPHICS MODES)          :
                                ;    (AH)= 03H  READ CURSOR POSITION                                           :
                                ;                 (BH) = PAGE NUMBER (MUST BE 00H FOR GRAPHICS MODES)          :
                                ;                 ON EXIT (DH,DL) = ROW,COLUMN OF CURRENT CURSOR               :
                                ;                         (CH,CL) = CURSOR MODE CURRENTLY SET                  :
                                ;    (AH)= 04H  READ LIGHT PEN POSITION                                        :
                                ;                 ON EXIT:                                                     :
                                ;                 (AH) = 00H -- LIGHT PEN SWITCH NOT DOWN/NOT TRIGGERED        :
                                ;                 (AH) = 01H -- VALID LIGHT PEN VALUE IN REGISTERS             :
                                ;                        (DH,DL) = ROW,COLUMN OF CHARACTER LP POSITION         :
                                ;                        (CH) = RASTER LINE (0-199)                            :
                                ;                        (BX) = PIXEL COLUMN (0-319,639)                       :
                                ;    (AH)= 05H  SELECT ACTIVE DISPLAY PAGE (VALID ONLY FOR ALPHA MODES)        :
                                ;                 (AL) = NEW PAGE VALUE (0-7 FOR MODES 0&1, 0-3 FOR MODES 2&3) :
                                ;    (AH)= 06H  SCROLL ACTIVE PAGE UP                                          :
                                ;                 (AL) = NUMBER OF LINES, ( LINES BLANKED AT BOTTOM OF WINDOW ) :
                                ;                        (AL) = 00H MEANS BLANK ENTIRE WINDOW                  :
                                ;                 (CH,CL) = ROW,COLUMN OF UPPER LEFT CORNER OF SCROLL          :
                                ;                 (DH,DL) = ROW,COLUMN OF LOWER RIGHT CORNER OF SCROLL         :
                                ;                 (BH) = ATTRIBUTE TO BE USED ON BLANK LINE                    :
                                ;    (AH)= 07H  SCROLL ACTIVE PAGE DOWN                                        :
                                ;                 (AL) = NUMBER OF LINES, INPUT LINES BLANKED AT TOP OF WINDOW :
                                ;                        (AL) = 00H MEANS BLANK ENTIRE WINDOW                  :
                                ;                 (CH,CL) = ROW,COLUMN OF UPPER LEFT CORNER OF SCROLL          :
                                ;                 (DH,DL) = ROW,COLUMN OF LOWER RIGHT CORNER OF SCROLL         :
                                ;                 (BH) = ATTRIBUTE TO BE USED ON BLANK LINE                    :
                                ;                                                                              :
                                ;  CHARACTER HANDLING ROUTINES                                                 :
                                ;                                                                              :
                                ;    (AH)= 08H  READ ATTRIBUTE/CHARACTER AT CURRENT CURSOR POSITION            :
                                ;                 (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)             :
                                ;                 ON EXIT:                                                     :
                                ;                 (AL) = CHAR READ                                             :
                                ;                 (AH) = ATTRIBUTE OF CHARACTER READ (ALPHA MODES ONLY)        :
                                ;    (AH)= 09H  WRITE ATTRIBUTE/CHARACTER AT CURRENT CURSOR POSITION           :
                                ;                 (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)             :
                                ;                 (CX) = COUNT OF CHARACTERS TO WRITE                          :
                                ;                 (AL) = CHAR TO WRITE                                         :
                                ;                 (BL) = ATTRIBUTE OF CHARACTER (ALPHA)/COLOR OF CHAR (GRAPHICS):
                                ;                        SEE NOTE ON WRITE DOT FOR BIT 7 OF BL = 1.            :
                                ;    (AH)= 0AH  WRITE CHARACTER ONLY AT CURRENT CURSOR POSITION                :
                                ;                 (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)             :
                                ;                 (CX) = COUNT OF CHARACTERS TO WRITE                          :
                                ;                 (AL) = CHAR TO WRITE                                         :
                                ;                        NOTE: USE FUNCTION (AH)= 09H IN GRAPHICS MODES        :
                                ;       FOR READ/WRITE CHARACTER INTERFACE WHILE IN GRAPHICS MODE, THE         :
                                ;               CHARACTERS ARE FORMED FROM A CHARACTER GENERATOR IMAGE         :
                                ;               MAINTAINED IN THE SYSTEM ROM.  ONLY THE 1ST 128 CHARS          :
                                ;               ARE CONTAINED THERE.  TO READ/WRITE THE SECOND 128 CHARS,      :
                                ;               THE USER MUST INITIALIZE THE POINTER AT INTERRUPT 1FH          :
                                ;               (LOCATION 0007CH) TO POINT TO THE 1K BYTE TABLE CONTAINING     :
                                ;               THE CODE POINTS FOR THE SECOND 128 CHARS (128-255).            :
                                ;       FOR WRITE CHARACTER INTERFACE IN GRAPHICS MODE, THE REPLICATION FACTOR :
                                ;               CONTAINED IN (CX) ON ENTRY WILL PRODUCE VALID RESULTS ONLY     :
                                ;               FOR CHARACTERS CONTAINED ON THE SAME ROW.  CONTINUATION TO     :
                                ;               SUCCEEDING LINES WILL NOT PRODUCE CORRECTLY.                   :
                                ;                                                                              :
```

SECTION 5

```
                                ;       GRAPHICS INTERFACE                                                :
                                ;                                                                         :
                                ;       (AH)= 0BH  SET COLOR PALETTE                                      :
                                ;                  (BH) = PALETTE COLOR ID BEING SET (0-127)              :
                                ;                  (BL) = COLOR VALUE TO BE USED WITH THAT COLOR ID       :
                                ;                         NOTE: FOR THE CURRENT COLOR CARD, THIS ENTRY POINT HAS :
                                ;                                MEANING ONLY FOR 320X200 GRAPHICS.      :
                                ;                         COLOR ID = 0 SELECTS THE BACKGROUND COLOR (0-15) :
                                ;                         COLOR ID = 1 SELECTS THE PALETTE TO BE USED:   :
                                ;                                0 = GREEN(1)/RED(2)/YELLOW(3)           :
                                ;                                1 = CYAN(1)/MAGENTA(2)/WHITE(3)         :
                                ;                         IN 40X25 OR 80X25 ALPHA MODES, THE VALUE SET FOR :
                                ;                                PALETTE COLOR 0 INDICATES THE BORDER COLOR :
                                ;                                TO BE USED (VALUES 0-31, WHERE 16-31 SELECT :
                                ;                                THE HIGH INTENSITY BACKGROUND SET.      :
                                ;       (AH)= 0CH  WRITE DOT                                              :
                                ;                  (DX) = ROW NUMBER                                      :
                                ;                  (CX) = COLUMN NUMBER                                   :
                                ;                  (AL) = COLOR VALUE                                     :
                                ;                         IF BIT 7 OF AL = 1, THEN THE COLOR VALUE IS EXCLUSIVE :
                                ;                         ORed WITH THE CURRENT CONTENTS OF THE DOT       :
                                ;       (AH)= 0DH  READ DOT                                               :
                                ;                  (DX) = ROW NUMBER                                      :
                                ;                  (CX) = COLUMN NUMBER                                   :
                                ;                  (AL) RETURNS THE DOT READ                              :
                                ;                                                                         :
                                ;       ASCII TELETYPE ROUTINE FOR OUTPUT                                 :
                                ;                                                                         :
                                ;       (AH)= 0EH  WRITE TELETYPE TO ACTIVE PAGE                          :
                                ;                  (AL) = CHAR TO WRITE                                   :
                                ;                  (BL) = FOREGROUND COLOR IN GRAPHICS MODE               :
                                ;                  NOTE -- SCREEN WIDTH IS CONTROLLED BY PREVIOUS MODE SET :
                                ;       (AH)= 0FH  CURRENT VIDEO STATE                                    :
                                ;                  RETURNS THE CURRENT VIDEO STATE                        :
                                ;                  (AL) = MODE CURRENTLY SET ( SEE (AH)= 00H FOR EXPLANATION) :
                                ;                  (AH) = NUMBER OF CHARACTER COLUMNS ON SCREEN           :
                                ;                  (BH) = CURRENT ACTIVE DISPLAY PAGE                     :
                                ;       (AH)= 10H  RESERVED                                               :
                                ;       (AH)= 11H  RESERVED                                               :
                                ;       (AH)= 12H  RESERVED                                               :
                                ;       (AH)= 13H  WRITE STRING                                           :
                                ;                          ES:BP  -  POINTER TO STRING TO BE WRITTEN     :
                                ;                          CX     -  LENGTH OF CHARACTER STRING TO WRITTEN :
                                ;                          DX     -  CURSOR POSITION FOR STRING TO BE WRITTEN :
                                ;                          BH     -  PAGE NUMBER                          :
                                ;               (AL)= 00H  WRITE CHARACTER STRING                         :
                                ;                          BL     -  ATTRIBUTE                            :
                                ;                          STRING IS  <CHAR,CHAR, ... ,CHAR>              :
                                ;                          CURSOR NOT MOVED                               :
                                ;               (AL)= 01H  WRITE CHARACTER STRING AND MOVE CURSOR         :
                                ;                          BL     -  ATTRIBUTE                            :
                                ;                          STRING IS  <CHAR,CHAR, ... ,CHAR>              :
                                ;                          CURSOR IS MOVED                                :
                                ;               (AL)= 02H  WRITE CHARACTER AND ATTRIBUTE STRING           :
                                ;                                (VALID FOR ALPHA MODES ONLY)             :
                                ;                          STRING IS  <CHAR,ATTR,CHAR,ATTR ..  ,CHAR,ATTR> :
                                ;                          CURSOR IS NOT MOVED                            :
                                ;               (AL)= 03H  WRITE CHARACTER AND ATTRIBUTE STRING AND MOVE CURSOR :
                                ;                                (VALID FOR ALPHA MODES ONLY)             :
                                ;                          STRING IS  <CHAR,ATTR,CHAR,ATTR ..  ,CHAR,ATTR> :
                                ;                          CURSOR IS MOVED                                :
                                ;                 NOTE:  CARRIAGE RETURN, LINE FEED, BACKSPACE, AND BELL ARE :
                                ;                        TREATED AS COMMANDS RATHER THAN PRINTABLE CHARACTERS. :
                                ;                                                                         :
                                ;          BX,CX,DX,SI,DI,BP,SP,DS,ES,SS PRESERVED DURING CALLS EXCEPT FOR :
                                ;          BX,CX,DX RETURN VALUES ON FUNCTIONS 03H,04H,0DH AND 0DH. ON ALL CALLS :
                                ;          AX IS MODIFIED.                                                :
                                ;--------------------------------------------------------------------------

                                       ASSUME  CS:CODE,DS:DATA,ES:NOTHING

 0000 0067 R                    M1     DW      OFFSET  SET_MODE         ; TABLE OF ROUTINES WITHIN VIDEO I/O
 0002 0137 R                           DW      OFFSET  SET_CTYPE
 0004 015C R                           DW      OFFSET  SET_CPOS
 0006 0184 R                           DW      OFFSET  READ_CURSOR
 0008 0771 R                           DW      OFFSET  READ_LPEN
 000A 019B R                           DW      OFFSET  ACT_DISP_PAGE
 000C 0208 R                           DW      OFFSET  SCROLL_UP
 000E 02A7 R                           DW      OFFSET  SCROLL_DOWN
 0010 02F9 R                           DW      OFFSET  READ_AC_CURRENT
 0012 0353 R                           DW      OFFSET  WRITE_AC_CURRENT
 0014 0385 R                           DW      OFFSET  WRITE_C_CURRENT
 0016 01BF R                           DW      OFFSET  SET_COLOR
 0018 0446 R                           DW      OFFSET  WRITE_DOT
 001A 0435 R                           DW      OFFSET  READ_DOT
 001C 06EA R                           DW      OFFSET  WRITE_TTY
 001E 01E5 R                           DW      OFFSET  VIDEO_STATE
 0020 012E R                           DW      OFFSET  VIDEO_RETURN     ; RESERVED
 0022 012E R                           DW      OFFSET  VIDEO_RETURN     ; RESERVED
 0024 012E R                           DW      OFFSET  VIDEO_RETURN     ; RESERVED
 0026 03B2 R                           DW      OFFSET  WRITE_STRING     ; CASE 19H, WRITE STRING
 = 0028                         M1L    EQU     $-M1

 0028                           VIDEO_IO_1     PROC    NEAR             ;      ENTRY POINT FOR ORG 0F065H
 0028 FB                               STI                              ; INTERRUPTS BACK ON
 0029 FC                               CLD                              ; SET DIRECTION FORWARD
 002A 06                               PUSH    ES
 002B 1E                               PUSH    DS                       ; SAVE WORK AND PARAMETER REGISTERS
 002C 52                               PUSH    DX
 002D 51                               PUSH    CX
 002E 53                               PUSH    BX
 002F 56                               PUSH    SI
 0030 57                               PUSH    DI
 0031 55                               PUSH    BP
 0032 E8 0000 E                        CALL    DDS                      ; POINT DS: TO DATA SEGMENT
 0035 BE B800                          MOV     SI,0B800H                ; GET SEGMENT FOR COLOR CARD
 0038 8B 3E 0010 R                     MOV     DI,@EQUIP_FLAG           ; GET EQUIPMENT FLAGS SETTING
 003C 81 E7 0030                       AND     DI,30H                   ; ISOLATE CRT SWITCHES
 0040 83 FF 30                         CMP     DI,30H                   ; IS SETTING FOR BW CARD?
 0043 75 03                            JNE     M2                       ; SKIP IF NOT BW CARD
 0045 BE B000                          MOV     SI,0B000H                ; ELSE GET SEGMENT FOR BW CARD
 0048                           M2:
 0048 80 FC 13                         CMP     AH,13H                   ; TEST FOR WRITE STRING OPERATION
 004B 74 02                            JE      M3                       ; SKIP IF ES:BP VALID AS PASSED
```

```
004D 8E C6                             MOV    ES,SI                   ; SET UP TO POINT AT VIDEO MEMORY AREAS
004F                           M3:
004F 8B F0                             MOV    SI,AX                   ; MOVE COMMAND TO LOOK UP REGISTER
0051 C1 EE 08                          SHR    SI,8                    ; SHIFT COMMAND TO FORM BYTE OFFSET
0054 D1 E6                             SAL    SI,1                    ; TIMES 2 FOR WORD TABLE LOOKUP
0056 83 FE 28                          CMP    SI,MIL                  ; TEST FOR WITHIN TABLE RANGE
0059 73 09                             JNB    M4                      ; BRANCH TO EXIT IF NOT A VALID COMMAND

005B 8A 26 0049 R                      MOV    AH,@CRT_MODE            ; MOVE CURRENT MODE INTO AH
005F 2E: FF A4 0000 R                  JMP    WORD PTR CS:[SI+OFFSET M1]      ; GO TO SELECTED FUNCTION

0064                           M4:                                    ; COMMAND NOT VALID
0064 E9 012E R                         JMP    VIDEO_RETURN            ; DO NOTHING IF NOT IN VALID RANGE
0067                           VIDEO_IO_1      ENDP
                               ;--------------------------------------------------------
                               ; SET_MODE                                              :
                               ;       THIS ROUTINE INITIALIZES THE ATTACHMENT TO      :
                               ;       THE SELECTED MODE.  THE SCREEN IS BLANKED.      :
                               ; INPUT                                                 :
                               ;       (AL) = MODE SELECTED (RANGE 0-7)                :
                               ; OUTPUT                                                :
                               ;       NONE                                            :
                               ;--------------------------------------------------------
0067                           SET_MODE        PROC    NEAR
0067 BA 03D4                           MOV    DX,03D4H                ; ADDRESS OF COLOR CARD
006A 83 FF 30                          CMP    DI,30H                  ; IS BW CARD INSTALLED
006D 75 04                             JNE    M8                      ; OK WITH COLOR
006F B0 07                             MOV    AL,7                    ; INDICATE INTERNAL BW CARD MODE
0071 B2 B4                             MOV    DL,0B4H                 ; ADDRESS OF BW (MONOCHROME) CARD
0073                           M8:
0073 A2 0049 R                         MOV    @CRT_MODE,AL            ; SAVE MODE IN GLOBAL VARIABLE
0076 89 16 0063 R                      MOV    @ADDR_6845,DX           ; SAVE ADDRESS OF BASE
007A C6 06 0084 R 18                   MOV    @ROWS,25-1              ; INITIALIZE DEFAULT ROW COUNT OF 25
007F 1E                                PUSH   DS                      ; SAVE POINTER TO DATA SEGMENT
0080 50                                PUSH   AX                      ; SAVE MODE NUMBER (AL)
0081 98                                CBW                            ; CLEAR HIGH BYTE OF MODE
0082 8B F0                             MOV    SI,AX                   ; SET TABLE POINTER, INDEXED BY MODE
0084 2E: 8A 84 0000 E                  MOV    AL,CS:[SI + OFFSET M7]  ; GET THE MODE SET VALUE FROM TABLE
0089 A2 0065 R                         MOV    @CRT_MODE_SET,AL        ; SAVE THE MODE SET VALUE
008C 24 37                             AND    AL,037H                 ; VIDEO OFF, SAVE HIGH RESOLUTION BIT
008E 52                                PUSH   DX                      ; SAVE OUTPUT PORT VALUE
008F 83 C2 04                          ADD    DX,4                    ; POINT TO CONTROL REGISTER
0092 EE                                OUT    DX,AL                   ; RESET VIDEO TO OFF TO SUPPRESS ROLLING
0093 5A                                POP    DX                      ; BACK TO BASE REGISTER
                                       ASSUME DS:ABS0
0094 2B DB                             SUB    BX,BX                   ; SET UP FOR ABS0 SEGMENT
0096 8E DB                             MOV    DS,BX                   ; ESTABLISH VECTOR TABLE ADDRESSING
0098 C5 1E 0074 R                      LDS    BX,@PARM_PTR            ; GET POINTER TO VIDEO PARMS
                                       ASSUME DS:CODE
009C 58                                POP    AX                      ; RECOVER MODE NUMBER IN (AL)
009D B9 0010                           MOV    CX,16                   ; LENGTH OF EACH ROW OF TABLE
00A0 3C 02                             CMP    AL,2                    ; DETERMINE WHICH ONE TO USE
00A2 72 0E                             JC     M9                      ; MODE IS 0 OR 1
00A4 03 D9                             ADD    BX,CX                   ; NEXT ROW OF INITIALIZATION TABLE
00A6 3C 04                             CMP    AL,4
00A8 72 08                             JC     M9                      ; MODE IS 2 OR 3
00AA 03 D9                             ADD    BX,CX                   ; MOVE TO GRAPHICS ROW OF INIT_TABLE
00AC 3C 07                             CMP    AL,7
00AE 72 02                             JC     M9                      ; MODE IS 4,5, OR 6
00B0 03 D9                             ADD    BX,CX                   ; MOVE TO BW CARD ROW OF INIT_TABLE

                               ;-----  BX POINTS TO CORRECT ROW OF INITIALIZATION TABLE

00B2                           M9:                                    ; OUT_INIT
00B2 50                                PUSH   AX                      ; SAVE MODE IN (AL)
00B3 8B 47 0A                          MOV    AX,[BX+10]              ; GET THE CURSOR MODE FROM THE TABLE
00B6 86 E0                             XCHG   AH,AL                   ; PUT CURSOR MODE IN CORRECT POSITION
00B8 1E                                PUSH   DS                      ; SAVE TABLE SEGMENT POINTER
                                       ASSUME DS:DATA
00B9 E8 0000 E                         CALL   DDS                     ; POINT DS TO DATA SEGMENT
00BC A3 0060 R                         MOV    @CURSOR_MODE,AX         ; PLACE INTO BIOS DATA SAVE AREA
                                       ASSUME DS:CODE
00BF 1F                                POP    DS                      ; RESTORE THE TABLE SEGMENT POINTER
00C0 32 E4                             XOR    AH,AH                   ; AH IS REGISTER NUMBER DURING LOOP

                               ;-----  LOOP THROUGH TABLE, OUTPUTTING REGISTER ADDRESS, THEN VALUE FROM TABLE

00C2                           M10:                                   ;  INITIALIZATION LOOP
00C2 8A C4                             MOV    AL,AH                   ; GET 6845 REGISTER NUMBER
00C4 EE                                OUT    DX,AL
00C5 42                                INC    DX                      ; POINT TO DATA PORT
00C6 FE C4                             INC    AH                      ; NEXT REGISTER VALUE
00C8 8A 07                             MOV    AL,[BX]                 ; GET TABLE VALUE
00CA EE                                OUT    DX,AL                   ; OUT TO CHIP
00CB 43                                INC    BX                      ; NEXT IN TABLE
00CC 4A                                DEC    DX                      ; BACK TO POINTER REGISTER
00CD E2 F3                             LOOP   M10                     ; DO THE WHOLE TABLE
00CF 58                                POP    AX                      ; GET MODE BACK INTO (AL)
00D0 1F                                POP    DS                      ; RECOVER SEGMENT VALUE
                                       ASSUME DS:DATA

                               ;-----  FILL REGEN AREA WITH BLANK

00D1 33 FF                             XOR    DI,DI                   ; SET UP POINTER FOR REGEN
00D3 89 3E 004E R                      MOV    @CRT_START,DI           ; START ADDRESS SAVED IN GLOBAL
00D7 C6 06 0062 R 00                   MOV    @ACTIVE_PAGE,0          ; SET PAGE VALUE
00DC B9 2000                           MOV    CX,8192                 ; NUMBER OF WORDS IN COLOR CARD
00DF 3C 04                             CMP    AL,4                    ; TEST FOR GRAPHICS
00E1 72 0A                             JC     M12                     ; NO_GRAPHICS_INIT
00E3 3C 07                             CMP    AL,7                    ; TEST FOR BW CARD
00E5 74 04                             JE     M11                     ; BW_CARD_INIT
00E7 33 C0                             XOR    AX,AX                   ; FILL FOR GRAPHICS MODE
00E9 EB 05                             JMP    SHORT M13               ; CLEAR_BUFFER
00EB                           M11:                                   ; BW_CARD_INIT
00EB B5 08                             MOV    CH,08H                  ; BUFFER SIZE ON BW CARD (2048)
00ED                           M12:                                   ; NO_GRAPHICS_INIT
00ED B8 0720                           MOV    AX,' '+7*H              ; FILL CHAR FOR ALPHA + ATTRIBUTE
00F0                           M13:                                   ; CLEAR_BUFFER
00F0 F3/ AB                            REP    STOSW                   ; FILL THE REGEN BUFFER WITH BLANKS

                               ;-----  ENABLE VIDEO AND CORRECT PORT SETTING

00F2 8B 16 0063 R                      MOV    DX,@ADDR_6845           ; PREPARE TO OUTPUT TO VIDEO ENABLE PORT
00F6 83 C2 04                          ADD    DX,4                    ; POINT TO THE MODE CONTROL REGISTER
```

SECTION 5

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00F9 A0 0065 R                      MOV     AL,@CRT_MODE_SET            ; GET THE MODE SET VALUE
00FC EE                             OUT     DX,AL                       ; SET VIDEO ENABLE PORT

                            ;-----  DETERMINE NUMBER OF COLUMNS, BOTH FOR ENTIRE DISPLAY
                            ;-----  AND THE NUMBER TO BE USED FOR TTY INTERFACE

00FD 2E: 8A 84 0000 E               MOV     AL,CS:[SI + OFFSET M6]      ; GET NUMBER OF COLUMNS ON THIS SCREEN
0102 98                             CBW                                 ; CLEAR HIGH BYTE
0103 A3 004A R                      MOV     @CRT_COLS,AX                ; INITIALIZE NUMBER OF COLUMNS COUNT

                            ;-----  SET CURSOR POSITIONS

0106 81 E6 000E                     AND     SI,000EH                    ; WORD OFFSET INTO CLEAR LENGTH TABLE
010A 2E: 8B 84 0000 E               MOV     AX,CS:[SI + OFFSET M5]      ; LENGTH TO CLEAR
010F A3 004C R                      MOV     @CRT_LEN,AX                 ; SAVE LENGTH OF CRT -- NOT USED FOR BW
0112 B9 0008                        MOV     CX,8                        ; CLEAR ALL CURSOR POSITIONS
0115 BF 0050 R                      MOV     DI,OFFSET @CURSOR_POSN
0118 1E                             PUSH    DS                          ; ESTABLISH SEGMENT
0119 07                             POP     ES                          ;   ADDRESSING
011A 33 C0                          XOR     AX,AX
011C F3/ AB                         REP     STOSW                       ; FILL WITH ZEROES

                            ;-----  SET UP OVERSCAN REGISTER

011E 42                             INC     DX                          ; SET OVERSCAN PORT TO A DEFAULT
011F B0 30                          MOV     AL,30H                      ; 30H VALUE FOR ALL MODES EXCEPT 640X200
0121 80 3E 0049 R 06                CMP     @CRT_MODE,6                 ; SEE IF THE MODE IS 640X200 BW
0126 75 02                          JNZ     M14                         ; IF NOT 640X200, THEN GO TO REGULAR
0128 B0 3F                          MOV     AL,3FH                      ; IF IT IS 640X200, THEN PUT IN 3FH
012A                        M14:
012A EE                             OUT     DX,AL                       ; OUTPUT THE CORRECT VALUE TO 3D9 PORT
012B A2 0066 R                      MOV     @CRT_PALETTE,AL             ; SAVE THE VALUE FOR FUTURE USE

                            ;-----  NORMAL RETURN FROM ALL VIDEO RETURNS

012E                        VIDEO_RETURN:
012E 5D                             POP     BP
012F 5F                             POP     DI
0130 5E                             POP     SI
0131 5B                             POP     BX
0132                        M15:                                        ; VIDEO_RETURN_C
0132 59                             POP     CX
0133 5A                             POP     DX
0134 1F                             POP     DS
0135 07                             POP     ES                          ; RECOVER SEGMENTS
0136 CF                             IRET                                ; ALL DONE
0137                        SET_MODE        ENDP
                            ;--------------------------------------------------
                            ; SET_CTYPE
                            ;       THIS ROUTINE SETS THE CURSOR VALUE
                            ; INPUT
                            ;       (CX) HAS CURSOR VALUE CH-START LINE, CL-STOP LINE
                            ; OUTPUT
                            ;       NONE
                            ;--------------------------------------------------
0137                        SET_CTYPE       PROC    NEAR
0137 B4 0A                          MOV     AH,10                       ; 6845 REGISTER FOR CURSOR SET
0139 89 0E 0060 R                   MOV     @CURSOR_MODE,CX             ; SAVE IN DATA AREA
013D E8 0142 R                      CALL    M16                         ; OUTPUT CX REGISTER
0140 EB EC                          JMP     VIDEO_RETURN

                            ;-----  THIS ROUTINE OUTPUTS THE CX REGISTER TO THE 6845 REGISTERS NAMED IN (AH)


0142                        M16:
0142 8B 16 0063 R                   MOV     DX,@ADDR_6845               ; ADDRESS REGISTER
0146 8A C4                          MOV     AL,AH                       ; GET VALUE
0148 EE                             OUT     DX,AL                       ; REGISTER SET
0149 42                             INC     DX                          ; DATA REGISTER
014A EB 00                          JMP     $+2                         ; I/O DELAY
014C 8A C5                          MOV     AL,CH                       ; DATA
014E EE                             OUT     DX,AL
014F 4A                             DEC     DX
0150 8A C4                          MOV     AL,AH
0152 FE C0                          INC     AL                          ; POINT TO OTHER DATA REGISTER
0154 EE                             OUT     DX,AL                       ; SET FOR SECOND REGISTER
0155 42                             INC     DX
0156 EB 00                          JMP     $+2                         ; I/O DELAY
0158 8A C1                          MOV     AL,CL                       ; SECOND DATA VALUE
015A EE                             OUT     DX,AL
015B C3                             RET                                 ; ALL DONE
015C                        SET_CTYPE       ENDP

                            ;----------------------------------------
                            ; SET_CPOS
                            ;       THIS ROUTINE SETS THE CURRENT CURSOR POSITION TO THE
                            ;       NEW X-Y VALUES PASSED
                            ; INPUT
                            ;       DX - ROW,COLUMN OF NEW CURSOR
                            ;       BH - DISPLAY PAGE OF CURSOR
                            ; OUTPUT
                            ;       CURSOR IS SET AT 6845 IF DISPLAY PAGE IS CURRENT DISPLAY
                            ;----------------------------------------
015C                        SET_CPOS        PROC    NEAR
015C 8A C7                          MOV     AL,BH                       ; MOVE PAGE NUMBER TO WORK REGISTER
015E 98                             CBW                                 ; CONVERT PAGE TO WORD VALUE
015F D1 E0                          SAL     AX,1                        ; WORD OFFSET
0161 96                             XCHG    AX,SI                       ; USE INDEX REGISTER
0162 89 94 0050 R                   MOV     [SI+OFFSET @CURSOR_POSN],DX     ; SAVE THE POINTER
0166 38 3E 0062 R                   CMP     @ACTIVE_PAGE,BH
016A 75 05                          JNZ     M17                         ; SET_CPOS_RETURN
016C 8B C2                          MOV     AX,DX                       ; GET ROW/COLUMN TO AX
016E E8 0173 R                      CALL    M18                         ; CURSOR_SET
0171                        M17:                                        ; SET_CPOS_RETURN
0171 EB BB                          JMP     VIDEO_RETURN
0173                        SET_CPOS        ENDP

                            ;-----  SET CURSOR POSITION, AX HAS ROW/COLUMN FOR CURSOR

0173                        M18     PROC    NEAR
0173 E8 01F7 R                      CALL    POSITION                    ; DETERMINE LOCATION IN REGEN BUFFER
0176 8B C8                          MOV     CX,AX
0178 03 0E 004E R                   ADD     CX,@CRT_START               ; ADD IN THE START ADDRESS FOR THIS PAGE
017C D1 F9                          SAR     CX,1                        ; DIVIDE BY 2 FOR CHAR ONLY COUNT
```

```
017E B4 0E                          MOV     AH,14                   ; REGISTER NUMBER FOR CURSOR
0180 E8 0142 R                      CALL    M16                     ; OUTPUT THE VALUE TO THE 6845
0183 C3                             RET
0184                        M18     ENDP
                            ;---------------------------------------------------
                            ; READ_CURSOR
                            ;       THIS ROUTINE READS THE CURRENT CURSOR VALUE FROM THE
                            ;       6845, FORMATS IT, AND SENDS IT BACK TO THE CALLER
                            ; INPUT
                            ;       BH - PAGE OF CURSOR
                            ; OUTPUT
                            ;       DX - ROW, COLUMN OF THE CURRENT CURSOR POSITION
                            ;       CX - CURRENT CURSOR MODE
                            ;----------------------------------------
0184                        READ_CURSOR     PROC    NEAR
0184 8A DF                          MOV     BL,BH
0186 32 FF                          XOR     BH,BH
0188 D1 E3                          SAL     BX,1                    ; WORD OFFSET
018A 8B 97 0050 R                   MOV     DX,[BX+OFFSET @CURSOR_POSN]
018E 8B 0E 0060 R                   MOV     CX,@CURSOR_MODE
0192 5D                             POP     BP
0193 5F                             POP     DI
0194 5E                             POP     SI
0195 5B                             POP     BX
0196 58                             POP     AX                      ; DISCARD SAVED CX AND DX
0197 58                             POP     AX
0198 1F                             POP     DS
0199 07                             POP     ES
019A CF                             IRET
019B                        READ_CURSOR     ENDP
                            ;---------------------------------------------
                            ; ACT_DISP_PAGE
                            ;       THIS ROUTINE SETS THE ACTIVE DISPLAY PAGE, ALLOWING
                            ;       THE FULL USE OF THE MEMORY SET ASIDE FOR THE VIDEO ATTACHMENT
                            ; INPUT
                            ;       AL HAS THE NEW ACTIVE DISPLAY PAGE
                            ; OUTPUT
                            ;       THE 6845 IS RESET TO DISPLAY THAT PAGE
                            ;---------------------------------------------
019B                        ACT_DISP_PAGE   PROC    NEAR
019B A2 0062 R                      MOV     @ACTIVE_PAGE,AL         ; SAVE ACTIVE PAGE VALUE
019E 8B 0E 004C R                   MOV     CX,@CRT_LEN             ; GET SAVED LENGTH OF REGEN BUFFER
01A2 98                             CBW                             ; CONVERT AL TO WORD
01A3 50                             PUSH    AX                      ; SAVE PAGE VALUE
01A4 F7 E1                          MUL     CX                      ; DISPLAY PAGE TIMES REGEN LENGTH
01A6 A3 004E R                      MOV     @CRT_START,AX           ; SAVE START ADDRESS FOR LATER
01A9 8B C8                          MOV     CX,AX                   ; START ADDRESS TO CX
01AB D1 F9                          SAR     CX,1                    ; DIVIDE BY 2 FOR 6845 HANDLING
01AD B4 0C                          MOV     AH,12                   ; 6845 REGISTER FOR START ADDRESS
01AF E8 0142 R                      CALL    M16
01B2 5B                             POP     BX                      ; RECOVER PAGE VALUE
01B3 D1 E3                          SAL     BX,1                    ; *2 FOR WORD OFFSET
01B5 8B 87 0050 R                   MOV     AX,[BX + OFFSET @CURSOR_POSN]   ; GET CURSOR FOR THIS PAGE
01B9 E8 0173 R                      CALL    M18                     ; SET THE CURSOR POSITION
01BC E9 012E R                      JMP     VIDEO_RETURN
01BF                        ACT_DISP_PAGE   ENDP
                            ;----------------------------------------
                            ; SET COLOR
                            ;       THIS ROUTINE WILL ESTABLISH THE BACKGROUND COLOR, THE OVERSCAN COLOR,
                            ;       AND THE FOREGROUND COLOR SET FOR MEDIUM RESOLUTION GRAPHICS
                            ; INPUT
                            ;       (BH) HAS COLOR ID
                            ;               IF BH=0, THE BACKGROUND COLOR VALUE IS SET
                            ;                       FROM THE LOW BITS OF BL (0-31)
                            ;               IF BH=1, THE PALETTE SELECTION IS MADE
                            ;                       BASED ON THE LOW BIT OF BL:
                            ;                               0 = GREEN, RED, YELLOW FOR COLORS 1,2,3
                            ;                               1 = BLUE, CYAN, MAGENTA FOR COLORS 1,2,3
                            ;       (BL) HAS THE COLOR VALUE TO BE USED
                            ; OUTPUT
                            ;       THE COLOR SELECTION IS UPDATED
                            ;---------------------------------------------
01BF                        SET_COLOR       PROC    NEAR
01BF 8B 16 0063 R                   MOV     DX,@ADDR_6845           ; I/O PORT FOR PALETTE
01C3 83 C2 05                       ADD     DX,5                    ; OVERSCAN PORT
01C6 A0 0066 R                      MOV     AL,@CRT_PALETTE         ; GET THE CURRENT PALETTE VALUE
01C9 0A FF                          OR      BH,BH                   ; IS THIS COLOR 0?
01CB 75 0E                          JNZ     M20                     ; OUTPUT COLOR 1

                            ;-----  HANDLE COLOR 0 BY SETTING THE BACKGROUND COLOR

01CD 24 E0                          AND     AL,0E0H                 ; TURN OFF LOW 5 BITS OF CURRENT
01CF 80 E3 1F                       AND     BL,01FH                 ; TURN OFF HIGH 3 BITS OF INPUT VALUE
01D2 0A C3                          OR      AL,BL                   ; PUT VALUE INTO REGISTER
01D4                        M19:                                    ; OUTPUT THE PALETTE
01D4 EE                             OUT     DX,AL                   ; OUTPUT COLOR SELECTION TO 3D9 PORT
01D5 A2 0066 R                      MOV     @CRT_PALETTE,AL         ; SAVE THE COLOR VALUE
01D8 E9 012E R                      JMP     VIDEO_RETURN

                            ;-----  HANDLE COLOR 1 BY SELECTING THE PALETTE TO BE USED

01DB                        M20:
01DB 24 DF                          AND     AL,0DFH                 ; TURN OFF PALETTE SELECT BIT
01DD D0 EB                          SHR     BL,1                    ; TEST THE LOW ORDER BIT OF BL
01DF 73 F3                          JNC     M19                     ; ALREADY DONE
01E1 0C 20                          OR      AL,20H                  ; TURN ON PALETTE SELECT BIT
01E3 EB EF                          JMP     M19                     ; GO DO IT
01E5                        SET_COLOR       ENDP
                            ;---------------------------------------------
                            ; VIDEO STATE
                            ;  RETURNS THE CURRENT VIDEO STATE IN AX
                            ;  AH = NUMBER OF COLUMNS ON THE SCREEN
                            ;  AL = CURRENT VIDEO MODE
                            ;  BH = CURRENT ACTIVE PAGE
                            ;---------------------------------------------
01E5                        VIDEO_STATE     PROC    NEAR
01E5 8A 26 004A R                   MOV     AH,BYTE PTR @CRT_COLS   ; GET NUMBER OF COLUMNS
01E9 A0 0049 R                      MOV     AL,@CRT_MODE            ; CURRENT MODE
01EC 8A 3E 0062 R                   MOV     BH,@ACTIVE_PAGE         ; GET CURRENT ACTIVE PAGE
01F0 5D                             POP     BP                      ; RECOVER REGISTERS
01F1 5F                             POP     DI
01F2 5E                             POP     SI
01F3 59                             POP     CX                      ; DISCARD SAVED BX
01F4 E9 0132 R                      JMP     M15                     ; RETURN TO CALLER
```

```
 01F7                      VIDEO_STATE     ENDP
                           ;---------------------------------------
                           ; POSITION
                           ;       THIS SERVICE ROUTINE CALCULATES THE REGEN BUFFER ADDRESS
                           ;       OF A CHARACTER IN THE ALPHA MODE
                           ; INPUT
                           ;       AX = ROW, COLUMN POSITION
                           ; OUTPUT
                           ;       AX = OFFSET OF CHAR POSITION IN REGEN BUFFER
                           ;---------------------------------------
 01F7                      POSITION        PROC    NEAR
 01F7 53                           PUSH    BX                      ; SAVE REGISTER
 01F8 8B D8                        MOV     BX,AX
 01FA 8A C4                        MOV     AL,AH                   ; ROWS TO AL
 01FC F6 26 004A R                 MUL     BYTE PTR @CRT_COLS      ; DETERMINE BYTES TO ROW
 0200 32 FF                        XOR     BH,BH
 0202 03 C3                        ADD     AX,BX                   ; ADD IN COLUMN VALUE
 0204 D1 E0                        SAL     AX,1                    ; * 2 FOR ATTRIBUTE BYTES
 0206 5B                           POP     BX
 0207 C3                           RET
 0208                      POSITION        ENDP
                           ;---------------------------------------
                           ; SCROLL UP
                           ;       THIS ROUTINE MOVES A BLOCK OF CHARACTERS UP
                           ;       ON THE SCREEN
                           ; INPUT
                           ;       (AH) = CURRENT CRT MODE
                           ;       (AL) = NUMBER OF ROWS TO SCROLL
                           ;       (CX) = ROW/COLUMN OF UPPER LEFT CORNER
                           ;       (DX) = ROW/COLUMN OF LOWER RIGHT CORNER
                           ;       (BH) = ATTRIBUTE TO BE USED ON BLANKED LINE
                           ;       (DS) = DATA SEGMENT
                           ;       (ES) = REGEN BUFFER SEGMENT
                           ; OUTPUT
                           ;       NONE -- THE REGEN BUFFER IS MODIFIED
                           ;---------------------------------------
                                   ASSUME  DS:DATA,ES:DATA
 0208                      SCROLL_UP       PROC    NEAR

 0208 E8 02E4 R                    CALL    TEST_LINE_COUNT
 020B 80 FC 04                     CMP     AH,4                    ; TEST FOR GRAPHICS MODE
 020E 72 08                        JC      N1                      ; HANDLE SEPARATELY
 0210 80 FC 07                     CMP     AH,7                    ; TEST FOR BW CARD
 0213 74 03                        JE      N1
 0215 E9 04A3 R                    JMP     GRAPHICS_UP
 0218                      N1:                                     ; UP_CONTINUE
 0218 53                           PUSH    BX                      ; SAVE FILL ATTRIBUTE IN BH
 0219 8B C1                        MOV     AX,CX                   ; UPPER LEFT POSITION
 021B E8 0255 R                    CALL    SCROLL_POSITION         ; DO SETUP FOR SCROLL
 021E 74 31                        JZ      N7                      ; BLANK_FIELD
 0220 03 F0                        ADD     SI,AX                   ; FROM ADDRESS
 0222 8A E6                        MOV     AH,DH                   ; # ROWS IN BLOCK
 0224 2A E3                        SUB     AH,BL                   ; # ROWS TO BE MOVED
 0226                      N2:                                     ; ROW_LOOP
 0226 E8 0297 R                    CALL    N10                     ; MOVE ONE ROW
 0229 03 F5                        ADD     SI,BP
 022B 03 FD                        ADD     DI,BP                   ; POINT TO NEXT LINE IN BLOCK
 022D FE CC                        DEC     AH                      ; COUNT OF LINES TO MOVE
 022F 75 F5                        JNZ     N2                      ; ROW_LOOP
 0231                      N3:                                     ; CLEAR_ENTRY
 0231 58                           POP     AX                      ; RECOVER ATTRIBUTE IN AH
 0232 B0 20                        MOV     AL,' '                  ; FILL WITH BLANKS
 0234                      N4:                                     ; CLEAR_LOOP
 0234 E8 02A0 R                    CALL    N11                     ; CLEAR THE ROW
 0237 03 FD                        ADD     DI,BP                   ; POINT TO NEXT LINE
 0239 FE CB                        DEC     BL                      ; COUNTER OF LINES TO SCROLL
 023B 75 F7                        JNZ     N4                      ; CLEAR_LOOP
 023D                      N5:                                     ; SCROLL_END
 023D E8 0000 E                    CALL    DDS
 0240 80 3E 0049 R 07              CMP     @CRT_MODE,7             ; IS THIS THE BLACK AND WHITE CARD
 0245 74 07                        JE      N6                      ; IF SO, SKIP THE MODE RESET
 0247 A0 0065 R                    MOV     AL,@CRT_MODE_SET        ; GET THE VALUE OF THE MODE SET
 024A BA 03D8                      MOV     DX,03D8H                ; ALWAYS SET COLOR CARD PORT
 024D EE                           OUT     DX,AL
 024E                      N6:                                     ; VIDEO_RET_HERE
 024E E9 012E R                    JMP     VIDEO_RETURN
 0251                      N7:                                     ; BLANK_FIELD
 0251 8A DE                        MOV     BL,DH                   ; GET ROW COUNT
 0253 EB DC                        JMP     N3                      ; GO CLEAR THAT AREA
 0255                      SCROLL_UP       ENDP

                           ;----- HANDLE COMMON SCROLL SET UP HERE

 0255                      SCROLL_POSITION PROC    NEAR
 0255 E8 01F7 R                    CALL    POSITION                ; CONVERT TO REGEN POINTER
 0258 03 06 004E R                 ADD     AX,@CRT_START           ; OFFSET OF ACTIVE PAGE
 025C 8B F8                        MOV     DI,AX                   ; TO ADDRESS FOR SCROLL
 025E 8B F0                        MOV     SI,AX                   ; FROM ADDRESS FOR SCROLL
 0260 2B D1                        SUB     DX,CX                   ; DX = #ROWS, #COLS IN BLOCK
 0262 FE C6                        INC     DH
 0264 FE C2                        INC     DL                      ; INCREMENT FOR 0 ORIGIN
 0266 32 ED                        XOR     CH,CH                   ; SET HIGH BYTE OF COUNT TO ZERO
 0268 8B 2E 004A R                 MOV     BP,@CRT_COLS            ; GET NUMBER OF COLUMNS IN DISPLAY
 026C 03 ED                        ADD     BP,BP                   ; TIMES 2 FOR ATTRIBUTE BYTE
 026E 8A C3                        MOV     AL,BL                   ; GET LINE COUNT
 0270 F6 26 004A R                 MUL     BYTE PTR @CRT_COLS      ; DETERMINE OFFSET TO FROM ADDRESS
 0274 03 C0                        ADD     AX,AX                   ; *2 FOR ATTRIBUTE BYTE
 0276 50                           PUSH    AX                      ; SAVE LINE COUNT
 0277 A0 0049 R                    MOV     AL,@CRT_MODE            ; GET CURRENT MODE
 027A 06                           PUSH    ES                      ; ESTABLISH ADDRESSING TO REGEN BUFFER
 027B 1F                           POP     DS                      ;  FOR BOTH POINTERS
 027C 3C 02                        CMP     AL,2                    ; TEST FOR COLOR CARD SPECIAL CASES HERE
 027E 72 13                        JB      N9                      ; HAVE TO HANDLE 80X25 SEPARATELY
 0280 3C 03                        CMP     AL,3
 0282 77 0F                        JA      N9
                           ;-----                                  ; 80X25 COLOR CARD SCROLL
 0284 52                           PUSH    DX
 0285 BA 03DA                      MOV     DX,3DAH                 ; GUARANTEED TO BE COLOR CARD HERE
 0288                      N8:                                     ; WAIT_DISP_ENABLE
 0288 EC                           IN      AL,DX                   ; GET PORT
 0289 A8 08                        TEST    AL,RVRT                 ; WAIT FOR VERTICAL RETRACE
 028B 74 FB                        JZ      N8                      ; WAIT_DISP_ENABLE
 028D B0 25                        MOV     AL,25H
 028F B2 D8                        MOV     DL,0D8H                 ; ADDRESS CONTROL PORT
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0291 EE                     OUT     DX,AL               ; TURN OFF VIDEO DURING VERTICAL RETRACE
0292 5A                     POP     DX
0293                N9:
0293 58                     POP     AX                  ; RESTORE LINE COUNT
0294 0A DB                  OR      BL,BL               ; 0 SCROLL MEANS BLANK FIELD
0296 C3                     RET                         ; RETURN WITH FLAGS SET
0297                SCROLL_POSITION ENDP

                    ;----- MOVE_ROW
0297                N10     PROC    NEAR
0297 8A CA                  MOV     CL,DL               ; GET # OF COLS TO MOVE
0299 56                     PUSH    SI
029A 57                     PUSH    DI                  ; SAVE START ADDRESS
029B F3/ A5                 REP     MOVSW               ; MOVE THAT LINE ON SCREEN
029D 5F                     POP     DI
029E 5E                     POP     SI                  ; RECOVER ADDRESSES
029F C3                     RET
02A0                N10     ENDP

                    ;----- CLEAR_ROW
02A0                N11     PROC    NEAR
02A0 8A CA                  MOV     CL,DL               ; GET # COLUMNS TO CLEAR
02A2 57                     PUSH    DI
02A3 F3/ AB                 REP     STOSW               ; STORE THE FILL CHARACTER
02A5 5F                     POP     DI
02A6 C3                     RET
02A7                N11     ENDP
                    ;----------------------------------------
                    ; SCROLL_DOWN
                    ;       THIS ROUTINE MOVES THE CHARACTERS WITHIN A DEFINED
                    ;       BLOCK DOWN ON THE SCREEN, FILLING THE TOP LINES
                    ;       WITH A DEFINED CHARACTER
                    ; INPUT
                    ;       (AH) = CURRENT CRT MODE
                    ;       (AL) = NUMBER OF LINES TO SCROLL
                    ;       (CX) = UPPER LEFT CORNER OF REGION
                    ;       (DX) = LOWER RIGHT CORNER OF REGION
                    ;       (BH) = FILL CHARACTER
                    ;       (DS) = DATA SEGMENT
                    ;       (ES) = REGEN SEGMENT
                    ; OUTPUT
                    ;       NONE -- SCREEN IS SCROLLED
                    ;----------------------------------------
02A7                SCROLL_DOWN     PROC    NEAR
02A7 FD                     STD                         ; DIRECTION FOR SCROLL DOWN
02A8 E8 02E4 R              CALL    TEST_LINE_COUNT     ;
02AB 80 FC 04               CMP     AH,4                ; TEST FOR GRAPHICS
02AE 72 08                  JC      N12
02B0 80 FC 07               CMP     AH,7                ; TEST FOR BW CARD
02B3 74 03                  JE      N12
02B5 E9 04FA R              JMP     GRAPHICS_DOWN
02B8                N12:                                ; CONTINUE_DOWN
02B8 53                     PUSH    BX                  ; SAVE ATTRIBUTE IN BH
02B9 8B C2                  MOV     AX,DX               ; LOWER RIGHT CORNER
02BB E8 0255 R              CALL    SCROLL_POSITION     ; GET REGEN LOCATION
02BE 74 20                  JZ      N16
02C0 2B F0                  SUB     SI,AX               ; SI IS FROM ADDRESS
02C2 8A E6                  MOV     AH,DH               ; GET TOTAL # ROWS
02C4 2A E3                  SUB     AH,BL               ; COUNT TO MOVE IN SCROLL
02C6                N13:
02C6 E8 0297 R              CALL    N10                 ; MOVE ONE ROW
02C9 2B F5                  SUB     SI,BP
02CB 2B FD                  SUB     DI,BP
02CD FE CC                  DEC     AH
02CF 75 F5                  JNZ     N13
02D1                N14:
02D1 58                     POP     AX                  ; RECOVER ATTRIBUTE IN AH
02D2 B0 20                  MOV     AL,' '
02D4                N15:
02D4 E8 02A0 R              CALL    N11                 ; CLEAR ONE ROW
02D7 2B FD                  SUB     DI,BP               ; GO TO NEXT ROW
02D9 FE CB                  DEC     BL
02DB 75 F7                  JNZ     N15
02DD E9 023D R              JMP     N5                  ; SCROLL_END
02E0                N16:
02E0 8A DE                  MOV     BL,DH
02E2 EB ED                  JMP     N14
02E4                SCROLL_DOWN     ENDP

                    ;-----  IF  AMOUNT OF LINES TO BE SCROLLED = AMOUNT OF LINES IN WINDOW
                    ;-----    THEN  ADJUST AL; ELSE  RETURN;

02E4                TEST_LINE_COUNT PROC    NEAR

02E4 8A D8                  MOV     BL,AL               ; SAVE LINE COUNT IN BL
02E6 0A C0                  OR      AL,AL               ; TEST IF AL IS ALREADY ZERO
02E8 74 0E                  JZ      BL_SET              ; IF IT IS THEN RETURN...
02EA 50                     PUSH    AX                  ; SAVE AX
02EB 8A C6                  MOV     AL,DH               ; SUBTRACT LOWER ROW FROM UPPER ROW
02ED 2A C5                  SUB     AL,CH
02EF FE C0                  INC     AL                  ; ADJUST DIFFERENCE BY 1
02F1 3A C3                  CMP     AL,BL               ; LINE COUNT = AMOUNT OF ROWS IN WINDOW?
02F3 58                     POP     AX                  ; RESTORE AX
02F4 75 02                  JNE     BL_SET              ; IF NOT THEN WE'RE ALL SET
02F6 2A DB                  SUB     BL,BL               ; OTHERWISE SET BL TO ZERO
02F8                BL_SET:
02F8 C3                     RET                         ; RETURN
02F9                TEST_LINE_COUNT ENDP
```

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                              PAGE
                              ;-----------------------------------------------------------------------
                              ; READ_AC_CURRENT                                                       :
                              ;       THIS ROUTINE READS THE ATTRIBUTE AND CHARACTER AT THE CURRENT   :
                              ;       CURSOR POSITION AND RETURNS THEM TO THE CALLER                  :
                              ; INPUT                                                                 :
                              ;       (AH) = CURRENT CRT MODE                                         :
                              ;       (BH) = DISPLAY PAGE ( ALPHA MODES ONLY )                        :
                              ;       (DS) = DATA SEGMENT                                             :
                              ;       (ES) = REGEN SEGMENT                                            :
                              ; OUTPUT                                                                :
                              ;       (AL) = CHARACTER READ                                           :
                              ;       (AH) = ATTRIBUTE READ                                           :
                              ;-----------------------------------------------------------------------
                                      ASSUME  DS:DATA,ES:DATA

 02F9                         READ_AC_CURRENT PROC    NEAR
 02F9 80 FC 04                        CMP     AH,4                    ; IS THIS GRAPHICS
 02FC 72 08                           JC      P10

 02FE 80 FC 07                        CMP     AH,7                    ; IS THIS BW CARD
 0301 74 03                           JE      P10

 0303 E9 062A R                       JMP     GRAPHICS_READ
 0306                         P10:                                    ;  READ_AC_CONTINUE
 0306 E8 0322 R                       CALL    FIND_POSITION           ; GET REGEN LOCATION AND PORT ADDRESS
 0309 8B F7                           MOV     SI,DI                   ; ESTABLISH ADDRESSING IN SI
 030B 06                              PUSH    ES                      ; GET REGEN SEGMENT FOR QUICK ACCESS
 030C 1F                              POP     DS

                              ;-----  WAIT FOR HORIZONTAL RETRACE OR VERTICAL RETRACE IF COLOR 80

 030D 0A DB                           OR      BL,BL                   ; CHECK MODE FLAG FOR COLOR CARD IN 80
 030F 75 0D                           JNZ     P13                     ; ELSE SKIP RETRACE WAIT - DO FAST READ
 0311                         P11:                                    ;  WAIT FOR HORZ RETRACE LOW OR VERTICAL
 0311 FB                              STI                             ; ENABLE INTERRUPTS FIRST
 0312 90                              NOP                             ; ALLOW FOR SMALL INTERRUPT WINDOW
 0313 FA                              CLI                             ; BLOCK INTERRUPTS FOR SINGLE LOOP
 0314 EC                              IN      AL,DX                   ; GET STATUS FROM THE ADAPTER
 0315 A8 01                           TEST    AL,RHRZ                 ; IS HORIZONTAL RETRACE LOW
 0317 75 F8                           JNZ     P11                     ; WAIT UNTIL IT IS
 0319                         P12:                                    ;  NOW WAIT FOR EITHER RETRACE HIGH
 0319 EC                              IN      AL,DX                   ; GET STATUS
 031A A8 09                           TEST    AL,RVRT+RHRZ            ; IS HORIZONTAL OR VERTICAL RETRACE HIGH
 031C 74 FB                           JZ      P12                     ; WAIT UNTIL EITHER IS ACTIVE
 031E                         P13:
 031E AD                              LODSW                           ; GET THE CHARACTER AND ATTRIBUTE
 031F E9 012E R                       JMP     VIDEO_RETURN            ;  EXIT WITH (AX)

 0322                         READ_AC_CURRENT ENDP


 0322                         FIND_POSITION   PROC    NEAR            ;       SETUP FOR BUFFER READ OR WRITE
 0322 86 E3                           XCHG    AH,BL                   ; SWAP MODE TYPE WITH ATTRIBUTE
 0324 8B E8                           MOV     BP,AX                   ; SAVE CHARACTER/ATTR IN (BP) REGISTER
 0326 80 EB 02                        SUB     BL,2                    ; CONVERT DISPLAY MODE TYPE TO A
 0329 D0 EB                           SHR     BL,1                    ;  ZERO VALUE FOR COLOR IN 80 COLUMN
 032B 8B F3                           MOV     SI,BX                   ;  AND SAVE (2 OR 3 --> ZERO)
 032D 8A DF                           MOV     BL,BH                   ; MOVE DISPLAY PAGE TO LOW BYTE
 032F 32 FF                           XOR     BH,BH                   ; CLEAR HIGH BYTE OF COUNT/BYTE OFFSET
 0331 8B FB                           MOV     DI,BX                   ; MOVE DISPLAY PAGE (COUNT) TO WORK REG
 0333 D1 E7                           SAL     DI,1                    ; TIMES 2 FOR WORD OFFSET
 0335 8B 85 0050 R                    MOV     AX,[DI+OFFSET @CURSOR_POSN]     ; GET ROW/COLUMN OF THAT PAGE
 0339 74 09                           JZ      P21                     ; SKIP BUFFER ADJUSTMENT IF PAGE ZERO

 033B 33 FF                           XOR     DI,DI                   ; ELSE SET BUFFER START ADDRESS TO ZERO
 033D                         P20:
 033D 03 3E 004C R                    ADD     DI,@CRT_LEN             ; ADD LENGTH OF BUFFER FOR ONE PAGE
 0341 4B                              DEC     BX                      ; DECREMENT PAGE COUNT
 0342 75 F9                           JNZ     P20                     ; LOOP TILL PAGE COUNT EXHAUSTED
 0344                         P21:
 0344 E8 01F7 R                       CALL    POSITION                ; DETERMINE LOCATION IN REGEN IN PAGE
 0347 03 F8                           ADD     DI,AX                   ; ADD LOCATION TO START OF REGEN PAGE
 0349 8B 16 0063 R                    MOV     DX,@ADDR_6845           ; GET BASE ADDRESS OF ACTIVE DISPLAY
 034D 83 C2 06                        ADD     DX,6                    ; POINT AT STATUS PORT
 0350 8B DE                           MOV     BX,SI                   ; RECOVER CONVERTED MODE TYPE IN (BL)
 0352 C3                              RET                             ;  BP= ATTRIBUTE/CHARACTER (FROM BL/AL)
                                                                      ;  DI= POSITION (OFFSET IN REGEN BUFFER)
                                                                      ;  DX= STATUS PORT ADDRESS OF ADAPTER
 0353                         FIND_POSITION   ENDP                    ;  BL= MODE FLAG (ZERO FOR 80X25 COLOR)
```

```
                                PAGE
                                ;-------------------------------------------------------------------------
                                ; WRITE_AC_CURRENT                                                        :
                                ;       THIS ROUTINE WRITES THE ATTRIBUTE AND CHARACTER                   :
                                ;       AT THE CURRENT CURSOR POSITION                                    :
                                ; INPUT                                                                   :
                                ;       (AH) = CURRENT CRT MODE                                           :
                                ;       (BH) = DISPLAY PAGE                                               :
                                ;       (CX) = COUNT OF CHARACTERS TO WRITE                               :
                                ;       (AL) = CHAR TO WRITE                                              :
                                ;       (BL) = ATTRIBUTE OF CHAR TO WRITE                                 :
                                ;       (DS) = DATA SEGMENT                                               :
                                ;       (ES) = REGEN SEGMENT                                              :
                                ; OUTPUT                                                                  :
                                ;       DISPLAY REGEN BUFFER UPDATED                                      :
                                ;-------------------------------------------------------------------------

 0353                           WRITE_AC_CURRENT        PROC    NEAR
 0353 80 FC 04                          CMP     AH,4                    ; IS THIS GRAPHICS
 0356 72 08                             JC      P30
 0358 80 FC 07                          CMP     AH,7                    ; IS THIS BW CARD
 035B 74 03                             JE      P30
 035D E9 0582 R                         JMP     GRAPHICS_WRITE
 0360                           P30:                                    ;  WRITE_AC_CONTINUE
 0360 E8 0322 R                         CALL    FIND_POSITION           ; GET REGEN LOCATION AND PORT ADDRESS
                                                                        ; ADDRESS IN (DI) REGISTER
 0363 0A DB                             OR      BL,BL                   ; CHECK MODE FLAG FOR COLOR CARD AT 80
 0365 74 06                             JZ      P32                     ; SKIP TO RETRACE WAIT IF COLOR AT 80

 0367 95                                XCHG    AX,BP                   ; GET THE ATTR/CHAR SAVED FOR FAST WRITE
 0368 F3/ AB                            REP     STOSW                   ; STRING WRITE THE ATTRIBUTE & CHARACTER
 036A EB 16                             JMP     SHORT  P35              ; EXIT FAST WRITE ROUTINE

                                ;-----  WAIT FOR HORIZONTAL RETRACE OR VERTICAL RETRACE IF COLOR 80

 036C                           P31:                                    ;  LOOP FOR EACH ATTR/CHAR WRITE
 036C 95                                XCHG    BP,AX                   ; PLACE ATTR/CHAR BACK IN SAVE REGISTER
 036D                           P32:                                    ;  WAIT FOR HORZ RETRACE LOW OR VERTICAL
 036D FB                                STI                             ; ENABLE INTERRUPTS FIRST
 036E 90                                NOP                             ; ALLOW FOR INTERRUPT WINDOW
 036F FA                                CLI                             ; BLOCK INTERRUPTS FOR SINGLE LOOP
 0370 EC                                IN      AL,DX                   ; GET STATUS FROM THE ADAPTER
 0371 A8 08                             TEST    AL,RVRT                 ; CHECK FOR VERTICAL RETRACE FIRST
 0373 75 09                             JNZ     P34                     ; DO FAST WRITE NOW IF VERTICAL RETRACE
 0375 A8 01                             TEST    AL,RHRZ                 ; IS HORIZONTAL RETRACE LOW THEN
 0377 75 F4                             JNZ     P32                     ; WAIT UNTIL IT IS
 0379                           P33:                                    ;  WAIT FOR EITHER RETRACE HIGH
 0379 EC                                IN      AL,DX                   ; GET STATUS AGAIN
 037A A8 09                             TEST    AL,RVRT+RHRZ            ; IS HORIZONTAL OR VERTICAL RETRACE HIGH
 037C 74 FB                             JZ      P33                     ; WAIT UNTIL EITHER IS ACTIVE
 037E                           P34:
 037E 95                                XCHG    AX,BP                   ; GET THE ATTR/CHAR SAVED IN (BP)
 037F AB                                STOSW                           ; WRITE THE ATTRIBUTE AND CHARACTER
 0380 E2 EA                             LOOP    P31                     ; AS MANY TIMES AS REQUESTED - TILL CX=0
 0382                           P35:
 0382 E9 012E R                         JMP     VIDEO_RETURN            ; EXIT

 0385                           WRITE_AC_CURRENT        ENDP

                                ;-------------------------------------------------------------------------
                                ; WRITE_C_CURRENT                                                         :
                                ;       THIS ROUTINE WRITES THE CHARACTER AT                              :
                                ;       THE CURRENT CURSOR POSITION, ATTRIBUTE UNCHANGED                  :
                                ; INPUT                                                                   :
                                ;       (AH) = CURRENT CRT MODE                                           :
                                ;       (BH) = DISPLAY PAGE                                               :
                                ;       (CX) = COUNT OF CHARACTERS TO WRITE                               :
                                ;       (AL) = CHAR TO WRITE                                              :
                                ;       (DS) = DATA SEGMENT                                               :
                                ;       (ES) = REGEN SEGMENT                                              :
                                ; OUTPUT                                                                  :
                                ;       DISPLAY REGEN BUFFER UPDATED                                      :
                                ;-------------------------------------------------------------------------

 0385                           WRITE_C_CURRENT PROC    NEAR
 0385 80 FC 04                          CMP     AH,4                    ; IS THIS GRAPHICS
 0388 72 08                             JC      P40
 038A 80 FC 07                          CMP     AH,7                    ; IS THIS BW CARD
 038D 74 03                             JE      P40
 038F E9 0582 R                         JMP     GRAPHICS_WRITE
 0392                           P40:
 0392 E8 0322 R                         CALL    FIND_POSITION           ; GET REGEN LOCATION AND PORT ADDRESS
                                                                        ; ADDRESS OF LOCATION IN (DI)

                                ;-----  WAIT FOR HORIZONTAL RETRACE OR VERTICAL RETRACE IF COLOR 80

 0395                           P41:                                    ;  WAIT FOR HORZ RETRACE LOW OR VERTICAL
 0395 FB                                STI                             ; ENABLE INTERRUPTS FIRST
 0396 0A DB                             OR      BL,BL                   ; CHECK MODE FLAG FOR COLOR CARD IN 80
 0398 75 0F                             JNZ     P43                     ; ELSE SKIP RETRACE WAIT - DO FAST WRITE
 039A FA                                CLI                             ; BLOCK INTERRUPTS FOR SINGLE LOOP
 039B EC                                IN      AL,DX                   ; GET STATUS FROM THE ADAPTER
 039C A8 08                             TEST    AL,RVRT                 ; CHECK FOR VERTICAL RETRACE FIRST
 039E 75 09                             JNZ     P43                     ; DO FAST WRITE NOW IF VERTICAL RETRACE
 03A0 A8 01                             TEST    AL,RHRZ                 ; IS HORIZONTAL RETRACE LOW THEN
 03A2 75 F1                             JNZ     P41                     ; WAIT UNTIL IT IS
 03A4                           P42:                                    ;  WAIT FOR EITHER RETRACE HIGH
 03A4 EC                                IN      AL,DX                   ; GET STATUS AGAIN
 03A5 A8 09                             TEST    AL,RVRT+RHRZ            ; IS HORIZONTAL OR VERTICAL RETRACE HIGH
 03A7 74 FB                             JZ      P42                     ; WAIT UNTIL EITHER RETRACE ACTIVE
 03A9                           P43:
 03A9 8B C5                             MOV     AX,BP                   ; GET THE CHARACTER SAVE IN (BP)
 03AB AA                                STOSB                           ; PUT THE CHARACTER INTO REGEN BUFFER
 03AC 47                                INC     DI                      ; BUMP POINTER PAST ATTRIBUTE
 03AD E2 E6                             LOOP    P41                     ;  AS MANY TIMES AS REQUESTED

 03AF E9 012E R                         JMP     VIDEO_RETURN

 03B2                           WRITE_C_CURRENT ENDP
```

SECTION 5

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                               PAGE
                               ;--------------------------------------------------------------------------------
                               ; WRITE_STRING                                                                   :
                               ;       THIS ROUTINE WRITES A STRING OF CHARACTERS TO THE CRT.                   :
                               ; INPUT                                                                          :
                               ;       (AL) = WRITE STRING COMMAND  0 - 3                                       :
                               ;       (BH) = DISPLAY PAGE                                                      :
                               ;       (CX) = COUNT OF CHARACTERS TO WRITE, IF (CX) = 0 THEN RETURN             :
                               ;       (DX) = CURSOR POSITION FOR START OF STRING WRITE                         :
                               ;       (BL) = ATTRIBUTE OF CHARACTER TO WRITE IF (AL) = 0  OR  (AL) = 1         :
                               ;       (ES) = SOURCE STRING SEGMENT                                             :
                               ;       (BP) = SOURCE STRING OFFSET                                              :
                               ; OUTPUT                                                                         :
                               ;       NONE                                                                     :
                               ;--------------------------------------------------------------------------------
 03B2                          WRITE_STRING    PROC    NEAR
 03B2 3C 04                            CMP     AL,04                   ; TEST FOR INVALID WRITE STRING OPTION
 03B4 73 7C                            JNB     P59                     ; IF OPTION INVALID THEN RETURN
 03B6 E3 7A                            JCXZ    P59                     ; IF ZERO LENGTH STRING THEN RETURN

 03B8 8B F3                            MOV     SI,BX                   ; GET CURRENT CURSOR PAGE
 03BA C1 EE 08                         SHR     SI,8                    ; CLEAR HIGH BYTE
 03BD D1 E6                            SAL     SI,1                    ; CONVERT TO PAGE OFFSET  (SI= PAGE)
 03BF FF B4 0050 R                     PUSH    [SI+OFFSET @CURSOR_POSN]; SAVE CURRENT CURSOR POSITION IN STACK
 03C3 50                               PUSH    AX                      ; SAVE WRITE STRING OPTION
 03C4 B8 0200                          MOV     AX,0200H                ; SET NEW CURSOR POSITION
 03C7 CD 10                            INT     10H
 03C9 58                               POP     AX                      ; RESTORE WRITE STRING OPTION
 03CA                          P50:
 03CA 51                               PUSH    CX
 03CB 53                               PUSH    BX
 03CC 50                               PUSH    AX
 03CD 86 E0                            XCHG    AH,AL                   ; PUT THE WRITE STRING OPTION INTO (AH)
 03CF 26: 8A 46 00                     MOV     AL,ES:[BP]              ; GET CHARACTER FROM INPUT STRING
 03D3 45                               INC     BP                      ; BUMP POINTER TO CHARACTER

                               ;-----  TEST FOR SPECIAL CHARACTER'S

 03D4 3C 08                            CMP     AL,08H                  ; IS IT A BACKSPACE
 03D6 74 0C                            JE      P51                     ; BACK_SPACE
 03D8 3C 0D                            CMP     AL,CR                   ; IS IT CARRIAGE RETURN
 03DA 74 08                            JE      P51                     ; CAR_RET
 03DC 3C 0A                            CMP     AL,LF                   ; IS IT A LINE FEED
 03DE 74 04                            JE      P51                     ; LINE_FEED
 03E0 3C 07                            CMP     AL,07H                  ; IS IT A BELL
 03E2 75 0D                            JNE     P52                     ; IF NOT THEN DO WRITE CHARACTER
 03E4                          P51:
 03E4 B4 0E                            MOV     AH,0EH                  ; TTY_CHARACTER WRITE
 03E6 CD 10                            INT     10H                       ; WRITE TTY CHARACTER TO THE CRT
 03E8 8B 94 0050 R                     MOV     DX,[SI+OFFSET @CURSOR_POSN] ; GET CURRENT CURSOR POSITION
 03EC 58                               POP     AX                        ; RESTORE REGISTERS
 03ED 5B                               POP     BX
 03EE 59                               POP     CX
 03EF EB 2E                            JMP     SHORT P54               ; GO SET CURSOR POSITION AND CONTINUE
 03F1                          P52:
 03F1 B9 0001                          MOV     CX,1                    ; SET CHARACTER WRITE AMOUNT TO ONE
 03F4 80 FC 02                         CMP     AH,2                    ; IS THE ATTRIBUTE IN THE STRING
 03F7 72 05                            JB      P53                     ; IF NOT THEN SKIP
 03F9 26: 8A 5E 00                     MOV     BL,ES:[BP]              ; ELSE GET NEW ATTRIBUTE
 03FD 45                               INC     BP                      ; BUMP STRING POINTER
 03FE                          P53:
 03FE B4 09                            MOV     AH,09H                  ;  GOT_CHARACTER
 0400 CD 10                            INT     10H                     ; WRITE CHARACTER TO THE CRT
 0402 58                               POP     AX                      ; RESTORE REGISTERS
 0403 5B                               POP     BX
 0404 59                               POP     CX
 0405 FE C2                            INC     DL                      ; INCREMENT COLUMN COUNTER
 0407 3A 16 004A R                     CMP     DL,BYTE PTR @CRT_COLS   ; IF COLS ARE WITHIN RANGE FOR THIS MODE
 040B 72 12                            JB      P54                     ;    THEN GO TO COLUMNS SET
 040D FE C6                            INC     DH                      ; BUMP ROW COUNTER BY ONE
 040F 2A D2                            SUB     DL,DL                   ; SET COLUMN COUNTER TO ZERO
 0411 80 FE 19                         CMP     DH,25                   ; IF ROWS ARE LESS THAN 25 THEN
 0414 72 09                            JB      P54                     ;    GO TO ROWS_COLUMNS_SET

 0416 50                               PUSH    AX                      ; ELSE SCROLL SCREEN
 0417 B8 0E0A                          MOV     AX,0E0AH                ; DO SCROLL ONE LINE
 041A CD 10                            INT     10H                     ; RESET ROW COUNTER TO 24
 041C FE CE                            DEC     DH
 041E 58                               POP     AX                      ; RESTORE REGISTERS
 041F                          P54:                                    ;  ROW_COLUMNS_SET
 041F 50                               PUSH    AX                      ; SAVE WRITE STRING OPTION
 0420 B8 0200                          MOV     AX,0200H                ; SET NEW CURSOR POSITION COMMAND
 0423 CD 10                            INT     10H                     ; ESTABLISH NEW CURSOR POSITION
 0425 58                               POP     AX
 0426 E2 A2                            LOOP    P50                     ; DO IT ONCE MORE UNTIL (CX) = ZERO

 0428 5A                               POP     DX                      ; RESTORE OLD CURSOR COORDINATES
 0429 A8 01                            TEST    AL,01H                  ; IF CURSOR WAS NOT TO BE MOVED THEN
 042B 75 05                            JNZ     P59                     ;  THEN EXIT WITHOUT RESETTING OLD VALUE
 042D B8 0200                          MOV     AX,0200H                ; ELSE RESTORE OLD CURSOR POSITION
 0430 CD 10                            INT     10H
 0432                          P59:                                    ;  DONE - EXIT WRITE STRING
 0432 E9 012E R                        JMP     VIDEO_RETURN            ; RETURN TO CALLER

 0435                          WRITE_STRING    ENDP
```

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                                  PAGE
                                  ;--------------------------------------------
                                  ; READ DOT  -- WRITE DOT
                                  ; THESE ROUTINES WILL WRITE A DOT, OR READ THE
                                  ;  DOT AT THE INDICATED LOCATION
                                  ; ENTRY --
                                  ;    DX = ROW (0-199)     (THE ACTUAL VALUE DEPENDS ON THE MODE)
                                  ;    CX = COLUMN ( 0-639) ( THE VALUES ARE NOT RANGE CHECKED )
                                  ;    AL = DOT VALUE TO WRITE (1,2 OR 4 BITS DEPENDING ON MODE,
                                  ;         REQUIRED FOR WRITE DOT ONLY, RIGHT JUSTIFIED)
                                  ;         BIT 7 OF AL = 1 INDICATES XOR THE VALUE INTO THE LOCATION
                                  ;    DS = DATA SEGMENT
                                  ;    ES = REGEN SEGMENT
                                  ;
                                  ; EXIT
                                  ;         AL = DOT VALUE READ, RIGHT JUSTIFIED, READ ONLY
                                  ;--------------------------------------------
                                          ASSUME  DS:DATA,ES:DATA
0435                              READ_DOT        PROC    NEAR
0435  E8 0469 R                           CALL    R3                      ; DETERMINE BYTE POSITION OF DOT
0438  26: 8A 04                           MOV     AL,ES:[SI]              ; GET THE BYTE
043B  22 C4                               AND     AL,AH                   ; MASK OFF THE OTHER BITS IN THE BYTE
043D  D2 E0                               SHL     AL,CL                   ; LEFT JUSTIFY THE VALUE
043F  8A CE                               MOV     CL,DH                   ; GET NUMBER OF BITS IN RESULT
0441  D2 C0                               ROL     AL,CL                   ; RIGHT JUSTIFY THE RESULT
0443  E9 012E R                           JMP     VIDEO_RETURN            ; RETURN FROM VIDEO I/O
0446                              READ_DOT        ENDP

0446                              WRITE_DOT       PROC    NEAR
0446  50                                  PUSH    AX                      ; SAVE DOT VALUE
0447  50                                  PUSH    AX                      ;  TWICE
0448  E8 0469 R                           CALL    R3                      ; DETERMINE BYTE POSITION OF THE DOT
044B  D2 E8                               SHR     AL,CL                   ; SHIFT TO SET UP THE BITS FOR OUTPUT
044D  22 C4                               AND     AL,AH                   ; STRIP OFF THE OTHER BITS
044F  26: 8A 0C                           MOV     CL,ES:[SI]              ; GET THE CURRENT BYTE
0452  5B                                  POP     BX                      ; RECOVER XOR FLAG
0453  F6 C3 80                            TEST    BL,80H                  ; IS IT ON
0456  75 0D                               JNZ     R2                      ; YES, XOR THE DOT
0458  F6 D4                               NOT     AH                      ; SET MASK TO REMOVE THE INDICATED BITS
045A  22 CC                               AND     CL,AH
045C  0A C1                               OR      AL,CL                   ; OR IN THE NEW VALUE OF THOSE BITS
045E                              R1:                                     ; FINISH_DOT
045E  26: 88 04                           MOV     ES:[SI],AL              ; RESTORE THE BYTE IN MEMORY
0461  58                                  POP     AX
0462  E9 012E R                           JMP     VIDEO_RETURN            ; RETURN FROM VIDEO I/O
0465                              R2:                                     ; XOR_DOT
0465  32 C1                               XOR     AL,CL                   ; EXCLUSIVE OR THE DOTS
0467  EB F5                               JMP     R1                      ; FINISH UP THE WRITING
0469                              WRITE_DOT       ENDP
                                  ;--------------------------------------------
                                  ; THIS SUBROUTINE DETERMINES THE REGEN BYTE LOCATION OF THE
                                  ; INDICATED ROW COLUMN VALUE IN GRAPHICS MODE.
                                  ; ENTRY --
                                  ;  DX = ROW VALUE (0-199)
                                  ;  CX = COLUMN VALUE (0-639)
                                  ; EXIT --
                                  ;  SI = OFFSET INTO REGEN BUFFER FOR BYTE OF INTEREST
                                  ;  AH = MASK TO STRIP OFF THE BITS OF INTEREST
                                  ;  CL = BITS TO SHIFT TO RIGHT JUSTIFY THE MASK IN AH
                                  ;  DH = # BITS IN RESULT
                                  ;  BX = MODIFIED
                                  ;---------------------------------------------
0469                              R3      PROC    NEAR

                                  ;-----  DETERMINE 1ST BYTE IN INDICATED ROW BY MULTIPLYING ROW VALUE BY 40
                                  ;-----   ( LOW BIT OF ROW DETERMINES EVEN/ODD, 80 BYTES/ROW )

0469  93                                  XCHG    AX,BX                   ; WILL SAVE AL AND AH DURING OPERATION
046A  B0 28                               MOV     AL,40
046C  F6 E2                               MUL     DL                      ; AX= ADDRESS OF START OF INDICATED ROW
046E  A8 08                               TEST    AL,008H                 ; TEST FOR EVEN/ODD ROW CALCULATED
0470  74 03                               JZ      R4                      ; JUMP IF EVEN ROW
0472  05 1FD8                             ADD     AX,2000H-40             ; OFFSET TO LOCATION OF ODD ROWS ADJUST
0475                              R4:                                     ; EVEN_ROW
0475  96                                  XCHG    SI,AX                   ; MOVE POINTER TO SI
0476  93                                  XCHG    AX,BX                   ; RECOVER AL AND AH VALUES
0477  8B D1                               MOV     DX,CX                   ; COLUMN VALUE TO DX

                                  ;-----  DETERMINE GRAPHICS MODE CURRENTLY IN EFFECT

                                  ; SET UP THE REGISTERS ACCORDING TO THE MODE
                                  ; CH = MASK FOR LOW OF COLUMN ADDRESS ( 7/3 FOR HIGH/MED RES )
                                  ; CL = # OF ADDRESS BITS IN COLUMN VALUE ( 3/2 FOR H/M )
                                  ; BL = MASK TO SELECT BITS FROM POINTED BYTE ( 80H/C0H FOR H/M )
                                  ; BH = NUMBER OF VALID BITS IN POINTED BYTE ( 1/2 FOR H/M )

0479  BB 02C0                             MOV     BX,2C0H
047C  B9 0302                             MOV     CX,302H                 ; SET PARMS FOR MED RES
047F  80 3E 0049 R 06                     CMP     @CRT_MODE,6
0484  72 06                               JC      R5                      ; HANDLE IF MED RES
0486  BB 0180                             MOV     BX,180H
0489  B9 0703                             MOV     CX,703H                 ; SET PARMS FOR HIGH RES

                                  ;-----  DETERMINE BIT OFFSET IN BYTE FROM COLUMN MASK
048C                              R5:
048C  22 EA                               AND     CH,DL                   ; ADDRESS OF PEL WITHIN BYTE TO CH

                                  ;-----  DETERMINE BYTE OFFSET FOR THIS LOCATION IN COLUMN

048E  D3 EA                               SHR     DX,CL                   ; SHIFT BY CORRECT AMOUNT
0490  03 F2                               ADD     SI,DX                   ; INCREMENT THE POINTER
0492  8A F7                               MOV     DH,BH                   ; GET THE # OF BITS IN RESULT TO DH

                                  ;-----  MULTIPLY BH (VALID BITS IN BYTE) BY CH (BIT OFFSET)

0494  2A C9                               SUB     CL,CL                   ; ZERO INTO STORAGE LOCATION
0496                              R6:
0496  D0 C8                               ROR     AL,1                    ; LEFT JUSTIFY VALUE IN AL (FOR WRITE)
0498  02 CD                               ADD     CL,CH                   ; ADD IN THE BIT OFFSET VALUE
049A  FE CF                               DEC     BH                      ; LOOP CONTROL
049C  75 F8                               JNZ     R6                      ; ON EXIT, CL HAS COUNT TO RESTORE BITS
049E  8A E3                               MOV     AH,BL                   ;  GET MASK TO AH
04A0  D2 EC                               SHR     AH,CL                   ;  MOVE THE MASK TO CORRECT LOCATION
04A2  C3                                  RET                             ;  RETURN WITH EVERYTHING SET UP
```

SECTION 5

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04A3                          R3      ENDP
                              ;--------------------------------------------------------
                              ;  SCROLL UP
                              ;   THIS ROUTINE SCROLLS UP THE INFORMATION ON THE CRT
                              ; ENTRY --
                              ;  CH,CL = UPPER LEFT CORNER OF REGION TO SCROLL
                              ;  DH,DL = LOWER RIGHT CORNER OF REGION TO SCROLL
                              ;   BOTH OF THE ABOVE ARE IN CHARACTER POSITIONS
                              ;  BH = FILL VALUE FOR BLANKED LINES
                              ;  AL = # LINES TO SCROLL (AL=0 MEANS BLANK THE ENTIRE FIELD)
                              ;  DS = DATA SEGMENT
                              ;  ES = REGEN SEGMENT
                              ; EXIT --
                              ;  NOTHING, THE SCREEN IS SCROLLED
                              ;--------------------------------------------------------
04A3                          GRAPHICS_UP     PROC    NEAR
04A3 8A D8                            MOV     BL,AL                   ; SAVE LINE COUNT IN BL
04A5 8B C1                            MOV     AX,CX                   ; GET UPPER LEFT POSITION INTO AX REG

                              ;-----  USE CHARACTER SUBROUTINE FOR POSITIONING
                              ;-----  ADDRESS RETURNED IS MULTIPLIED BY 2 FROM CORRECT VALUE

04A7 E8 06D8 R                        CALL    GRAPH_POSN
04AA 8B F8                            MOV     DI,AX                   ; SAVE RESULT AS DESTINATION ADDRESS

                              ;-----  DETERMINE SIZE OF WINDOW

04AC 2B D1                            SUB     DX,CX
04AE 81 C2 0101                       ADD     DX,101H                 ; ADJUST VALUES
04B2 C0 E6 02                         SAL     DH,2                    ; MULTIPLY ROWS BY 4 AT 8 VERT DOTS/CHAR
                                                                      ;  AND EVEN/ODD ROWS
                              ;-----  DETERMINE CRT MODE

04B5 80 3E 0049 R 06                  CMP     @CRT_MODE,6             ; TEST FOR MEDIUM RES
04BA 73 04                            JNC     R7                      ; FIND_SOURCE

                              ;-----  MEDIUM RES UP
04BC D0 E2                            SAL     DL,1                    ; # COLUMNS * 2, SINCE 2 BYTES/CHAR
04BE D1 E7                            SAL     DI,1                    ; OFFSET *2 SINCE 2 BYTES/CHAR

                              ;-----  DETERMINE THE SOURCE ADDRESS IN THE BUFFER
04C0                          R7:                                     ; FIND_SOURCE
04C0 06                               PUSH    ES                      ; GET SEGMENTS BOTH POINTING TO REGEN
04C1 1F                               POP     DS
04C2 2A ED                            SUB     CH,CH                   ; ZERO TO HIGH OF COUNT REGISTER
04C4 C0 E3 02                         SAL     BL,2                    ; MULTIPLY NUMBER OF LINES BY 4
04C7 74 2D                            JZ      R11                     ; IF ZERO, THEN BLANK ENTIRE FIELD
04C9 8A C3                            MOV     AL,BL                   ; GET NUMBER OF LINES IN AL
04CB B4 50                            MOV     AH,80                   ; 80 BYTES/ROW
04CD F6 E4                            MUL     AH                      ; DETERMINE OFFSET TO SOURCE
04CF 8B F7                            MOV     SI,DI                   ; SET UP SOURCE
04D1 03 F0                            ADD     SI,AX                   ;  ADD IN OFFSET TO IT
04D3 8A E6                            MOV     AH,DH                   ; NUMBER OF ROWS IN FIELD
04D5 2A E3                            SUB     AH,BL                   ; DETERMINE NUMBER TO MOVE

                              ;-----  LOOP THROUGH, MOVING ONE ROW AT A TIME, BOTH EVEN AND ODD FIELDS
04D7                          R8:                                     ; ROW_LOOP
04D7 E8 0558 R                        CALL    R17                     ; MOVE ONE ROW
04DA 81 EE 1FB0                       SUB     SI,2000H-80             ; MOVE TO NEXT ROW
04DE 81 EF 1FB0                       SUB     DI,2000H-80
04E2 FE CC                            DEC     AH                      ; NUMBER OF ROWS TO MOVE
04E4 75 F1                            JNZ     R8                      ; CONTINUE TILL ALL MOVED

                              ;-----  FILL IN THE VACATED LINE(S)
04E6                          R9:                                     ; CLEAR_ENTRY
04E6 8A C7                            MOV     AL,BH                   ; ATTRIBUTE TO FILL WITH
04E8                          R10:
04E8 E8 0571 R                        CALL    R18                     ; CLEAR THAT ROW
04EB 81 EF 1FB0                       SUB     DI,2000H-80             ; POINT TO NEXT LINE
04EF FE CB                            DEC     BL                      ; NUMBER OF LINES TO FILL
04F1 75 F5                            JNZ     R10                     ; CLEAR_LOOP
04F3 E9 012E R                        JMP     VIDEO_RETURN            ; EVERYTHING DONE

04F6                          R11:                                    ; BLANK_FIELD
04F6 8A DE                            MOV     BL,DH                   ; SET BLANK COUNT TO EVERYTHING IN FIELD
04F8 EB EC                            JMP     R9                      ; CLEAR THE FIELD
04FA                          GRAPHICS_UP     ENDP
                              ;--------------------------------------------------------
                              ; SCROLL DOWN
                              ;  THIS ROUTINE SCROLLS DOWN THE INFORMATION ON THE CRT
                              ; ENTRY --
                              ;  CH,CL = UPPER LEFT CORNER OF REGION TO SCROLL
                              ;  DH,DL = LOWER RIGHT CORNER OF REGION TO SCROLL
                              ;   BOTH OF THE ABOVE ARE IN CHARACTER POSITIONS
                              ;  BH = FILL VALUE FOR BLANKED LINES
                              ;  AL = # LINES TO SCROLL (AL=0 MEANS BLANK THE ENTIRE FIELD)
                              ;  DS = DATA SEGMENT
                              ;  ES = REGEN SEGMENT
                              ; EXIT --
                              ;  NOTHING, THE SCREEN IS SCROLLED
                              ;--------------------------------------------------------

04FA                          GRAPHICS_DOWN   PROC    NEAR
04FA FD                               STD                             ; SET DIRECTION
04FB 8A D8                            MOV     BL,AL                   ; SAVE LINE COUNT IN BL
04FD 8B C2                            MOV     AX,DX                   ; GET LOWER RIGHT POSITION INTO AX REG

                              ;-----  USE CHARACTER SUBROUTINE FOR POSITIONING
                              ;-----  ADDRESS RETURNED IS MULTIPLIED BY 2 FROM CORRECT VALUE

04FF E8 06D8 R                        CALL    GRAPH_POSN
0502 8B F8                            MOV     DI,AX                   ; SAVE RESULT AS DESTINATION ADDRESS

                              ;-----  DETERMINE SIZE OF WINDOW

0504 2B D1                            SUB     DX,CX
0506 81 C2 0101                       ADD     DX,101H                 ; ADJUST VALUES
050A C0 E6 02                         SAL     DH,2                    ; MULTIPLY ROWS BY 4 AT 8 VERT DOTS/CHAR
                                                                      ;  AND EVEN/ODD ROWS
                              ;-----  DETERMINE CRT MODE

050D 80 3E 0049 R 06                  CMP     @CRT_MODE,6             ; TEST FOR MEDIUM RES
0512 73 05                            JNC     R12                     ; FIND_SOURCE_DOWN
```

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                           ;-----  MEDIUM RES DOWN
0514 D0 E2                         SAL     DL,1                    ; # COLUMNS * 2, SINCE 2 BYTES/CHAR
0516 D1 E7                         SAL     DI,1                    ; OFFSET *2 SINCE 2 BYTES/CHAR
0518 47                            INC     DI                      ; POINT TO LAST BYTE
                           ;-----  DETERMINE THE SOURCE ADDRESS IN THE BUFFER
0519                       R12:                                    ; FIND_SOURCE_DOWN
0519 06                            PUSH    ES                      ; BOTH SEGMENTS TO REGEN
051A 1F                            POP     DS
051B 2A ED                         SUB     CH,CH                   ; ZERO TO HIGH OF COUNT REGISTER
051D 81 C7 00F0                    ADD     DI,240                  ; POINT TO LAST ROW OF PIXELS
0521 C0 E3 02                      SAL     BL,2                    ; MULTIPLY NUMBER OF LINES BY 4
0524 74 2E                         JZ      R16                     ; IF ZERO, THEN BLANK ENTIRE FIELD
0526 8A C3                         MOV     AL,BL                   ; GET NUMBER OF LINES IN AL
0528 B4 50                         MOV     AH,80                   ; 80 BYTES/ROW
052A F6 E4                         MUL     AH                      ; DETERMINE OFFSET TO SOURCE
052C 8B F7                         MOV     SI,DI                   ; SET UP SOURCE
052E 2B F0                         SUB     SI,AX                   ;  SUBTRACT THE OFFSET
0530 8A E6                         MOV     AH,DH                   ; NUMBER OF ROWS IN FIELD
0532 2A E3                         SUB     AH,BL                   ; DETERMINE NUMBER TO MOVE
                           ;-----  LOOP THROUGH, MOVING ONE ROW AT A TIME, BOTH EVEN AND ODD FIELDS
0534                       R13:                                    ; ROW_LOOP_DOWN
0534 E8 0558 R                     CALL    R17                     ; MOVE ONE ROW
0537 81 EE 2050                    SUB     SI,2000H+80             ; MOVE TO NEXT ROW
053B 81 EF 2050                    SUB     DI,2000H+80
053F FE CC                         DEC     AH                      ; NUMBER OF ROWS TO MOVE
0541 75 F1                         JNZ     R13                     ; CONTINUE TILL ALL MOVED
                           ;-----  FILL IN THE VACATED LINE(S)
0543                       R14:                                    ; CLEAR_ENTRY_DOWN
0543 8A C7                         MOV     AL,BH                   ; ATTRIBUTE TO FILL WITH
0545                       R15:                                    ; CLEAR_LOOP_DOWN
0545 E8 0571 R                     CALL    R18                     ; CLEAR A ROW
0548 81 EF 2050                    SUB     DI,2000H+80             ; POINT TO NEXT LINE
054C FE CB                         DEC     BL                      ; NUMBER OF LINES TO FILL
054E 75 F5                         JNZ     R15                     ; CLEAR_LOOP_DOWN
0550 FC                            CLD                             ; RESET THE DIRECTION FLAG
0551 E9 012E R                     JMP     VIDEO_RETURN            ; EVERYTHING DONE
0554                       R16:                                    ; BLANK_FIELD_DOWN
0554 8A DE                         MOV     BL,DH                   ; SET BLANK COUNT TO EVERYTHING IN FIELD
0556 EB EB                         JMP     R14                     ; CLEAR THE FIELD
0558                       GRAPHICS_DOWN   ENDP
                           ;-----  ROUTINE TO MOVE ONE ROW OF INFORMATION
0558                       R17     PROC    NEAR
0558 8A CA                         MOV     CL,DL                   ; NUMBER OF BYTES IN THE ROW
055A 56                            PUSH    SI
055B 57                            PUSH    DI                      ; SAVE POINTERS
055C F3/ A4                        REP     MOVSB                   ; MOVE THE EVEN FIELD
055E 5F                            POP     DI
055F 5E                            POP     SI
0560 81 C6 2000                    ADD     SI,2000H
0564 81 C7 2000                    ADD     DI,2000H                ; POINT TO THE ODD FIELD
0568 56                            PUSH    SI
0569 57                            PUSH    DI                      ; SAVE THE POINTERS
056A 8A CA                         MOV     CL,DL                   ; COUNT BACK
056C F3/ A4                        REP     MOVSB                   ; MOVE THE ODD FIELD
056E 5F                            POP     DI
056F 5E                            POP     SI                      ; POINTERS BACK
0570 C3                            RET                             ; RETURN TO CALLER
0571                       R17     ENDP
                           ;-----  CLEAR A SINGLE ROW
0571                       R18     PROC    NEAR
0571 8A CA                         MOV     CL,DL                   ; NUMBER OF BYTES IN FIELD
0573 57                            PUSH    DI                      ; SAVE POINTER
0574 F3/ AA                        REP     STOSB                   ; STORE THE NEW VALUE
0576 5F                            POP     DI                      ; POINTER BACK
0577 81 C7 2000                    ADD     DI,2000H                ; POINT TO ODD FIELD
057B 57                            PUSH    DI
057C 8A CA                         MOV     CL,DL
057E F3/ AA                        REP     STOSB                   ; FILL THE ODD FIELD
0580 5F                            POP     DI
0581 C3                            RET                             ; RETURN TO CALLER
0582                       R18     ENDP
                           ;--------------------------------------------------
                           ; GRAPHICS WRITE
                           ;  THIS ROUTINE WRITES THE ASCII CHARACTER TO THE CURRENT
                           ;  POSITION ON THE SCREEN.
                           ; ENTRY --
                           ;  AL = CHARACTER TO WRITE
                           ;  BL = COLOR ATTRIBUTE TO BE USED FOR FOREGROUND COLOR
                           ;       IF BIT 7 IS SET, THE CHAR IS XOR'D INTO THE REGEN BUFFER
                           ;       (0 IS USED FOR THE BACKGROUND COLOR)
                           ;  CX = NUMBER OF CHARS TO WRITE
                           ;  DS = DATA SEGMENT
                           ;  ES = REGEN SEGMENT
                           ; EXIT --
                           ;  NOTHING IS RETURNED
                           ;
                           ; GRAPHICS READ
                           ;   THIS ROUTINE READS THE ASCII CHARACTER AT THE CURRENT CURSOR
                           ;   POSITION ON THE SCREEN BY MATCHING THE DOTS ON THE SCREEN TO THE
                           ;   CHARACTER GENERATOR CODE POINTS
                           ; ENTRY --
                           ;  NONE  (0 IS ASSUMED AS THE BACKGROUND COLOR)
                           ; EXIT --
                           ;  AL = CHARACTER READ AT THAT POSITION (0 RETURNED IF NONE FOUND)
                           ;
                           ; FOR BOTH ROUTINES, THE IMAGES USED TO FORM CHARS ARE CONTAINED IN ROM
                           ;  FOR THE 1ST 128 CHARS.  TO ACCESS CHARS IN THE SECOND HALF, THE USER
                           ;  MUST INITIALIZE THE VECTOR AT INTERRUPT 1FH (LOCATION 0007CH) TO
                           ;  POINT TO THE USER SUPPLIED TABLE OF GRAPHIC IMAGES (8X8 BOXES).
                           ;  FAILURE TO DO SO WILL CAUSE IN STRANGE RESULTS
                           ;--------------------------------------------------
                                   ASSUME  DS:DATA,ES:DATA
0582                       GRAPHICS_WRITE  PROC    NEAR
0582 B4 00                         MOV     AH,0                    ; ZERO TO HIGH OF CODE POINT
0584 50                            PUSH    AX                      ; SAVE CODE POINT VALUE
```

SECTION 5

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                        ;----- DETERMINE POSITION IN REGEN BUFFER TO PUT CODE POINTS

0585 E8 06D5 R                 CALL    S26                     ; FIND LOCATION IN REGEN BUFFER
0588 8B F8                     MOV     DI,AX                   ; REGEN POINTER IN DI

                        ;----- DETERMINE REGION TO GET CODE POINTS FROM

058A 58                        POP     AX                      ; RECOVER CODE POINT
058B 3C 80                     CMP     AL,80H                  ; IS IT IN SECOND HALF
058D 73 06                     JAE     S1                      ; YES

                        ;----- IMAGE IS IN FIRST HALF, CONTAINED IN ROM

058F BE 0000 E                 MOV     SI,OFFSET CRT_CHAR_GEN  ; OFFSET OF IMAGES
0592 0E                        PUSH    CS                      ; SAVE SEGMENT ON STACK
0593 EB 0F                     JMP     SHORT S2                ; DETERMINE_MODE

                        ;----- IMAGE IS IN SECOND HALF, IN USER MEMORY

0595                    S1:                                    ; EXTEND_CHAR
0595 2C 80                     SUB     AL,80H                  ; ZERO ORIGIN FOR SECOND HALF
0597 1E                        PUSH    DS                      ; SAVE DATA POINTER
0598 2B F6                     SUB     SI,SI
059A 8E DE                     MOV     DS,SI                   ; ESTABLISH VECTOR ADDRESSING
                               ASSUME  DS:ABS0
059C C5 36 007C R              LDS     SI,@EXT_PTR             ; GET THE OFFSET OF THE TABLE
05A0 8C DA                     MOV     DX,DS                   ; GET THE SEGMENT OF THE TABLE
                               ASSUME  DS:DATA
05A2 1F                        POP     DS                      ; RECOVER DATA SEGMENT
05A3 52                        PUSH    DX                      ; SAVE TABLE SEGMENT ON STACK

                        ;----- DETERMINE GRAPHICS MODE IN OPERATION

05A4                    S2:                                    ;       DETERMINE_MODE
05A4 C1 E0 03                  SAL     AX,3                    ; MULTIPLY CODE POINT VALUE BY 8
05A7 03 F0                     ADD     SI,AX                   ; SI HAS OFFSET OF DESIRED CODES
05A9 80 3E 0049 R 06           CMP     @CRT_MODE,6
05AE 1F                        POP     DS                      ; RECOVER TABLE POINTER SEGMENT
05AF 72 2C                     JC      S7                      ; TEST FOR MEDIUM RESOLUTION MODE

                        ;----- HIGH RESOLUTION MODE
05B1                    S3:                                    ; HIGH_CHAR
05B1 57                        PUSH    DI                      ; SAVE REGEN POINTER
05B2 56                        PUSH    SI                      ; SAVE CODE POINTER
05B3 B6 04                     MOV     DH,4                    ; NUMBER OF TIMES THROUGH LOOP
05B5                    S4:
05B5 AC                        LODSB                           ; GET BYTE FROM CODE POINTS
05B6 F6 C3 80                  TEST    BL,80H                  ; SHOULD WE USE THE FUNCTION
05B9 75 16                     JNZ     S6                      ;  TO PUT CHAR IN
05BB AA                        STOSB                           ; STORE IN REGEN BUFFER
05BC AC                        LODSB
05BD                    S5:
05BD 26: 88 85 1FFF            MOV     ES:[DI+2000H-1],AL      ; STORE IN SECOND HALF
05C2 83 C7 4F                  ADD     DI,79                   ; MOVE TO NEXT ROW IN REGEN
05C5 FE CE                     DEC     DH                      ; DONE WITH LOOP
05C7 75 EC                     JNZ     S4
05C9 5E                        POP     SI
05CA 5F                        POP     DI                      ; RECOVER REGEN POINTER
05CB 47                        INC     DI                      ; POINT TO NEXT CHAR POSITION
05CC E2 E3                     LOOP    S3                      ; MORE CHARS TO WRITE
05CE E9 012E R                 JMP     VIDEO_RETURN

05D1                    S6:
05D1 26: 32 05                 XOR     AL,ES:[DI]              ; EXCLUSIVE OR WITH CURRENT
05D4 AA                        STOSB                           ; STORE THE CODE POINT
05D5 AC                        LODSB                           ; AGAIN FOR ODD FIELD
05D6 26: 32 85 1FFF            XOR     AL,ES:[DI+2000H-1]
05DB EB E0                     JMP     S5                      ; BACK TO MAINSTREAM

                        ;----- MEDIUM RESOLUTION WRITE
05DD                    S7:                                    ;  MED_RES_WRITE
05DD 8A D3                     MOV     DL,BL                   ; SAVE HIGH COLOR BIT
05DF D1 E7                     SAL     DI,1                    ; OFFSET*2 SINCE 2 BYTES/CHAR
                                                               ; EXPAND BL TO FULL WORD OF COLOR
05E1 80 E3 03                  AND     BL,3                    ; ISOLATE THE COLOR BITS ( LOW 2 BITS )
05E4 B0 55                     MOV     AL,055H                 ; GET BIT CONVERSION MULTIPLIER
05E6 F6 E3                     MUL     BL                      ; EXPAND 2 COLOR BITS TO 4 REPLICATIONS
05E8 8A D8                     MOV     BL,AL                   ; PLACE BACK IN WORK REGISTER
05EA 8A F8                     MOV     BH,AL                   ; EXPAND TO 8 REPLICATIONS OF COLOR BITS
05EC                    S8:                                    ;  MED_CHAR
05EC 57                        PUSH    DI                      ; SAVE REGEN POINTER
05ED 56                        PUSH    SI                      ; SAVE THE CODE POINTER
05EE B6 04                     MOV     DH,4                    ; NUMBER OF LOOPS
05F0                    S9:
05F0 AC                        LODSB                           ; GET CODE POINT
05F1 E8 06AD R                 CALL    S21                     ; DOUBLE UP ALL THE BITS
05F4 23 C3                     AND     AX,BX                   ; CONVERT TO FOREGROUND COLOR ( 0 BACK )
05F6 86 E0                     XCHG    AH,AL                   ; SWAP HIGH/LOW BYTES FOR WORD MOVE
05F8 F6 C2 80                  TEST    DL,80H                  ; IS THIS XOR FUNCTION
05FB 74 03                     JZ      S10                     ; NO, STORE IT IN AS IT IS
05FD 26: 33 05                 XOR     AX,ES:[DI]              ; DO FUNCTION WITH LOW/HIGH
0600                    S10:                                   ;
0600 26: 89 05                 MOV     ES:[DI],AX              ; STORE FIRST BYTE HIGH, SECOND LOW
0603 AC                        LODSB                           ; GET CODE POINT
0604 E8 06AD R                 CALL    S21
0607 23 C3                     AND     AX,BX                   ; CONVERT TO COLOR
0609 86 E0                     XCHG    AH,AL                   ; SWAP HIGH/LOW BYTES FOR WORD MOVE
060B F6 C2 80                  TEST    DL,80H                  ; AGAIN, IS THIS XOR FUNCTION
060E 74 05                     JZ      S11                     ; NO, JUST STORE THE VALUES
0610 26: 33 85 2000            XOR     AX,ES:[DI+2000H]        ; FUNCTION WITH FIRST HALF LOW
0615                    S11:
0615 26: 89 85 2000            MOV     ES:[DI+2000H],AX        ; STORE SECOND PORTION HIGH
061A 83 C7 50                  ADD     DI,80                   ; POINT TO NEXT LOCATION
061D FE CE                     DEC     DH
061F 75 CF                     JNZ     S9                      ; KEEP GOING
0621 5E                        POP     SI                      ; RECOVER CODE POINTER
0622 5F                        POP     DI                      ; RECOVER REGEN POINTER
0623 47                        INC     DI                      ; POINT TO NEXT CHAR POSITION
0624 47                        INC     DI
0625 E2 C5                     LOOP    S8                      ; MORE TO WRITE
0627 E9 012E R                 JMP     VIDEO_RETURN
062A                    GRAPHICS_WRITE  ENDP

                        ;----------------------------------------
                        ; GRAPHICS READ
```

```
                                ;---------------------------------------
     062A                       GRAPHICS_READ   PROC    NEAR
     062A E8 06D5 R                     CALL    S26                     ; CONVERTED TO OFFSET IN REGEN
     062D 8B F0                         MOV     SI,AX                   ; SAVE IN SI
     062F 83 EC 08                      SUB     SP,8                    ; ALLOCATE SPACE FOR THE READ CODE POINT
     0632 8B EC                         MOV     BP,SP                   ; POINTER TO SAVE AREA
                                ;-----  DETERMINE GRAPHICS MODES
     0634 80 3E 0049 R 06               CMP     @CRT_MODE,6
     0639 06                            PUSH    ES
     063A 1F                            POP     DS                      ; POINT TO REGEN SEGMENT
     063B 72 19                         JC      S13                     ; MEDIUM RESOLUTION
                                ;-----  HIGH RESOLUTION READ
                                ;-----  GET VALUES FROM REGEN BUFFER AND CONVERT TO CODE POINT
     063D B6 04                         MOV     DH,4                    ; NUMBER OF PASSES
     063F                       S12:
     063F 8A 04                         MOV     AL,[SI]                 ; GET FIRST BYTE
     0641 88 46 00                      MOV     [BP],AL                 ; SAVE IN STORAGE AREA
     0644 45                            INC     BP                      ; NEXT LOCATION
     0645 8A 84 2000                    MOV     AL,[SI+2000H]           ; GET LOWER REGION BYTE
     0649 88 46 00                      MOV     [BP],AL                 ; ADJUST AND STORE
     064C 45                            INC     BP
     064D 83 C6 50                      ADD     SI,80                   ; POINTER INTO REGEN
     0650 FE CE                         DEC     DH                      ; LOOP CONTROL
     0652 75 EB                         JNZ     S12                     ; DO IT SOME MORE
     0654 EB 16                         JMP     SHORT S15               ; GO MATCH THE SAVED CODE POINTS
                                ;-----  MEDIUM RESOLUTION READ
     0656                       S13:                                    ; MED_RES_READ
     0656 D1 E6                         SAL     SI,1                    ; OFFSET*2 SINCE 2 BYTES/CHAR
     0658 B6 04                         MOV     DH,4                    ; NUMBER OF PASSES
     065A                       S14:
     065A E8 06BC R                     CALL    S23                     ; GET BYTES FROM REGEN INTO SINGLE SAVE
     065D 81 C6 1FFE                    ADD     SI,2000H-2              ; GO TO LOWER REGION
     0661 E8 06BC R                     CALL    S23                     ; GET THIS PAIR INTO SAVE
     0664 81 EE 1FB2                    SUB     SI,2000H-80+2           ; ADJUST POINTER BACK INTO UPPER
     0668 FE CE                         DEC     DH
     066A 75 EE                         JNZ     S14                     ; KEEP GOING UNTIL ALL 8 DONE
                                ;-----  SAVE AREA HAS CHARACTER IN IT, MATCH IT
     066C                       S15:                                    ; FIND_CHAR
     066C BF 0000 E                     MOV     DI,OFFSET CRT_CHAR_GEN  ; ESTABLISH ADDRESSING
     066F 0E                            PUSH    CS
     0670 07                            POP     ES                      ; CODE POINTS IN CS
     0671 83 ED 08                      SUB     BP,8                    ; ADJUST POINTER TO START OF SAVE AREA
     0674 8B F5                         MOV     SI,BP
     0676 FC                            CLD                             ; ENSURE DIRECTION
     0677 B0 00                         MOV     AL,0                    ; CURRENT CODE POINT BEING MATCHED
     0679                       S16:
     0679 16                            PUSH    SS                      ; ESTABLISH ADDRESSING TO STACK
     067A 1F                            POP     DS                      ; FOR THE STRING COMPARE
     067B BA 0080                       MOV     DX,128                  ; NUMBER TO TEST AGAINST
     067E                       S17:
     067E 56                            PUSH    SI                      ; SAVE SAVE AREA POINTER
     067F 57                            PUSH    DI                      ; SAVE CODE POINTER
     0680 B9 0004                       MOV     CX,4                    ; NUMBER OF WORDS TO MATCH
     0683 F3/ A7                        REPE    CMPSW                   ; COMPARE THE 8 BYTES AS WORDS
     0685 5F                            POP     DI                      ; RECOVER THE POINTERS
     0686 5E                            POP     SI
     0687 74 1E                         JZ      S18                     ; IF ZERO FLAG SET, THEN MATCH OCCURRED
     0689 FE C0                         INC     AL                      ; NO MATCH, MOVE ON TO NEXT
     068B 83 C7 08                      ADD     DI,8                    ; NEXT CODE POINT
     068E 4A                            DEC     DX                      ; LOOP CONTROL
     068F 75 ED                         JNZ     S17                     ; DO ALL OF THEM
                                ;-----  CHAR NOT MATCHED, MIGHT BE IN USER SUPPLIED SECOND HALF
     0691 3C 00                         CMP     AL,0                    ;  AL<> 0 IF ONLY 1ST HALF SCANNED
     0693 74 12                         JE      S18                     ;  IF = 0, THEN ALL HAS BEEN SCANNED
     0695 2B C0                         SUB     AX,AX
     0697 8E D8                         MOV     DS,AX                   ;  ESTABLISH ADDRESSING TO VECTOR
                                        ASSUME  DS:ABS0
     0699 C4 3E 007C R                  LES     DI,@EXT_PTR             ;  GET POINTER
     069D 8C C0                         MOV     AX,ES                   ;  SEE IF THE POINTER REALLY EXISTS
     069F 0B C7                         OR      AX,DI                   ; IF ALL 0, THEN DOESN'T EXIST
     06A1 74 04                         JZ      S18                     ; NO SENSE LOOKING
     06A3 B0 80                         MOV     AL,128                  ; ORIGIN FOR SECOND HALF
     06A5 EB D2                         JMP     S16                     ; GO BACK AND TRY FOR IT
                                        ASSUME  DS:DATA
                                ;-----  CHARACTER IS FOUND ( AL=0 IF NOT FOUND )
     06A7                       S18:
     06A7 83 C4 08                      ADD     SP,8                    ; READJUST THE STACK, THROW AWAY SAVE
     06AA E9 012E R                     JMP     VIDEO_RETURN            ; ALL DONE
     06AD                       GRAPHICS_READ   ENDP
                                ;---------------------------------------
                                ; EXPAND_BYTE
                                ;  THIS ROUTINE TAKES THE BYTE IN AL AND DOUBLES ALL
                                ;  OF THE BITS, TURNING THE 8 BITS INTO 16 BITS.
                                ;  THE RESULT IS LEFT IN AX
                                ;---------------------------------------
     06AD                       S21     PROC    NEAR
     06AD 51                            PUSH    CX                      ; SAVE REGISTER
     06AE B9 0008                       MOV     CX,8                    ; SHIFT COUNT REGISTER FOR ONE BYTE
     06B1                       S22:
     06B1 D0 C8                         ROR     AL,1                    ; SHIFT BITS, LOW BIT INTO CARRY FLAG
     06B3 D1 DD                         RCR     BP,1                    ; MOVE CARRY FLAG (LOW BIT) INTO RESULTS
     06B5 D1 FD                         SAR     BP,1                    ; SIGN EXTEND HIGH BIT (DOUBLE IT)
     06B7 E2 F8                         LOOP    S22                     ; REPEAT FOR ALL 8 BITS
     06B9 95                            XCHG    AX,BP                   ; MOVE RESULTS TO PARAMETER REGISTER
     06BA 59                            POP     CX                      ; RECOVER REGISTER
     06BB C3                            RET                             ; ALL DONE
     06BC                       S21     ENDP
                                ;-------------------------------------------
                                ; MED_READ_BYTE
                                ; THIS ROUTINE WILL TAKE 2 BYTES FROM THE REGEN BUFFER,
                                ;  COMPARE AGAINST THE CURRENT FOREGROUND COLOR, AND PLACE
                                ;  THE CORRESPONDING ON/OFF BIT PATTERN INTO THE CURRENT
                                ;  POSITION IN THE SAVE AREA
                                ; ENTRY --
```

SECTION 5

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                          ;  SI,DS = POINTER TO REGEN AREA OF INTEREST
                          ;  BX = EXPANDED FOREGROUND COLOR
                          ;  BP = POINTER TO SAVE AREA
                          ; EXIT --
                          ;  SI AND BP ARE INCREMENTED
                          ;-----------------------------------------------
06BC                      S23     PROC    NEAR
06BC AD                           LODSW                       ; GET FIRST BYTE AND SECOND BYTES
06BD 86 C4                        XCHG    AL,AH               ; SWAP FOR COMPARE
06BF B9 C000                      MOV     CX,0C000H           ; 2 BIT MASK TO TEST THE ENTRIES
06C2 B2 00                        MOV     DL,0                ; RESULT REGISTER
06C4                      S24:
06C4 85 C1                        TEST    AX,CX               ; IS THIS SECTION BACKGROUND?
06C6 74 01                        JZ      S25                 ; IF ZERO, IT IS BACKGROUND (CARRY=0)
06C8 F9                           STC                         ; WASN'T, SO SET CARRY
06C9                      S25:
06C9 D0 D2                        RCL     DL,1                ; MOVE THAT BIT INTO THE RESULT
06CB C1 E9 02                     SHR     CX,2                ; MOVE THE MASK TO THE RIGHT BY 2 BITS
06CE 73 F4                        JNC     S24                 ; DO IT AGAIN IF MASK DIDN'T FALL OUT
06D0 88 56 00                     MOV     [BP],DL             ; STORE RESULT IN SAVE AREA
06D3 45                           INC     BP                  ; ADJUST POINTER
06D4 C3                           RET                         ; ALL DONE
06D5                      S23     ENDP
                          ;----------------------------------------
                          ; V4_POSITION
                          ;  THIS ROUTINE TAKES THE CURSOR POSITION CONTAINED IN
                          ;  THE MEMORY LOCATION, AND CONVERTS IT INTO AN OFFSET
                          ;  INTO THE REGEN BUFFER, ASSUMING ONE BYTE/CHAR.
                          ;  FOR MEDIUM RESOLUTION GRAPHICS, THE NUMBER MUST
                          ;  BE DOUBLED.
                          ; ENTRY -- NO REGISTERS,MEMORY LOCATION @CURSOR_POSN IS USED
                          ; EXIT--
                          ;  AX CONTAINS OFFSET INTO REGEN BUFFER
                          ;----------------------------------------
06D5                      S26     PROC    NEAR
06D5 A1 0050 R                    MOV     AX,@CURSOR_POSN     ; GET CURRENT CURSOR
06D8                      GRAPH_POSN      LABEL   NEAR
06D8 53                           PUSH    BX                  ; SAVE REGISTER
06D9 8B D8                        MOV     BX,AX               ; SAVE A COPY OF CURRENT CURSOR
06DB 8A C4                        MOV     AL,AH               ; GET ROWS TO AL
06DD F6 26 004A R                 MUL     BYTE PTR @CRT_COLS  ; MULTIPLY BY BYTES/COLUMN
06E1 C1 E0 02                     SHL     AX,2                ; MULTIPLY * 4 SINCE 4 ROWS/BYTE
06E4 2A FF                        SUB     BH,BH               ; ISOLATE COLUMN VALUE
06E6 03 C3                        ADD     AX,BX               ; DETERMINE OFFSET
06E8 5B                           POP     BX                  ; RECOVER POINTER
06E9 C3                           RET                         ; ALL DONE
06EA                      S26     ENDP
                          ;--- WRITE_TTY -----------------------------------------------------------
                          ;                                                                        :
                          ;    THIS INTERFACE PROVIDES A TELETYPE LIKE INTERFACE TO THE            :
                          ;      VIDEO CARDS.  THE INPUT CHARACTER IS WRITTEN TO THE CURRENT       :
                          ;      CURSOR POSITION, AND THE CURSOR IS MOVED TO THE NEXT POSITION.    :
                          ;      IF THE CURSOR LEAVES THE LAST COLUMN OF THE FIELD, THE COLUMN     :
                          ;      IS SET TO ZERO, AND THE ROW VALUE IS INCREMENTED.  IF THE ROW     :
                          ;      ROW VALUE LEAVES THE FIELD, THE CURSOR IS PLACED ON THE LAST ROW, :
                          ;      FIRST COLUMN, AND THE ENTIRE SCREEN IS SCROLLED UP ONE LINE.      :
                          ;      WHEN THE SCREEN IS SCROLLED UP, THE ATTRIBUTE FOR FILLING THE     :
                          ;      NEWLY BLANKED LINE IS READ FROM THE CURSOR POSITION ON THE PREVIOUS :
                          ;      LINE BEFORE THE SCROLL, IN CHARACTER MODE.  IN GRAPHICS MODE,     :
                          ;      THE 0 COLOR IS USED.                                              :
                          ;    ENTRY --                                                            :
                          ;      (AH) = CURRENT CRT MODE                                           :
                          ;      (AL) = CHARACTER TO BE WRITTEN                                    :
                          ;             NOTE THAT BACK SPACE, CARRIAGE RETURN, BELL AND LINE FEED ARE
                          ;             HANDLED AS COMMANDS RATHER THAN AS DISPLAY GRAPHICS CHARACTERS :
                          ;      (BL) = FOREGROUND COLOR FOR CHAR WRITE IF CURRENTLY IN A GRAPHICS MODE :
                          ;    EXIT --                                                             :
                          ;       ALL REGISTERS SAVED                                              :
                          ;                                                                        :
                          ;------------------------------------------------------------------------
                                  ASSUME  DS:DATA
06EA                      WRITE_TTY       PROC    NEAR
06EA 50                           PUSH    AX                  ; SAVE REGISTERS
06EB 50                           PUSH    AX                  ; SAVE CHARACTER TO WRITE
06EC B4 03                        MOV     AH,03H
06EE 8A 3E 0062 R                 MOV     BH,@ACTIVE_PAGE     ; GET CURRENT PAGE SETTING
06F2 CD 10                        INT     10H                 ; READ THE CURRENT CURSOR POSITION
06F4 58                           POP     AX                  ; RECOVER CHARACTER

                          ;-----  DX NOW HAS THE CURRENT CURSOR POSITION

06F5 3C 0D                        CMP     AL,CR               ; IS IT CARRIAGE RETURN OR CONTROL
06F7 76 46                        JBE     U8                  ; GO TO CONTROL CHECKS IF IT IS

                          ;-----  WRITE THE CHAR TO THE SCREEN
06F9                      U0:
06F9 B4 0A                        MOV     AH,0AH              ; WRITE CHARACTER ONLY COMMAND
06FB B9 0001                      MOV     CX,1                ; ONLY ONE CHARACTER
06FE CD 10                        INT     10H                 ; WRITE THE CHARACTER

                          ;-----  POSITION THE CURSOR FOR NEXT CHAR

0700 FE C2                        INC     DL
0702 3A 16 004A R                 CMP     DL,BYTE PTR @CRT_COLS  ; TEST FOR COLUMN OVERFLOW
0706 75 33                        JNZ     U7                  ;  SET_CURSOR
0708 B2 00                        MOV     DL,0                ; COLUMN FOR CURSOR
070A 80 FE 18                     CMP     DH,25-1             ; CHECK FOR LAST ROW
070D 75 2A                        JNZ     U6                  ;  SET_CURSOR_INC

                          ;-----  SCROLL REQUIRED
070F                      U1:
070F B4 02                        MOV     AH,02H
0711 CD 10                        INT     10H                 ; SET THE CURSOR

                          ;-----  DETERMINE VALUE TO FILL WITH DURING SCROLL

0713 A0 0049 R                    MOV     AL,@CRT_MODE        ; GET THE CURRENT MODE
0716 3C 04                        CMP     AL,4
0718 72 06                        JC      U2                  ; READ-CURSOR
071A 3C 07                        CMP     AL,7
071C B7 00                        MOV     BH,0                ; FILL WITH BACKGROUND
071E 75 06                        JNE     U3                  ; SCROLL-UP
0720                      U2:                                 ; READ-CURSOR
0720 B4 08                        MOV     AH,08H              ; GET READ CURSOR COMMAND
0722 CD 10                        INT     10H                 ; READ CHAR/ATTR AT CURRENT CURSOR
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0724 8A FC                          MOV     BH,AH                   ; STORE IN BH
0726                        U3:                                     ; SCROLL-UP
0726 B8 0601                        MOV     AX,0601H                ; SCROLL ONE LINE
0729 2B C9                          SUB     CX,CX                   ; UPPER LEFT CORNER
072B B6 18                          MOV     DH,25-1                 ; LOWER RIGHT ROW
072D 8A 16 004A R                   MOV     DL,BYTE PTR @CRT_COLS   ; LOWER RIGHT COLUMN
0731 FE CA                          DEC     DL
0733                        U4:                                     ; VIDEO-CALL-RETURN
0733 CD 10                          INT     10H                     ; SCROLL UP THE SCREEN
0735                        U5:                                     ; TTY-RETURN
0735 58                             POP     AX                      ; RESTORE THE CHARACTER
0736 E9 012E R                      JMP     VIDEO_RETURN            ; RETURN TO CALLER

0739                        U6:                                     ; SET-CURSOR-INC
0739 FE C6                          INC     DH                      ; NEXT ROW
073B                        U7:                                     ; SET-CURSOR
073B B4 02                          MOV     AH,02H
073D EB F4                          JMP     U4                      ; ESTABLISH THE NEW CURSOR

                            ;-----  CHECK FOR CONTROL CHARACTERS
073F                        U8:
073F 74 13                          JE      U9                      ; WAS IT A CARRIAGE RETURN
0741 3C 0A                          CMP     AL,LF                   ; IS IT A LINE FEED
0743 74 13                          JE      U10                     ; GO TO LINE FEED
0745 3C 07                          CMP     AL,07H                  ; IS IT A BELL
0747 74 16                          JE      U11                     ; GO TO BELL
0749 3C 08                          CMP     AL,08H                  ; IS IT A BACKSPACE
074B 75 AC                          JNE     U0                      ; IF NOT A CONTROL, DISPLAY IT

                            ;-----  BACK SPACE FOUND

074D 0A D2                          OR      DL,DL                   ; IS IT ALREADY AT START OF LINE
074F 74 EA                          JE      U7                      ; SET_CURSOR
0751 4A                             DEC     DX                      ; NO -- JUST MOVE IT BACK
0752 EB E7                          JMP     U7                      ; SET_CURSOR

                            ;-----  CARRIAGE RETURN FOUND

0754                        U9:
0754 B2 00                          MOV     DL,0                    ; MOVE TO FIRST COLUMN
0756 EB E3                          JMP     U7                      ; SET_CURSOR

                            ;-----  LINE FEED FOUND

0758                        U10:
0758 80 FE 18                       CMP     DH,25-1                 ; BOTTOM OF SCREEN
075B 75 DC                          JNE     U6                      ; YES, SCROLL THE SCREEN
075D EB B0                          JMP     U1                      ; NO, JUST SET THE CURSOR

                            ;-----  BELL FOUND

075F                        U11:
075F B9 0533                        MOV     CX,1331                 ; DIVISOR FOR 896 HZ TONE
0762 B3 1F                          MOV     BL,31                   ; SET COUNT FOR 31/64 SECOND FOR BEEP
0764 E8 0000 E                      CALL    BEEP                    ; SOUND THE POD BELL
0767 EB CC                          JMP     U5                      ; TTY_RETURN
0769                        WRITE_TTY       ENDP
                            ;--------------------------------------------------------------------
                            ; LIGHT PEN                                                         :
                            ;       THIS ROUTINE TESTS THE LIGHT PEN SWITCH AND THE LIGHT       :
                            ;       PEN TRIGGER. IF BOTH ARE SET, THE LOCATION OF THE LIGHT     :
                            ;       PEN IS DETERMINED. OTHERWISE, A RETURN WITH NO INFORMATION  :
                            ;       IS MADE.                                                    :
                            ; ON EXIT:                                                          :
                            ;       (AH) = 0 IF NO LIGHT PEN INFORMATION IS AVAILABLE           :
                            ;               BX,CX,DX ARE DESTROYED                              :
                            ;       (AH) = 1 IF LIGHT PEN IS AVAILABLE                          :
                            ;               (DH,DL) = ROW,COLUMN OF CURRENT LIGHT PEN POSITION  :
                            ;               (CH) = RASTER POSITION                              :
                            ;               (BX) = BEST GUESS AT PIXEL HORIZONTAL POSITION      :
                            ;--------------------------------------------------------------------
                                    ASSUME  DS:DATA
0769 03 03 05 05 03 03      V1      DB      3,3,5,5,3,3,3,4         ; SUBTRACT_TABLE
     03 04
                            ;-----  WAIT FOR LIGHT PEN TO BE DEPRESSED

0771                        READ_LPEN       PROC    NEAR
0771 B4 00                          MOV     AH,0                    ; SET NO LIGHT PEN RETURN CODE
0773 8B 16 0063 R                   MOV     DX,@ADDR_6845           ; GET BASE ADDRESS OF 6845
0777 83 C2 06                       ADD     DX,6                    ; POINT TO STATUS REGISTER
077A EC                             IN      AL,DX                   ; GET STATUS REGISTER
077B A8 04                          TEST    AL,004H                 ; TEST LIGHT PEN SWITCH
077D 74 03                          JZ      V6_A                    ; GO IF YES
077F E9 0803 R                      JMP     V6                      ; NOT SET, RETURN

                            ;-----  NOW TEST FOR LIGHT PEN TRIGGER

0782 A8 02                  V6_A:   TEST    AL,2                    ; TEST LIGHT PEN TRIGGER
0784 75 03                          JNZ     V7A                     ; RETURN WITHOUT RESETTING TRIGGER
0786 E9 080D R                      JMP     V7

                            ;-----  TRIGGER HAS BEEN SET, READ THE VALUE IN

0789                        V7A:
0789 B4 10                          MOV     AH,16                   ; LIGHT PEN REGISTERS ON 6845

                            ;-----  INPUT REGISTERS POINTED TO BY AH, AND CONVERT TO ROW COLUMN IN (DX)

078B 8B 16 0063 R                   MOV     DX,@ADDR_6845           ; ADDRESS REGISTER FOR 6845
078F 8A C4                          MOV     AL,AH                   ; REGISTER TO READ
0791 EE                             OUT     DX,AL                   ; SET IT UP
0792 EB 00                          JMP     $+2                     ; I/O DELAY
0794 42                             INC     DX                      ; DATA REGISTER
0795 EC                             IN      AL,DX                   ; GET THE VALUE
0796 8A E8                          MOV     CH,AL                   ; SAVE IN CX
0798 4A                             DEC     DX                      ; ADDRESS REGISTER
0799 FE C4                          INC     AH
079B 8A C4                          MOV     AL,AH                   ; SECOND DATA REGISTER
079D EE                             OUT     DX,AL
079E 42                             INC     DX                      ; POINT TO DATA REGISTER
079F EB 00                          JMP     $+2                     ; I/O DELAY
07A1 EC                             IN      AL,DX                   ; GET SECOND DATA VALUE
07A2 8A E5                          MOV     AH,CH                   ; AX HAS INPUT VALUE
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SECTION 5

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                                ;-----  AX HAS THE VALUE READ IN FROM THE 6845

07A4 8A 1E 0049 R                       MOV     BL,@CRT_MODE
07A8 2A FF                              SUB     BH,BH                   ; MODE VALUE TO BX
07AA 2E: 8A 9F 0769 R                   MOV     BL,CS:V1[BX]            ; DETERMINE AMOUNT TO SUBTRACT
07AF 2B C3                              SUB     AX,BX                   ; TAKE IT AWAY
07B1 8B 1E 004E R                       MOV     BX,@CRT_START
07B5 D1 EB                              SHR     BX,1
07B7 2B C3                              SUB     AX,BX                   ; CONVERT TO CORRECT PAGE ORIGIN
07B9 79 02                              JNS     V2                      ; IF POSITIVE, DETERMINE MODE
07BB 2B C0                              SUB     AX,AX                   ; <0 PLAYS AS 0

                                ;-----  DETERMINE MODE OF OPERATION

07BD                            V2:                                     ; DETERMINE_MODE
07BD B1 03                              MOV     CL,3                    ; SET *8 SHIFT COUNT
07BF 80 3E 0049 R 04                    CMP     @CRT_MODE,4             ; DETERMINE IF GRAPHICS OR ALPHA
07C4 72 29                              JB      V4                      ; ALPHA_PEN
07C6 80 3E 0049 R 07                    CMP     @CRT_MODE,7
07CB 74 22                              JE      V4                      ; ALPHA_PEN

                                ;-----  GRAPHICS MODE

07CD B2 28                              MOV     DL,40                   ; DIVISOR FOR GRAPHICS
07CF F6 F2                              DIV     DL                      ; DETERMINE ROW(AL) AND COLUMN(AH)
                                                                        ;  AL RANGE 0-99, AH RANGE 0-39
                                ;-----  DETERMINE GRAPHIC ROW POSITION

07D1 8A E8                              MOV     CH,AL                   ; SAVE ROW VALUE IN CH
07D3 02 ED                              ADD     CH,CH                   ; *2 FOR EVEN/ODD FIELD
07D5 8A DC                              MOV     BL,AH                   ; COLUMN VALUE TO BX
07D7 2A FF                              SUB     BH,BH                   ; MULTIPLY BY 8 FOR MEDIUM RES
07D9 80 3E 0049 R 06                    CMP     @CRT_MODE,6             ; DETERMINE MEDIUM OR HIGH RES
07DE 75 04                              JNE     V3                      ; NOT_HIGH_RES
07E0 B1 04                              MOV     CL,4                    ; SHIFT VALUE FOR HIGH RES
07E2 D0 E4                              SAL     AH,1                    ; COLUMN VALUE TIMES 2 FOR HIGH RES
07E4                            V3:                                     ; NOT_HIGH_RES
07E4 D3 E3                              SHL     BX,CL                   ; MULTIPLY *16 FOR HIGH RES

                                ;-----  DETERMINE ALPHA CHAR POSITION

07E6 8A D4                              MOV     DL,AH                   ; COLUMN VALUE FOR RETURN
07E8 8A F0                              MOV     DH,AL                   ; ROW VALUE
07EA C0 EE 02                           SHR     DH,2                    ; DIVIDE BY 4 FOR VALUE IN 0-24 RANGE
07ED EB 12                              JMP     SHORT V5                ; LIGHT_PEN_RETURN_SET

                                ;-----  ALPHA MODE ON LIGHT PEN

07EF                            V4:                                     ; ALPHA_PEN
07EF F6 36 004A R                       DIV     BYTE PTR @CRT_COLS      ; DETERMINE ROW,COLUMN VALUE
07F3 8A F0                              MOV     DH,AL                   ; ROWS TO DH
07F5 8A D4                              MOV     DL,AH                   ; COLS TO DL
07F7 D2 E0                              SAL     AL,CL                   ; MULTIPLY ROWS * 8
07F9 8A E8                              MOV     CH,AL                   ; GET RASTER VALUE TO RETURN REGISTER
07FB 8A DC                              MOV     BL,AH                   ; COLUMN VALUE
07FD 32 FF                              XOR     BH,BH                   ;  TO BX
07FF D3 E3                              SAL     BX,CL
0801                            V5:                                     ; LIGHT_PEN_RETURN_SET
0801 B4 01                              MOV     AH,1                    ; INDICATE EVERY THING SET
0803                            V6:                                     ; LIGHT_PEN_RETURN
0803 52                                 PUSH    DX                      ; SAVE RETURN VALUE (IN CASE)
0804 8B 16 0063 R                       MOV     DX,@ADDR_6845           ; GET BASE ADDRESS
0808 83 C2 07                           ADD     DX,7                    ; POINT TO RESET PARM
080B EE                                 OUT     DX,AL                   ; ADDRESS, NOT DATA, IS IMPORTANT
080C 5A                                 POP     DX                      ; RECOVER VALUE
080D                            V7:                                     ; RETURN_NO_RESET
080D 5D                                 POP     BP
080E 5F                                 POP     DI
080F 5E                                 POP     SI
0810 1F                                 POP     DS                      ; DISCARD SAVED BX,CX,DX
0811 1F                                 POP     DS
0812 1F                                 POP     DS
0813 1F                                 POP     DS
0814 07                                 POP     ES
0815 CF                                 IRET
0816                            READ_LPEN       ENDP
0816                            CODE    ENDS
                                        END
```

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                            PAGE 118,121
                            TITLE BIOS ----- 06/10/85  BIOS ROUTINES
                            .286C
                            .LIST
 0000                       CODE     SEGMENT BYTE PUBLIC

                                     PUBLIC  EQUIPMENT_1
                                     PUBLIC  MEMORY_SIZE_DET_1
                                     PUBLIC  NMI_INT_1

                                     EXTRN   C8042:NEAR             ; POST SEND 8042 COMMAND ROUTINE
                                     EXTRN   CMOS_READ:NEAR         ; READ CMOS LOCATION ROUTINE
                                     EXTRN   D1:NEAR                ; "PARITY CHECK 1" MESSAGE
                                     EXTRN   D2:NEAR                ; "PARITY CHECK 2" MESSAGE
                                     EXTRN   D2A:NEAR               ; "?????" UNKNOWN ADDRESS MESSAGE
                                     EXTRN   DDS:NEAR               ; LOAD (DS) WITH DATA SEGMENT SELECTOR
                                     EXTRN   OBF_42:NEAR            ; POST WAIT 8042 RESPONSE ROUTINE
                                     EXTRN   PRT_HEX:NEAR           ; DISPLAY CHARACTER ROUTINE
                                     EXTRN   PRT_SEG:NEAR           ; DISPLAY FIVE CHARACTER ADDRESS ROUTINE
                                     EXTRN   P_MSG:NEAR             ; DISPLAY MESSAGE STRING ROUTINE

                            ;--- INT  12 H -------------------------------------------------------------
                            ; MEMORY_SIZE_DETERMINE                                                     :
                            ;       THIS ROUTINE RETURNS THE AMOUNT OF MEMORY IN THE SYSTEM AS          :
                            ;       DETERMINED BY THE POST ROUTINES.  (UP TO 640K)                      :
                            ;       NOTE THAT THE SYSTEM MAY NOT BE ABLE TO USE I/O MEMORY UNLESS       :
                            ;       THERE IS A FULL COMPLEMENT OF 512K BYTES ON THE PLANAR.             :
                            ; INPUT                                                                     :
                            ;       NO REGISTERS                                                        :
                            ;       THE @MEMORY_SIZE VARIABLE IS SET DURING POWER ON DIAGNOSTICS        :
                            ;       ACCORDING TO THE FOLLOWING ASSUMPTIONS:                             :
                            ;                                                                           :
                            ;       1. CONFIGURATION RECORD IN NON-VOLATILE MEMORY EQUALS THE ACTUAL    :
                            ;          MEMORY SIZE INSTALLED.                                           :
                            ;                                                                           :
                            ;       2. ALL INSTALLED MEMORY IS FUNCTIONAL.  IF THE MEMORY TEST DURING   :
                            ;          POST INDICATES LESS, THEN THIS VALUE BECOMES THE DEFAULT.        :
                            ;          IF NON-VOLATILE MEMORY IS NOT VALID (NOT INITIALIZED OR BATTERY  :
                            ;          FAILURE) THEN ACTUAL MEMORY DETERMINED BECOMES THE DEFAULT.      :
                            ;                                                                           :
                            ;       3. ALL MEMORY FROM 0 TO 640K MUST BE CONTIGUOUS.                    :
                            ;                                                                           :
                            ; OUTPUT                                                                    :
                            ;       (AX) = NUMBER OF CONTIGUOUS 1K BLOCKS OF MEMORY                     :
                            ;----------------------------------------------------------------------------
                                     ASSUME  CS:CODE,DS:DATA

 0000                       MEMORY_SIZE_DET_1  PROC FAR
 0000 FB                             STI                            ; INTERRUPTS BACK ON
 0001 1E                             PUSH    DS                     ; SAVE SEGMENT
 0002 E8 0000 E                      CALL    DDS                    ; ESTABLISH ADDRESSING
 0005 A1 0013 R                      MOV     AX,@MEMORY_SIZE        ; GET VALUE
 0008 1F                             POP     DS                     ; RECOVER SEGMENT
 0009 CF                             IRET                           ; RETURN TO CALLER
 000A                       MEMORY_SIZE_DET_1 ENDP

                            ;--- INT  11 H -------------------------------------------------------------
                            ; EQUIPMENT DETERMINATION                                                   :
                            ;       THIS ROUTINE ATTEMPTS TO DETERMINE WHAT OPTIONAL                    :
                            ;       DEVICES ARE ATTACHED TO THE SYSTEM.                                 :
                            ; INPUT                                                                     :
                            ;       NO REGISTERS                                                        :
                            ;       THE @EQUIP_FLAG VARIABLE IS SET DURING THE POWER ON                 :
                            ;       DIAGNOSTICS USING THE FOLLOWING HARDWARE ASSUMPTIONS:               :
                            ;       PORT 03FA = INTERRUPT ID REGISTER OF 8250 (PRIMARY)                 :
                            ;            02FA = INTERRUPT ID REGISTER OF 8250 (SECONDARY)               :
                            ;                 BITS 7-3 ARE ALWAYS 0                                     :
                            ;       PORT 0378 = OUTPUT PORT OF PRINTER (PRIMARY)                        :
                            ;            0278 = OUTPUT PORT OF PRINTER (SECONDARY)                      :
                            ;            03BC = OUTPUT PORT OF PRINTER (MONOCHROME-PRINTER)             :
                            ;  OUTPUT                                                                   :
                            ;       (AX) IS SET, BIT SIGNIFICANT, TO INDICATE ATTACHED I/O              :
                            ;       BIT 15,14 = NUMBER OF PRINTERS ATTACHED                             :
                            ;       BIT 13 = INTERNAL MODEM INSTALLED                                   :
                            ;       BIT 12 NOT USED                                                     :
                            ;       BIT 11,10,9 = NUMBER OF RS232 CARDS ATTACHED                        :
                            ;       BIT 8 = NOT USED                                                    :
                            ;       BIT 7,6 = NUMBER OF DISKETTE DRIVES                                 :
                            ;                 00=1, 01=2 ONLY IF BIT 0 = 1                              :
                            ;       BIT 5,4 = INITIAL VIDEO MODE                                        :
                            ;                          00 - UNUSED                                      :
                            ;                          01 - 40X25 BW USING COLOR CARD                   :
                            ;                          10 - 80X25 BW USING COLOR CARD                   :
                            ;                          11 - 80X25 BW USING BW CARD                      :
                            ;                                                                           :
                            ;       BIT 3 = NOT USED                                                    :
                            ;       BIT 2 = NOT USED                                                    :
                            ;       BIT 1 = MATH COPROCESSOR                                            :
                            ;       BIT 0 = 1 (IPL DISKETTE INSTALLED)                                  :
                            ;       NO OTHER REGISTERS AFFECTED                                         :
                            ;----------------------------------------------------------------------------

 000A                       EQUIPMENT_1  PROC  FAR                  ; ENTRY POINT FOR ORG 0F84DH
 000A FB                             STI                            ; INTERRUPTS BACK ON
 000B 1E                             PUSH    DS                     ; SAVE SEGMENT REGISTER
 000C E8 0000 E                      CALL    DDS                    ; ESTABLISH ADDRESSING
 000F A1 0010 R                      MOV     AX,@EQUIP_FLAG         ; GET THE CURRENT SETTINGS
 0012 1F                             POP     DS                     ; RECOVER SEGMENT
 0013 CF                             IRET                           ; RETURN TO CALLER
 0014                       EQUIPMENT_1      ENDP
```

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                                PAGE
                                ;-- HARDWARE INT  02 H -- ( NMI LEVEL ) -----------------------------------------
                                ; NON-MASKABLE INTERRUPT ROUTINE (REAL MODE)                                      :
                                ;       THIS ROUTINE WILL PRINT A "PARITY CHECK 1 OR 2" MESSAGE AND ATTEMPT       :
                                ;       TO FIND THE STORAGE LOCATION IN BASE 640K CONTAINING THE BAD PARITY.      :
                                ;       IF FOUND, THE SEGMENT ADDRESS WILL BE PRINTED.  IF NO PARITY ERROR        :
                                ;       CAN BE FOUND (INTERMITTENT READ PROBLEM)  ?????  WILL BE DISPLAYED        :
                                ;       WHERE THE ADDRESS WOULD NORMALLY GO.                                      :
                                ;                                                                                 :
                                ;       PARITY CHECK 1 = PLANAR BOARD MEMORY FAILURE.                             :
                                ;       PARITY CHECK 2 = OFF PLANAR BOARD MEMORY FAILURE.                         :
                                ;---------------------------------------------------------------------------------

 0014                           NMI_INT_1 PROC    NEAR
 0014 50                                PUSH    AX                      ; SAVE ORIGINAL CONTENTS OF (AX)

 0015 E4 61                             IN      AL,PORT_B               ; READ STATUS PORT
 0017 A8 C0                             TEST    AL,PARITY_ERR           ; PARITY CHECK OR I/O CHECK ?
 0019 75 07                             JNZ     NMI_1                   ; GO TO ERROR HALTS IF HARDWARE ERROR

 001B B0 0D                             MOV     AL,CMOS_REG_D           ; ELSE ?? - LEAVE NMI ON
 001D E8 0000 E                         CALL    CMOS_READ               ; TOGGLE NMI USING COMMON READ ROUTINE
 0020 58                                POP     AX                      ; RESTORE ORIGINAL CONTENTS OF (AX)
 0021 CF                                IRET                            ; EXIT NMI HANDLER BACK TO PROGRAM


 0022                           NMI_1:                                  ;       HARDWARE ERROR
 0022 50                                PUSH    AX                      ; SAVE INITIAL CHECK MASK IN (AL)
 0023 B0 8D                             MOV     AL,CMOS_REG_D+NMI       ; MASK TRAP (NMI) INTERRUPTS OFF
 0025 E6 70                             OUT     CMOS_PORT,AL
 0027 B0 AD                             MOV     AL,DIS_KBD              ; DISABLE THE KEYBOARD
 0029 E8 0000 E                         CALL    C8042                   ; SEND COMMAND TO ADAPTER
 002C E8 0000 E                         CALL    DDS                     ; ADDRESS DATA SEGMENT
 002F B4 00                             MOV     AH,0                    ; INITIALIZE AND SET MODE FOR VIDEO
 0031 A0 0049 R                         MOV     AL,@CRT_MODE            ; GET CURRENT MODE
 0034 CD 10                             INT     10H                     ; CALL VIDEO_IO TO CLEAR SCREEN

                                ;-----  DISPLAY "PARITY CHECK ?" ERROR MESSAGES

 0036 58                                POP     AX                      ; RECOVER INITIAL CHECK STATUS
 0037 BE 0000 E                         MOV     SI,OFFSET D1            ; PLANAR ERROR, ADDRESS "PARITY CHECK 1"
 003A A8 80                             TEST    AL,PARITY_CHECK         ; CHECK FOR PLANAR ERROR
 003C 74 05                             JZ      NMI_2                   ; SKIP IF NOT

 003E 50                                PUSH    AX                      ; SAVE STATUS
 003F E8 0000 E                         CALL    P_MSG                   ; DISPLAY "PARITY CHECK 1" MESSAGE
 0042 58                                POP     AX                      ; AND RECOVER STATUS
 0043                           NMI_2:
 0043 BE 0000 E                         MOV     SI,OFFSET D2            ; ADDRESS OF "PARITY CHECK 2" MESSAGE
 0046 A8 40                             TEST    AL,IO_CHECK             ; I/O PARITY CHECK ?
 0048 74 03                             JZ      NMI_3                   ; SKIP IF CORRECT ERROR DISPLAYED
 004A E8 0000 E                         CALL    P_MSG                   ; DISPLAY "PARITY CHECK 2" ERROR

                                ;-----  TEST FOR HOT NMI ON PLANAR PARITY LINE

 004D                           NMI_3:
 004D E4 61                             IN      AL,PORT_B
 004F 0C 0C                             OR      AL,RAM_PAR_OFF          ; TOGGLE PARITY CHECK ENABLES
 0051 E6 61                             OUT     PORT_B,AL
 0053 24 F3                             AND     AL,RAM_PAR_ON           ; TO CLEAR THE PENDING CHECK
 0055 E6 61                             OUT     PORT_B,AL

 0057 FC                                CLD                             ; SET DIRECTION FLAG TO INCREMENT
 0058 2B D2                             SUB     DX,DX                   ; POINT (DX) AT START OF REAL MEMORY
 005A 2B F6                             SUB     SI,SI                   ; SET (SI) TO START OF (DS:)
 005C E4 61                             IN      AL,PORT_B               ; READ CURRENT PARITY CHECK LATCH
 005E A8 C0                             TEST    AL,PARITY_ERR           ; CHECK FOR HOT NMI SOURCE
 0060 75 19                             JNZ     NMI_5                   ; SKIP IF ERROR NOT RESET (DISPLAY ???)

                                ;-----  SEE IF LOCATION THAT CAUSED PARITY CHECK CAN BE FOUND IN BASE MEMORY

 0062 8B 1E 0013 R                      MOV     BX,@MEMORY_SIZE         ; GET BASE MEMORY SIZE WORD
 0066                           NMI_4:
 0066 8E DA                             MOV     DS,DX                   ; POINT TO 64K SEGMENT
 0068 B9 8000                           MOV     CX,4000H*2              ; SET WORD COUNT FOR 64 KB SCAN
 006B F3/ AD                            REP     LODSW                   ; READ 64 KB OF MEMORY
 006D E4 61                             IN      AL,PORT_B               ; READ PARITY CHECK LATCHES
 006F A8 C0                             TEST    AL,PARITY_ERR           ; CHECK FOR ANY PARITY ERROR PENDING
 0071 75 10                             JNZ     NMI_6                   ; GO PRINT SEGMENT ADDRESS IF ERROR

 0073 80 C6 10                          ADD     DH,010H                 ; POINT TO NEXT 64K BLOCK
 0076 83 EB 40                          SUB     BX,16D*4                ; DECREMENT COUNT OF 1024 BYTE SEGMENTS
 0079 77 EB                             JA      NMI_4                   ; LOOP TILL ALL 64K SEGMENTS DONE
 007B                           NMI_5:
 007B BE 0000 E                         MOV     SI,OFFSET D2A           ; PRINT ROW OF ????? IF PARITY
 007E E8 0000 E                         CALL    P_MSG                   ; CHECK COULD NOT BE RE-CREATED
 0081 FA                                CLI
 0082 F4                                HLT                             ; HALT SYSTEM

 0083                           NMI_6:
 0083 E8 0000 E                         CALL    PRT_SEG                 ; PRINT SEGMENT VALUE (IN DX)
 0086 B0 28                             MOV     AL,'('                  ; PRINT (S)
 0088 E8 0000 E                         CALL    PRT_HEX
 008B B0 53                             MOV     AL,'S'
 008D E8 0000 E                         CALL    PRT_HEX
 0090 B0 29                             MOV     AL,')'
 0092 E8 0000 E                         CALL    PRT_HEX
 0095 FA                                CLI                             ; HALT SYSTEM
 0096 F4                                HLT

 0097                           NMI_INT_1 ENDP

 0097                           CODE    ENDS
                                        END
```

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                        PAGE 118,121
                        TITLE BIOS1 ---- 06/10/85  INTERRUPT 15H BIOS ROUTINES
                        .286C
                        .LIST
 0000                   CODE     SEGMENT BYTE PUBLIC

                                 PUBLIC   CASSETTE_IO_1
                                 PUBLIC   GATE_A20
                                 PUBLIC   SHUT9

                                 EXTRN    CMOS_READ:NEAR           ; READ CMOS LOCATION ROUTINE
                                 EXTRN    CMOS_WRITE:NEAR          ; WRITE CMOS LOCATION ROUTINE
                                 EXTRN    CONF_TBL:NEAR            ; SYSTEM/BIOS CONFIGURATION TABLE
                                 EXTRN    DDS:NEAR                 ; LOAD (DS) WITH DATA SEGMENT SELECTOR
                                 EXTRN    PROC_SHUTDOWN:NEAR       ; 80286 HARDWARE RESET ROUTINE

                        ;--- INT 15 H ---------------------------------------------------------------
                        ;     INPUT - CASSETTE I/O FUNCTIONS                                         :
                        ;                                                                            :
                        ;          (AH) = 00H                                                        :
                        ;          (AH) = 01H                                                        :
                        ;          (AH) = 02H                                                        :
                        ;          (AH) = 03H                                                        :
                        ;        RETURNS FOR THESE FUNCTIONS ALWAYS (AH) = 86H, CY = 1)              :
                        ;        IF CASSETTE PORT NOT PRESENT                                        :
                        ;----------------------------------------------------------------------------:
                        ;     INPUT - UNUSED FUNCTIONS                                               :
                        ;          (AH) = 04H THROUGH 7FH                                            :
                        ;        RETURNS FOR THESE FUNCTIONS ALWAYS (AH) = 86H, CY = 1)              :
                        ;                (UNLESS INTERCEPTED BY SYSTEM HANDLERS)                     :
                        ;                NOTE: THE KEYBOARD INTERRUPT HANDLER INTERRUPTS WITH AH=4FH :
                        ;----------------------------------------------------------------------------:
                        ; EXTENSIONS                                                                 :
                        ;          (AH) = 80H    DEVICE OPEN                                         :
                        ;                          (BX) = DEVICE ID                                  :
                        ;                          (CX) = PROCESS ID                                 :
                        ;                                                                            :
                        ;          (AH) = 81H    DEVICE CLOSE                                        :
                        ;                          (BX) = DEVICE ID                                  :
                        ;                          (CX) = PROCESS ID                                 :
                        ;                                                                            :
                        ;          (AH) = 82H    PROGRAM TERMINATION                                 :
                        ;                          (BX) = DEVICE ID                                  :
                        ;                                                                            :
                        ;          (AH) = 83H    EVENT WAIT                                          :
                        ;                                                                            :
                        ;                          (AL) = 00H SET INTERVAL                           :
                        ;                           (ES:BX) POINTER TO A BYTE IN CALLERS MEMORY      :
                        ;                                   THAT WILL HAVE THE HIGH ORDER BIT SET    :
                        ;                                   AS SOON AS POSSIBLE AFTER THE INTERVAL   :
                        ;                                   EXPIRES.                                 :
                        ;                           (CX,DX) NUMBER OF MICROSECONDS TO ELAPSE BEFORE  :
                        ;                                   POSTING.                                 :
                        ;                          (AL) = 01H CANCEL                                 :
                        ;                                                                            :
                        ;                   RETURNS: CARRY IF AL NOT = 00H OR 01H                    :
                        ;                            OR IF FUNCTION AL=0 ALREADY BUSY                :
                        ;                                                                            :
                        ;          (AH) = 84H    JOYSTICK SUPPORT                                    :
                        ;                          (DX) = 00H - READ THE CURRENT SWITCH SETTINGS     :
                        ;                                   RETURNS AL = SWITCH SETTINGS (BITS 7-4)  :
                        ;                          (DX) = 01H - READ THE RESISTIVE INPUTS            :
                        ;                                   RETURNS AX = A(x) VALUE                  :
                        ;                                           BX = A(y) VALUE                  :
                        ;                                           CX = B(x) VALUE                  :
                        ;                                           DX = B(y) VALUE                  :
                        ;                                                                            :
                        ;          (AH) = 85H    SYSTEM REQUEST KEY PRESSED                          :
                        ;                          (AL) = 00H MAKE OF KEY                            :
                        ;                          (AL) = 01H BREAK OF KEY                           :
                        ;                                                                            :
                        ;          (AH) = 86H    WAIT                                                :
                        ;                          (CX,DX) NUMBER OF MICROSECONDS TO ELAPSE BEFORE   :
                        ;                                  RETURN TO CALLER                          :
                        ;                                                                            :
                        ;          (AH) = 87H    MOVE BLOCK                                          :
                        ;                          (CX)    NUMBER OF WORDS TO MOVE                   :
                        ;                          (ES:SI)  POINTER TO DESCRIPTOR TABLE              :
                        ;                                                                            :
                        ;          (AH) = 88H    EXTENDED MEMORY SIZE DETERMINE                      :
                        ;                                                                            :
                        ;          (AH) = 89H    PROCESSOR TO VIRTUAL MODE                           :
                        ;                                                                            :
                        ;          (AH) = 90H     DEVICE BUSY LOOP                                   :
                        ;                          (AL)    SEE TYPE CODE                             :
                        ;                                                                            :
                        ;          (AH) = 91H    INTERRUPT COMPLETE FLAG SET                         :
                        ;                          (AL)    TYPE CODE                                 :
                        ;                          00H -> 7FH                                        :
                        ;                                  SERIALLY REUSABLE DEVICES                 :
                        ;                                  OPERATING SYSTEM MUST SERIALIZE ACCESS    :
                        ;                          80H -> BFH                                        :
                        ;                                  REENTRANT DEVICES; ES:BX IS USED TO       :
                        ;                                  DISTINGUISH DIFFERENT CALLS (MULTIPLE I/O :
                        ;                                  CALLS ARE ALLOWED SIMULTANEOUSLY)         :
                        ;                          C0H -> FFH                                        :
                        ;                                  WAIT ONLY CALLS --  THERE IS NO           :
                        ;                                  COMPLEMENTARY 'POST' FOR THESE WAITS.     :
                        ;                                  THESE ARE TIMEOUT ONLY.  TIMES ARE        :
                        ;                                  FUNCTION NUMBER DEPENDENT.                :
                        ;                                                                            :
                        ;                          TYPE  DESCRIPTION              TIMEOUT            :
                        ;                                                                            :
                        ;                          00H = DISK                     YES                :
                        ;                          01H = DISKETTE                 YES                :
                        ;                          02H = KEYBOARD                 NO                 :
                        ;                          80H = NETWORK                  NO                 :
                        ;                                ES:BX --> NCB                               :
                        ;                          FDH = DISKETTE MOTOR START     YES                :
                        ;                          FEH = PRINTER                  YES                :
                        ;                                                                            :
```

SECTION 5

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                        PAGE
                        ;           (AH) = C0H   RETURN CONFIGURATION PARAMETERS POINTER               :
                        ;                          RETURNS                                              :
                        ;                           (AH) = 00H AND CY= 0 (IF PRESENT ELSE 86 AND CY= 1) :
                        ;                           (ES:BX) = PARAMETER TABLE ADDRESS POINTER           :
                        ;                                      WHERE:                                   :
                        ;                                                                               :
                        ;                    DW    8            LENGTH OF FOLLOWING TABLE               :
                        ;                    DB    MODEL_BYTE   SYSTEM MODEL BYTE                       :
                        ;                    DB    TYPE_BYTE    SYSTEM MODEL TYPE BYTE                  :
                        ;                    DB    BIOS_LEVEL   BIOS REVISION LEVEL                     :
                        ;                    DB    ?            10000000 = DMA CHANNEL 3 USE BY BIOS    :
                        ;                                       01000000 = CASCADED INTERRUPT LEVEL 2   :
                        ;                                       00100000 = REAL TIME CLOCK AVAILABLE    :
                        ;                                       00010000 = KEYBOARD SCAN CODE HOOK 1AH  :
                        ;                    DB    0            RESERVED                                :
                        ;                    DB    0            RESERVED                                :
                        ;                    DB    0            RESERVED                                :
                        ;                    DB    0            RESERVED                                :
                        ;                                                                               :
                        ;--------------------------------------------------------------------------------

                                ASSUME  CS:CODE

 0000                   CASSETTE_IO_1   PROC    FAR
 0000  FB                       STI                             ; ENABLE INTERRUPTS
 0001  80 FC 80                 CMP     AH,080H                 ; CHECK FOR RANGE
 0004  72 4E                    JB      C1                      ; RETURN IF 00-7FH
 0006  80 FC C0                 CMP     AH,0C0H                 ; CHECK FOR CONFIGURATION PARAMETERS
 0009  74 51                    JE      CONF_PARMS
 000B  80 EC 80                 SUB     AH,080H                 ; BASE ON 0
 000E  0A E4                    OR      AH,AH
 0010  74 48                    JZ      DEV_OPEN                ; DEVICE OPEN
 0012  FE CC                    DEC     AH
 0014  74 44                    JZ      DEV_CLOSE               ; DEVICE CLOSE
 0016  FE CC                    DEC     AH
 0018  74 40                    JZ      PROG_TERM               ; PROGRAM TERMINATION
 001A  FE CC                    DEC     AH
 001C  74 47                    JZ      EVENT_WAIT              ; EVENT WAIT
 001E  FE CC                    DEC     AH
 0020  75 03                    JNZ     NOT_JOYSTICK
 0022  E9 00D0 R                JMP     JOY_STICK               ; JOYSTICK BIOS
 0025                   NOT_JOYSTICK:
 0025  FE CC                    DEC     AH
 0027  74 31                    JZ      SYS_REQ                 ; SYSTEM REQUEST KEY
 0029  FE CC                    DEC     AH
 002B  74 07                    JZ      C1_A                    ; WAIT
 002D  FE CC                    DEC     AH
 002F  75 06                    JNZ     C1_B
 0031  E9 01CA R                JMP     BLOCKMOVE               ; MOVE BLOCK

 0034  E9 016A R        C1_A:   JMP     WAIT                    ; WAIT

 0037  FE CC            C1_B:   DEC     AH

 0039  75 03                    JNZ     C1_C
 003B  E9 03EE R                JMP     EXT_MEMORY              ; GO GET THE EXTENDED MEMORY

 003E  FE CC            C1_C:   DEC     AH
 0040  75 03                    JNZ     C1_D                    ; CHECK FOR FUNCTION 89H
 0042  E9 03FA R                JMP     SET_VMODE               ; SWAP TO VIRTUAL MODE

 0045  80 EC 07         C1_D:   SUB     AH,7                    ; CHECK FOR FUNCTION 90H
 0048  75 03                    JNZ     C1_E                    ; GO IF NOT
 004A  E9 0483 R                JMP     DEVICE_BUSY

 004D  FE CC            C1_E:   DEC     AH                      ; CHECK FOR FUNCTION 8BH
 004F  75 03                    JNZ     C1                      ; GO IF NOT
 0051  E9 0487 R                JMP     INT_COMPLETE

 0054  B4 86            C1:     MOV     AH,86H                  ; SET BAD COMMAND
 0056  F9                       STC                             ; SET CARRY FLAG ON
 0057                   C1_F:
 0057  CA 0002                  RET     2                       ; FAR RETURN EXIT FROM ROUTINES


 005A                   DEV_OPEN:                               ; NULL HANDLERS

 005A                   DEV_CLOSE:

 005A                   PROG_TERM:

 005A                   SYS_REQ:
 005A  EB FB                    JMP     C1_F                    ; RETURN
 005C                   CASSETTE_IO_1   ENDP

 005C                   CONF_PARMS      PROC    NEAR
 005C  0E                       PUSH    CS                      ; GET CODE SEGMENT
 005D  07                       POP     ES                      ; PLACE IN SELECTOR POINTER
 005E  BB 0000 E                MOV     BX,OFFSET CONF_TBL      ; GET OFFSET OF PARAMETER TABLE
 0061  32 E4                    XOR     AH,AH                   ; CLEAR AH AND SET CARRY OFF
 0063  EB F2                    JMP     C1_F                    ; EXIT THROUGH COMMON RETURN
 0065                   CONF_PARMS      ENDP

 0065                   EVENT_WAIT      PROC    NEAR
                                ASSUME  DS:DATA
 0065  1E                       PUSH    DS                      ; SAVE
 0066  E8 0000 E                CALL    DDS
 0069  0A C0                    OR      AL,AL
 006B  74 08                    JZ      EVENT_WAIT_2            ; GO IF ZERO
 006D  FE C8                    DEC     AL                      ; CHECK IF 1
 006F  74 45                    JZ      EVENT_WAIT_3
 0071  1F                       POP     DS                      ; RESTORE DATA SEGMENT
 0072  F9                       STC                             ; SET CARRY
 0073  EB E2                    JMP     C1_F                    ; EXIT

 0075                   EVENT_WAIT_2:
 0075  FA                       CLI                             ; NO INTERRUPTS ALLOWED
 0076  F6 06 00A0 R 01          TEST    @RTC_WAIT_FLAG,01       ; CHECK FOR FUNCTION ACTIVE
 007B  74 05                    JZ      EVENT_WAIT_1
 007D  FB                       STI                             ; ENABLE INTERRUPTS
 007E  1F                       POP     DS
 007F  F9                       STC                             ; SET ERROR
 0080  EB D5                    JMP     C1_F                    ; RETURN
```

```
0082                      EVENT_WAIT_1:
0082 E4 A1                        IN      AL,INTB01               ; ENSURE INTERRUPT UNMASKED
0084 EB 00                        JMP     $+2
0086 24 FE                        AND     AL,0FEH
0088 E6 A1                        OUT     INTB01,AL
008A 8C 06 009A R                 MOV     @USER_FLAG_SEG,ES       ; SET UP TRANSFER TABLE
008E 89 1E 0098 R                 MOV     @USER_FLAG,BX
0092 89 0E 009E R                 MOV     @RTC_HIGH,CX
0096 89 16 009C R                 MOV     @RTC_LOW,DX
009A C6 06 00A0 R 01              MOV     @RTC_WAIT_FLAG,01       ; SET ON FUNCTION ACTIVE SWITCH
009F B0 0B                        MOV     AL,CMOS_REG_B           ; ENABLE PIE
00A1 E8 0000 E                    CALL    CMOS_READ               ; READ CMOS LOCATION
00A4 24 7F                        AND     AL,07FH                 ; CLEAR SET
00A6 0C 40                        OR      AL,040H                 ; ENABLE PIE
00A8 50                           PUSH    AX                      ; SAVE AH
00A9 8A E0                        MOV     AH,AL                   ; PLACE DATA INTO DATA REGISTER
00AB B0 0B                        MOV     AL,CMOS_REG_B           ; ADDRESS ALARM REGISTER
00AD E8 0000 E                    CALL    CMOS_WRITE              ; PLACE DATA IN AH INTO ALARM REGISTER
00B0 58                           POP     AX                      ; RESTORE AH
00B1 1F                           POP     DS
00B2 FB                           STI                             ; ENABLE INTERRUPTS
00B3 F8                           CLC                             ; CLEAR CARRY
00B4 EB A1                        JMP     C1_F

                          ;-----  CANCEL

00B6                      EVENT_WAIT_3:
00B6 50                           PUSH    AX                      ; SAVE
00B7 FA                           CLI                             ; DISABLE INTERRUPTS
00B8 B8 0B0B                      MOV     AX,X*CMOS_REG_B         ; TURN OFF PIE
00BB E8 0000 E                    CALL    CMOS_READ               ; GET ALARM REGISTER
00BE 24 BF                        AND     AL,0BFH                 ; CLEAR PIE
00C0 86 E0                        XCHG    AH,AL                   ; PLACE INTO WRITE REGISTER
00C2 E8 0000 E                    CALL    CMOS_WRITE              ; WRITE BACK TO ALARM REGISTER
00C5 58                           POP     AX                      ; RESTORE AH
00C6 C6 06 00A0 R 00              MOV     @RTC_WAIT_FLAG,0        ; SET FUNCTION ACTIVE FLAG OFF
00CB FB                           STI                             ; ENABLE INTERRUPTS
00CC 1F                           POP     DS                      ; RESTORE DATA SEGMENT
00CD F8                           CLC                             ; SET CARRY OFF
00CE EB 87                        JMP     C1_F                    ; RETURN

00D0                      EVENT_WAIT      ENDP
                          ;--- JOY_STICK -----------------------------------------------
                          ;       THIS ROUTINE WILL READ THE JOYSTICK PORT              :
                          ;                                                             :
                          ;       INPUT                                                 :
                          ;       (DX)=0 READ THE CURRENT SWITCHES                      :
                          ;               RETURNS (AL)= SWITCH SETTINGS IN BITS 7-4     :
                          ;                                                             :
                          ;       (DX)=1  READ THE RESISTIVE INPUTS                     :
                          ;               RETURNS (AX)=A(x) VALUE                       :
                          ;                       (BX)=A(y) VALUE                       :
                          ;                       (CX)=B(x) VALUE                       :
                          ;                       (DX)=B(y) VALUE                       :
                          ;                                                             :
                          ;       CY FLAG ON IF NO ADAPTER CARD OR INVALID CALL         :
                          ;-------------------------------------------------------------

00D0                      JOY_STICK       PROC    NEAR
00D0 FB                           STI                             ; INTERRUPTS BACK ON
00D1 8B C2                        MOV     AX,DX                   ; GET SUB FUNCTION CODE
00D3 BA 0201                      MOV     DX,201H                 ; ADDRESS OF PORT
00D6 0A C0                        OR      AL,AL
00D8 74 0B                        JZ      JOY_2                   ; READ SWITCHES
00DA FE C8                        DEC     AL
00DC 74 0C                        JZ      JOY_3                   ; READ RESISTIVE INPUTS
00DE E9 0054 R                    JMP     C1                      ; GO TO ERROR RETURN
00E1                      JOY_1:
00E1 FB                           STI
00E2 E9 0057 R                    JMP     C1_F                    ; GO TO COMMON RETURN

00E5                      JOY_2:
00E5 EC                           IN      AL,DX
00E6 24 F0                        AND     AL,0F0H                 ; STRIP UNWANTED BITS OFF
00E8 EB F7                        JMP     JOY_1                   ; FINISHED

00EA                      JOY_3:
00EA B3 01                        MOV     BL,1
00EC E8 0108 R                    CALL    TEST_CORD
00EF 51                           PUSH    CX                      ; SAVE A(X) VALUE
00F0 B3 02                        MOV     BL,2
00F2 E8 0108 R                    CALL    TEST_CORD
00F5 51                           PUSH    CX                      ; SAVE A(Y) VALUE
00F6 B3 04                        MOV     BL,4
00F8 E8 0108 R                    CALL    TEST_CORD
00FB 51                           PUSH    CX                      ; SAVE B(X) VALUE
00FC B3 08                        MOV     BL,8
00FE E8 0108 R                    CALL    TEST_CORD
0101 8B D1                        MOV     DX,CX                   ; SAVE B(Y) VALUE
0103 59                           POP     CX                      ; GET B(X) VALUE
0104 5B                           POP     BX                      ; GET A(Y) VALUE
0105 58                           POP     AX                      ; GET A(X) VALUE
0106 EB D9                        JMP     JOY_1                   ; FINISHED - RETURN

0108                      TEST_CORD       PROC  NEAR
0108 52                           PUSH    DX                      ; SAVE
0109 FA                           CLI                             ; BLOCK INTERRUPTS WHILE READING
010A B0 00                        MOV     AL,0                    ; SET UP TO LATCH TIMER 0
010C E6 43                        OUT     TIMER+3,AL
010E EB 00                        JMP     $+2
0110 E4 40                        IN      AL,TIMER                ; READ LOW BYTE OF TIMER 0
0112 EB 00                        JMP     $+2
0114 8A E0                        MOV     AH,AL
0116 E4 40                        IN      AL,TIMER                ; READ HIGH BYTE OF TIMER 0
0118 86 E0                        XCHG    AH,AL                   ; REARRANGE TO HIGH,LOW
011A 50                           PUSH    AX                      ; SAVE
011B B9 04FF                      MOV     CX,4FFH                 ; SET COUNT
011E EE                           OUT     DX,AL                   ; FIRE TIMER
011F EB 00                        JMP     $+2
0121                      TEST_CORD_1:
0121 EC                           IN      AL,DX                   ; READ VALUES
0122 84 C3                        TEST    AL,BL                   ; HAS PULSE ENDED?
0124 E0 FB                        LOOPNZ  TEST_CORD_1
```

```
0126 83 F9 00                   CMP     CX,0
0129 59                         POP     CX                      ; ORIGINAL COUNT
012A 75 04                      JNZ     SHORT TEST_CORD_2
012C 2B C9                      SUB     CX,CX                   ; SET 0 COUNT FOR RETURN
012E EB 28                      JMP     SHORT TEST_CORD_3       ; EXIT WITH COUNT = 0
0130                    TEST_CORD_2:
0130 B0 00                      MOV     AL,0                    ; SET UP TO LATCH TIMER 0
0132 E6 43                      OUT     TIMER+3,AL
0134 EB 00                      JMP     $+2
0136 E4 40                      IN      AL,TIMER                ; READ LOW BYTE OF TIMER 0
0138 8A E0                      MOV     AH,AL
013A EB 00                      JMP     $+2
013C E4 40                      IN      AL,TIMER                ; READ HIGH BYTE OF TIMER 0
013E 86 E0                      XCHG    AH,AL                   ; REARRANGE TO HIGH,LOW

0140 3B C8                      CMP     CX,AX                   ; CHECK FOR COUNTER WRAP
0142 73 0B                      JAE     TEST_CORD_4             ; GO IF NO
0144 52                         PUSH    DX
0145 BA FFFF                    MOV     DX,-1

0148 2B D0                      SUB     DX,AX                   ; ADJUST FOR WRAP
014A 03 CA                      ADD     CX,DX
014C 5A                         POP     DX
014D EB 02                      JMP     SHORT TEST_CORD_5

014F                    TEST_CORD_4:
014F 2B C8                      SUB     CX,AX
0151                    TEST_CORD_5:
0151 81 E1 1FF0                 AND     CX,1FF0H                ; ADJUST
0155 C1 E9 04                   SHR     CX,4

0158                    TEST_CORD_3:
0158 FB                         STI                             ; INTERRUPTS BACK ON
0159 BA 0201                    MOV     DX,201H                 ; FLUSH OTHER INPUTS
015C 51                         PUSH    CX
015D 50                         PUSH    AX
015E B9 04FF                    MOV     CX,4FFH                 ; COUNT
0161                    TEST_CORD_6:
0161 EC                         IN      AL,DX
0162 A8 0F                      TEST    AL,0FH
0164 E0 FB                      LOOPNZ  TEST_CORD_6

0166 58                         POP     AX
0167 59                         POP     CX
0168 5A                         POP     DX                      ; SET COUNT

0169 C3                         RET                             ; RETURN

016A                    TEST_CORD       ENDP
016A                    JOY_STICK       ENDP

016A                    WAIT    PROC    NEAR
016A 1E                         PUSH    DS                      ; SAVE
016B E8 0000 E                  CALL    DDS
016E F6 06 00A0 R 01            TEST    @RTC_WAIT_FLAG,01       ; TEST FOR FUNCTION ACTIVE
0173 74 05                      JZ      WAIT_1
0175 1F                         POP     DS
0176 F9                         STC                             ; SET ERROR
0177 E9 0057 R                  JMP     C1_F                    ; RETURN
017A                    WAIT_1:
017A FA                         CLI                             ; NO INTERRUPTS ALLOWED
017B E4 A1                      IN      AL,INTB01               ; ENSURE INTERRUPT UNMASKED
017D EB 00                      JMP     $+2
017F 24 FE                      AND     AL,0FEH
0181 E6 A1                      OUT     INTB01,AL
0183 8C 1E 009A R               MOV     @USER_FLAG_SEG,DS       ; SET UP TRANSFER TABLE
0187 C7 06 0098 R 00A0 R        MOV     @USER_FLAG,OFFSET @RTC_WAIT_FLAG
018D 89 0E 009E R               MOV     @RTC_HIGH,CX
0191 89 16 009C R               MOV     @RTC_LOW,DX
0195 C6 06 00A0 R 01            MOV     @RTC_WAIT_FLAG,01       ; SET ON FUNCTION ACTIVE SWITCH
019A 50                         PUSH    AX                      ; SAVE (AH)
019B B8 0B0B                    MOV     AX,X*CMOS_REG_B         ; ENABLE PIE
019E E8 0000 E                  CALL    CMOS_READ               ; READ ALARM BYTE
01A1 24 7F                      AND     AL,07FH                 ; CLEAR SIT BIT
01A3 0C 40                      OR      AL,040H                 ; ENABLE PIE BIT
01A5 86 E0                      XCHG    AH,AL                   ; DATA TO WORK REGISTER
01A7 E8 0000 E                  CALL    CMOS_WRITE              ; WRITE NEW ALARM BYTE
01AA 58                         POP     AX                      ; RESTORE (AH)

                        ;-----  WAIT TILL RTC TIMEOUT POSTED   (WITH ERROR TIMEOUT)

01AB FB                         STI                             ; ENABLE INTERRUPTS
01AC 51                         PUSH    CX
01AD 52                         PUSH    DX                      ; SAVE CALLERS PARAMETERS
01AE 87 D1                      XCHG    DX,CX                   ; SWAP COUNT WORK REGISTERS
01B0                    WAIT_2:
01B0 F6 06 00A0 R 80            TEST    @RTC_WAIT_FLAG,080H     ; CHECK FOR END OF WAIT - CLEAR CARRY
01B5 E1 F9                      LOOPZ   WAIT_2                  ; DECREMENT TIMEOUT DELAY TILL WAIT END
01B7 75 05                      JNZ     WAIT_9                  ; EXIT IF RTC TIMER WAIT ENDED FLAG SET
01B9 83 EA 01                   SUB     DX,1                    ; DECREMENT ERROR TIMEOUT COUNTER
01BC 73 F2                      JNC     WAIT_2                  ; LOOP TILL COUNTERS TIMEOUT
01BE                    WAIT_9:
01BE C6 06 00A0 R 00            MOV     @RTC_WAIT_FLAG,0        ; SET FUNCTION INACTIVE
01C3 5A                         POP     DX
01C4 59                         POP     CX                      ; RESTORE CALLERS PARAMETERS
01C5 1F                         POP     DS
01C6 F8                         CLC                             ; CLEAR CARRY FLAG
01C7 E9 0057 R                  JMP     C1_F

01CA                    WAIT    ENDP
```

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                              PAGE
                              ;--- INT  15 H -- ( FUNCTION 87 H - BLOCK MOVE ) ------------------------------
                              ;                                                                              :
                              ;       THIS BIOS FUNCTION PROVIDES A MEANS FOR A REAL MODE PROGRAM OR SYSTEM  :
                              ;       TO TRANSFER A BLOCK OF STORAGE TO AND FROM STORAGE ABOVE THE 1 MEG     :
                              ;       ADDRESS RANGE IN PROTECTED MODE SPACE BY SWITCHING TO PROTECTED MODE.  :
                              ;                                                                              :
                              ; ENTRY:                                                                       :
                              ;       (AH) =  87H (FUNCTION CALL) - BLOCK MOVE.                              :
                              ;       (CX) =  WORD COUNT OF STORAGE BLOCK TO BE MOVED.                       :
                              ;               NOTE: MAX COUNT = 8000H FOR 32K WORDS (65K BYTES)              :
                              ;       ES:SI = LOCATION OF A GDT TABLE BUILT BY ROUTINE USING THIS FUNCTION.  :
                              ;                                                                              :
                              ;       (ES:SI) POINTS TO A DESCRIPTOR TABLE (GDT) BUILT BEFORE INTERRUPTING   :
                              ;       TO THIS FUNCTION.  THE DESCRIPTORS ARE USE TO PERFORM THE BLOCK        :
                              ;       MOVE IN THE PROTECTED MODE.  THE SOURCE AND TARGET DESCRIPTORS         :
                              ;       BUILT BY THE USER MUST HAVE A SEGMENT LENGTH = 2 * CX-1 OR GREATER.    :
                              ;       THE DATA ACCESS RIGHTS BYTE MUST BE SET TO CPL0-R/W (93H).  THE        :
                              ;       24 BIT ADDRESS (BYTE HI, WORD LOW) MUST BE SET TO THE TARGET/SOURCE.   :
                              ;                                                                              :
                              ;       ***  NO INTERRUPTS ARE ALLOWED DURING TRANSFER.  LARGE BLOCK MOVES     :
                              ;            MAY CAUSE LOST INTERRUPTS.                                        :
                              ;                                                                              :
                              ; EXIT:                                                                        :
                              ;       (AH) = 00H  IF SUCCESSFUL                                              :
                              ;       (AH) = 01H  IF MEMORY PARITY (PARITY ERROR REGISTERS ARE CLEARED)      :
                              ;       (AH) = 02H  IF ANY OTHER EXCEPTION INTERRUPT ERROR OCCURRED            :
                              ;       (AH) = 03H  IF GATE ADDRESS LINE 20 FAILED                             :
                              ;               ALL REGISTERS ARE RESTORED EXCEPT (AH).                        :
                              ;                                                                              :
                              ;       IF SUCCESSFUL - CARRY FLAG = 0                                         :
                              ;       IF ERROR ------ CARRY FLAG = 1                                         :
                              ;                                                                              :
                              ; DESCRIPTION:                                                                 :
                              ;                                                                              :
                              ;        1.  SAVE ENTRY REGISTERS AND SETUP FOR SHUTDOWN EXIT.                 :
                              ;        2.  THE REQUIRED ENTRIES ARE BUILT IN THE GDT AT (ES:SI).             :
                              ;        3.  GATE ADDRESS LINE 20 ACTIVE, CLI AND SET SHUTDOWN CODES.          :
                              ;        4.  THE IDTR IS LOADED AND POINTS TO A ROM RESIDENT TABLE.            :
                              ;        5.  THE GDTR IS LOADED FROM THE OFFSET POINTER (ES:SI).               :
                              ;        6.  THE PROCESSOR IS PUT INTO PROTECTED MODE.                         :
                              ;        7.  LOAD (DS) AND (ES) WITH SELECTORS FOR THE SOURCE AND TARGET.      :
                              ;        8.  DS:SI (SOURCE) (ES:DI) (TARGET) REP MOVSW IS EXECUTED.            :
                              ;        9.  CHECK MADE FOR PARITY ERRORS.                                     :
                              ;       10.  REAL MODE RESTORED WHEN SHUTDOWN 09H IS EXECUTED.                 :
                              ;       11.  ERRORS ARE CHECKED FOR AND RETURN CODES ARE SET FOR (AH).         :
                              ;       12.  ADDRESS LINE 20 GATE IS DISABLED.                                 :
                              ;       13.  RETURN WITH REGISTERS RESTORED AND STATUS RETURN CODE.            :
                              ;             (FOR PC-AT COMPATIBILITY ZF=1 IF SUCCESSFUL, ZF=0 IF ERROR.)     :
                              ;------------------------------------------------------------------------------
                              ;
                              ;       THE FOLLOWING DIAGRAM DEPICTS THE ORGANIZATION OF A BLOCK MOVE GDT.
                              ;------------------------------------------------------------------------------
                              ;              G D T                                                           :
                              ; (ES:SI)                                                                      :
                              ;     |              .-----------.                                             :
                              ;     |              v           |                                             :
                              ;    +00 .---------------.       |                                             :
                              ;        |     DUMMY     |       |  1. THE FIRST DESCRIPTOR IS THE REQUIRED DUMMY. :
                              ;        |               |       |     (USER INITIALIZED TO 0)                 :
                              ;    +08 |---------------|       |                                             :
                              ;        |    GDT LOC    | --'    2. THE SECOND DESCRIPTOR POINTS TO THE GDT    :
                              ;        |               |           TABLE AS A DATA SEGMENT.                  :
                              ;    +10 |---------------|            (USER INITIALIZED TO 0 - MODIFIED BY BIOS) :
                              ;        |    SOURCE     |         3. THE THIRD DESCRIPTOR POINTS TO THE SOURCE :
                              ;        |     GDT       |            TO BE MOVED. (FROM)                      :
                              ;    +18 |---------------|             (USER INITIALIZED)                      :
                              ;        |    TARGET     |         4. THE FOURTH DESCRIPTOR POINTS TO THE       :
                              ;        |     GDT       |            DESTINATION SEGMENT. (TO)                :
                              ;    +20 |---------------|             (USER INITIALIZED)                      :
                              ;        |     BIOS      |         5. THE FIFTH IS A DESCRIPTOR THAT BIOS USES  :
                              ;        |     (CS)      |            TO CREATE THE PROTECTED MODE CODE SEGMENT. :
                              ;    +28 |---------------|             (USER INITIALIZED TO 0 - MODIFIED BY BIOS) :
                              ;        |     (SS)      |         6. THE SIXTH DESCRIPTOR IS USED BY BIOS TO   :
                              ;        |               |            CREATE A PROTECTED MODE STACK SEGMENT.   :
                              ;        '---------------'             (USER INITIALIZED TO 0 - MODIFIED BY BIOS) :
                              ;                                     (POINTS TO USERS STACK)                  :
                              ;                                                                              :
                              ;                                                                              :
                              ;              SAMPLE  OF  SOURCE  OR  TARGET  DESCRIPTOR                      :
                              ;                                                                              :
                              ;          SOURCE_TARGET_DEF      STRUC                                        :
                              ;                                                                              :
                              ;           SEG_LIMIT        DW      ?   ; SEGMENT LIMIT (1-65536 BYTES)       :
                              ;           LO_WORD          DW      ?   ; 24 BIT SEGMENT PHYSICAL             :
                              ;           HI_BYTE          DB      ?   ;    ADDRESS (0 TO (16M-1))           :
                              ;           DATA_ACC_RIGHTS  DB     93H  ; ACCESS RIGHTS BYTE (CPL0-R/W)       :
                              ;           RESERVED         DW      0   ; RESERVED WORD (MUST BE ZERO)        :
                              ;                                                                              :
                              ;          SOURCE_TARGET_DEF      ENDS                                         :
                              ;                                                                              :
                              ;------------------------------------------------------------------------------
                              ;
                              ;    THE GLOBAL DESCRIPTOR TABLE (ACTUAL LOCATION POINTED TO BY ES:SI)

                              BLOCKMOVE_GDT_DEF       STRUC
0000 ????????????????                          DQ      ?               ; FIRST DESCRIPTOR NOT ACCESSIBLE
0008 ????????????????         CGDT_LOC         DQ      ?               ; LOCATION OF CALLING ROUTINE GDT
0010 ????????????????         SOURCE           DQ      ?               ; SOURCE DESCRIPTOR
0018 ????????????????         TARGET           DQ      ?               ; TARGET DESCRIPTOR
0020 ????????????????         BIOS_CS          DQ      ?               ; BIOS CODE DESCRIPTOR
0028 ????????????????         TEMP_SS          DQ      ?               ; STACK DESCRIPTOR
0030                          BLOCKMOVE_GDT_DEF       ENDS

01CA                          BLOCKMOVE   PROC     NEAR

01CA FC                               CLD                              ; SET DIRECTION FORWARD
01CB 60                               PUSHA                            ; SAVE GENERAL PURPOSE REGISTERS
01CC 06                               PUSH    ES                       ; SAVE USERS EXTRA SEGMENT
01CD 1E                               PUSH    DS                       ; SAVE USERS DATA SEGMENT

                              ;-----  SAVE THE CALLING ROUTINE"S STACK

01CE E8 0000 E                        CALL    DDS                      ; SET DS TO DATA AREA
```

```
0 1D1 8C 16 0069 R                      MOV     @IO_ROM_SEG,SS          ; SAVE USERS STACK SEGMENT
01D5 89 26 0067 R                       MOV     @IO_ROM_INIT,SP         ; SAVE USERS STACK POINTER

                                ;=====  SET UP THE PROTECTED MODE DEFINITIONS  =====

                                ;-----  MAKE A 24 BIT ADDRESS OUT OF THE ES:SI FOR THE GDT POINTER

                                        ASSUME  DS:NOTHING              ; POINT (DS) TO USERS CONTROL BLOCK
01D9 8C C0                              MOV     AX,ES                   ; GET THE GDT DATA SEGMENT
01DB 8E D8                              MOV     DS,AX                   ; MOVE THE GDT SEGMENT POINTER TO (DS)
01DD 8A F4                              MOV     DH,AH                   ; BUILD HIGH BYTE OF THE 24 BIT ADDRESS
01DF C0 EE 04                           SHR     DH,4                    ; USE ONLY HIGH NIBBLE SHIFT - RIGHT 4
01E2 C1 E0 04                           SHL     AX,4                    ; STRIP HIGH NIBBLE FROM (AX)
01E5 03 C6                              ADD     AX,SI                   ; ADD THE GDT OFFSET TO DEVELOP LOW WORD
01E7 80 D6 00                           ADC     DH,0                    ; ADJUST HIGH BYTE IF CARRY FROM LOW

                                ;-----  SET THE GDT_LOC

01EA C7 44 08 FFFF                      MOV     [SI].CGDT_LOC.SEG_LIMIT,MAX_SEG_LEN
01EF 89 44 0A                           MOV     [SI].CGDT_LOC.BASE_LO_WORD,AX    ; SET THE LOW WORD
01F2 88 74 0C                           MOV     [SI].CGDT_LOC.BASE_HI_BYTE,DH    ; SET THE HIGH BYTE
01F5 C7 44 0E 0000                      MOV     [SI].CGDT_LOC.DATA_RESERVED,0    ; RESERVED

                                ;-----  SET UP THE CODE SEGMENT DESCRIPTOR

01FA C7 44 20 FFFF                      MOV     [SI].BIOS_CS.SEG_LIMIT,MAX_SEG_LEN
01FF C7 44 22 0000                      MOV     [SI].BIOS_CS.BASE_LO_WORD,CSEG@_LO      ; LOW WORD OF (CS)= 0
0204 C6 44 24 0F                        MOV     [SI].BIOS_CS.BASE_HI_BYTE,CSEG@_HI      ; HIGH BYTE OF (CS)= 0FH
0208 C6 44 25 9B                        MOV     [SI].BIOS_CS.DATA_ACC_RIGHTS,CPL0_CODE_ACCESS
020C C7 44 26 0000                      MOV     [SI].BIOS_CS.DATA_RESERVED,0            ; RESERVED

                                ;-----  MAKE A 24 BIT ADDRESS OUT OF THE (SS) - ( (SP) REMAINS USER (SP) )

0211 8C D0                              MOV     AX,SS                   ; GET THE CURRENT STACK SEGMENT
0213 8A F4                              MOV     DH,AH                   ; FORM HIGH BYTE OF 24 BIT ADDRESS
0215 C0 EE 04                           SHR     DH,4                    ; FORM HIGH BYTE - SHIFT RIGHT 4
0218 C1 E0 04                           SHL     AX,4                    ; STRIP HIGH NIBBLE FROM (AX)

                                ;-----  SS IS NOW IN POSITION FOR A 24 BIT ADDRESS --> SETUP THE (SS) DESCRIPTOR

021B C7 44 28 FFFF                      MOV     [SI].TEMP_SS.SEG_LIMIT,MAX_SEG_LEN    ; SET THE SS SEGMENT LIMIT
0220 89 44 2A                           MOV     [SI].TEMP_SS.BASE_LO_WORD,AX          ; SET THE LOW WORD
0223 88 74 2C                           MOV     [SI].TEMP_SS.BASE_HI_BYTE,DH          ; SET THE HIGH BYTE
0226 C6 44 2D 93                        MOV     [SI].TEMP_SS.DATA_ACC_RIGHTS,CPL0_DATA_ACCESS  ; SET CPL 0

                                ;-----  GATE ADDRESS BIT 20 ON  (DISABLE INTERRUPTS)

022A B4 DF                              MOV     AH,ENABLE_BIT20         ; GET ENABLE MASK
022C E8 03CC R                          CALL    GATE_A20                ; ENABLE A20 AND CLEAR INTERRUPTS
022F 3C 00                              CMP     AL,0                    ; WAS THE COMMAND ACCEPTED?
0231 74 06                              JZ      BL4                     ; GO IF YES

0233 B0 03                              MOV     AL,03H                  ; SET THE ERROR FLAG IF NOT
0235 E6 80                              OUT     MFG_PORT,AL
0237 EB 51                              JMP     SHORT SHUT9             ; EARLY ERROR EXIT

                                ;-----  SET SHUTDOWN RETURN ADDRESS AND DISABLE NMI
0239                            BL4:
0239 B8 098F                            MOV     AX,9*H+CMOS_SHUT_DOWN+NMI        ; SET THE SHUTDOWN BYTE LOCATION
023C E8 0000 E                          CALL    CMOS_WRITE                       ; TO SHUT DOWN 9 AND DISABLE NMI

                                ;-----  CLEAR EXCEPTION ERROR FLAG

023F 2A C0                              SUB     AL,AL
0241 E6 80                              OUT     MFG_PORT,AL             ; SET ERROR FLAG LOCATION TO 0

                                ;-----  LOAD THE IDT AND GDT

0243 BD 02C6 R                          MOV     BP,OFFSET ROM_IDT_LOC
                                        SEGOV   CS                      ; LOAD THE IDT
0246 2E                         +       DB      02EH
                                        LIDT    [BP]                    ;   REGISTER FROM THIS AREA
0247 0F                         +       DB      00FH
0248                            + ??0001 LABEL  BYTE
0248 8B 5E 00                   +       MOV     BX,WORD PTR [BP]
024B                            + ??0002 LABEL  BYTE
0248                            +       ORG     OFFSET CS:??0001
0248 01                         +       DB      001H
024B                            +       ORG     OFFSET CS:??0002

                                        LGDT    [SI].CGDT_LOC           ; LOAD GLOBAL DESCRIPTOR TABLE REGISTER
024B 0F                         +       DB      00FH
024C                            + ??0003 LABEL  BYTE
024C 8B 54 08                   +       MOV     DX,WORD PTR [SI].CGDT_LOC
024F                            + ??0004 LABEL  BYTE
024C                            +       ORG     OFFSET CS:??0003
024C 01                         +       DB      001H
024F                            +       ORG     OFFSET CS:??0004


                                ;-----  SWITCH TO VIRTUAL MODE

024F B8 0001                            MOV     AX,VIRTUAL_ENABLE       ; MACHINE STATUS WORD NEEDED TO
                                        LMSW    AX                      ;  SWITCH TO VIRTUAL MODE
0252 0F 01 F0                   +       DB      00FH,001H,0F0H
0255 EA                                  DB     0EAH                    ; PURGE PRE-FETCH QUEUE WITH FAR JUMP
0256 025A R                              DW     OFFSET VIRT             ;  - TO OFFSET
0258 0020                                DW     BIOS_CS                 ;  - IN SEGMENT -PROTECTED MODE SELECTOR
025A                            VIRT:

                                ;-----  IN PROTECTED MODE - SETUP STACK SELECTOR AND SOURCE/TARGET SELECTORS

025A B8 0028                            MOV     AX,TEMP_SS              ; USER'S SS+SP IS NOT A DESCRIPTOR
025D 8E D0                              MOV     SS,AX                   ; LOAD STACK SELECTOR
025F B8 0010                            MOV     AX,SOURCE               ; GET THE SOURCE ENTRY
0262 8E D8                              MOV     DS,AX                   ; LOAD SOURCE SELECTOR
0264 B8 0018                            MOV     AX,TARGET               ; GET THE TARGET ENTRY
0267 8E C0                              MOV     ES,AX                   ; LOAD TARGET SELECTOR
0269 2B F6                              SUB     SI,SI                   ; SET SOURCE INDEX REGISTER TO ZERO
026B 2B FF                              SUB     DI,DI                   ; SET TARGET INDEX REGISTER TO ZERO

026D F3/ A5                             REP     MOVSW                   ; MOVE THE BLOCK COUNT PASSED IN (CX)

                                ;-----  CHECK FOR MEMORY PARITY BEFORE SHUTDOWN
```

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026F E4 61                       IN      AL,PORT_B               ; GET THE PARITY LATCHES
0271 24 C0                       AND     AL,PARITY_ERR           ; STRIP UNWANTED BITS
0273 74 12                       JZ      DONE1                   ; GO IF NO PARITY ERROR

                        ;-----  CLEAR PARITY BEFORE SHUTDOWN

0275 8B 05                       MOV     AX,DS:[DI]              ; FETCH CURRENT SOURCE DATA
0277 89 05                       MOV     DS:[DI],AX              ; WRITE IT BACK
0279 B0 01                       MOV     AL,01                   ; SET PARITY CHECK ERROR = 01
027B E6 80                       OUT     MFG_PORT,AL
027D E4 61                       IN      AL,PORT_B
027F 0C 0C                       OR      AL,RAM_PAR_OFF          ; TOGGLE PARITY CHECK LATCHES
0281 E6 61                       OUT     PORT_B,AL               ;  TO CLEAR THE PENDING ERROR
0283 24 F3                       AND     AL,RAM_PAR_ON           ;  AND ENABLE CHECKING
0285 E6 61                       OUT     PORT_B,AL

                        ;-----  CAUSE A SHUTDOWN

0287                    DONE1:
0287 E9 0000 E                   JMP     PROC_SHUTDOWN           ; GO RESET PROCESSOR AND SHUTDOWN

                                 ;=====================
                        ;------   RETURN FROM SHUTDOWN
                                 ;=====================
028A                    SHUT9:                                   ;       RESTORE USERS STACK
                                 ASSUME  DS:DATA
028A B8 ---- R                   MOV     AX,DATA                 ; SET DS TO DATA AREA
028D 8E D8                       MOV     DS,AX
028F 8E 16 0069 R                MOV     SS,@IO_ROM_SEG          ; GET USER STACK SEGMENT
0293 8B 26 0067 R                MOV     SP,@IO_ROM_INIT         ; GET USER STACK POINTER

                        ;-----  GATE ADDRESS BIT 20 OFF

0297 B4 DD                       MOV     AH,DISABLE_BIT20        ; DISABLE MASK
0299 E8 03CC R                   CALL    GATE_A20                ; GATE ADDRESS 20 LINE OFF
029C 3C 00                       CMP     AL,0                    ; COMMAND ACCEPTED?
029E 74 0A                       JZ      DONE3                   ; GO IF YES

02A0 E4 80                       IN      AL,MFG_PORT             ; CHECK FOR ANY OTHER ERROR FIRST
02A2 3C 00                       CMP     AL,0                    ; WAS THERE AN ERROR?
02A4 75 04                       JNZ     DONE3                   ; REPORT FIRST ERROR IF YES
02A6 B0 03                       MOV     AL,03H                  ; ELSE SET GATE A20 ERROR FLAG
02A8 E6 80                       OUT     MFG_PORT,AL

                        ;-----  RESTORE THE USERS REGISTERS AND SET RETURN CODES

02AA                    DONE3:
02AA B8 000D                     MOV     AX,CMOS_REG_D           ; CLEAR (AH) TO ZERO AND (AL) TO DEFAULT
02AD E6 70                       OUT     CMOS_PORT,AL            ; ENABLE NMI INTERRUPTS

02AF 1F                          POP     DS                      ; RESTORE USER DATA SEGMENT
02B0 07                          POP     ES                      ; RESTORE USER EXTRA SEGMENT
02B1 E4 80                       IN      AL,MFG_PORT             ; GET THE ENDING STATUS RETURN CODE
02B3 8B EC                       MOV     BP,SP                   ; POINT TO REGISTERS IN THE STACK
02B5 88 46 0F                    MOV     [BP+15],AL              ; PLACE ERROR CODE INTO STACK AT (AH)
02B8 3A E0                       CMP     AH,AL                   ; SET THE ZF & CY FLAGS WITH RETURN CODE
02BA 61                          POPA                            ; RESTORE THE GENERAL PURPOSE REGISTERS
02BB FB                          STI                             ; TURN INTERRUPTS ON
02BC                    DONE4    PROC    FAR
02BC CA 0002                     RET     2                       ; RETURN WITH FLAGS SET --   (AH)= CODE
02BF                    DONE4    ENDP                            ;  (CY=0,ZF=1)= OK    (CY=1,ZF=0)= ERROR

                        ;-----  BLOCK MOVE EXCEPTION INTERRUPT HANDLER

02BF                    EX_INT:
02BF B0 02                       MOV     AL,02H                  ; GET EXCEPTION ERROR CODE
02C1 E6 80                       OUT     MFG_PORT,AL             ; SET EXCEPTION INTERRUPT OCCURRED FLAG
02C3 E9 0000 E                   JMP     PROC_SHUTDOWN           ; CAUSE A EARLY SHUTDOWN

                        ;-----  ROM IDT LOCATION

02C6                    ROM_IDT_LOC:
02C6 0100                        DW      ROM_IDT_END-ROM_IDT     ; LENGTH OF ROM IDT TABLE
02C8 02CC R                      DW      ROM_IDT                 ; LOW WORD OF BASE ADDRESS
02CA 0F                          DB      CSEG@_HI                ; HIGH BYTE OF BASE ADDRESS
02CB 00                          DB      0                       ; RESERVED

                        ;-----  THE ROM EXCEPTION INTERRUPT VECTOR GATES FOR BLOCK MOVE

02CC                    ROM_IDT:                                 ;       EXCEPTION 00
02CC 02BF R                      DW      EX_INT                  ; DESTINATION OFFSET
02CE 0020                        DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
02D0 00                          DB      0                       ; WORD COPY COUNT
02D1 87                          DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
02D2 0000                        DW      0                       ; RESERVED
                                                                 ;       EXCEPTION 01
02D4 02BF R                      DW      EX_INT                  ; DESTINATION OFFSET
02D6 0020                        DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
02D8 00                          DB      0                       ; WORD COPY COUNT
02D9 87                          DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
02DA 0000                        DW      0                       ; RESERVED
                                                                 ;       EXCEPTION 02
02DC 02BF R                      DW      EX_INT                  ; DESTINATION OFFSET
02DE 0020                        DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
02E0 00                          DB      0                       ; WORD COPY COUNT
02E1 87                          DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
02E2 0000                        DW      0                       ; RESERVED
                                                                 ;       EXCEPTION 03
02E4 02BF R                      DW      EX_INT                  ; DESTINATION OFFSET
02E6 0020                        DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
02E8 00                          DB      0                       ; WORD COPY COUNT
02E9 87                          DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
02EA 0000                        DW      0                       ; RESERVED
                                                                 ;       EXCEPTION 04
02EC 02BF R                      DW      EX_INT                  ; DESTINATION OFFSET
02EE 0020                        DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
02F0 00                          DB      0                       ; WORD COPY COUNT
02F1 87                          DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
02F2 0000                        DW      0                       ; RESERVED
                                                                 ;       EXCEPTION 05
02F4 02BF R                      DW      EX_INT                  ; DESTINATION OFFSET
02F6 0020                        DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
02F8 00                          DB      0                       ; WORD COPY COUNT
```

SECTION 5

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02F9 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
02FA 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 06
02FC 02BF R            DW      EX_INT          ; DESTINATION OFFSET
02FE 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0300 00                DB      0               ; WORD COPY COUNT
0301 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
0302 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 07
0304 02BF R            DW      EX_INT          ; DESTINATION OFFSET
0306 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0308 00                DB      0               ; WORD COPY COUNT
0309 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
030A 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 08
030C 02BF R            DW      EX_INT          ; DESTINATION OFFSET
030E 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0310 00                DB      0               ; WORD COPY COUNT
0311 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
0312 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 09
0314 02BF R            DW      EX_INT          ; DESTINATION OFFSET
0316 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0318 00                DB      0               ; WORD COPY COUNT
0319 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
031A 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 10
031C 02BF R            DW      EX_INT          ; DESTINATION OFFSET
031E 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0320 00                DB      0               ; WORD COPY COUNT
0321 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
0322 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 11
0324 02BF R            DW      EX_INT          ; DESTINATION OFFSET
0326 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0328 00                DB      0               ; WORD COPY COUNT
0329 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
032A 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 12
032C 02BF R            DW      EX_INT          ; DESTINATION OFFSET
032E 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0330 00                DB      0               ; WORD COPY COUNT
0331 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
0332 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 13
0334 02BF R            DW      EX_INT          ; DESTINATION OFFSET
0336 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0338 00                DB      0               ; WORD COPY COUNT
0339 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
033A 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 14
033C 02BF R            DW      EX_INT          ; DESTINATION OFFSET
033E 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0340 00                DB      0               ; WORD COPY COUNT
0341 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
0342 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 15
0344 02BF R            DW      EX_INT          ; DESTINATION OFFSET
0346 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0348 00                DB      0               ; WORD COPY COUNT
0349 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
034A 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 16
034C 02BF R            DW      EX_INT          ; DESTINATION OFFSET
034E 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0350 00                DB      0               ; WORD COPY COUNT
0351 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
0352 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 17
0354 02BF R            DW      EX_INT          ; DESTINATION OFFSET
0356 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0358 00                DB      0               ; WORD COPY COUNT
0359 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
035A 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 18
035C 02BF R            DW      EX_INT          ; DESTINATION OFFSET
035E 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0360 00                DB      0               ; WORD COPY COUNT
0361 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
0362 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 19
0364 02BF R            DW      EX_INT          ; DESTINATION OFFSET
0366 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0368 00                DB      0               ; WORD COPY COUNT
0369 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
036A 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 20
036C 02BF R            DW      EX_INT          ; DESTINATION OFFSET
036E 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0370 00                DB      0               ; WORD COPY COUNT
0371 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
0372 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 21
0374 02BF R            DW      EX_INT          ; DESTINATION OFFSET
0376 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0378 00                DB      0               ; WORD COPY COUNT
0379 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
037A 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 22
037C 02BF R            DW      EX_INT          ; DESTINATION OFFSET
037E 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0380 00                DB      0               ; WORD COPY COUNT
0381 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
0382 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 23
0384 02BF R            DW      EX_INT          ; DESTINATION OFFSET
0386 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0388 00                DB      0               ; WORD COPY COUNT
0389 87                DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
038A 0000              DW      0               ; RESERVED
                                               ;         EXCEPTION 24
038C 02BF R            DW      EX_INT          ; DESTINATION OFFSET
038E 0020              DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0390 00                DB      0               ; WORD COPY COUNT
```

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0391 87                      DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
0392 0000                    DW      0               ; RESERVED
                                                     ;       EXCEPTION 25
0394 02BF R                  DW      EX_INT          ; DESTINATION OFFSET
0396 0020                    DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
0398 00                      DB      0               ; WORD COPY COUNT
0399 87                      DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
039A 0000                    DW      0               ; RESERVED
                                                     ;       EXCEPTION 26
039C 02BF R                  DW      EX_INT          ; DESTINATION OFFSET
039E 0020                    DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
03A0 00                      DB      0               ; WORD COPY COUNT
03A1 87                      DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
03A2 0000                    DW      0               ; RESERVED
                                                     ;       EXCEPTION 27
03A4 02BF R                  DW      EX_INT          ; DESTINATION OFFSET
03A6 0020                    DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
03A8 00                      DB      0               ; WORD COPY COUNT
03A9 87                      DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
03AA 0000                    DW      0               ; RESERVED
                                                     ;       EXCEPTION 28
03AC 02BF R                  DW      EX_INT          ; DESTINATION OFFSET
03AE 0020                    DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
03B0 00                      DB      0               ; WORD COPY COUNT
03B1 87                      DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
03B2 0000                    DW      0               ; RESERVED
                                                     ;       EXCEPTION 29
03B4 02BF R                  DW      EX_INT          ; DESTINATION OFFSET
03B6 0020                    DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
03B8 00                      DB      0               ; WORD COPY COUNT
03B9 87                      DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
03BA 0000                    DW      0               ; RESERVED
                                                     ;       EXCEPTION 30
03BC 02BF R                  DW      EX_INT          ; DESTINATION OFFSET
03BE 0020                    DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
03C0 00                      DB      0               ; WORD COPY COUNT
03C1 87                      DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
03C2 0000                    DW      0               ; RESERVED
                                                     ;       EXCEPTION 31
03C4 02BF R                  DW      EX_INT          ; DESTINATION OFFSET
03C6 0020                    DW      BIOS_CS         ; DESTINATION SEGMENT SELECTOR
03C8 00                      DB      0               ; WORD COPY COUNT
03C9 87                      DB      TRAP_GATE       ; GATE TYPE - ACCESS RIGHTS BYTE
03CA 0000                    DW      0               ; RESERVED
03CC                 ROM_IDT_END:

03CC                 BLOCKMOVE    ENDP
```

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                              PAGE
                              ;--------------------------------------------------------------------------------
                              ; GATE_A20                                                                       :
                              ;       THIS ROUTINE CONTROLS A SIGNAL WHICH GATES ADDRESS BIT 20.               :
                              ;       THE GATE A20 SIGNAL IS AN OUTPUT OF THE 8042 SLAVE PROCESSOR.            :
                              ;       ADDRESS BIT 20 SHOULD BE GATED ON BEFORE ENTERING PROTECTED MODE.        :
                              ;       IT SHOULD BE GATED OFF AFTER ENTERING REAL MODE FROM PROTECTED           :
                              ;       MODE.   INTERRUPTS ARE LEFT DISABLED ON EXIT.                            :
                              ; INPUT                                                                          :
                              ;       (AH)= DDH  ADDRESS BIT 20 GATE OFF. (A20 ALWAYS ZERO)                    :
                              ;       (AH)= DFH  ADDRESS BIT 20 GATE ON. (A20 CONTROLLED BY 80286)             :
                              ; OUTPUT                                                                         :
                              ;       (AL)= 00H  OPERATION SUCCESSFUL. 8042 HAS ACCEPTED COMMAND.              :
                              ;       (AL)= 02H  FAILURE--8042 UNABLE TO ACCEPT COMMAND.                       :
                              ;--------------------------------------------------------------------------------
03CC                          GATE_A20        PROC
03CC 51                               PUSH    CX                      ; SAVE USERS (CX)
03CD FA                               CLI                             ; DISABLE INTERRUPTS WHILE USING 8042
03CE E8 03E5 R                        CALL    EMPTY_8042              ; INSURE 8042 INPUT BUFFER EMPTY
03D1 75 10                            JNZ     GATE_A20_RETURN         ; EXIT IF 8042 UNABLE TO ACCEPT COMMAND
03D3 B0 D1                            MOV     AL,0D1H                 ; 8042 COMMAND TO WRITE OUTPUT PORT
03D5 E6 64                            OUT     STATUS_PORT,AL          ; OUTPUT COMMAND TO 8042
03D7 E8 03E5 R                        CALL    EMPTY_8042              ; WAIT FOR 8042 TO ACCEPT COMMAND
03DA 75 07                            JNZ     GATE_A20_RETURN         ; EXIT IF 8042 UNABLE TO ACCEPT COMMAND
03DC 8A C4                            MOV     AL,AH                   ; 8042 PORT DATA
03DE E6 60                            OUT     PORT_A,AL               ; OUTPUT PORT DATA TO 8042
03E0 E8 03E5 R                        CALL    EMPTY_8042              ; WAIT FOR 8042 TO ACCEPT PORT DATA

                              ;-----  8042 OUTPUT WILL SWITCH WITHIN 20 MICRO SECONDS OF ACCEPTING PORT DATA

03E3                          GATE_A20_RETURN:
03E3 59                               POP     CX                      ; RESTORE USERS (CX)
03E4 C3                               RET
                              ;--------------------------------------------------------------------------------
                              ; EMPTY_8042                                                                     :
                              ;       THIS ROUTINE WAITS FOR THE 8042 INPUT BUFFER TO EMPTY.                   :
                              ; INPUT                                                                          :
                              ;       NONE                                                                     :
                              ; OUTPUT                                                                         :
                              ;       (AL)= 00H  8042 INPUT BUFFER EMPTY (ZERO FLAG SET)                       :
                              ;       (AL)= 02H  TIME OUT, 8042 INPUT BUFFER FULL (NON-ZERO FLAG SET)          :
                              ;       (CX)       - MODIFIED                                                    :
                              ;--------------------------------------------------------------------------------
03E5                          EMPTY_8042:
03E5 2B C9                            SUB     CX,CX                   ; (CX)=0, WILL BE USED AS TIME OUT VALUE
03E7                          EMPTY_L:
03E7 E4 64                            IN      AL,STATUS_PORT          ; READ 8042 STATUS PORT
03E9 24 02                            AND     AL,INPT_BUF_FULL        ; TEST INPUT BUFFER FULL FLAG (BIT 1)
03EB E0 FA                            LOOPNZ  EMPTY_L                 ; LOOP UNTIL BUFFER EMPTY OR TIME OUT
03ED C3                               RET
03EE                          GATE_A20        ENDP


                              ;--- INT 15 H -- ( FUNCTION 88 H - I/O MEMORY SIZE DETERMINE ) ----------------
                              ; EXT_MEMORY                                                                     :
                              ;       THIS ROUTINE RETURNS  THE AMOUNT OF MEMORY IN THE SYSTEM THAT IS         :
                              ;       LOCATED STARTING AT THE 1024K ADDRESSING RANGE, AS DETERMINED BY         :
                              ;       THE POST ROUTINES.                                                       :
                              ;       NOTE THAT THE SYSTEM MAY NOT BE ABLE TO USE I/O MEMORY UNLESS THERE      :
                              ;       IS A FULL COMPLEMENT OF 512K OR 640 BYTES ON THE PLANAR.  THIS SIZE      :
                              ;       SIZE IS STORED IN CMOS AT ADDRESS LOCATIONS 30H AND 31H.                 :
                              ; INPUT                                                                          :
                              ;       AH = 88H                                                                 :
                              ;                                                                                :
                              ;       THE I/O MEMORY SIZE VARIABLE IS SET DURING POWER ON                      :
                              ;       DIAGNOSTICS ACCORDING TO THE FOLLOWING ASSUMPTIONS:                      :
                              ;                                                                                :
                              ;       1. ALL INSTALLED MEMORY IS FUNCTIONAL.                                   :
                              ;       2. ALL MEMORY FROM 0 TO 640K MUST BE CONTIGUOUS.                         :
                              ;                                                                                :
                              ; OUTPUT                                                                         :
                              ;       (AX) = NUMBER OF CONTIGUOUS 1K BLOCKS OF MEMORY A                        :
                              ;              AVAILABLE STARTING AT ADDRESS 1024K.                              :
                              ;                                                                                :
                              ;--------------------------------------------------------------------------------

03EE                          EXT_MEMORY      PROC

03EE B8 3031                          MOV     AX,CMOS_U_M_S_LO*H+CMOS_U_M_S_HI ; ADDRESS HIGH/LOW BYTES
03F1 E8 0000 E                        CALL    CMOS_READ               ; GET THE HIGH BYTE OF I/O MEMORY
03F4 86 C4                            XCHG    AL,AH                   ; PUT HIGH BYTE IN POSITION (AH)
03F6 E8 0000 E                        CALL    CMOS_READ               ; GET THE LOW BYTE OF I/O MEMORY
03F9 CF                               IRET                            ; RETURN TO USER

03FA                          EXT_MEMORY      ENDP
```

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PAGE
;--- INT 15 H ( FUNCTION 89 H ) -------------------------------------------------
; PURPOSE:                                                                        :
;       THIS BIOS FUNCTION PROVIDES A MEANS TO THE USER TO SWITCH INTO             :
;       VIRTUAL (PROTECTED) MODE.  UPON COMPLETION OF THIS FUNCTION THE            :
;       PROCESSOR WILL BE IN  VIRTUAL (PROTECTED) MODE AND CONTROL WILL            :
;       BE TRANSFERRED TO THE CODE SEGMENT THAT WAS SPECIFIED BY THE USER.         :
;                                                                                  :
; ENTRY REQUIREMENTS:                                                              :
;                                                                                  :
;       (ES:SI) POINTS TO A DESCRIPTOR TABLE (GDT) BUILT BEFORE INTERRUPTING       :
;       TO THIS FUNCTION.  THESE DESCRIPTORS ARE USED BY THIS FUNCTION TO          :
;       INITIALIZE THE IDTR, THE GDTR AND THE STACK SEGMENT SELECTOR.  THE         :
;       DATA SEGMENT (DS) SELECTOR AND THE EXTRA SEGMENT (ES) SELECTOR WILL        :
;       BE INITIALIZE TO DESCRIPTORS BUILT BY THE ROUTINE USING THIS FUNCTION.     :
;       BH - OFFSET INTO THE INTERRUPT DESCRIPTOR TABLE STATING WHERE THE          :
;            FIRST EIGHT HARDWARE INTERRUPTS WILL BEGIN. ( INTERRUPT LEVEL 1 )     :
;       BL - OFFSET INTO THE INTERRUPT DESCRIPTOR TABLE STATING WHERE THE          :
;            SECOND EIGHT HARDWARE INTERRUPTS BEGIN. ( INTERRUPT LEVEL 2 )         :
;                                                                                  :
; THE DESCRIPTORS ARE DEFINED AS FOLLOWS:                                          :
;                                                                                  :
;       1.  THE FIRST DESCRIPTOR IS THE REQUIRED DUMMY.                            :
;           (USER INITIALIZED TO 0)                                                :
;       2.  THE SECOND DESCRIPTOR POINTS TO THE GDT TABLE AS                       :
;           A DATA SEGMENT.                                                        :
;           (USER INITIALIZED)                                                     :
;       3.  THE THIRD DESCRIPTOR POINTS TO THE USER DEFINED                        :
;           INTERRUPT DESCRIPTOR TABLE (IDT).                                      :
;           (USER INITIALIZED)                                                     :
;       4.  THE FORTH DESCRIPTOR POINTS TO THE USER'S DATA                         :
;           SEGMENT (DS).                                                          :
;           (USER INITIALIZED)                                                     :
;       5.  THE FIFTH DESCRIPTOR POINTS TO THE USER'S EXTRA                        :
;           SEGMENT (ES).                                                          :
;           (USER INITIALIZED)                                                     :
;       6.  THE SIXTH DESCRIPTOR POINTS TO THE USER'S STACK                        :
;           SEGMENT (SS).                                                          :
;           (USER INITIALIZED)                                                     :
;       7.  THE SEVENTH DESCRIPTOR POINTS TO THE CODE SEGMENT                      :
;           THAT THIS FUNCTION WILL RETURN TO.                                     :
;           (USER INITIALIZED TO THE USER'S CODE SEGMENT.)                         :
;       8.  THE EIGHTH DESCRIPTOR IS USED BY THIS FUNCTION TO                      :
;           ESTABLISH A CODE SEGMENT FOR ITSELF. THIS IS                           :
;           NEEDED SO THAT THIS FUNCTION CAN COMPLETE IT'S                         :
;           EXECUTION WHILE IN PROTECTED MODE.  WHEN CONTROL                       :
;           GETS PASSED TO THE USER'S CODE THIS DESCRIPTOR CAN                     :
;           BE USED BY HIM IN ANY WAY HE CHOOSES.                                  :
;                                                                                  :
;    NOTE -  EACH DESCRIPTOR MUST CONTAIN ALL THE NECESSARY DATA                   :
;            I.E. THE LIMIT,  BASE ADDRESS AND THE ACCESS RIGHTS BYTE.             :
;                                                                                  :
;       AH= 89H  (FUNCTION CALL)                                                   :
;       ES:SI = LOCATION OF THE GDT TABLE BUILD BY ROUTINE                         :
;       USING THIS FUNCTION.                                                       :
;                                                                                  :
; EXIT PARAMETERS:                                                                 :
;                                                                                  :
;       AH = 0  IF SUCCESSFUL                                                      :
;       ALL SEGMENT REGISTERS ARE CHANGED, (AX) AND (BP) DESTROYED                 :
;                                                                                  :
; CONSIDERATIONS:                                                                  :
;                                                                                  :
;       1.  NO BIOS AVAILABLE TO USER.  USER MUST HANDLE ALL                       :
;           I/O COMMANDS.                                                          :
;       2.  INTERRUPTS - INTERRUPT VECTOR LOCATIONS MUST BE                        :
;           MOVED,  DUE TO THE 286 RESERVED AREAS.  THE                            :
;           HARDWARE INTERRUPT CONTROLLERS MUST BE REINITIALIZED                   :
;           TO DEFINE LOCATIONS THAT DO NOT RESIDE IN THE 286                      :
;           RESERVED AREAS.                                                        :
;       3.  EXCEPTION INTERRUPT TABLE AND HANDLER MUST BE                          :
;           INITIALIZED BY THE USER.                                               :
;       4.  THE INTERRUPT DESCRIPTOR TABLE MUST NOT OVERLAP                        :
;           THE REAL MODE BIOS INTERRUPT DESCRIPTOR TABLE.                         :
;       5.  THE FOLLOWING GIVES AN IDEA OF WHAT THE USER CODE                      :
;           SHOULD LOOK LIKE WHEN INVOKING THIS FUNCTION.                          :
;                                                                                  :
;       REAL MODE --->      "USER CODE"                                            :
;                   "       MOV    AX,GDT SEGMENT                                  :
;                   "       MOV    ES,AX                                           :
;                   "       MOV    SI,GDT OFFSET                                   :
;                   "       MOV    BH,HARDWARE INT LEVEL 1 OFFSET                  :
;                   "       MOV    BL,HARDWARE INT LEVEL 2 OFFSET                  :
;                   "       MOV    AH,89H                                          :
;                   "       INT    15H                                             :
;    VIRTUAL MODE --->      "USER CODE"                                            :
;                                                                                  :
; DESCRIPTION:                                                                     :
;                                                                                  :
;       1.  CLI (NO INTERRUPTS ALLOWED) WHILE THIS FUNCTION IS EXECUTING.          :
;       2.  ADDRESS LINE 20 IS GATED ACTIVE.                                       :
;       3.  THE CURRENT USER STACK SEGMENT DESCRIPTOR IS INITIALIZED.              :
;       4.  THE GDTR IS LOADED WITH THE GDT BASE ADDRESS.                          :
;       5.  THE IDTR IS LOADED WITH THE IDT BASE ADDRESS.                          :
;       6.  THE 8259 IS REINITIALIZED WITH THE NEW INTERRUPT OFFSETS.              :
;       7.  THE PROCESSOR IS PUT IN VIRTUAL MODE WITH THE CODE                     :
;           SEGMENT DESIGNATED FOR THIS FUNCTION.                                  :
;       8.  DATA SEGMENT IS LOADED WITH THE USER DEFINED                           :
;           SELECTOR FOR THE DS REGISTER.                                          :
;       9.  EXTRA SEGMENT IS LOADED WITH THE USER DEFINED                          :
;           SELECTOR FOR THE ES REGISTER.                                          :
;      10.  STACK SEGMENT IS LOADED WITH THE USER DEFINED                          :
;           SELECTOR FOR THE SS REGISTER.                                          :
;      11.  CODE SEGMENT DESCRIPTOR SELECTOR VALUE IS                              :
;           SUBSTITUTED ON THE STACK FOR RETURN TO USER.                           :
;      12.  WE TRANSFER CONTROL TO THE USER WITH INTERRUPTS DISABLED.              :
;--------------------------------------------------------------------------------
```

SECTION 5

```
                                PAGE
                                ;
                                ;       THE FOLLOWING DIAGRAM DEPICTS THE ORGANIZATION
                                ;       OF GDT.
                                ;-----------------------------------------------------------------------------
                                ;                               G D T                                        :
                                ;                                                                            :
                                ;                                  .-------------.                           :
                                ;                                  v             |                           :
                                ;     (ES:SI)-->>  +00 .---------------.         |                           :
                                ;                      |     DUMMY     |         |                           :
                                ;                      |               |         |                           :
                                ;                  +08 |---------------|         |                           :
                                ;                      |      GDT      |  ---'                               :
                                ;                      |               |                                     :
                                ;                  +10 |---------------|                                     :
                                ;                      |      IDT      |                                     :
                                ;                      |               |                                     :
                                ;                  +18 |---------------|                                     :
                                ;                      |      DS       |                                     :
                                ;                      |               |                                     :
                                ;                  +20 |---------------|                                     :
                                ;                      |      ES       |                                     :
                                ;                      |               |                                     :
                                ;                  +28 |---------------|                                     :
                                ;                      |      SS       |                                     :
                                ;                      |               |                                     :
                                ;                  +30 |---------------|                                     :
                                ;                      |      CS       |                                     :
                                ;                      |               |                                     :
                                ;                  +38 |---------------|                                     :
                                ;                      |   TEMP BIOS   |                                     :
                                ;                      |      CS       |                                     :
                                ;                      |---------------|                                     :
                                ;                                                                            :
                                ;-----------------------------------------------------------------------------

                                ;-----------------------------------------------------------------------------
                                ;     THE GLOBAL DESCRIPTOR TABLE (ACTUAL LOCATION POINTED TO BY ES:SI)      :
                                ;-----------------------------------------------------------------------------

                                VIRTUAL_ENABLE_GDT_DEF  STRUC
0000 ????????????????                   DQ      ?               ; FIRST DESCRIPTOR NOT ACCESSIBLE
0008 ????????????????           GDTPTR  DQ      ?               ; GDT DESCRIPTOR
0010 ????????????????           IDTPTR  DQ      ?               ; IDT DESCRIPTOR
0018 ????????????????           USER_DS DQ      ?               ; USER DATA SEGMENT DESCRIPTOR
0020 ????????????????           USER_ES DQ      ?               ; USER EXTRA SEGMENT DESCRIPTOR
0028 ????????????????           USER_SS DQ      ?               ; USER STACK SEGMENT DESCRIPTOR
0030 ????????????????           USER_CS DQ      ?               ; USER CODE SEGMENT DESCRIPTOR
0038 ????????????????           BIO_CS  DQ      ?               ; TEMPORARY BIOS DESCRIPTOR
0040                            VIRTUAL_ENABLE_GDT_DEF  ENDS

                                        ASSUME  DS:DATA

03FA                            X_VIRTUAL       PROC    FAR
03FA                            SET_VMODE:

                                ;-----  ENABLE ADDRESS LATCH BIT 20

03FA FA                                 CLI                             ; NO INTERRUPTS ALLOWED
03FB B4 DF                              MOV     AH,ENABLE_BIT20         ; ENABLE BIT 20 FOR ADDRESS GATE
03FD E8 03CC R                          CALL    GATE_A20
0400 3C 00                              CMP     AL,0                    ; WAS THE COMMAND ACCEPTED?
0402 74 04                              JZ      BIT20_ON                ; GO IF YES
0404 B4 FF                              MOV     AH,0FFH                 ; SET THE ERROR FLAG
0406 F9                                 STC                             ; SET CARRY
0407 CF                                 IRET                            ; EARLY EXIT


0408                            BIT20_ON:
0408 06                                 PUSH    ES                      ; MOVE SEGMENT POINTER
0409 1F                                 POP     DS                      ; TO THE DATA SEGMENT

                                ;-----------------------------------------------------------------------------
                                ; REINITIALIZE THE 8259 INTERRUPT CONTROLLER #1 TO THE USER SPECIFIED OFFSET :
                                ;-----------------------------------------------------------------------------

040A B0 11                              MOV     AL,11H                  ; START INITIALIZATION SEQUENCE-ICW1
040C E6 20                              OUT     INTA00,AL               ; EDGE,INTERVAL-8,MASTER,ICW4 NEEDED
040E EB 00                              JMP     $+2
0410 8A C7                              MOV     AL,BH                   ; HARDWARE INT'S START AT INT # (BH)
0412 E6 21                              OUT     INTA01,AL               ; SEND ICW2
0414 EB 00                              JMP     $+2
0416 B0 04                              MOV     AL,04H                  ; SEND ICW3 - MASTER LEVEL 2
0418 E6 21                              OUT     INTA01,AL
041A EB 00                              JMP     $+2
041C B0 01                              MOV     AL,01H                  ; SEND ICW4 - MASTER,8086 MODE
041E E6 21                              OUT     INTA01,AL
0420 EB 00                              JMP     $+2
0422 B0 FF                              MOV     AL,0FFH                 ; MASK OFF ALL INTERRUPTS
0424 E6 21                              OUT     INTA01,AL

                                ;----------------------------------------------------------------------------
                                ; REINITIALIZE THE 8259 INTERRUPT CONTROLLER #2 TO THE USER SPECIFIED OFFSET :
                                ;----------------------------------------------------------------------------

0426 B0 11                              MOV     AL,11H                  ; INITIALIZE SEQUENCE-ICW1 FOR SLAVE
0428 E6 A0                              OUT     INTB00,AL               ; EDGE,INTERVAL-8,MASTER,ICW4 NEEDED
042A EB 00                              JMP     $+2
042C 8A C3                              MOV     AL,BL                   ; HARDWARE INT'S START AT INT # (BL)
042E E6 A1                              OUT     INTB01,AL               ; SEND ICW2
0430 B0 02                              MOV     AL,02H
0432 EB 00                              JMP     $+2
0434 E6 A1                              OUT     INTB01,AL               ; SEND ICW3 - SLAVE LEVEL 2
0436 EB 00                              JMP     $+2
0438 B0 01                              MOV     AL,01H
043A E6 A1                              OUT     INTB01,AL               ; SEND ICW4 - SLAVE,8086 MODE
043C EB 00                              JMP     $+2
043E B0 FF                              MOV     AL,0FFH
0440 E6 A1                              OUT     INTB01,AL               ; MASK OFF ALL INTERRUPTS

                                ;--------------------------------------
                                ; SETUP BIOS CODE SEGMENT DESCRIPTOR  :
                                ;--------------------------------------
```

```
0442 C7 44 38 FFFF              MOV     [SI].BIO_CS.SEG_LIMIT,MAX_SEG_LEN       ; SET LENGTH
0447 C6 44 3C 0F                MOV     [SI].BIO_CS.BASE_HI_BYTE,CSEG@_HI       ; SET HIGH BYTE OF CS=0F
044B C7 44 3A 0000              MOV     [SI].BIO_CS.BASE_LO_WORD,CSEG@_LO       ; SET LOW WORD OF CS=0
0450 C6 44 3D 9B                MOV     [SI].BIO_CS.DATA_ACC_RIGHTS,CPL0_CODE_ACCESS
0454 C7 44 3E 0000              MOV     [SI].BIO_CS.DATA_RESERVED,0             ; ZERO RESERVED AREA
                        ;----------------------------------------
                        ;       ENABLE PROTECTED MODE           :
                        ;----------------------------------------
                                LGDT    [SI].GDTPTR             ; LOAD GLOBAL DESCRIPTOR TABLE REGISTER
0459 0F                 +       DB      00FH
045A                    + ??0005 LABEL  BYTE
045A 8B 54 08           +       MOV     DX,WORD PTR [SI].GDTPTR
045D                    + ??0006 LABEL  BYTE
045A                    +       ORG     OFFSET CS:??0005
045A 01                 +       DB      001H
045D                    +       ORG     OFFSET CS:??0006
                                LIDT    [SI].IDTPTR             ; INTERRUPT DESCRIPTOR TABLE REGISTER
045D 0F                 +       DB      00FH
045E                    + ??0007 LABEL  BYTE
045E 8B 5C 10           +       MOV     BX,WORD PTR [SI].IDTPTR
0461                    + ??0008 LABEL  BYTE
045E                    +       ORG     OFFSET CS:??0007
045E 01                 +       DB      001H
0461                    +       ORG     OFFSET CS:??0008

0461 B8 0001                    MOV     AX,VIRTUAL_ENABLE       ; MACHINE STATUS WORD NEEDED TO
                                LMSW    AX                      ;  SWITCH TO VIRTUAL MODE
0464 0F 01 F0           +       DB      00FH,001H,0F0H
0467 EA                          DB     0EAH                    ; PURGE PRE-FETCH QUEUE WITH FAR JUMP
0468 046C R                      DW     OFFSET VMODE            ;  - TO OFFSET
046A 0038                        DW     BIO_CS                  ;  - IN SEGMENT -PROTECTED MODE SELECTOR

046C                    VMODE:
                        ;----------------------------------------
                        ;       SETUP USER SEGMENT REGISTERS    :
                        ;----------------------------------------
046C B8 0018                    MOV     AX,USER_DS              ; SETUP USER'S DATA SEGMENT
046F 8E D8                      MOV     DS,AX                   ; TO PROTECTED MODE SELECTORS
0471 B8 0020                    MOV     AX,USER_ES              ; SETUP USER'S EXTRA SEGMENT
0474 8E C0                      MOV     ES,AX
0476 B8 0028                    MOV     AX,USER_SS              ; SETUP USER'S STACK SEGMENT
0479 8E D0                      MOV     SS,AX
                        ;----------------------------------------
                        ;       PUT TRANSFER ADDRESS ON STACK   :
                        ;       AND RETURN TO THE USER          :
                        ;----------------------------------------
047B 5B                         POP     BX                      ; GET RETURN IP FROM THE STACK
047C 83 C4 04                   ADD     SP,4                    ; NORMALIZE STACK POINTER
047F 6A 30                      PUSH    USER_CS                 ; SET STACK FOR A RETURN FAR
0481 53                         PUSH    BX
0482 CB                         RET                             ; RETURN TO USER IN VIRTUAL MODE

0483                    X_VIRTUAL       ENDP

                        ;--- DEVICE BUSY AND INTERRUPT COMPLETE ------------------------
                        ;                                                              :
                        ;       THIS ROUTINE IS A TEMPORARY HANDLER FOR DEVICE BUSY    :
                        ;       AND INTERRUPT COMPLETE                                 :
                        ;                                                              :
                        ;       INPUT   - SEE PROLOGUE                                 :
                        ;--------------------------------------------------------------

0483                    DEVICE_BUSY     PROC    NEAR
0483 F8                         CLC                             ; TURN CARRY OFF
0484 E9 0057 R                  JMP     C1_F                    ; RETURN WITH CARRY FLAG
0487                    DEVICE_BUSY     ENDP

0487                    INT_COMPLETE    PROC    NEAR
0487 CF                         IRET                            ; RETURN
0488                    INT_COMPLETE    ENDP

0488                    CODE    ENDS
                                END
```

SECTION 5

```
                        PAGE 118,121
                        TITLE BIOS2 ---- 06/10/85  BIOS INTERRUPT ROUTINES
                        .286C
                        .LIST
 0000                   CODE    SEGMENT BYTE PUBLIC
                                PUBLIC  PRINT_SCREEN_1
                                PUBLIC  RTC_INT
                                PUBLIC  TIME_OF_DAY_1
                                PUBLIC  TIMER_INT_1
                                EXTRN   CMOS_READ:NEAR          ; READ CMOS LOCATION ROUTINE
                                EXTRN   CMOS_WRITE:NEAR         ; WRITE CMOS LOCATION ROUTINE
                                EXTRN   DDS:NEAR                ; LOAD (DS) WITH DATA SEGMENT SELECTOR
                        ;--- INT  1A H -- (TIME_OF_DAY) ---------------------------------------------
                        ;       THIS BIOS ROUTINE ALLOWS THE CLOCKS TO BE SET OR READ              :
                        ;                                                                          :
                        ; PARAMETERS:                                                              :
                        ;       (AH) = 00H  READ THE CURRENT CLOCK SETTING AND RETURN WITH,        :
                        ;                   (CX) = HIGH PORTION OF COUNT                           :
                        ;                   (DX) = LOW PORTION OF COUNT                            :
                        ;                   (AL) = 0 TIMER HAS NOT PASSED 24 HOURS SINCE LAST READ :
                        ;                          1 IF ON ANOTHER DAY. (RESET TO ZERO AFTER READ) :
                        ;                                                                          :
                        ;       (AH) = 01H  SET THE CURRENT CLOCK USING,                           :
                        ;                   (CX) = HIGH PORTION OF COUNT                           :
                        ;                   (DX) = LOW PORTION OF COUNT.                           :
                        ;                                                                          :
                        ;           NOTE: COUNTS OCCUR AT THE RATE OF 1193180/65536 COUNTS/SECOND  :
                        ;                   (OR ABOUT 18.2 PER SECOND -- SEE EQUATES)              :
                        ;                                                                          :
                        ;       (AH) = 02H  READ THE REAL TIME CLOCK AND RETURN WITH,              :
                        ;                   (CH) = HOURS IN BCD (00-23)                            :
                        ;                   (CL) = MINUTES IN BCD (00-59)                          :
                        ;                   (DH) = SECONDS IN BCD (00-59)                          :
                        ;                   (DL) = DAYLIGHT SAVINGS ENABLE (00-01).                :
                        ;                                                                          :
                        ;       (AH) = 03H  SET THE REAL TIME CLOCK USING,                         :
                        ;                   (CH) = HOURS IN BCD (00-23)                            :
                        ;                   (CL) = MINUTES IN BCD (00-59)                          :
                        ;                   (DH) = SECONDS IN BCD (00-59)                          :
                        ;                   (DL) = 01 IF DAYLIGHT SAVINGS ENABLE OPTION, ELSE 00.  :
                        ;                                                                          :
                        ;           NOTE: (DL)= 00 IF DAYLIGHT SAVINGS TIME ENABLE IS NOT ENABLED. :
                        ;                 (DL)= 01 ENABLES TWO SPECIAL UPDATES THE LAST SUNDAY IN  :
                        ;                 APRIL   (1:59:59 --> 3:00:00 AM) AND THE LAST SUNDAY IN  :
                        ;                 OCTOBER (1:59:59 --> 1:00:00 AM) THE FIRST TIME.         :
                        ;                                                                          :
                        ;       (AH) = 04H  READ THE DATE FROM THE REAL TIME CLOCK AND RETURN WITH,:
                        ;                   (CH) = CENTURY IN BCD (19 OR 20)                       :
                        ;                   (CL) = YEAR IN BCD (00-99)                             :
                        ;                   (DH) = MONTH IN BCD (01-12)                            :
                        ;                   (DL) = DAY IN BCD (01-31).                             :
                        ;                                                                          :
                        ;       (AH) = 05H  SET THE DATE INTO THE REAL TIME CLOCK USING,           :
                        ;                   (CH) = CENTURY IN BCD (19 OR 20)                       :
                        ;                   (CL) = YEAR IN BCD (00 - 99)                           :
                        ;                   (DH) = MONTH IN BCD (01 - 12)                          :
                        ;                   (DL) = DAY IN BCD (01-31).                             :
                        ;                                                                          :
                        ;       (AH) = 06H  SET THE ALARM TO INTERRUPT AT SPECIFIED TIME,          :
                        ;                   (CH) = HOURS IN BCD (00-23 (OR FFH))                   :
                        ;                   (CL) = MINUTES IN BCD (00-59 (OR FFH))                 :
                        ;                   (DH) = SECONDS IN BCD (00-59 (OR FFH)).                :
                        ;                                                                          :
                        ;       (AH) = 07H  RESET THE ALARM INTERRUPT FUNCTION.                    :
                        ;                                                                          :
                        ; NOTES: FOR ALL RETURNS CY= 0 FOR SUCCESSFUL OPERATION.                   :
                        ;        FOR (AH)= 2, 4, 6 - CARRY FLAG SET IF REAL TIME CLOCK NOT OPERATING. :
                        ;        FOR (AH)= 6 - CARRY FLAG SET IF ALARM ALREADY ENABLED.            :
                        ;        FOR THE ALARM FUNCTION (AH = 6) THE USER MUST SUPPLY A ROUTINE AND :
                        ;         INTERCEPT THE CORRECT ADDRESS IN THE VECTOR TABLE FOR INTERRUPT 4AH. :
                        ;         USE 0FFH FOR ANY "DO NOT CARE" POSITION FOR INTERVAL INTERRUPTS. :
                        ;        INTERRUPTS ARE DISABLED DURING DATA MODIFICATION.                 :
                        ;        AH & AL ARE RETURNED MODIFIED AND NOT DEFINED EXCEPT WHERE INDICATED. :
                        ;---------------------------------------------------------------------------
                                ASSUME  CS:CODE,DS:DATA
 0000                   TIME_OF_DAY_1   PROC    FAR
 0000 FB                        STI                             ; INTERRUPTS BACK ON
 0001 80 FC 08                  CMP     AH,(RTC_TBE-RTC_TB)/2   ; CHECK IF COMMAND IN VALID RANGE (0-7)
 0004 F5                        CMC                             ; COMPLEMENT CARRY FOR ERROR EXIT
 0005 72 17                     JC      TIME_9                  ; EXIT WITH CARRY = 1 IF NOT VALID
 0007 1E                        PUSH    DS                      ; SAVE USERS (DS) SEGMENT
 0008 E8 0000 E                 CALL    DDS                     ; GET DATA SEGMENT SELECTOR
 000B 56                        PUSH    SI                      ; SAVE WORK REGISTER
 000C C1 E8 08                  SHR     AX,8                    ; CONVERT FUNCTION TO BYTE OFFSET
 000F 03 C0                     ADD     AX,AX                   ; CONVERT FUNCTION TO WORD OFFSET (CY=0)
 0011 8B F0                     MOV     SI,AX                   ; PLACE INTO ADDRESSING REGISTER
 0013 FA                        CLI                             ; NO INTERRUPTS DURING TIME FUNCTIONS
 0014 2E: FF 94 0021 R          CALL    CS:[SI]+OFFSET RTC_TB   ; VECTOR TO FUNCTION REQUESTED WITH CY=0
                                                                ;  RETURN WITH CARRY FLAG SET FOR RESULT
 0019 FB                        STI                             ; INTERRUPTS BACK ON
 001A B4 00                     MOV     AH,0                    ; CLEAR (AH) TO ZERO
 001C 5E                        POP     SI                      ; RECOVER USERS REGISTER
 001D 1F                        POP     DS                      ; RECOVER USERS SEGMENT SELECTOR
 001E                   TIME_9:                                 ; RETURN WITH CY= 0 IF NO ERROR
 001E CA 0002                   RET     2
                                                                ;       ROUTINE VECTOR TABLE (AH)=
 0021 0031 R            RTC_TB  DW      RTC_00                  ; 0 = READ CURRENT CLOCK COUNT
 0023 0042 R                    DW      RTC_10                  ; 1 = SET CLOCK COUNT
 0025 0050 R                    DW      RTC_20                  ; 2 = READ THE REAL TIME CLOCK TIME
 0027 0075 R                    DW      RTC_30                  ; 3 = SET REAL TIME CLOCK TIME
 0029 00A8 R                    DW      RTC_40                  ; 4 = READ THE REAL TIME CLOCK DATE
 002B 00CB R                    DW      RTC_50                  ; 5 = SET REAL TIME CLOCK DATE
 002D 0104 R                    DW      RTC_60                  ; 6 = SET THE REAL TIME CLOCK ALARM
 002F 0145 R                    DW      RTC_70                  ; 7 = RESET ALARM
 = 0031                 RTC_TBE EQU     $
 0031                   TIME_OF_DAY_1   ENDP
```

```
                                PAGE
0031                            RTC_00  PROC    NEAR                    ;       READ TIME COUNT
0031 A0 0070 R                          MOV     AL,@TIMER_OFL           ; GET THE OVERFLOW FLAG
0034 C6 06 0070 R 00                    MOV     @TIMER_OFL,0            ; AND THEN RESET THE OVERFLOW FLAG
0039 8B 0E 006E R                       MOV     CX,@TIMER_HIGH          ; GET COUNT OF TIME HIGH WORD
003D 8B 16 006C R                       MOV     DX,@TIMER_LOW           ; GET COUNT OF TIME LOW WORD
0041 C3                                 RET                             ; RETURN WITH NO CARRY

0042                            RTC_10:                                 ;       SET TIME COUNT
0042 89 16 006C R                       MOV     @TIMER_LOW,DX           ; SET TIME COUNT LOW WORD
0046 89 0E 006E R                       MOV     @TIMER_HIGH,CX          ; SET THE TIME COUNT HIGH WORD
004A C6 06 0070 R 00                    MOV     @TIMER_OFL,0            ; RESET OVERFLOW FLAG
004F C3                                 RET                             ; RETURN WITH NO CARRY

0050                            RTC_20:                                 ;       GET RTC TIME
0050 E8 016B R                          CALL    UPD_IPR                 ; CHECK FOR UPDATE IN PROCESS
0053 72 1F                              JC      RTC_29                  ; EXIT IF ERROR (CY= 1)

0055 B0 00                              MOV     AL,CMOS_SECONDS         ; SET ADDRESS OF SECONDS
0057 E8 0000 E                          CALL    CMOS_READ               ; GET SECONDS
005A 8A F0                              MOV     DH,AL                   ; SAVE
005C B0 0B                              MOV     AL,CMOS_REG_B           ; ADDRESS ALARM REGISTER
005E E8 0000 E                          CALL    CMOS_READ               ; READ CURRENT VALUE OF DSE BIT
0061 24 01                              AND     AL,00000001B            ; MASK FOR VALID DSE BIT
0063 8A D0                              MOV     DL,AL                   ; SET (DL) TO ZERO FOR NO DSE BIT
0065 B0 02                              MOV     AL,CMOS_MINUTES         ; SET ADDRESS OF MINUTES
0067 E8 0000 E                          CALL    CMOS_READ               ; GET MINUTES
006A 8A C8                              MOV     CL,AL                   ; SAVE
006C B0 04                              MOV     AL,CMOS_HOURS           ; SET ADDRESS OF HOURS
006E E8 0000 E                          CALL    CMOS_READ               ; GET HOURS
0071 8A E8                              MOV     CH,AL                   ; SAVE
0073 F8                                 CLC                             ; SET CY= 0
0074                            RTC_29:
0074 C3                                 RET                             ; RETURN WITH RESULT IN CARRY FLAG

0075                            RTC_30:                                 ;       SET RTC TIME
0075 E8 016B R                          CALL    UPD_IPR                 ; CHECK FOR UPDATE IN PROCESS
0078 73 03                              JNC     RTC_35                  ; GO AROUND IF CLOCK OPERATING
007A E8 0154 R                          CALL    RTC_STA                 ; ELSE TRY INITIALIZING CLOCK
007D                            RTC_35:
007D 8A E6                              MOV     AH,DH                   ; GET TIME BYTE - SECONDS
007F B0 00                              MOV     AL,CMOS_SECONDS         ; ADDRESS SECONDS
0081 E8 0000 E                          CALL    CMOS_WRITE              ; UPDATE SECONDS
0084 8A E1                              MOV     AH,CL                   ; GET TIME BYTE - MINUTES
0086 B0 02                              MOV     AL,CMOS_MINUTES         ; ADDRESS MINUTES
0088 E8 0000 E                          CALL    CMOS_WRITE              ; UPDATE MINUTES
008B 8A E5                              MOV     AH,CH                   ; GET TIME BYTE - HOURS
008D B0 04                              MOV     AL,CMOS_HOURS           ; ADDRESS HOURS
008F E8 0000 E                          CALL    CMOS_WRITE              ; UPDATE ADDRESS
0092 B8 0B0B                            MOV     AX,X*CMOS_REG_B         ; ADDRESS ALARM REGISTER
0095 E8 0000 E                          CALL    CMOS_READ               ; READ CURRENT VALUE
0098 24 62                              AND     AL,01100010B            ; MASK FOR VALID BIT POSITIONS
009A 0C 02                              OR      AL,00000010B            ; TURN ON 24 HOUR MODE
009C 80 E2 01                           AND     DL,00000001B            ; USE ONLY THE DSE BIT
009F 0A C2                              OR      AL,DL                   ; GET DAY LIGHT SAVINGS TIME BIT (DSE)
00A1 86 E0                              XCHG    AH,AL                   ; PLACE IN WORK REGISTER AND GET ADDRESS
00A3 E8 0000 E                          CALL    CMOS_WRITE              ; SET NEW ALARM BITS
00A6 F8                                 CLC                             ; SET CY= 0
00A7 C3                                 RET                             ; RETURN WITH CY= 0

00A8                            RTC_40:                                 ;       GET RTC DATE
00A8 E8 016B R                          CALL    UPD_IPR                 ; CHECK FOR UPDATE IN PROCESS
00AB 72 1D                              JC      RTC_49                  ; EXIT IF ERROR (CY= 1)

00AD B0 07                              MOV     AL,CMOS_DAY_MONTH       ; ADDRESS DAY OF MONTH
00AF E8 0000 E                          CALL    CMOS_READ               ; READ DAY OF MONTH
00B2 8A D0                              MOV     DL,AL                   ; SAVE
00B4 B0 08                              MOV     AL,CMOS_MONTH           ; ADDRESS MONTH
00B6 E8 0000 E                          CALL    CMOS_READ               ; READ MONTH
00B9 8A F0                              MOV     DH,AL                   ; SAVE
00BB B0 09                              MOV     AL,CMOS_YEAR            ; ADDRESS YEAR
00BD E8 0000 E                          CALL    CMOS_READ               ; READ YEAR
00C0 8A C8                              MOV     CL,AL                   ; SAVE
00C2 B0 32                              MOV     AL,CMOS_CENTURY         ; ADDRESS CENTURY LOCATION
00C4 E8 0000 E                          CALL    CMOS_READ               ; GET CENTURY BYTE
00C7 8A E8                              MOV     CH,AL                   ; SAVE
00C9 F8                                 CLC                             ; SET CY=0
00CA                            RTC_49:
00CA C3                                 RET                             ; RETURN WITH RESULTS IN CARRY FLAG

00CB                            RTC_50:                                 ;       SET RTC DATE
00CB E8 016B R                          CALL    UPD_IPR                 ; CHECK FOR UPDATE IN PROCESS
00CE 73 03                              JNC     RTC_55                  ; GO AROUND IF NO ERROR
00D0 E8 0154 R                          CALL    RTC_STA                 ; ELSE INITIALIZE CLOCK
00D3                            RTC_55:
00D3 B8 0006                            MOV     AX,CMOS_DAY_WEEK        ; ADDRESS OF DAY OF WEEK BYTE
00D6 E8 0000 E                          CALL    CMOS_WRITE              ; LOAD ZEROS TO DAY OF WEEK
00D9 8A E2                              MOV     AH,DL                   ; GET DAY OF MONTH BYTE
00DB B0 07                              MOV     AL,CMOS_DAY_MONTH       ; ADDRESS DAY OF MONTH BYTE
00DD E8 0000 E                          CALL    CMOS_WRITE              ; WRITE OF DAY OF MONTH REGISTER
00E0 8A E6                              MOV     AH,DH                   ; GET MONTH
00E2 B0 08                              MOV     AL,CMOS_MONTH           ; ADDRESS MONTH BYTE
00E4 E8 0000 E                          CALL    CMOS_WRITE              ; WRITE MONTH REGISTER
00E7 8A E1                              MOV     AH,CL                   ; GET YEAR BYTE
00E9 B0 09                              MOV     AL,CMOS_YEAR            ; ADDRESS YEAR REGISTER
00EB E8 0000 E                          CALL    CMOS_WRITE              ; WRITE YEAR REGISTER
00EE 8A E5                              MOV     AH,CH                   ; GET CENTURY BYTE
00F0 B0 32                              MOV     AL,CMOS_CENTURY         ; ADDRESS CENTURY BYTE
00F2 E8 0000 E                          CALL    CMOS_WRITE              ; WRITE CENTURY LOCATION
00F5 B8 0B0B                            MOV     AX,X*CMOS_REG_B         ; ADDRESS ALARM REGISTER
00F8 E8 0000 E                          CALL    CMOS_READ               ; READ CURRENT SETTINGS
00FB 24 7F                              AND     AL,07FH                 ; CLEAR 'SET BIT'
00FD 86 E0                              XCHG    AH,AL                   ; MOVE TO WORK REGISTER
00FF E8 0000 E                          CALL    CMOS_WRITE              ;  AND START CLOCK UPDATING
0102 F8                                 CLC                             ; SET CY= 0
0103 C3                                 RET                             ; RETURN CY=0

0104                            RTC_60:                                 ;       SET RTC ALARM
0104 B0 0B                              MOV     AL,CMOS_REG_B           ; ADDRESS ALARM
0106 E8 0000 E                          CALL    CMOS_READ               ; READ ALARM REGISTER
0109 A8 20                              TEST    AL,20H                  ; CHECK FOR ALARM ALREADY ENABLED
010B F9                                 STC                             ; SET CARRY IN CASE OF ERROR
010C 75 33                              JNZ     RTC_69                  ; ERROR EXIT IF ALARM SET
```

SECTION 5

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010E E8 016B R              CALL  UPD_IPR               ; CHECK FOR UPDATE IN PROCESS
0111 73 03                  JNC   RTC_65                ; SKIP INITIALIZATION IF NO ERROR
0113 E8 0154 R              CALL  RTC_STA               ; ELSE INITIALIZE CLOCK
0116              RTC_65:
0116 8A E6                  MOV   AH,DH                 ; GET SECONDS BYTE
0118 B0 01                  MOV   AL,CMOS_SEC_ALARM     ; ADDRESS THE SECONDS ALARM REGISTER
011A E8 0000 E              CALL  CMOS_WRITE            ; INSERT SECONDS
011D 8A E1                  MOV   AH,CL                 ; GET MINUTES PARAMETER
011F B0 03                  MOV   AL,CMOS_MIN_ALARM     ; ADDRESS MINUTES ALARM REGISTER
0121 E8 0000 E              CALL  CMOS_WRITE            ; INSERT MINUTES
0124 8A E5                  MOV   AH,CH                 ; GET HOURS PARAMETER
0126 B0 05                  MOV   AL,CMOS_HR_ALARM      ; ADDRESS HOUR ALARM REGISTER
0128 E8 0000 E              CALL  CMOS_WRITE            ; INSERT HOURS
012B E4 A1                  IN    AL,INTB01             ; READ SECOND INTERRUPT MASK REGISTER
012D 24 FE                  AND   AL,0FEH               ; ENABLE ALARM TIMER BIT (CY= 0)
012F E6 A1                  OUT   INTB01,AL             ; WRITE UPDATED MASK
0131 B8 0B0B                MOV   AX,X*CMOS_REG_B       ; ADDRESS ALARM REGISTER
0134 E8 0000 E              CALL  CMOS_READ             ; READ CURRENT ALARM REGISTER
0137 24 7F                  AND   AL,07FH               ; ENSURE SET BIT TURNED OFF
0139 0C 20                  OR    AL,20H                ; TURN ON ALARM ENABLE
013B 86 E0                  XCHG  AH,AL                 ; MOVE MASK TO OUTPUT REGISTER
013D E8 0000 E              CALL  CMOS_WRITE            ; WRITE NEW ALARM MASK
0140 F8                     CLC                         ; SET CY= 0
0141              RTC_69:
0141 B8 0000                MOV   AX,0                  ; CLEAR AX REGISTER
0144 C3                     RET                         ; RETURN WITH RESULTS IN CARRY FLAG

0145              RTC_70:                               ;       RESET ALARM
0145 B8 0B0B                MOV   AX,X*CMOS_REG_B       ; ADDRESS ALARM REGISTER (TO BOTH AH,AL)
0148 E8 0000 E              CALL  CMOS_READ             ; READ ALARM REGISTER
014B 24 57                  AND   AL,57H                ; TURN OFF ALARM ENABLE
014D 86 E0                  XCHG  AH,AL                 ; SAVE DATA AND RECOVER ADDRESS
014F E8 0000 E              CALL  CMOS_WRITE            ; RESTORE NEW VALUE
0152 F8                     CLC                         ; SET CY= 0
0153 C3                     RET                         ; RETURN WITH NO CARRY

0154              RTC_00    ENDP

0154              RTC_STA   PROC  NEAR                  ;       INITIALIZE REAL TIME CLOCK
0154 B8 260A                MOV   AX,26H*H+CMOS_REG_A   ; ADDRESS REGISTER A AND LOAD DATA MASK
0157 E8 0000 E              CALL  CMOS_WRITE            ; INITIALIZE STATUS REGISTER A
015A B8 820B                MOV   AX,82H*H+CMOS_REG_B   ; SET "SET BIT" FOR CLOCK INITIALIZATION
015D E8 0000 E              CALL  CMOS_WRITE            ; AND 24 HOUR MODE TO REGISTER B
0160 B0 0C                  MOV   AL,CMOS_REG_C         ; ADDRESS REGISTER C
0162 E8 0000 E              CALL  CMOS_READ             ; READ REGISTER C TO INITIALIZE
0165 B0 0D                  MOV   AL,CMOS_REG_D         ; ADDRESS REGISTER D
0167 E8 0000 E              CALL  CMOS_READ             ; READ REGISTER D TO INITIALIZE
016A C3                     RET

016B              RTC_STA   ENDP

016B              UPD_IPR   PROC  NEAR                  ;       WAIT TILL UPDATE NOT IN PROGRESS
016B 51                     PUSH  CX                    ; SAVE CALLERS REGISTER
016C B9 0320                MOV   CX,800                ; SET TIMEOUT LOOP COUNT
016F              UPD_10:
016F B0 0A                  MOV   AL,CMOS_REG_A         ; ADDRESS STATUS REGISTER A
0171 FA                     CLI                         ; NO TIMER INTERRUPTS DURING UPDATES
0172 E8 0000 E              CALL  CMOS_READ             ; READ UPDATE IN PROCESS FLAG
0175 A8 80                  TEST  AL,80H                ; IF UIP BIT IS ON ( CANNOT READ TIME )
0177 74 06                  JZ    UPD_90                ; EXIT WITH CY= 0 IF CAN READ CLOCK NOW
0179 FB                     STI                         ; ALLOW INTERRUPTS WHILE WAITING
017A E2 F3                  LOOP  UPD_10                ; LOOP TILL READY OR TIMEOUT
017C 33 C0                  XOR   AX,AX                 ; CLEAR RESULTS IF ERROR
017E F9                     STC                         ; SET CARRY FOR ERROR
017F              UPD_90:
017F 59                     POP   CX                    ; RESTORE CALLERS REGISTER
0180 FA                     CLI                         ; INTERRUPTS OFF DURING SET
0181 C3                     RET                         ; RETURN WITH CY FLAG SET

0182              UPD_IPR   ENDP
```

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                              PAGE
                              ;--- HARDWARE INT  70 H -- ( IRQ LEVEL  8 ) -----------------------------------
                              ; ALARM INTERRUPT HANDLER (RTC)                                               :
                              ;       THIS ROUTINE HANDLES THE PERIODIC AND ALARM INTERRUPTS FROM THE CMOS   :
                              ;       TIMER.  INPUT FREQUENCY IS 1.024 KHZ OR APPROXIMATELY 1024 INTERRUPTS  :
                              ;       EVERY SECOND FOR THE PERIODIC INTERRUPT.  FOR THE ALARM FUNCTION,      :
                              ;       THE INTERRUPT WILL OCCUR AT THE DESIGNATED TIME.                       :
                              ;                                                                              :
                              ;       INTERRUPTS ARE ENABLED WHEN THE EVENT OR ALARM FUNCTION IS ACTIVATED.  :
                              ;       FOR THE EVENT INTERRUPT, THE HANDLER WILL DECREMENT THE WAIT COUNTER   :
                              ;       AND WHEN IT EXPIRES WILL SET THE DESIGNATED LOCATION TO 80H.  FOR      :
                              ;       THE ALARM INTERRUPT, THE USER MUST PROVIDE A ROUTINE TO INTERCEPT      :
                              ;       THE CORRECT ADDRESS FROM THE VECTOR TABLE INVOKED BY INTERRUPT 4AH     :
                              ;       PRIOR TO SETTING THE REAL TIME CLOCK ALARM (INT 1AH, AH= 06H).         :
                              ;-------------------------------------------------------------------------------

0182                          RTC_INT PROC    FAR                     ;       ALARM INTERRUPT
0182 1E                               PUSH    DS                      ; LEAVE INTERRUPTS DISABLED
0183 50                               PUSH    AX                      ; SAVE REGISTERS
0184 57                               PUSH    DI

0185                          RTC_I_1:                                ;       CHECK FOR SECOND INTERRUPT
0185 B8 8B8C                          MOV     AX,(CMOS_REG_B+NMI)*H+CMOS_REG_C+NMI ; ALARM AND STATUS
0188 E6 70                            OUT     CMOS_PORT,AL            ; WRITE ALARM FLAG MASK ADDRESS
018A 90                               NOP                             ; I/O DELAY
018B E4 71                            IN      AL,CMOS_DATA            ; READ AND RESET INTERRUPT REQUEST FLAGS
018D A8 60                            TEST    AL,01100000B            ; CHECK FOR EITHER INTERRUPT PENDING
018F 74 4D                            JZ      RTC_I_9                 ; EXIT IF NOT A VALID RTC INTERRUPT

0191 86 E0                            XCHG    AH,AL                   ; SAVE FLAGS AND GET ENABLE ADDRESS
0193 E6 70                            OUT     CMOS_PORT,AL            ; WRITE ALARM ENABLE MASK ADDRESS
0195 90                               NOP                             ; I/O DELAY
0196 E4 71                            IN      AL,CMOS_DATA            ; READ CURRENT ALARM ENABLE MASK
0198 22 C4                            AND     AL,AH                   ; ALLOW ONLY SOURCES THAT ARE ENABLED
019A A8 40                            TEST    AL,01000000B            ; CHECK FOR PERIODIC INTERRUPT
019C 74 30                            JZ      RTC_I_5                 ; SKIP IF NOT A PERIODIC INTERRUPT

                              ;-----  DECREMENT WAIT COUNT BY INTERRUPT INTERVAL

019E E8 0000 E                        CALL    DDS                     ; ESTABLISH DATA SEGMENT ADDRESSABILITY
01A1 81 2E 009C R 03D0                SUB     @RTC_LOW,0976           ; DECREMENT COUNT LOW BY 1/1024
01A7 83 1E 009E R 00                  SBB     @RTC_HIGH,0             ; ADJUST HIGH WORD FOR LOW WORD BORROW
01AC 73 20                            JNC     RTC_I_5                 ; SKIP TILL 32 BIT WORD LESS THAN ZERO

                              ;-----  TURN OFF PERIODIC INTERRUPT ENABLE

01AE 50                               PUSH    AX                      ; SAVE INTERRUPT FLAG MASK
01AF B8 8B8B                          MOV     AX,X*(CMOS_REG_B+NMI)   ; INTERRUPT ENABLE REGISTER
01B2 E6 70                            OUT     CMOS_PORT,AL            ; WRITE ADDRESS TO CMOS CLOCK
01B4 90                               NOP                             ; I/O DELAY
01B5 E4 71                            IN      AL,CMOS_DATA            ; READ CURRENT ENABLES
01B7 24 BF                            AND     AL,0BFH                 ; TURN OFF PIE
01B9 86 C4                            XCHG    AL,AH                   ; GET CMOS ADDRESS AND SAVE VALUE
01BB E6 70                            OUT     CMOS_PORT,AL            ; ADDRESS REGISTER B
01BD 86 C4                            XCHG    AL,AH                   ; GET NEW INTERRUPT ENABLE MASK
01BF E6 71                            OUT     CMOS_DATA,AL            ; SET MASK IN INTERRUPT ENABLE REGISTER
01C1 C6 06 00A0 R 00                  MOV     @RTC_WAIT_FLAG,0        ; SET FUNCTION ACTIVE FLAG OFF
01C6 C5 3E 0098 R                     LDS     DI,DWORD PTR @USER_FLAG ; SET UP (DS:DI) TO POINT TO USER FLAG
01CA C6 05 80                         MOV     BYTE PTR [DI],80H       ; TURN ON USERS FLAG
01CD 58                               POP     AX                      ; GET INTERRUPT SOURCE BACK
01CE                          RTC_I_5:
01CE A8 20                            TEST    AL,00100000B            ; TEST FOR ALARM INTERRUPT
01D0 74 0A                            JZ      RTC_I_7                 ; SKIP USER INTERRUPT CALL IF NOT ALARM

01D2 B0 0D                            MOV     AL,CMOS_REG_D           ; POINT TO DEFAULT READ ONLY REGISTER
01D4 E6 70                            OUT     CMOS_PORT,AL            ; ENABLE NMI AND CMOS ADDRESS TO DEFAULT
01D6 FB                               STI                             ; INTERRUPTS BACK ON NOW
01D7 52                               PUSH    DX
01D8 CD 4A                            INT     4AH                     ; TRANSFER TO USER ROUTINE
01DA 5A                               POP     DX
01DB FA                               CLI                             ; BLOCK INTERRUPT FOR RETRY
01DC                          RTC_I_7:                                ; RESTART ROUTINE TO HANDLE DELAYED
01DC EB A7                            JMP     RTC_I_1                 ;  ENTRY AND SECOND EVENT BEFORE DONE


01DE                          RTC_I_9:                                ;       EXIT - NO PENDING INTERRUPTS
01DE B0 0D                            MOV     AL,CMOS_REG_D           ; POINT TO DEFAULT READ ONLY REGISTER
01E0 E6 70                            OUT     CMOS_PORT,AL            ; ENABLE NMI AND CMOS ADDRESS TO DEFAULT
01E2 B0 20                            MOV     AL,EOI                  ; END OF INTERRUPT MASK TO 8259 - 2
01E4 E6 A0                            OUT     INTB00,AL               ;  TO 8259 - 2
01E6 E6 20                            OUT     INTA00,AL               ;  TO 8259 - 1
01E8 5F                               POP     DI                      ; RESTORE REGISTERS
01E9 58                               POP     AX
01EA 1F                               POP     DS
01EB CF                               IRET                            ; END OF INTERRUPT

01EC                          RTC_INT ENDP
```

SECTION 5

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                                PAGE
                                ;--- INT  05 H ---------------------------------------------------------------
                                ; PRINT_SCREEN
                                ;       THIS LOGIC WILL BE INVOKED BY INTERRUPT 05H TO PRINT THE SCREEN.      :
                                ;       THE CURSOR POSITION AT THE TIME THIS ROUTINE IS INVOKED WILL BE       :
                                ;       SAVED AND RESTORED UPON COMPLETION.  THE ROUTINE IS INTENDED TO       :
                                ;       RUN WITH INTERRUPTS ENABLED.   IF A SUBSEQUENT PRINT SCREEN KEY       :
                                ;       IS DEPRESSED WHILE THIS ROUTINE IS PRINTING IT WILL BE IGNORED.       :
                                ;       THE BASE PRINTERS STATUS IS CHECKED FOR NOT BUSY AND NOT OUT OF       :
                                ;       PAPER.  AN INITIAL STATUS ERROR WILL ABEND THE PRINT REQUEST.         :
                                ;       ADDRESS  0050:0000  CONTAINS THE STATUS OF THE PRINT SCREEN:          :
                                ;                                                                             :
                                ;       50:0     = 0     PRINT SCREEN HAS NOT BEEN CALLED OR UPON RETURN      :
                                ;                         FROM A CALL THIS INDICATES A SUCCESSFUL OPERATION.  :
                                ;                = 1     PRINT SCREEN IS IN PROGRESS - IGNORE THIS REQUEST.   :
                                ;                = 255   ERROR ENCOUNTERED DURING PRINTING.                   :
                                ;-----------------------------------------------------------------------------

 01EC                           PRINT_SCREEN_1  PROC    FAR
                                                                ; DELAY INTERRUPT ENABLE TILL FLAG SET
 01EC 1E                                PUSH    DS
 01ED 50                                PUSH    AX              ; SAVE WORK REGISTERS
 01EE 53                                PUSH    BX
 01EF 51                                PUSH    CX
 01F0 52                                PUSH    DX              ; USE 0040:0100 FOR STATUS AREA STORAGE
 01F1 E8 0000 E                         CALL    DDS             ; GET STATUS_BYTE DATA SEGMENT
 01F4 80 3E 0100 R 01                   CMP     @STATUS_BYTE,1  ; SEE IF PRINT ALREADY IN PROGRESS
 01F9 74 74                             JE      PRI90           ; EXIT IF PRINT ALREADY IN PROGRESS
 01FB C6 06 0100 R 01                   MOV     @STATUS_BYTE,1  ; INDICATE PRINT NOW IN PROGRESS
 0200 FB                                STI                     ; MUST RUN WITH INTERRUPTS ENABLED
 0201 B4 0F                             MOV     AH,0FH          ; WILL REQUEST THE CURRENT SCREEN MODE
 0203 CD 10                             INT     10H             ;       (AL)= MODE
                                                                ;       (AH)= NUMBER COLUMNS/LINE
                                                                ;       (BH)= VISUAL PAGE
 0205 8A CC                             MOV     CL,AH           ; WILL MAKE USE OF (CX) REGISTER TO
 0207 8A 2E 0084 R                      MOV     CH,@ROWS        ;  CONTROL ROWS ON SCREEN & COLUMNS
 020B FE C5                             INC     CH              ; ADJUST ROWS ON DISPLAY COUNT
                                                                ;       (CL)= NUMBER COLUMNS/LINE
                                                                ;       (CH)= NUMBER OF ROWS ON DISPLAY
                                        ;---------------------------------------------------------------
                                        ;       AT THIS POINT WE KNOW THE COLUMNS/LINE COUNT IS IN (CL) :
                                        ;       AND THE NUMBER OF ROWS ON THE DISPLAY IS IN (CH).       :
                                        ;       THE PAGE IF APPLICABLE IS IN (BH).  THE STACK HAS       :
                                        ;       (DS),(AX),(BX),(CX),(DX)  PUSHED.                       :
                                        ;---------------------------------------------------------------
 020D 33 D2                             XOR     DX,DX           ; FIRST PRINTER
 020F B4 02                             MOV     AH,02H          ; SET PRINTER STATUS REQUEST COMMAND
 0211 CD 17                             INT     17H             ; REQUEST CURRENT PRINTER STATUS
 0213 80 F4 80                          XOR     AH,080H         ; CHECK FOR PRINTER BUSY (NOT CONNECTED)
 0216 F6 C4 A0                          TEST    AH,0A0H         ;  OR  OUT OF PAPER
 0219 75 4E                             JNZ     PRI80           ; ERROR EXIT IF PRINTER STATUS ERROR

 021B E8 0275 R                         CALL    CRLF            ; CARRIAGE RETURN LINE FEED TO PRINTER

 021E 51                                PUSH    CX              ; SAVE SCREEN BOUNDS
 021F B4 03                             MOV     AH,03H          ; NOW READ THE CURRENT CURSOR POSITION
 0221 CD 10                             INT     10H             ; AND RESTORE AT END OF ROUTINE
 0223 59                                POP     CX              ; RECALL SCREEN BOUNDS
 0224 52                                PUSH    DX              ; PRESERVE THE ORIGINAL POSITION
 0225 33 D2                             XOR     DX,DX           ; INITIAL CURSOR (0,0) AND FIRST PRINTER
                                        ;---------------------------------------------------------------
                                        ;       THIS LOOP IS TO READ EACH CURSOR POSITION FROM THE      :
                                        ;       SCREEN AND PRINT IT.  (BH)= VISUAL PAGE  (CH)= ROWS     :
                                        ;---------------------------------------------------------------
 0227                           PRI10:
 0227 B4 02                             MOV     AH,02H          ; INDICATE CURSOR SET REQUEST
 0229 CD 10                             INT     10H             ; NEW CURSOR POSITION ESTABLISHED
 022B B4 08                             MOV     AH,08H          ; INDICATE READ CHARACTER FROM DISPLAY
 022D CD 10                             INT     10H             ; CHARACTER NOW IN (AL)
 022F 0A C0                             OR      AL,AL           ; SEE IF VALID CHAR
 0231 75 02                             JNZ     PRI20           ; JUMP IF VALID CHAR
 0233 B0 20                             MOV     AL,' '          ; ELSE MAKE IT A BLANK
 0235                           PRI20:
 0235 52                                PUSH    DX              ; SAVE CURSOR POSITION
 0236 33 D2                             XOR     DX,DX           ; INDICATE FIRST PRINTER (DX= 0)
 0238 32 E4                             XOR     AH,AH           ; INDICATE PRINT CHARACTER IN (AL)
 023A CD 17                             INT     17H             ; PRINT THE CHARACTER
 023C 5A                                POP     DX              ; RECALL CURSOR POSITION
 023D F6 C4 29                          TEST    AH,29H          ; TEST FOR PRINTER ERROR
 0240 75 22                             JNZ     PRI70           ; EXIT IF ERROR DETECTED
 0242 FE C2                             INC     DL              ; ADVANCE TO NEXT COLUMN
 0244 3A CA                             CMP     CL,DL           ; SEE IF AT END OF LINE
 0246 75 DF                             JNZ     PRI10           ; IF NOT LOOP FOR NEXT COLUMN
 0248 32 D2                             XOR     DL,DL           ; BACK TO COLUMN 0
 024A 8A E2                             MOV     AH,DL           ; (AH)=0
 024C 52                                PUSH    DX              ; SAVE NEW CURSOR POSITION
 024D E8 0275 R                         CALL    CRLF            ; LINE FEED CARRIAGE RETURN
 0250 5A                                POP     DX              ; RECALL CURSOR POSITION
 0251 FE C6                             INC     DH              ; ADVANCE TO NEXT LINE
 0253 3A EE                             CMP     CH,DH           ; FINISHED?
 0255 75 D0                             JNZ     PRI10           ; IF NOT LOOP FOR NEXT LINE

 0257 5A                                POP     DX              ; GET CURSOR POSITION
 0258 B4 02                             MOV     AH,02H          ; INDICATE REQUEST CURSOR SET
 025A CD 10                             INT     10H             ; CURSOR POSITION RESTORED
 025C FA                                CLI                     ; BLOCK INTERRUPTS TILL STACK CLEARED
 025D C6 06 0100 R 00                   MOV     @STATUS_BYTE,0  ; MOVE OK RESULTS FLAG TO STATUS_BYTE
 0262 EB 0B                             JMP     SHORT PRI90     ; EXIT PRINTER ROUTINE

 0264                           PRI70:                          ;       ERROR EXIT
 0264 5A                                POP     DX              ; GET CURSOR POSITION
 0265 B4 02                             MOV     AH,02H          ; INDICATE REQUEST CURSOR SET
 0267 CD 10                             INT     10H             ; CURSOR POSITION RESTORED
 0269                           PRI80:
 0269 FA                                CLI                     ; BLOCK INTERRUPTS TILL STACK CLEARED
 026A C6 06 0100 R FF                   MOV     @STATUS_BYTE,0FFH ; SET ERROR FLAG
 026F                           PRI90:
 026F 5A                                POP     DX              ;       EXIT ROUTINE
 0270 59                                POP     CX              ; RESTORE ALL THE REGISTERS USED
 0271 5B                                POP     BX
 0272 58                                POP     AX
 0273 1F                                POP     DS
 0274 CF                                IRET                    ; RETURN WITH INITIAL INTERRUPT MASK
 0275                           PRINT_SCREEN_1  ENDP
```

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                         ;-----  CARRIAGE RETURN, LINE FEED SUBROUTINE

0275                     CRLF    PROC    NEAR
                                                         ;       SEND CR,LF TO FIRST PRINTER
0275 33 D2                       XOR     DX,DX           ; ASSUME FIRST PRINTER (DX= 0)
0277 B8 000D                     MOV     AX,CR           ; GET THE PRINT CHARACTER COMMAND AND
027A CD 17                       INT     17H             ;   THE CARRIAGE RETURN CHARACTER
027C B8 000A                     MOV     AX,LF           ; NOW GET THE LINE FEED AND
027F CD 17                       INT     17H             ;   SEND IT TO THE BIOS PRINTER ROUTINE
0281 C3                          RET
0282                     CRLF    ENDP



                         ;-- HARDWARE INT  08 H -- ( IRQ LEVEL 0 ) ---------------------------------------
                         ;                                                                               :
                         ;       THIS ROUTINE HANDLES THE TIMER INTERRUPT FROM FROM CHANNEL 0 OF         :
                         ;       THE 8254 TIMER.  INPUT FREQUENCY IS 1.19318 MHZ AND THE DIVISOR         :
                         ;       IS 65536, RESULTING IN APPROXIMATELY 18.2 INTERRUPTS EVERY SECOND.      :
                         ;                                                                               :
                         ;       THE INTERRUPT HANDLER MAINTAINS A COUNT (40:6C) OF INTERRUPTS SINCE     :
                         ;       POWER ON TIME, WHICH MAY BE USED TO ESTABLISH TIME OF DAY.              :
                         ;       THE INTERRUPT HANDLER ALSO DECREMENTS THE MOTOR CONTROL COUNT (40:40)   :
                         ;       OF THE DISKETTE, AND WHEN IT EXPIRES, WILL TURN OFF THE                 :
                         ;       DISKETTE MOTOR(s), AND RESET THE MOTOR RUNNING FLAGS.                   :
                         ;       THE INTERRUPT HANDLER WILL ALSO INVOKE A USER ROUTINE THROUGH           :
                         ;       INTERRUPT 1CH AT EVERY TIME TICK.  THE USER MUST CODE A                 :
                         ;       ROUTINE AND PLACE THE CORRECT ADDRESS IN THE VECTOR TABLE.              :
                         ;--------------------------------------------------------------------------------

0282                     TIMER_INT_1     PROC    FAR
0282 FB                          STI                             ; INTERRUPTS BACK ON
0283 1E                          PUSH    DS
0284 50                          PUSH    AX
0285 52                          PUSH    DX                      ; SAVE MACHINE STATE
0286 E8 0000 E                   CALL    DDS                     ; ESTABLISH ADDRESSABILITY
0289 FF 06 006C R                INC     @TIMER_LOW              ; INCREMENT TIME
028D 75 04                       JNZ     T4                      ; GO TO TEST_DAY
028F FF 06 006E R                INC     @TIMER_HIGH             ; INCREMENT HIGH WORD OF TIME
0293                     T4:                                     ;       TEST_DAY
0293 83 3E 006E R 18             CMP     @TIMER_HIGH,018H        ; TEST FOR COUNT EQUALING 24 HOURS
0298 75 15                       JNZ     T5                      ; GO TO DISKETTE_CTL
029A 81 3E 006C R 00B0           CMP     @TIMER_LOW,0B0H
02A0 75 0D                       JNZ     T5                      ; GO TO DISKETTE_CTL

                         ;-----  TIMER HAS GONE 24 HOURS

02A2 2B C0                       SUB     AX,AX
02A4 A3 006E R                   MOV     @TIMER_HIGH,AX
02A7 A3 006C R                   MOV     @TIMER_LOW,AX
02AA C6 06 0070 R 01             MOV     @TIMER_OFL,1

                         ;-----  TEST FOR DISKETTE TIME OUT

02AF                     T5:
02AF FE 0E 0040 R                DEC     @MOTOR_COUNT            ; DECREMENT DISKETTE MOTOR CONTROL
02B3 75 0B                       JNZ     T6                      ; RETURN IF COUNT NOT OUT
02B5 80 26 003F R F0             AND     @MOTOR_STATUS,0F0H      ; TURN OFF MOTOR RUNNING BITS
02BA B0 0C                       MOV     AL,0CH
02BC BA 03F2                     MOV     DX,03F2H                ; FDC CTL PORT
02BF EE                          OUT     DX,AL                   ; TURN OFF THE MOTOR

02C0                     T6:                                     ;       TIMER TICK INTERRUPT
02C0 CD 1C                       INT     1CH                     ; TRANSFER CONTROL TO A USER ROUTINE

02C2 5A                          POP     DX                      ; RESTORE (DX)
02C3 B0 20                       MOV     AL,EOI                  ; GET END OF INTERRUPT MASK
02C5 FA                          CLI                             ; DISABLE INTERRUPTS TILL STACK CLEARED
02C6 E6 20                       OUT     INTA00,AL               ; END OF INTERRUPT TO 8259 - 1
02C8 58                          POP     AX
02C9 1F                          POP     DS                      ; RESET MACHINE STATE
02CA CF                          IRET                            ; RETURN FROM INTERRUPT

02CB                     TIMER_INT_1     ENDP

02CB                     CODE    ENDS
                                 END
```

SECTION 5

```
                                PAGE 118,121
                                TITLE ORGS ----- 06/10/85  COMPATIBILITY MODULE
                                .LIST
 0000                           CODE    SEGMENT BYTE PUBLIC

                                        PUBLIC  A1
                                        PUBLIC  CONF_TBL
                                        PUBLIC  CRT_CHAR_GEN
                                        PUBLIC  D1
                                        PUBLIC  D2
                                        PUBLIC  D2A
                                        PUBLIC  DISK_BASE
                                        PUBLIC  DUMMY_RETURN
                                        PUBLIC  E101
                                        PUBLIC  E102
                                        PUBLIC  E103
                                        PUBLIC  E104
                                        PUBLIC  E105
                                        PUBLIC  E106
                                        PUBLIC  E107
                                        PUBLIC  E108
                                        PUBLIC  E109
                                        PUBLIC  E161
                                        PUBLIC  E162
                                        PUBLIC  E163
                                        PUBLIC  E164
                                        PUBLIC  E201
                                        PUBLIC  E202
                                        PUBLIC  E203
                                        PUBLIC  E301
                                        PUBLIC  E302
                                        PUBLIC  E303
                                        PUBLIC  E304
                                        PUBLIC  E401
                                        PUBLIC  E501
                                        PUBLIC  E601
                                        PUBLIC  E602
                                        PUBLIC  F1780
                                        PUBLIC  F1781
                                        PUBLIC  F1782
                                        PUBLIC  F1790
                                        PUBLIC  F1791
                                        PUBLIC  F3A
                                        PUBLIC  F3D
                                        PUBLIC  F3D1
                                        PUBLIC  FD_TBL
                                        PUBLIC  FLOPPY
                                        PUBLIC  HRD
                                        PUBLIC  K10
                                        PUBLIC  K11
                                        PUBLIC  K12
                                        PUBLIC  K13
                                        PUBLIC  K14
                                        PUBLIC  K15
                                        PUBLIC  K6
                                        PUBLIC  K6L
                                        PUBLIC  K7
                                        PUBLIC  K8
                                        PUBLIC  K9
                                        PUBLIC  M4
                                        PUBLIC  M5
                                        PUBLIC  M6
                                        PUBLIC  M7
                                        PUBLIC  NMI_INT
                                        PUBLIC  PRINT_SCREEN
                                        PUBLIC  P_O_R
                                        PUBLIC  SEEKS_1
                                        PUBLIC  SLAVE_VECTOR_TABLE
                                        PUBLIC  TUTOR
                                        PUBLIC  VECTOR_TABLE
                                        PUBLIC  VIDEO_PARMS

                                        EXTRN   BOOT_STRAP_1:NEAR
                                        EXTRN   CASSETTE_IO_1:NEAR
                                        EXTRN   D11:NEAR
                                        EXTRN   DISK_INT_1:NEAR
                                        EXTRN   DISK_SETUP:NEAR
                                        EXTRN   DISKETTE_IO_1:NEAR
                                        EXTRN   DSKETTE_SETUP:NEAR
                                        EXTRN   EQUIPMENT_1:NEAR
                                        EXTRN   INT_287:NEAR
                                        EXTRN   K16:NEAR
                                        EXTRN   KEYBOARD_IO_1:NEAR
                                        EXTRN   KB_INT_1:NEAR
                                        EXTRN   MEMORY_SIZE_DET_1:NEAR
                                        EXTRN   NMI_INT_1:NEAR
                                        EXTRN   PRINT_SCREEN_1:NEAR
                                        EXTRN   PRINTER_IO_1:NEAR
                                        EXTRN   RE_DIRECT:NEAR
                                        EXTRN   RS232_IO_1:NEAR
                                        EXTRN   RTC_INT:NEAR
                                        EXTRN   SEEK:NEAR
                                        EXTRN   START_1:NEAR
                                        EXTRN   TIME_OF_DAY_1:NEAR
                                        EXTRN   TIMER_INT_1:NEAR
                                        EXTRN   VIDEO_IO_1:NEAR

                                        ASSUME  CS:CODE,DS:DATA

                                ;-----------------------------------------------------------------------------
                                ;                                                                            :
                                ;  THIS MODULE HAS BEEN ADDED TO FACILITATE THE EXPANSION OF THIS PROGRAM.   :
                                ;  IT ALLOWS FOR THE FIXED ORG STATEMENT ENTRY POINTS THAT HAVE TO REMAIN    :
                                ;  AT THE SAME ADDRESSES.  THE USE OF ENTRY POINTS AND TABLES WITHIN THIS    :
                                ;  MODULE SHOULD BE AVOIDED AND ARE INCLUDED ONLY TO SUPPORT EXISTING CODE   :
                                ;  THAT VIOLATE THE STRUCTURE AND DESIGN OF BIOS.   ALL BIOS ACCESS SHOULD   :
                                ;  USE THE DOCUMENTED INTERRUPT VECTOR INTERFACE FOR COMPATIBILITY.          :
                                ;                                                                            :
                                ;-----------------------------------------------------------------------------
```

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                                        PAGE
                                        ;---------------------------------
                                        ;       COPYRIGHT NOTICE          :
                                        ;---------------------------------
                                        ;;-     ORG     0E000H
 0000                                           ORG     00000H

 0000 36 34 38 30 30 39                         DB       '6480090 COPR. IBM 1981, 1985
      30 20 43 4F 50 52
      2E 20 49 42 4D 20
      31 39 38 31 2C 20
      31 39 38 35 20 20
      20 20

                                        ;----------------------------------------
                                        ;       PARITY ERROR MESSAGES           :
                                        ;----------------------------------------

 0020 50 41 52 49 54 59         D1      DB      'PARITY CHECK 1',CR,LF   ; PLANAR BOARD PARITY CHECK LATCH SET
      20 43 48 45 43 4B
      20 31 0D 0A
 0030 50 41 52 49 54 59         D2      DB      'PARITY CHECK 2',CR,LF   ; I/O CHANNEL CHECK LATCH SET
      20 43 48 45 43 4B
      20 32 0D 0A
 0040 3F 3F 3F 3F 3F 0D         D2A     DB      '?????',CR,LF
      0A
 = 0047                         IP      =       $
                                ;;-     ORG     0E05BH
 005B                                   ORG     0005BH
 005B                           RESET:                                   ;        RESET START
 005B E9 0000 E                         JMP     START_1                  ; VECTOR ON TO THE MOVED POST CODE

                                        ;---------------------------------
                                        ;       POST ERROR MESSAGES       :
                                        ;---------------------------------

 005E 20 31 30 31 2D 53         E101    DB      ' 101-System Board Error',CR,LF ; INTERRUPT FAILURE
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 0077 20 31 30 32 2D 53         E102    DB      ' 102-System Board Error',CR,LF ; TIMER FAILURE
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 0090 20 31 30 33 2D 53         E103    DB      ' 103-System Board Error',CR,LF ; TIMER INTERRUPT FAILURE
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 00A9 20 31 30 34 2D 53         E104    DB      ' 104-System Board Error',CR,LF ; PROTECTED MODE FAILURE
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 00C2 20 31 30 35 2D 53         E105    DB      ' 105-System Board Error',CR,LF ; LAST 8042 COMMAND NOT ACCEPTED
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 00DB 20 31 30 36 2D 53         E106    DB      ' 106-System Board Error',CR,LF ; CONVERTING LOGIC TEST
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 00F4 20 31 30 37 2D 53         E107    DB      ' 107-System Board Error',CR,LF ; HOT NMI TEST
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 010D 20 31 30 38 2D 53         E108    DB      ' 108-System Board Error',CR,LF ; TIMER BUS TEST
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 0126 20 31 30 39 2D 53         E109    DB      ' 109-System Board Error',CR,LF ; LOW MEG CHIP SELECT TEST
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 013F 20 31 36 31 2D 53         E161    DB      ' 161-System Options Not Set-(Run SETUP)',CR,LF ; DEAD BATTERY
      79 73 74 65 6D 20
      4F 70 74 69 6F 6E
      73 20 4E 6F 74 20
      53 65 74 2D 28 52
      75 6E 20 53 45 54
      55 50 29 0D 0A
 0168 20 31 36 32 2D 53         E162    DB      ' 162-System Options Not Set-(Run SETUP)',CR,LF ;CHECKSUM/CONFIG
      79 73 74 65 6D 20
      4F 70 74 69 6F 6E
      73 20 4E 6F 74 20
      53 65 74 2D 28 52
      75 6E 20 53 45 54
      55 50 29 0D 0A
 0191 20 31 36 33 2D 54         E163    DB      ' 163-Time & Date Not Set-(Run SETUP)',CR,LF ;CLOCK NOT UPDATING
      69 6D 65 20 26 20
      44 61 74 65 20 4E
      6F 74 20 53 65 74
      2D 28 52 75 6E 20
      53 45 54 55 50 29
      0D 0A
 01B7 20 31 36 34 2D 4D         E164    DB      ' 164-Memory Size Error-(Run SETUP)',CR,LF ; CMOS DOES NOT MATCH
      65 6D 6F 72 79 20
      53 69 7A 65 20 45
      72 72 6F 72 2D 28
      52 75 6E 20 53 45
      54 55 50 29 0D 0A
 01DB 20 32 30 31 2D 4D         E201    DB      ' 201-Memory Error',CR,LF
      65 6D 6F 72 79 20
      45 72 72 6F 72 0D
      0A
 01EE 20 32 30 32 2D 4D         E202    DB      ' 202-Memory Address Error',CR,LF          ; LINE ERROR 00->15
      65 6D 6F 72 79 20
```

SECTION 5

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      41 64 64 72 65 73
      73 20 45 72 72 6F
      72 0D 0A
0209 20 32 30 33 2D 4D   E203      DB       ' 203-Memory Address Error',CR,LF          ; LINE ERROR 16->23
      65 6D 6F 72 79 20
      41 64 64 72 65 73
      73 20 45 72 72 6F
      72 0D 0A
0224 20 33 30 31 2D 4B   E301      DB       ' 301-Keyboard Error',CR,LF                ; KEYBOARD ERROR
      65 79 62 6F 61 72
      64 20 45 72 72 6F
      72 0D 0A
0239 20 33 30 32 2D 53   E302      DB       ' 302-System Unit Keylock is Locked',CR,LF  ; KEYBOARD LOCK ON
      79 73 74 65 6D 20
      55 6E 69 74 20 4B
      65 79 6C 6F 63 6B
      20 69 73 20 4C 6F
      63 6B 65 64 0D 0A
025D 20 28 52 45 53 55   F3D       DB       ' (RESUME = "F1" KEY)',CR,LF
      4D 45 20 3D 20 22
      46 31 22 20 4B 45
      59 29 0D 0A

                         ;-----    NMI ENTRY

= 0273                   IP        =        $
                         ;;-       ORG      0E2C3H
02C3                               ORG      002C3H
= 02C3                   NMI_INT   EQU      $
02C3 E9 0000 E                     JMP      NMI_INT_1              ; VECTOR ON TO MOVED NMI CODE

02C6 20 33 30 33 2D 4B   E303      DB       ' 303-Keyboard Or System Unit Error',CR,LF
      65 79 62 6F 61 72
      64 20 4F 72 20 53
      79 73 74 65 6D 20
      55 6E 69 74 20 45
      72 72 6F 72 0D 0A
                         ;-----    KEYBOARD/SYSTEM ERROR
02EA 20 33 30 34 2D 4B   E304      DB       ' 304-Keyboard Or System Unit Error',CR,LF ; KEYBOARD CLOCK HIGH
      65 79 62 6F 61 72
      64 20 4F 72 20 53
      79 73 74 65 6D 20
      55 6E 69 74 20 45
      72 72 6F 72 0D 0A
030E 20 34 30 31 2D 43   E401      DB       ' 401-CRT Error',CR,LF                      ; MONOCHROME
      52 54 20 45 72 72
      6F 72 0D 0A
031E 20 35 30 31 2D 43   E501      DB       ' 501-CRT Error',CR,LF                      ; COLOR
      52 54 20 45 72 72
      6F 72 0D 0A
032E 20 36 30 31 2D 44   E601      DB       ' 601-Diskette Error',CR,LF                 ; DISKETTE ERROR
      69 73 6B 65 74 74
      65 20 45 72 72 6F
      72 0D 0A
                         ;-----    DISKETTE BOOT RECORD IS NOT VALID
0343 20 36 30 32 2D 44   E602      DB       ' 602-Diskette Boot Record Error',CR,LF
      69 73 6B 65 74 74
      65 20 42 6F 6F 74
      20 52 65 63 6F 72
      64 20 45 72 72 6F
      72 0D 0A
                         ;-----    HARD FILE ERROR MESSAGE
0364 31 37 38 30 2D 44   F1780     DB       '1780-Disk 0 Failure',CR,LF
      69 73 6B 20 30 20
      46 61 69 6C 75 72
      65 0D 0A
0379 31 37 38 31 2D 44   F1781     DB       '1781-Disk 1 Failure',CR,LF
      69 73 6B 20 31 20
      46 61 69 6C 75 72
      65 0D 0A
038E 31 37 38 32 2D 44   F1782     DB       '1782-Disk Controller Failure',CR,LF
      69 73 6B 20 43 6F
      6E 74 72 6F 6C 6C
      65 72 20 46 61 69
      6C 75 72 65 0D 0A
03AC 31 37 39 30 2D 44   F1790     DB       '1790-Disk 0 Error',CR,LF
      69 73 6B 20 30 20
      45 72 72 6F 72 0D
      0A
03BF 31 37 39 31 2D 44   F1791     DB       '1791-Disk 1 Error',CR,LF
      69 73 6B 20 31 20
      45 72 72 6F 72 0D
      0A

03D2 52 4F 4D 20 20 45   F3A       DB       'ROM  Error ',CR,LF                ; ROM CHECKSUM
      72 72 6F 72 20 0D
      0A
03DF 20 20 20 20 2D 55   F3D1      DB       '    -Unlock System Unit Keylock ',CR,LF
      6E 6C 6F 63 6B 20
      53 79 73 74 65 6D
      20 55 6E 69 74 20
      4B 65 79 6C 6F 63
      6B 20 0D 0A
```

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                        PAGE
                        ;---------------------------------------------------------
                        ; INITIALIZE DRIVE CHARACTERISTICS                        :
                        ;                                                         :
                        ; FIXED DISK PARAMETER TABLE                              :
                        ;                                                         :
                        ;  -  THE TABLE IS COMPOSED OF A BLOCK DEFINED AS:        :
                        ;                                                         :
                        ;  +0   (1 WORD) - MAXIMUM NUMBER OF CYLINDERS            :
                        ;  +2   (1 BYTE) - MAXIMUM NUMBER OF HEADS                :
                        ;  +3   (1 WORD) - NOT USED/SEE PC-XT                     :
                        ;  +5   (1 WORD) - STARTING WRITE PRECOMPENSATION CYL     :
                        ;  +7   (1 BYTE) - NOT USED/SEE PC-XT                     :
                        ;  +8   (1 BYTE) - CONTROL BYTE                           :
                        ;                  BIT    7 DISABLE RETRIES -OR-          :
                        ;                  BIT    6 DISABLE RETRIES               :
                        ;                  BIT    3 MORE THAN 8 HEADS             :
                        ;  +9   (3 BYTES)- NOT USED/SEE PC-XT                     :
                        ; +12   (1 WORD) - LANDING ZONE                           :
                        ; +14   (1 BYTE) - NUMBER OF SECTORS/TRACK                :
                        ; +15   (1 BYTE) - RESERVED FOR FUTURE USE                :
                        ;                                                         :
                        ;       - TO DYNAMICALLY DEFINE A SET OF PARAMETERS       :
                        ;         BUILD A TABLE FOR UP TO 15 TYPES AND PLACE      :
                        ;         THE CORRESPONDING VECTOR INTO INTERRUPT 41      :
                        ;         FOR DRIVE 0 AND INTERRUPT 46 FOR DRIVE 1.       :
                        ;                                                         :
                        ;---------------------------------------------------------

0401                    FD_TBL:

                        ;----- DRIVE TYPE 01

0401 0132                       DW      0306D           ; CYLINDERS
0403 04                         DB      04D             ; HEADS
0404 0000                       DW      0
0406 0080                       DW      0128D           ; WRITE PRE-COMPENSATION CYLINDER
0408 00                         DB      0
0409 00                         DB      0               ; CONTROL BYTE
040A 00 00 00                   DB      0,0,0
040D 0131                       DW      0305D           ; LANDING ZONE
040F 11                         DB      17D             ; SECTORS/TRACK
0410 00                         DB      0

                        ;----- DRIVE TYPE 02

0411 0267                       DW      0615D           ; CYLINDERS
0413 04                         DB      04D             ; HEADS
0414 0000                       DW      0
0416 012C                       DW      0300D           ; WRITE PRE-COMPENSATION CYLINDER
0418 00                         DB      0
0419 00                         DB      0               ; CONTROL BYTE
041A 00 00 00                   DB      0,0,0
041D 0267                       DW      0615D           ; LANDING ZONE
041F 11                         DB      17D             ; SECTORS/TRACK
0420 00                         DB      0

                        ;----- DRIVE TYPE 03

0421 0267                       DW      0615D           ; CYLINDERS
0423 06                         DB      06D             ; HEADS
0424 0000                       DW      0
0426 012C                       DW      0300D           ; WRITE PRE-COMPENSATION CYLINDER
0428 00                         DB      0
0429 00                         DB      0               ; CONTROL BYTE
042A 00 00 00                   DB      0,0,0
042D 0267                       DW      0615D           ; LANDING ZONE
042F 11                         DB      17D             ; SECTORS/TRACK
0430 00                         DB      0

                        ;----- DRIVE TYPE 04

0431 03AC                       DW      0940D           ; CYLINDERS
0433 08                         DB      08D             ; HEADS
0434 0000                       DW      0
0436 0200                       DW      0512D           ; WRITE PRE-COMPENSATION CYLINDER
0438 00                         DB      0
0439 00                         DB      0               ; CONTROL BYTE
043A 00 00 00                   DB      0,0,0
043D 03AC                       DW      0940D           ; LANDING ZONE
043F 11                         DB      17D             ; SECTORS/TRACK
0440 00                         DB      0

                        ;----- DRIVE TYPE 05

0441 03AC                       DW      0940D           ; CYLINDERS
0443 06                         DB      06D             ; HEADS
0444 0000                       DW      0
0446 0200                       DW      0512D           ; WRITE PRE-COMPENSATION CYLINDER
0448 00                         DB      0
0449 00                         DB      0               ; CONTROL BYTE
044A 00 00 00                   DB      0,0,0
044D 03AC                       DW      0940D           ; LANDING ZONE
044F 11                         DB      17D             ; SECTORS/TRACK
0450 00                         DB      0

                        ;----- DRIVE TYPE 06

0451 0267                       DW      0615D           ; CYLINDERS
0453 04                         DB      04D             ; HEADS
0454 0000                       DW      0
0456 FFFF                       DW      0FFFFH          ; NO WRITE PRE-COMPENSATION
0458 00                         DB      0
0459 00                         DB      0               ; CONTROL BYTE
045A 00 00 00                   DB      0,0,0
045D 0267                       DW      0615D           ; LANDING ZONE
045F 11                         DB      17D             ; SECTORS/TRACK
0460 00                         DB      0

                        ;----- DRIVE TYPE 07

0461 01CE                       DW      0462D           ; CYLINDERS
0463 08                         DB      08D             ; HEADS
0464 0000                       DW      0
```

SECTION 5

```
0466 0100                  DW      0256D           ; WRITE PRE-COMPENSATION CYLINDER
0468 00                    DB      0
0469 00                    DB      0               ; CONTROL BYTE
046A 00 00 00              DB      0,0,0
046D 01FF                  DW      0511D           ; LANDING ZONE
046F 11                    DB      17D             ; SECTORS/TRACK
0470 00                    DB      0

                   ;-----  DRIVE TYPE 08

0471 02DD                  DW      0733D           ; CYLINDERS
0473 05                    DB      05D             ; HEADS
0474 0000                  DW      0
0476 FFFF                  DW      0FFFFH          ; NO WRITE PRE-COMPENSATION
0478 00                    DB      0
0479 00                    DB      0               ; CONTROL BYTE
047A 00 00 00              DB      0,0,0
047D 02DD                  DW      0733D           ; LANDING ZONE
047F 11                    DB      17D             ; SECTORS/TRACK
0480 00                    DB      0

                   ;-----  DRIVE TYPE 09

0481 0384                  DW      0900D           ; CYLINDERS
0483 0F                    DB      15D             ; HEADS
0484 0000                  DW      0
0486 FFFF                  DW      0FFFFH          ; NO WRITE PRE-COMPENSATION
0488 00                    DB      0
0489 08                    DB      008H            ; CONTROL BYTE
048A 00 00 00              DB      0,0,0
048D 0385                  DW      0901D           ; LANDING ZONE
048F 11                    DB      17D             ; SECTORS/TRACK
0490 00                    DB      0

                   ;-----  DRIVE TYPE 10

0491 0334                  DW      0820D           ; CYLINDERS
0493 03                    DB      03D             ; HEADS
0494 0000                  DW      0
0496 FFFF                  DW      0FFFFH          ; NO WRITE PRE-COMPENSATION
0498 00                    DB      0
0499 00                    DB      0               ; CONTROL BYTE
049A 00 00 00              DB      0,0,0
049D 0334                  DW      0820D           ; LANDING ZONE
049F 11                    DB      17D             ; SECTORS/TRACK
04A0 00                    DB      0

                   ;-----  DRIVE TYPE 11

04A1 0357                  DW      0855D           ; CYLINDERS
04A3 05                    DB      05D             ; HEADS
04A4 0000                  DW      0
04A6 FFFF                  DW      0FFFFH          ; NO WRITE PRE-COMPENSATION
04A8 00                    DB      0
04A9 00                    DB      0               ; CONTROL BYTE
04AA 00 00 00              DB      0,0,0
04AD 0357                  DW      0855D           ; LANDING ZONE
04AF 11                    DB      17D             ; SECTORS/TRACK
04B0 00                    DB      0

                   ;-----  DRIVE TYPE 12

04B1 0357                  DW      0855D           ; CYLINDERS
04B3 07                    DB      07D             ; HEADS
04B4 0000                  DW      0
04B6 FFFF                  DW      0FFFFH          ; NO WRITE PRE-COMPENSATION
04B8 00                    DB      0
04B9 00                    DB      0               ; CONTROL BYTE
04BA 00 00 00              DB      0,0,0
04BD 0357                  DW      0855D           ; LANDING ZONE
04BF 11                    DB      17D             ; SECTORS/TRACK
04C0 00                    DB      0

                   ;-----  DRIVE TYPE 13

04C1 0132                  DW      0306D           ; CYLINDERS
04C3 08                    DB      08D             ; HEADS
04C4 0000                  DW      0
04C6 0080                  DW      0128D           ; WRITE PRE-COMPENSATION CYLINDER
04C8 00                    DB      0
04C9 00                    DB      0               ; CONTROL BYTE
04CA 00 00 00              DB      0,0,0
04CD 013F                  DW      0319D           ; LANDING ZONE
04CF 11                    DB      17D             ; SECTORS/TRACK
04D0 00                    DB      0

                   ;-----  DRIVE TYPE 14

04D1 02DD                  DW      0733D           ; CYLINDERS
04D3 07                    DB      07D             ; HEADS
04D4 0000                  DW      0
04D6 FFFF                  DW      0FFFFH          ; NO WRITE PRE-COMPENSATION
04D8 00                    DB      0
04D9 00                    DB      0               ; CONTROL BYTE
04DA 00 00 00              DB      0,0,0
04DD 02DD                  DW      0733D           ; LANDING ZONE
04DF 11                    DB      17D             ; SECTORS/TRACK
04E0 00                    DB      0

                   ;-----  DRIVE TYPE 15    RESERVED       ****  DO NOT USE****

04E1 0000                  DW      0000D           ; CYLINDERS
04E3 00                    DB      00D             ; HEADS
04E4 0000                  DW      0
04E6 0000                  DW      0000D           ; WRITE PRE-COMPENSATION CYLINDER
04E8 00                    DB      0
04E9 00                    DB      0               ; CONTROL BYTE
04EA 00 00 00              DB      0,0,0
04ED 0000                  DW      0000D           ; LANDING ZONE
04EF 00                    DB      00D             ; SECTORS/TRACK
04F0 00                    DB      0

                   ;-----  DRIVE TYPE 16

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```
04F1 0264                          DW      0612D             ; CYLINDERS
04F3 04                            DB      04D               ; HEADS
04F4 0000                          DW      0
04F6 0000                          DW      0000D             ; WRITE PRE-COMPENSATION ALL CYLINDER
04F8 00                            DB      0
04F9 00                            DB      0                 ; CONTROL BYTE
04FA 00 00 00                      DB      0,0,0
04FD 0297                          DW      0663D             ; LANDING ZONE
04FF 11                            DB      17D               ; SECTORS/TRACK
0500 00                            DB      0

                           ;-----  DRIVE TYPE 17

0501 03D1                          DW      0977D             ; CYLINDERS
0503 05                            DB      05D               ; HEADS
0504 0000                          DW      0
0506 012C                          DW      0300D             ; WRITE PRE-COMPENSATION CYL
0508 00                            DB      0
0509 00                            DB      0                 ; CONTROL BYTE
050A 00 00 00                      DB      0,0,0
050D 03D1                          DW      0977D             ; LANDING ZONE
050F 11                            DB      17D               ; SECTORS/TRACK
0510 00                            DB      0

                           ;-----  DRIVE TYPE 18

0511 03D1                          DW      0977D             ; CYLINDERS
0513 07                            DB      07D               ; HEADS
0514 0000                          DW      0
0516 FFFF                          DW      0FFFFH            ; NO WRITE PRE-COMPENSATION
0518 00                            DB      0
0519 00                            DB      0                 ; CONTROL BYTE
051A 00 00 00                      DB      0,0,0
051D 03D1                          DW      0977D             ; LANDING ZONE
051F 11                            DB      17D               ; SECTORS/TRACK
0520 00                            DB      0

                           ;-----  DRIVE TYPE 19

0521 0400                          DW      1024D             ; CYLINDERS
0523 07                            DB      07D               ; HEADS
0524 0000                          DW      0
0526 0200                          DW      0512D             ; WRITE PRE-COMPENSATION CYLINDER
0528 00                            DB      0
0529 00                            DB      0                 ; CONTROL BYTE
052A 00 00 00                      DB      0,0,0
052D 03FF                          DW      1023D             ; LANDING ZONE
052F 11                            DB      17D               ; SECTORS/TRACK
0530 00                            DB      0

                           ;-----  DRIVE TYPE 20

0531 02DD                          DW      0733D             ; CYLINDERS
0533 05                            DB      05D               ; HEADS
0534 0000                          DW      0
0536 012C                          DW      0300D             ; WRITE PRE-COMPENSATION CYL
0538 00                            DB      0
0539 00                            DB      0                 ; CONTROL BYTE
053A 00 00 00                      DB      0,0,0
053D 02DC                          DW      0732D             ; LANDING ZONE
053F 11                            DB      17D               ; SECTORS/TRACK
0540 00                            DB      0

                           ;-----  DRIVE TYPE 21

0541 02DD                          DW      0733D             ; CYLINDERS
0543 07                            DB      07D               ; HEADS
0544 0000                          DW      0
0546 012C                          DW      0300D             ; WRITE PRE-COMPENSATION CYL
0548 00                            DB      0
0549 00                            DB      0                 ; CONTROL BYTE
054A 00 00 00                      DB      0,0,0
054D 02DC                          DW      0732D             ; LANDING ZONE
054F 11                            DB      17D               ; SECTORS/TRACK
0550 00                            DB      0

                           ;-----  DRIVE TYPE 22

0551 02DD                          DW      0733D             ; CYLINDERS
0553 05                            DB      05D               ; HEADS
0554 0000                          DW      0
0556 012C                          DW      0300D             ; WRITE PRE-COMPENSATION CYL
0558 00                            DB      0
0559 00                            DB      0                 ; CONTROL BYTE
055A 00 00 00                      DB      0,0,0
055D 02DD                          DW      0733D             ; LANDING ZONE
055F 11                            DB      17D               ; SECTORS/TRACK
0560 00                            DB      0

                           ;-----  DRIVE TYPE 23

0561 0132                          DW      0306D             ; CYLINDERS
0563 04                            DB      04D               ; HEADS
0564 0000                          DW      0
0566 0000                          DW      0000D             ; WRITE PRE-COMPENSATION ALL CYL
0568 00                            DB      0
0569 00                            DB      0                 ; CONTROL BYTE
056A 00 00 00                      DB      0,0,0
056D 0150                          DW      0336D             ; LANDING ZONE
056F 11                            DB      17D               ; SECTORS/TRACK
0570 00                            DB      0

                           ;-----  DRIVE TYPE 24      *** RESERVED***

0571 0000                          DW      0000D             ; CYLINDERS
0573 00                            DB      00D               ; HEADS
0574 0000                          DW      0
0576 0000                          DW      0000D             ; WRITE PRE-COMPENSATION CYL
0578 00                            DB      0
0579 00                            DB      0                 ; CONTROL BYTE
057A 00 00 00                      DB      0,0,0
057D 0000                          DW      0000D             ; LANDING ZONE
057F 00                            DB      00D               ; SECTORS/TRACK
0580 00                            DB      0
```

```
                        ;-----  DRIVE TYPE 25     *** RESERVED***

0581 0000                       DW      0000D                   ; CYLINDERS
0583 00                         DB      00D                     ; HEADS
0584 0000                       DW      0
0586 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0588 00                         DB      0
0589 00                         DB      0                       ; CONTROL BYTE
058A 00 00 00                   DB      0,0,0
058D 0000                       DW      0000D                   ; LANDING ZONE
058F 00                         DB      00D                     ; SECTORS/TRACK
0590 00                         DB      0

                        ;-----  DRIVE TYPE 26     *** RESERVED***

0591 0000                       DW      0000D                   ; CYLINDERS
0593 00                         DB      00D                     ; HEADS
0594 0000                       DW      0
0596 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0598 00                         DB      0
0599 00                         DB      0                       ; CONTROL BYTE
059A 00 00 00                   DB      0,0,0
059D 0000                       DW      0000D                   ; LANDING ZONE
059F 00                         DB      00D                     ; SECTORS/TRACK
05A0 00                         DB      0

                        ;-----  DRIVE TYPE 27     *** RESERVED***

05A1 0000                       DW      0000D                   ; CYLINDERS
05A3 00                         DB      00D                     ; HEADS
05A4 0000                       DW      0
05A6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05A8 00                         DB      0
05A9 00                         DB      0                       ; CONTROL BYTE
05AA 00 00 00                   DB      0,0,0
05AD 0000                       DW      0000D                   ; LANDING ZONE
05AF 00                         DB      00D                     ; SECTORS/TRACK
05B0 00                         DB      0

                        ;-----  DRIVE TYPE 28     *** RESERVED***

05B1 0000                       DW      0000D                   ; CYLINDERS
05B3 00                         DB      00D                     ; HEADS
05B4 0000                       DW      0
05B6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05B8 00                         DB      0
05B9 00                         DB      0                       ; CONTROL BYTE
05BA 00 00 00                   DB      0,0,0
05BD 0000                       DW      0000D                   ; LANDING ZONE
05BF 00                         DB      00D                     ; SECTORS/TRACK
05C0 00                         DB      0

                        ;-----  DRIVE TYPE 29     *** RESERVED***

05C1 0000                       DW      0000D                   ; CYLINDERS
05C3 00                         DB      00D                     ; HEADS
05C4 0000                       DW      0
05C6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05C8 00                         DB      0
05C9 00                         DB      0                       ; CONTROL BYTE
05CA 00 00 00                   DB      0,0,0
05CD 0000                       DW      0000D                   ; LANDING ZONE
05CF 00                         DB      00D                     ; SECTORS/TRACK
05D0 00                         DB      0

                        ;-----  DRIVE TYPE 30     *** RESERVED***

05D1 0000                       DW      0000D                   ; CYLINDERS
05D3 00                         DB      00D                     ; HEADS
05D4 0000                       DW      0
05D6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05D8 00                         DB      0
05D9 00                         DB      0                       ; CONTROL BYTE
05DA 00 00 00                   DB      0,0,0
05DD 0000                       DW      0000D                   ; LANDING ZONE
05DF 00                         DB      00D                     ; SECTORS/TRACK
05E0 00                         DB      0

                        ;-----  DRIVE TYPE 31     *** RESERVED***

05E1 0000                       DW      0000D                   ; CYLINDERS
05E3 00                         DB      00D                     ; HEADS
05E4 0000                       DW      0
05E6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05E8 00                         DB      0
05E9 00                         DB      0                       ; CONTROL BYTE
05EA 00 00 00                   DB      0,0,0
05ED 0000                       DW      0000D                   ; LANDING ZONE
05EF 00                         DB      00D                     ; SECTORS/TRACK
05F0 00                         DB      0

                        ;-----  DRIVE TYPE 32     *** RESERVED***

05F1 0000                       DW      0000D                   ; CYLINDERS
05F3 00                         DB      00D                     ; HEADS
05F4 0000                       DW      0
05F6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05F8 00                         DB      0
05F9 00                         DB      0                       ; CONTROL BYTE
05FA 00 00 00                   DB      0,0,0
05FD 0000                       DW      0000D                   ; LANDING ZONE
05FF 00                         DB      00D                     ; SECTORS/TRACK
0600 00                         DB      0

                        ;-----  DRIVE TYPE 33     *** RESERVED***

0601 0000                       DW      0000D                   ; CYLINDERS
0603 00                         DB      00D                     ; HEADS
0604 0000                       DW      0
0606 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0608 00                         DB      0
0609 00                         DB      0                       ; CONTROL BYTE
060A 00 00 00                   DB      0,0,0
```

```
060D 0000                      DW      0000D                   ; LANDING ZONE
060F 00                        DB      00D                     ; SECTORS/TRACK
0610 00                        DB      0

               ;-----  DRIVE TYPE 34    *** RESERVED***

0611 0000                      DW      0000D                   ; CYLINDERS
0613 00                        DB      00D                     ; HEADS
0614 0000                      DW      0
0616 0000                      DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0618 00                        DB      0
0619 00                        DB      0                       ; CONTROL BYTE
061A 00 00 00                  DB      0,0,0
061D 0000                      DW      0000D                   ; LANDING ZONE
061F 00                        DB      00D                     ; SECTORS/TRACK
0620 00                        DB      0

               ;-----  DRIVE TYPE 35    *** RESERVED***

0621 0000                      DW      0000D                   ; CYLINDERS
0623 00                        DB      00D                     ; HEADS
0624 0000                      DW      0
0626 0000                      DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0628 00                        DB      0
0629 00                        DB      0                       ; CONTROL BYTE
062A 00 00 00                  DB      0,0,0
062D 0000                      DW      0000D                   ; LANDING ZONE
062F 00                        DB      00D                     ; SECTORS/TRACK
0630 00                        DB      0

               ;-----  DRIVE TYPE 36    *** RESERVED***

0631 0000                      DW      0000D                   ; CYLINDERS
0633 00                        DB      00D                     ; HEADS
0634 0000                      DW      0
0636 0000                      DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0638 00                        DB      0
0639 00                        DB      0                       ; CONTROL BYTE
063A 00 00 00                  DB      0,0,0
063D 0000                      DW      0000D                   ; LANDING ZONE
063F 00                        DB      00D                     ; SECTORS/TRACK
0640 00                        DB      0

               ;-----  DRIVE TYPE 37    *** RESERVED***

0641 0000                      DW      0000D                   ; CYLINDERS
0643 00                        DB      00D                     ; HEADS
0644 0000                      DW      0
0646 0000                      DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0648 00                        DB      0
0649 00                        DB      0                       ; CONTROL BYTE
064A 00 00 00                  DB      0,0,0
064D 0000                      DW      0000D                   ; LANDING ZONE
064F 00                        DB      00D                     ; SECTORS/TRACK
0650 00                        DB      0

               ;-----  DRIVE TYPE 38    *** RESERVED***

0651 0000                      DW      0000D                   ; CYLINDERS
0653 00                        DB      00D                     ; HEADS
0654 0000                      DW      0
0656 0000                      DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0658 00                        DB      0
0659 00                        DB      0                       ; CONTROL BYTE
065A 00 00 00                  DB      0,0,0
065D 0000                      DW      0000D                   ; LANDING ZONE
065F 00                        DB      00D                     ; SECTORS/TRACK
0660 00                        DB      0

               ;-----  DRIVE TYPE 39    *** RESERVED***

0661 0000                      DW      0000D                   ; CYLINDERS
0663 00                        DB      00D                     ; HEADS
0664 0000                      DW      0
0666 0000                      DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0668 00                        DB      0
0669 00                        DB      0                       ; CONTROL BYTE
066A 00 00 00                  DB      0,0,0
066D 0000                      DW      0000D                   ; LANDING ZONE
066F 00                        DB      00D                     ; SECTORS/TRACK
0670 00                        DB      0

               ;-----  DRIVE TYPE 40    *** RESERVED***

0671 0000                      DW      0000D                   ; CYLINDERS
0673 00                        DB      00D                     ; HEADS
0674 0000                      DW      0
0676 0000                      DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0678 00                        DB      0
0679 00                        DB      0                       ; CONTROL BYTE
067A 00 00 00                  DB      0,0,0
067D 0000                      DW      0000D                   ; LANDING ZONE
067F 00                        DB      00D                     ; SECTORS/TRACK
0680 00                        DB      0

               ;-----  DRIVE TYPE 41    *** RESERVED***

0681 0000                      DW      0000D                   ; CYLINDERS
0683 00                        DB      00D                     ; HEADS
0684 0000                      DW      0
0686 0000                      DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0688 00                        DB      0
0689 00                        DB      0                       ; CONTROL BYTE
068A 00 00 00                  DB      0,0,0
068D 0000                      DW      0000D                   ; LANDING ZONE
068F 00                        DB      00D                     ; SECTORS/TRACK
0690 00                        DB      0

               ;-----  DRIVE TYPE 42    *** RESERVED***

0691 0000                      DW      0000D                   ; CYLINDERS
0693 00                        DB      00D                     ; HEADS
0694 0000                      DW      0
0696 0000                      DW      0000D                   ; WRITE PRE-COMPENSATION CYL
```

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```
     0698 00                   DB      0
     0699 00                   DB      0                  ; CONTROL BYTE
     069A 00 00 00             DB      0,0,0
     069D 0000                 DW      0000D              ; LANDING ZONE
     069F 00                   DB      00D                ; SECTORS/TRACK
     06A0 00                   DB      0

                    ;-----  DRIVE TYPE 43    *** RESERVED***

     06A1 0000                 DW      0000D              ; CYLINDERS
     06A3 00                   DB      00D                ; HEADS
     06A4 0000                 DW      0
     06A6 0000                 DW      0000D              ; WRITE PRE-COMPENSATION CYL
     06A8 00                   DB      0
     06A9 00                   DB      0                  ; CONTROL BYTE
     06AA 00 00 00             DB      0,0,0
     06AD 0000                 DW      0000D              ; LANDING ZONE
     06AF 00                   DB      00D                ; SECTORS/TRACK
     06B0 00                   DB      0

                    ;-----  DRIVE TYPE 44    *** RESERVED***

     06B1 0000                 DW      0000D              ; CYLINDERS
     06B3 00                   DB      00D                ; HEADS
     06B4 0000                 DW      0
     06B6 0000                 DW      0000D              ; WRITE PRE-COMPENSATION CYL
     06B8 00                   DB      0
     06B9 00                   DB      0                  ; CONTROL BYTE
     06BA 00 00 00             DB      0,0,0
     06BD 0000                 DW      0000D              ; LANDING ZONE
     06BF 00                   DB      00D                ; SECTORS/TRACK
     06C0 00                   DB      0

                    ;-----  DRIVE TYPE 45    *** RESERVED***

     06C1 0000                 DW      0000D              ; CYLINDERS
     06C3 00                   DB      00D                ; HEADS
     06C4 0000                 DW      0
     06C6 0000                 DW      0000D              ; WRITE PRE-COMPENSATION CYL
     06C8 00                   DB      0
     06C9 00                   DB      0                  ; CONTROL BYTE
     06CA 00 00 00             DB      0,0,0
     06CD 0000                 DW      0000D              ; LANDING ZONE
     06CF 00                   DB      00D                ; SECTORS/TRACK
     06D0 00                   DB      0

                    ;-----  DRIVE TYPE 46    *** RESERVED***

     06D1 0000                 DW      0000D              ; CYLINDERS
     06D3 00                   DB      00D                ; HEADS
     06D4 0000                 DW      0
     06D6 0000                 DW      0000D              ; WRITE PRE-COMPENSATION CYL
     06D8 00                   DB      0
     06D9 00                   DB      0                  ; CONTROL BYTE
     06DA 00 00 00             DB      0,0,0
     06DD 0000                 DW      0000D              ; LANDING ZONE
     06DF 00                   DB      00D                ; SECTORS/TRACK
     06E0 00                   DB      0

                    ;-----  DRIVE TYPE 47    *** RESERVED***

     06E1 0000                 DW      0000D              ; CYLINDERS
     06E3 00                   DB      00D                ; HEADS
     06E4 0000                 DW      0
     06E6 0000                 DW      0000D              ; WRITE PRE-COMPENSATION CYL
     06E8 00                   DB      0
     06E9 00                   DB      0                  ; CONTROL BYTE
     06EA 00 00 00             DB      0,0,0
     06ED 0000                 DW      0000D              ; LANDING ZONE
     06EF 00                   DB      00D                ; SECTORS/TRACK
     06F0 00                   DB      0


                    ;-----  BOOT LOADER INTERRUPT

     = 06F1         IP         =       $
                    ;;-        ORG     0E6F2H
     06F2                      ORG     006F2H
     = 06F2         BOOT_STRAP EQU     $
     06F2 E9 0000 E            JMP     BOOT_STRAP_1       ; VECTOR ON TO MOVED BOOT CODE

                                                          ;       USE INT 15 H  AH= 0C0H
     06F5           CONF_TBL:                             ; CONFIGURATION TABLE FOR THIS SYSTEM
     06F5 0008                 DW      CONF_E-CONF_TBL-2  ; LENGTH OF FOLLOWING TABLE
     06F7 FC                   DB      MODEL_BYTE         ; SYSTEM MODEL BYTE
     06F8 00                   DB      SUB_MODEL_BYTE     ; SYSTEM SUB MODEL TYPE BYTE
     06F9 01                   DB      BIOS_LEVEL         ; BIOS REVISION LEVEL
     06FA 70                   DB      01110000B          ; 10000000 = DMA CHANNEL 3 USE BY BIOS
                                                          ; 01000000 = CASCADED INTERRUPT LEVEL 2
                                                          ; 00100000 = REAL TIME CLOCK AVAILABLE
                                                          ; 00010000 = KEYBOARD SCAN CODE HOOK 1AH
     06FB 00                   DB      0                  ; RESERVED
     06FC 00                   DB      0                  ; RESERVED
     06FD 00                   DB      0                  ; RESERVED
     06FE 00                   DB      0                  ; RESERVED
     = 06FF         CONF_E     EQU     $                  ; RESERVED FOR EXPANSION

                    ;-----  BAUD RATE INITIALIZATION TABLE

     = 06FF         IP         =       $
                    ;;-        ORG     0E729H
     0729                      ORG     00729H
     0729 0417      A1         DW      1047               ; 110 BAUD      ; TABLE OF VALUES
     072B 0300                 DW      768                ; 150           ; FOR INITIALIZATION
     072D 0180                 DW      384                ; 300
     072F 00C0                 DW      192                ; 600
     0731 0060                 DW      96                 ; 1200
     0733 0030                 DW      48                 ; 2400
     0735 0018                 DW      24                 ; 4800
     0737 000C                 DW      12                 ; 9600

                    ;-----  RS232

                    ;;-        ORG     0E739H
```

```
0739                       ORG     00739H
= 0739             RS232_IO        EQU     $
0739 E9 0000 E             JMP     RS232_IO_1          ; VECTOR ON TO MOVED RS232 CODE

                   ;-----  KEYBOARD

                   ;;-     ORG     0E82EH
082E                       ORG     0082EH
= 082E             KEYBOARD_IO     EQU     $
082E E9 0000 E             JMP     KEYBOARD_IO_1       ; VECTOR ON TO MOVED KEYBOARD CODE

                   ;-----  TABLE OF SHIFT KEYS AND MASK VALUES (EARLY PC)

                   ;;-     ORG     0E87EH
087E                       ORG     0087EH
087E 52            K6      DB      INS_KEY             ; INSERT KEY
087F 3A 45 46 38 1D        DB      CAPS_KEY,NUM_KEY,SCROLL_KEY,ALT_KEY,CTL_KEY
0884 2A 36                 DB      LEFT_KEY,RIGHT_KEY
= 0008             K6L     EQU     $-K6

                   ;-----  SHIFT_MASK_TABLE

0886 80            K7      DB      INS_SHIFT           ; INSERT MODE SHIFT
0887 40 20 10 08 04        DB      CAPS_SHIFT,NUM_SHIFT,SCROLL_SHIFT,ALT_SHIFT,CTL_SHIFT
088C 02 01                 DB      LEFT_SHIFT,RIGHT_SHIFT

                   ;-----  SCAN CODE TABLES

088E 1B FF 00 FF FF FF  K8   DB   27,-1,0,-1,-1,-1,30,-1,-1,-1,-1,31
     1E FF FF FF FF 1F
089A FF 7F FF 11 17 05       DB   -1,127,-1,17,23,5,18,20,25,21,9,15
     12 14 19 15 09 0F
08A6 10 1B 1D 0A FF 01       DB   16,27,29,10,-1,1,19,4,6,7,8,10
     13 04 06 07 08 0A
08B2 0B 0C FF FF FF FF       DB   11,12,-1,-1,-1,-1,28,26,24,3,22,2
     1C 1A 18 03 16 02
08BE 0E 0D FF FF FF FF       DB   14,13,-1,-1,-1,-1,-1,-1,' ',-1
     FF FF 20 FF
                        ;-----  CTL TABLE SCAN

08C8 5E 5F 60 61 62 63  K9   DB   94,95,96,97,98,99,100,101,102,103,-1,-1
     64 65 66 67 FF FF
08D4 77 FF 84 FF 73 FF       DB   119,-1,132,-1,115,-1,116,-1,117,-1,118,-1
     74 FF 75 FF 76 FF
08E0 FF                      DB   -1

                        ;-----  LC TABLE

08E1 1B 31 32 33 34 35  K10  DB   01BH,'1234567890-=',08H,09H
     36 37 38 39 30 2D
     3D 08 09
08F0 71 77 65 72 74 79       DB   'qwertyuiop[]',0DH,-1,'asdfghjkl;',027H
     75 69 6F 70 5B 5D
     0D FF 61 73 64 66
     67 68 6A 6B 6C 3B
     27
0909 60 FF 5C 7A 78 63       DB   60H,-1,5CH,'zxcvbnm,./',-1,'*',-1,' '
     76 62 6E 6D 2C 2E
     2F FF 2A FF 20
091A FF                      DB   -1

                        ;-----  UC TABLE

091B 1B 21 40 23 24 25  K11  DB   27,'!@#$',37,05EH,'&*()_+',08H,0
     5E 26 2A 28 29 5F
     2B 08 00
092A 51 57 45 52 54 59       DB   'QWERTYUIOP{}',0DH,-1,'ASDFGHJKL:"'
     55 49 4F 50 7B 7D
     0D FF 41 53 44 46
     47 48 4A 4B 4C 3A
     22
0943 7E FF 7C 5A 58 43       DB   07EH,-1,'|ZXCVBNM<>?',-1,0,-1,' ',-1
     56 42 4E 4D 3C 3E
     3F FF 00 FF 20 FF
                        ;-----  UC TABLE SCAN

0955 54 55 56 57 58 59  K12  DB   84,85,86,87,88,89
095B 5A 5B 5C 5D             DB   90,91,92,93
                        ;-----  ALT TABLE SCAN

095F 68 69 6A 6B 6C     K13  DB   104,105,106,107,108
0964 6D 6E 6F 70 71          DB   109,110,111,112,113

                        ;-----  NUM STATE TABLE

0969 37 38 39 2D 34 35  K14  DB   '789-456+1230.'
     36 2B 31 32 33 30
     2E
                        ;-----  BASE CASE TABLE

0976 47 48 49 FF 4B FF  K15  DB   71,72,73,-1,75,-1
097C 4D FF 4F 50 51 52       DB   77,-1,79,80,81,82,83
     53

                        ;-----  KEYBOARD INTERRUPT

                        ;;-  ORG    0E987H
0987                         ORG    00987H
= 0987                  KB_INT  EQU  $
0987 E9 0000 E               JMP    KB_INT_1           ; VECTOR ON TO MOVED KEYBOARD HANDLER
```

SECTION 5

```
                                PAGE
                                ;----- DISKETTE I/O

                                ;;-     ORG     0EC59H
0C59                                    ORG     00C59H
= 0C59                          DISKETTE_IO     EQU     $
0C59 E9 0000 E                          JMP     DISKETTE_IO_1           ; VECTOR ON TO MOVED DISKETTE CODE

                                ;----- DISKETTE INTERRUPT

                                ;;-     ORG     0EF57H
0F57                                    ORG     00F57H
= 0F57                          DISK_INT        EQU     $
0F57 E9 0000 E                          JMP     DISK_INT_1              ; VECTOR ON TO MOVED DISKETTE HANDLER

                                ;----- DISKETTE PARAMETERS

                                ;;-     ORG     0EFC7H
0FC7                                    ORG     00FC7H

                                ;------------------------------------------------------------------
                                ; DISK_BASE                                                        :
                                ;       THIS IS THE SET OF PARAMETERS REQUIRED FOR                 :
                                ;       DISKETTE OPERATION.  THEY ARE POINTED AT BY THE            :
                                ;       DATA VARIABLE @DISK_POINTER.  TO MODIFY THE PARAMETERS,    :
                                ;       BUILD ANOTHER PARAMETER BLOCK AND POINT AT IT              :
                                ;------------------------------------------------------------------

0FC7                            DISK_BASE       LABEL   BYTE

0FC7 DF                                 DB      11011111B       ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
0FC8 02                                 DB      2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0FC9 25                                 DB      MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0FCA 02                                 DB      2               ; 512 BYTES/SECTOR
0FCB 0F                                 DB      15              ; EOT ( LAST SECTOR ON TRACK)
0FCC 1B                                 DB      01BH            ; GAP LENGTH
0FCD FF                                 DB      0FFH            ; DTL
0FCE 54                                 DB      054H            ; GAP LENGTH FOR FORMAT
0FCF F6                                 DB      0F6H            ; FILL BYTE FOR FORMAT
0FD0 0F                                 DB      15              ; HEAD SETTLE TIME (MILLISECONDS)
0FD1 08                                 DB      8               ; MOTOR START TIME (1/8 SECONDS)

                                ;----- PRINTER I/O

                                ;;-     ORG     0EFD2H
0FD2                                    ORG     00FD2H
= 0FD2                          PRINTER_IO      EQU     $
0FD2 E9 0000 E                          JMP     PRINTER_IO_1            ; VECTOR ON TO MOVED PRINTER CODE

                                ;----- FOR POSSIBLE COMPATIBILITY ENTRY POINTS

                                ;;-     ORG     0F045H
1045                                    ORG     01045H
                                        ASSUME  CS:CODE,DS:DATA

                                        EXTRN   SET_MODE:NEAR
                                        EXTRN   SET_CTYPE:NEAR
                                        EXTRN   SET_CPOS:NEAR
                                        EXTRN   READ_CURSOR:NEAR
                                        EXTRN   READ_LPEN:NEAR
                                        EXTRN   ACT_DISP_PAGE:NEAR
                                        EXTRN   SCROLL_UP:NEAR
                                        EXTRN   SCROLL_DOWN:NEAR
                                        EXTRN   READ_AC_CURRENT:NEAR
                                        EXTRN   WRITE_AC_CURRENT:NEAR
                                        EXTRN   WRITE_C_CURRENT:NEAR
                                        EXTRN   SET_COLOR:NEAR
                                        EXTRN   WRITE_DOT:NEAR
                                        EXTRN   READ_DOT:NEAR
                                        EXTRN   WRITE_TTY:NEAR
                                        EXTRN   VIDEO_STATE:NEAR

1045 0000 E                     M1      DW      OFFSET  SET_MODE        ;  TABLE OF ROUTINES WITHIN VIDEO I/O
1047 0000 E                             DW      OFFSET  SET_CTYPE       ;       EXIT STACK VALUES MAY BE
1049 0000 E                             DW      OFFSET  SET_CPOS        ;       DIFFERENT DEPENDING ON THE
104B 0000 E                             DW      OFFSET  READ_CURSOR     ;       SYSTEM AND MODEL
104D 0000 E                             DW      OFFSET  READ_LPEN
104F 0000 E                             DW      OFFSET  ACT_DISP_PAGE
1051 0000 E                             DW      OFFSET  SCROLL_UP
1053 0000 E                             DW      OFFSET  SCROLL_DOWN
1055 0000 E                             DW      OFFSET  READ_AC_CURRENT
1057 0000 E                             DW      OFFSET  WRITE_AC_CURRENT
1059 0000 E                             DW      OFFSET  WRITE_C_CURRENT
105B 0000 E                             DW      OFFSET  SET_COLOR
105D 0000 E                             DW      OFFSET  WRITE_DOT
105F 0000 E                             DW      OFFSET  READ_DOT
1061 0000 E                             DW      OFFSET  WRITE_TTY
1063 0000 E                             DW      OFFSET  VIDEO_STATE
= 0020                          M1L     EQU     $-M1

                                ;;-     ORG     0F065H
1065                                    ORG     01065H
= 1065                          VIDEO_IO        EQU     $
1065 E9 0000 E                          JMP     VIDEO_IO_1              ; VECTOR ON TO MOVED VIDEO CODE

                                ;----- VIDEO PARAMETERS --- INIT_TABLE

                                ;;-     ORG     0F0A4H
10A4                                    ORG     010A4H

10A4                            VIDEO_PARMS     LABEL   BYTE
10A4 38 28 2D 0A 1F 06                  DB      38H,28H,2DH,0AH,1FH,6,19H       ; SET UP FOR 40X25
     19
10AB 1C 02 07 06 07                     DB      1CH,2,7,6,7
10B0 00 00 00 00                        DB      0,0,0,0
= 0010                          M4      EQU     $-VIDEO_PARMS

10B4 71 50 5A 0A 1F 06                  DB      71H,50H,5AH,0AH,1FH,6,19H       ; SET UP FOR 80X25
     19
10BB 1C 02 07 06 07                     DB      1CH,2,7,6,7
10C0 00 00 00 00                        DB      0,0,0,0

10C4 38 28 2D 0A 7F 06                  DB      38H,28H,2DH,0AH,7FH,6,64H       ; SET UP FOR GRAPHICS
     64
```

```
10CB 70 02 01 06 07             DB      70H,2,1,6,7
10D0 00 00 00 00                DB      0,0,0,0

10D4 61 50 52 0F 19 06          DB      61H,50H,52H,0FH,19H,6,19H       ; SET UP FOR 80X25 B&W CARD
     19
10DB 19 02 0D 0B 0C             DB      19H,2,0DH,0BH,0CH
10E0 00 00 00 00                DB      0,0,0,0
                                                                        ; TABLE OF REGEN LENGTHS
10E4 0800                  M5   DW      2048                            ; 40X25
10E6 1000                       DW      4096                            ; 80X25
10E8 4000                       DW      16384                           ; GRAPHICS
10EA 4000                       DW      16384

                           ;-----  COLUMNS

10EC 28 28 50 50 28 28     M6   DB      40,40,80,80,40,40,80,80
     50 50
                           ;-----  C_REG_TAB

10F4 2C 28 2D 29 2A 2E     M7   DB      2CH,28H,2DH,29H,2AH,2EH,1EH,29H ; TABLE OF MODE SETS
     1E 29
                           ;-----  MEMORY SIZE

                           ;;-     ORG     0F841H
1841                               ORG     01841H
= 1841                     MEMORY_SIZE_DET EQU  $
1841 E9 0000 E                     JMP     MEMORY_SIZE_DET_1            ; VECTOR ON TO MOVED BIOS CODE

                           ;-----  EQUIPMENT DETERMINE

                           ;;-     ORG     0F84DH
184D                               ORG     0184DH
= 184D                     EQUIPMENT       EQU     $
184D E9 0000 E                     JMP     EQUIPMENT_1                  ; VECTOR ON TO MOVED BIOS CODE

                           ;-----  CASSETTE (NO BIOS SUPPORT)

                           ;;-     ORG     0F859H
1859                               ORG     01859H
= 1859                     CASSETTE_IO     EQU     $
1859 E9 0000 E                     JMP     CASSETTE_IO_1                ; VECTOR ON TO MOVED BIOS CODE

                           ;-------------------------------------------------------------------
                           ; CHARACTER GENERATOR GRAPHICS FOR 320X200 AND 640X200 GRAPHICS    :
                           ;-------------------------------------------------------------------
                           ;;-     ORG     0FA6EH
1A6E                               ORG     01A6EH
1A6E                       CRT_CHAR_GEN    LABEL   BYTE
1A6E 00 00 00 00 00 00          DB      000H,000H,000H,000H,000H,000H,000H,000H ; D_00    BLANK
     00 00
1A76 7E 81 A5 81 BD 99          DB      07EH,081H,0A5H,081H,0BDH,099H,081H,07EH ; D_01    SMILING FACE
     81 7E
1A7E 7E FF DB FF C3 E7          DB      07EH,0FFH,0DBH,0FFH,0C3H,0E7H,0FFH,07EH ; D_02    SMILING FACE N
     FF 7E
1A86 6C FE FE FE 7C 38          DB      06CH,0FEH,0FEH,0FEH,07CH,038H,010H,000H ; D_03    HEART
     10 00
1A8E 10 38 7C FE 7C 38          DB      010H,038H,07CH,0FEH,07CH,038H,010H,000H ; D_04    DIAMOND
     10 00
1A96 38 7C 38 FE FE 7C          DB      038H,07CH,038H,0FEH,0FEH,07CH,038H,07CH ; D_05    CLUB
     38 7C
1A9E 10 10 38 7C FE 7C          DB      010H,010H,038H,07CH,0FEH,07CH,038H,07CH ; D_06    SPADE
     38 7C
1AA6 00 00 18 3C 3C 18          DB      000H,000H,018H,03CH,03CH,018H,000H,000H ; D_07    BULLET
     00 00
1AAE FF FF E7 C3 C3 E7          DB      0FFH,0FFH,0E7H,0C3H,0C3H,0E7H,0FFH,0FFH ; D_08    BULLET NEG
     FF FF
1AB6 00 3C 66 42 42 66          DB      000H,03CH,066H,042H,042H,066H,03CH,000H ; D_09    CIRCLE
     3C 00
1ABE FF C3 99 BD BD 99          DB      0FFH,0C3H,099H,0BDH,0BDH,099H,0C3H,0FFH ; D_0A    CIRCLE NEG
     C3 FF
1AC6 0F 07 0F 7D CC CC          DB      00FH,007H,00FH,07DH,0CCH,0CCH,0CCH,078H ; D_0B    MALE
     CC 78
1ACE 3C 66 66 66 3C 18          DB      03CH,066H,066H,066H,03CH,018H,07EH,018H ; D_0C    FEMALE
     7E 18
1AD6 3F 33 3F 30 30 70          DB      03FH,033H,03FH,030H,030H,070H,0F0H,0E0H ; D_0D    EIGHTH NOTE
     F0 E0
1ADE 7F 63 7F 63 63 67          DB      07FH,063H,07FH,063H,063H,067H,0E6H,0C0H ; D_0E    TWO 1/16 NOTE
     E6 C0
1AE6 99 5A 3C E7 E7 3C          DB      099H,05AH,03CH,0E7H,0E7H,03CH,05AH,099H ; D_0F    SUN
     5A 99

1AEE 80 E0 F8 FE F8 E0          DB      080H,0E0H,0F8H,0FEH,0F8H,0E0H,080H,000H ; D_10    R ARROWHEAD
     80 00
1AF6 02 0E 3E FE 3E 0E          DB      002H,00EH,03EH,0FEH,03EH,00EH,002H,000H ; D_11    L ARROWHEAD
     02 00
1AFE 18 3C 7E 18 18 7E          DB      018H,03CH,07EH,018H,018H,07EH,03CH,018H ; D_12    ARROW 2 VERT
     3C 18
1B06 66 66 66 66 66 00          DB      066H,066H,066H,066H,066H,000H,066H,000H ; D_13    2 EXCLAMATIONS
     66 00
1B0E 7F DB DB 7B 1B 1B          DB      07FH,0DBH,0DBH,07BH,01BH,01BH,01BH,000H ; D_14    PARAGRAPH
     1B 00
1B16 3E 63 38 6C 6C 38          DB      03EH,063H,038H,06CH,06CH,038H,0CCH,078H ; D_15    SECTION
     CC 78
1B1E 00 00 00 00 7E 7E          DB      000H,000H,000H,000H,07EH,07EH,07EH,000H ; D_16    RECTANGLE
     7E 00
1B26 18 3C 7E 18 7E 3C          DB      018H,03CH,07EH,018H,07EH,03CH,018H,0FFH ; D_17    ARROW 2 VRT UP
     18 FF
1B2E 18 3C 7E 18 18 18          DB      018H,03CH,07EH,018H,018H,018H,018H,000H ; D_18    ARROW VRT UP
     18 00
1B36 18 18 18 18 7E 3C          DB      018H,018H,018H,018H,07EH,03CH,018H,000H ; D_19    ARROW VRT DOWN
     18 00
1B3E 00 18 0C FE 0C 18          DB      000H,018H,00CH,0FEH,00CH,018H,000H,000H ; D_1A    ARROW RIGHT
     00 00
1B46 00 30 60 FE 60 30          DB      000H,030H,060H,0FEH,060H,030H,000H,000H ; D_1B    ARROW LEFT
     00 00
1B4E 00 00 C0 C0 C0 FE          DB      000H,000H,0C0H,0C0H,0C0H,0FEH,000H,000H ; D_1C    NOT INVERTED
     00 00
1B56 00 24 66 FF 66 24          DB      000H,024H,066H,0FFH,066H,024H,000H,000H ; D_1D    ARROW 2 HORZ
     00 00
1B5E 00 18 3C 7E FF FF          DB      000H,018H,03CH,07EH,0FFH,0FFH,000H,000H ; D_1E    ARROWHEAD UP
     00 00
1B66 00 FF FF 7E 3C 18          DB      000H,0FFH,0FFH,07EH,03CH,018H,000H,000H ; D_1F    ARROWHEAD DOWN
     00 00
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SECTION 5

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1B6E 00 00 00 00 00 00      DB      000H,000H,000H,000H,000H,000H,000H,000H ; D_20    SPACE
     00 00
1B76 30 78 78 30 30 00      DB      030H,078H,078H,030H,030H,000H,030H,000H ; D_21 !  EXCLAMATION
     30 00
1B7E 6C 6C 6C 00 00 00      DB      06CH,06CH,06CH,000H,000H,000H,000H,000H ; D_22 "  QUOTATION
     00 00
1B86 6C 6C FE 6C FE 6C      DB      06CH,06CH,0FEH,06CH,0FEH,06CH,06CH,000H ; D_23 #  LB.
     6C 00
1B8E 30 7C C0 78 0C F8      DB      030H,07CH,0C0H,078H,00CH,0F8H,030H,000H ; D_24 $  DOLLAR SIGN
     30 00
1B96 00 C6 CC 18 30 66      DB      000H,0C6H,0CCH,018H,030H,066H,0C6H,000H ; D_25 %  PERCENT
     C6 00
1B9E 38 6C 38 76 DC CC      DB      038H,06CH,038H,076H,0DCH,0CCH,076H,000H ; D_26 &  AMPERSAND
     76 00
1BA6 60 60 C0 00 00 00      DB      060H,060H,0C0H,000H,000H,000H,000H,000H ; D_27 '  APOSTROPHE
     00 00
1BAE 18 30 60 60 60 30      DB      018H,030H,060H,060H,060H,030H,018H,000H ; D_28 (  L. PARENTHESIS
     18 00
1BB6 60 30 18 18 18 30      DB      060H,030H,018H,018H,018H,030H,060H,000H ; D_29 )  R. PARENTHESIS
     60 00
1BBE 00 66 3C FF 3C 66      DB      000H,066H,03CH,0FFH,03CH,066H,000H,000H ; D_2A *  ASTERISK
     00 00
1BC6 00 30 30 FC 30 30      DB      000H,030H,030H,0FCH,030H,030H,000H,000H ; D_2B +  PLUS
     00 00
1BCE 00 00 00 00 00 30      DB      000H,000H,000H,000H,000H,030H,030H,060H ; D_2C ,  COMMA
     30 60
1BD6 00 00 00 FC 00 00      DB      000H,000H,000H,0FCH,000H,000H,000H,000H ; D_2D -  DASH
     00 00
1BDE 00 00 00 00 00 30      DB      000H,000H,000H,000H,000H,030H,030H,000H ; D_2E .  PERIOD
     30 00
1BE6 06 0C 18 30 60 C0      DB      006H,00CH,018H,030H,060H,0C0H,080H,000H ; D_2F /  SLASH
     80 00

1BEE 7C C6 CE DE F6 E6      DB      07CH,0C6H,0CEH,0DEH,0F6H,0E6H,07CH,000H ; D_30 0
     7C 00
1BF6 30 70 30 30 30 30      DB      030H,070H,030H,030H,030H,030H,0FCH,000H ; D_31 1
     FC 00
1BFE 78 CC 0C 38 60 CC      DB      078H,0CCH,00CH,038H,060H,0CCH,0FCH,000H ; D_32 2
     FC 00
1C06 78 CC 0C 38 0C CC      DB      078H,0CCH,00CH,038H,00CH,0CCH,078H,000H ; D_33 3
     78 00
1C0E 1C 3C 6C CC FE 0C      DB      01CH,03CH,06CH,0CCH,0FEH,00CH,01EH,000H ; D_34 4
     1E 00
1C16 FC C0 F8 0C 0C CC      DB      0FCH,0C0H,0F8H,00CH,00CH,0CCH,078H,000H ; D_35 5
     78 00
1C1E 38 60 C0 F8 CC CC      DB      038H,060H,0C0H,0F8H,0CCH,0CCH,078H,000H ; D_36 6
     78 00
1C26 FC CC 0C 18 30 30      DB      0FCH,0CCH,00CH,018H,030H,030H,030H,000H ; D_37 7
     30 00
1C2E 78 CC CC 78 CC CC      DB      078H,0CCH,0CCH,078H,0CCH,0CCH,078H,000H ; D_38 8
     78 00
1C36 78 CC CC 7C 0C 18      DB      078H,0CCH,0CCH,07CH,00CH,018H,070H,000H ; D_39 9
     70 00
1C3E 00 30 30 00 00 30      DB      000H,030H,030H,000H,000H,030H,030H,000H ; D_3A :  COLON
     30 00
1C46 00 30 30 00 00 30      DB      000H,030H,030H,000H,000H,030H,030H,060H ; D_3B ;  SEMICOLON
     30 60
1C4E 18 30 60 C0 60 30      DB      018H,030H,060H,0C0H,060H,030H,018H,000H ; D_3C <  LESS THAN
     18 00
1C56 00 00 FC 00 00 FC      DB      000H,000H,0FCH,000H,000H,0FCH,000H,000H ; D_3D =  EQUAL
     00 00
1C5E 60 30 18 0C 18 30      DB      060H,030H,018H,00CH,018H,030H,060H,000H ; D_3E >  GREATER THAN
     60 00
1C66 78 CC 0C 18 30 00      DB      078H,0CCH,00CH,018H,030H,000H,030H,000H ; D_3F ?  QUESTION MARK
     30 00

1C6E 7C C6 DE DE DE C0      DB      07CH,0C6H,0DEH,0DEH,0DEH,0C0H,078H,000H ; D_40 @  AT
     78 00
1C76 30 78 CC CC FC CC      DB      030H,078H,0CCH,0CCH,0FCH,0CCH,0CCH,000H ; D_41 A
     CC 00
1C7E FC 66 66 7C 66 66      DB      0FCH,066H,066H,07CH,066H,066H,0FCH,000H ; D_42 B
     FC 00
1C86 3C 66 C0 C0 C0 66      DB      03CH,066H,0C0H,0C0H,0C0H,066H,03CH,000H ; D_43 C
     3C 00
1C8E F8 6C 66 66 66 6C      DB      0F8H,06CH,066H,066H,066H,06CH,0F8H,000H ; D_44 D
     F8 00
1C96 FE 62 68 78 68 62      DB      0FEH,062H,068H,078H,068H,062H,0FEH,000H ; D_45 E
     FE 00
1C9E FE 62 68 78 68 60      DB      0FEH,062H,068H,078H,068H,060H,0F0H,000H ; D_46 F
     F0 00
1CA6 3C 66 C0 C0 CE 66      DB      03CH,066H,0C0H,0C0H,0CEH,066H,03EH,000H ; D_47 G
     3E 00
1CAE CC CC CC FC CC CC      DB      0CCH,0CCH,0CCH,0FCH,0CCH,0CCH,0CCH,000H ; D_48 H
     CC 00
1CB6 78 30 30 30 30 30      DB      078H,030H,030H,030H,030H,030H,078H,000H ; D_49 I
     78 00
1CBE 1E 0C 0C 0C CC CC      DB      01EH,00CH,00CH,00CH,0CCH,0CCH,078H,000H ; D_4A J
     78 00
1CC6 E6 66 6C 78 6C 66      DB      0E6H,066H,06CH,078H,06CH,066H,0E6H,000H ; D_4B K
     E6 00
1CCE F0 60 60 60 62 66      DB      0F0H,060H,060H,060H,062H,066H,0FEH,000H ; D_4C L
     FE 00
1CD6 C6 EE FE FE D6 C6      DB      0C6H,0EEH,0FEH,0FEH,0D6H,0C6H,0C6H,000H ; D_4D M
     C6 00
1CDE C6 E6 F6 DE CE C6      DB      0C6H,0E6H,0F6H,0DEH,0CEH,0C6H,0C6H,000H ; D_4E N
     C6 00
1CE6 38 6C C6 C6 C6 6C      DB      038H,06CH,0C6H,0C6H,0C6H,06CH,038H,000H ; D_4F O
     38 00

1CEE FC 66 66 7C 60 60      DB      0FCH,066H,066H,07CH,060H,060H,0F0H,000H ; D_50 P
     F0 00
1CF6 78 CC CC CC DC 78      DB      078H,0CCH,0CCH,0CCH,0DCH,078H,01CH,000H ; D_51 Q
     1C 00
1CFE FC 66 66 7C 6C 66      DB      0FCH,066H,066H,07CH,06CH,066H,0E6H,000H ; D_52 R
     E6 00
1D06 78 CC E0 70 1C CC      DB      078H,0CCH,0E0H,070H,01CH,0CCH,078H,000H ; D_53 S
     78 00
1D0E FC B4 30 30 30 30      DB      0FCH,0B4H,030H,030H,030H,030H,078H,000H ; D_54 T
     78 00
1D16 CC CC CC CC CC CC      DB      0CCH,0CCH,0CCH,0CCH,0CCH,0CCH,0FCH,000H ; D_55 U
     FC 00
1D1E CC CC CC CC CC 78      DB      0CCH,0CCH,0CCH,0CCH,0CCH,078H,030H,000H ; D_56 V
     30 00
1D26 C6 C6 C6 D6 FE EE      DB      0C6H,0C6H,0C6H,0D6H,0FEH,0EEH,0C6H,000H ; D_57 W
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      C6 00
1D2E C6 C6 6C 38 38 6C          DB      0C6H,0C6H,06CH,038H,038H,06CH,0C6H,000H ; D_58 X
      C6 00
1D36 CC CC CC 78 30 30          DB      0CCH,0CCH,0CCH,078H,030H,030H,078H,000H ; D_59 Y
      78 00
1D3E FE C6 8C 18 32 66          DB      0FEH,0C6H,08CH,018H,032H,066H,0FEH,000H ; D_5A Z
      FE 00
1D46 78 60 60 60 60 60          DB      078H,060H,060H,060H,060H,060H,078H,000H ; D_5B [  LEFT BRACKET
      78 00
1D4E C0 60 30 18 0C 06          DB      0C0H,060H,030H,018H,00CH,006H,002H,000H ; D_5C \  BACKSLASH
      02 00
1D56 78 18 18 18 18 18          DB      078H,018H,018H,018H,018H,018H,078H,000H ; D_5D ]  RIGHT BRACKET
      78 00
1D5E 10 38 6C C6 00 00          DB      010H,038H,06CH,0C6H,000H,000H,000H,000H ; D_5E ^  CIRCUMFLEX
      00 00
1D66 00 00 00 00 00 00          DB      000H,000H,000H,000H,000H,000H,000H,0FFH ; D_5F _  UNDERSCORE
      00 FF

1D6E 30 30 18 00 00 00          DB      030H,030H,018H,000H,000H,000H,000H,000H ; D_60 '  APOSTROPHE REV
      00 00
1D76 00 00 78 0C 7C CC          DB      000H,000H,078H,00CH,07CH,0CCH,076H,000H ; D_61 a
      76 00
1D7E E0 60 60 7C 66 66          DB      0E0H,060H,060H,07CH,066H,066H,0DCH,000H ; D_62 b
      DC 00
1D86 00 00 78 CC C0 CC          DB      000H,000H,078H,0CCH,0C0H,0CCH,078H,000H ; D_63 c
      78 00
1D8E 1C 0C 0C 7C CC CC          DB      01CH,00CH,00CH,07CH,0CCH,0CCH,076H,000H ; D_64 d
      76 00
1D96 00 00 78 CC FC C0          DB      000H,000H,078H,0CCH,0FCH,0C0H,078H,000H ; D_65 e
      78 00
1D9E 38 6C 60 F0 60 60          DB      038H,06CH,060H,0F0H,060H,060H,0F0H,000H ; D_66 f
      F0 00
1DA6 00 00 76 CC CC 7C          DB      000H,000H,076H,0CCH,0CCH,07CH,00CH,0F8H ; D_67 g
      0C F8
1DAE E0 60 6C 76 66 66          DB      0E0H,060H,06CH,076H,066H,066H,0E6H,000H ; D_68 h
      E6 00
1DB6 30 00 70 30 30 30          DB      030H,000H,070H,030H,030H,030H,078H,000H ; D_69 i
      78 00
1DBE 0C 00 0C 0C 0C CC          DB      00CH,000H,00CH,00CH,00CH,0CCH,0CCH,078H ; D_6A j
      CC 78
1DC6 E0 60 66 6C 78 6C          DB      0E0H,060H,066H,06CH,078H,06CH,0E6H,000H ; D_6B k
      E6 00
1DCE 70 30 30 30 30 30          DB      070H,030H,030H,030H,030H,030H,078H,000H ; D_6C l
      78 00
1DD6 00 00 CC FE FE D6          DB      000H,000H,0CCH,0FEH,0FEH,0D6H,0C6H,000H ; D_6D m
      C6 00
1DDE 00 00 F8 CC CC CC          DB      000H,000H,0F8H,0CCH,0CCH,0CCH,0CCH,000H ; D_6E n
      CC 00
1DE6 00 00 78 CC CC CC          DB      000H,000H,078H,0CCH,0CCH,0CCH,078H,000H ; D_6F o
      78 00

1DEE 00 00 DC 66 66 7C          DB      000H,000H,0DCH,066H,066H,07CH,060H,0F0H ; D_70 p
      60 F0
1DF6 00 00 76 CC CC 7C          DB      000H,000H,076H,0CCH,0CCH,07CH,00CH,01EH ; D_71 q
      0C 1E
1DFE 00 00 DC 76 66 60          DB      000H,000H,0DCH,076H,066H,060H,0F0H,000H ; D_72 r
      F0 00
1E06 00 00 7C C0 78 0C          DB      000H,000H,07CH,0C0H,078H,00CH,0F8H,000H ; D_73 s
      F8 00
1E0E 10 30 7C 30 30 34          DB      010H,030H,07CH,030H,030H,034H,018H,000H ; D_74 t
      18 00
1E16 00 00 CC CC CC CC          DB      000H,000H,0CCH,0CCH,0CCH,0CCH,076H,000H ; D_75 u
      76 00
1E1E 00 00 CC CC CC 78          DB      000H,000H,0CCH,0CCH,0CCH,078H,030H,000H ; D_76 v
      30 00
1E26 00 00 C6 D6 FE FE          DB      000H,000H,0C6H,0D6H,0FEH,0FEH,06CH,000H ; D_77 w
      6C 00
1E2E 00 00 C6 6C 38 6C          DB      000H,000H,0C6H,06CH,038H,06CH,0C6H,000H ; D_78 x
      C6 00
1E36 00 00 CC CC CC 7C          DB      000H,000H,0CCH,0CCH,0CCH,07CH,00CH,0F8H ; D_79 y
      0C F8
1E3E 00 00 FC 98 30 64          DB      000H,000H,0FCH,098H,030H,064H,0FCH,000H ; D_7A z
      FC 00
1E46 1C 30 30 E0 30 30          DB      01CH,030H,030H,0E0H,030H,030H,01CH,000H ; D_7B {  LEFT BRACE
      1C 00
1E4E 18 18 18 00 18 18          DB      018H,018H,018H,000H,018H,018H,018H,000H ; D_7C |  BROKEN STROKE
      18 00
1E56 E0 30 30 1C 30 30          DB      0E0H,030H,030H,01CH,030H,030H,0E0H,000H ; D_7D }  RIGHT BRACE
      E0 00
1E5E 76 DC 00 00 00 00          DB      076H,0DCH,000H,000H,000H,000H,000H,000H ; D_7E ~  TILDE
      00 00
1E66 00 10 38 6C C6 C6          DB      000H,010H,038H,06CH,0C6H,0C6H,0FEH,000H ; D_7F Δ  DELTA
      FE 00

                                ;-----  TIME OF DAY

                                ;;-     ORG     0FE6EH
1E6E                                    ORG     01E6EH
= 1E6E                          TIME_OF_DAY     EQU     $
1E6E E9 0000 E                          JMP     TIME_OF_DAY_1           ; VECTOR ON TO MOVED BIOS CODE

                                ;-----  TIMER INTERRUPT

                                ;;-     ORG     0FEA5H
1EA5                                    ORG     01EA5H
= 1EA5                          TIMER_INT       EQU     $
1EA5 E9 0000 E                          JMP     TIMER_INT_1             ; VECTOR ON TO MOVED BIOS CODE
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SECTION 5

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                                PAGE
                                ;-----  VECTOR TABLE
                                ;;-     ORG     0FEF3H
1EF3                                    ORG     01EF3H                  ;       AT LOCATION 0FEF3H
1EF3                            VECTOR_TABLE    LABEL   WORD            ; VECTOR TABLE VALUES FOR POST TESTS
1EF3 1EA5 R                             DW      OFFSET TIMER_INT        ; INT 08H - HARDWARE TIMER 0      IRQ  0
1EF5 0987 R                             DW      OFFSET KB_INT           ; INT 09H - KEYBOARD              IRQ  1
1EF7 0000 E                             DW      OFFSET  D11             ; INT 0AH - SLAVE INTERRUPT INPUT
1EF9 0000 E                             DW      OFFSET  D11             ; INT 0BH -                       IRQ  3
1EFB 0000 E                             DW      OFFSET  D11             ; INT 0CH -                       IRQ  4
1EFD 0000 E                             DW      OFFSET  D11             ; INT 0DH -                       IRQ  5
1EFF 0F57 R                             DW      OFFSET DISK_INT         ; INT 0EH - DISKETTE              IRQ  6
1F01 0000 E                             DW      OFFSET  D11             ; INT 0FH -                       IRQ  7
                                ;-----  SOFTWARE INTERRUPTS  ( BIOS CALLS AND POINTERS )
1F03 1065 R                             DW      OFFSET VIDEO_IO         ; INT 10H -- VIDEO DISPLAY
1F05 184D R                             DW      OFFSET EQUIPMENT        ; INT 11H -- GET EQUIPMENT FLAG WORD
1F07 1841 R                             DW      OFFSET MEMORY_SIZE_DET  ; INT 12H -- GET REAL MODE MEMORY SIZE
1F09 0C59 R                             DW      OFFSET DISKETTE_IO      ; INT 13H -- DISKETTE
1F0B 0739 R                             DW      OFFSET RS232_IO         ; INT 14H -- COMMUNICATION ADAPTER
1F0D 1859 R                             DW      OFFSET CASSETTE_IO      ; INT 15H -- EXPANDED BIOS FUNCTION CALL
1F0F 082E R                             DW      OFFSET KEYBOARD_IO      ; INT 16H -- KEYBOARD INPUT
1F11 0FD2 R                             DW      OFFSET PRINTER_IO       ; INT 17H -- PRINTER OUTPUT
1F13 0000                               DW      00000H                  ; INT 18H -- 0F600H INSERTED FOR BASIC
1F15 06F2 R                             DW      OFFSET BOOT_STRAP       ; INT 19H -- BOOT FROM SYSTEM MEDIA
1F17 1E6E R                             DW      OFFSET TIME_OF_DAY      ; INT 1AH -- TIME OF DAY
1F19 1F53 R                             DW      OFFSET DUMMY_RETURN     ; INT 1BH -- KEYBOARD BREAK ADDRESS
1F1B 1F53 R                             DW      OFFSET DUMMY_RETURN     ; INT 1CH -- TIMER BREAK ADDRESS
1F1D 10A4 R                             DW      OFFSET VIDEO_PARMS      ; INT 1DH -- VIDEO PARAMETERS
1F1F 0FC7 R                             DW      OFFSET DISK_BASE        ; INT 1EH -- DISKETTE PARAMETERS
1F21 0000                               DW      00000H                  ; INT 1FH -- POINTER TO VIDEO EXTENSION
1F23                            SLAVE_VECTOR_TABLE      LABEL WORD      ; ( INTERRUPT 70H THRU 7FH )
1F23 0000 E                             DW      OFFSET RTC_INT          ; INT 70H - REAL TIME CLOCK       IRQ  8
1F25 0000 E                             DW      OFFSET RE_DIRECT        ; INT 71H - REDIRECT TO INT 0AH   IRQ  9
1F27 0000 E                             DW      OFFSET  D11             ; INT 72H -                       IRQ 10
1F29 0000 E                             DW      OFFSET  D11             ; INT 73H -                       IRQ 11
1F2B 0000 E                             DW      OFFSET  D11             ; INT 74H -                       IRQ 12
1F2D 0000 E                             DW      OFFSET INT_287          ; INT 75H -  -MATH COPROCESSOR    IRQ 13
1F2F 0000 E                             DW      OFFSET  D11             ; INT 76H -  -FIXED DISK          IRQ 14
1F31 0000 E                             DW      OFFSET  D11             ; INT 77H -                       IRQ 15
                                ;-----  DUMMY INTERRUPT HANDLER
                                ;;-     ORG     0FF53H
1F53                                    ORG     01F53H
= 1F53                          DUMMY_RETURN    EQU     $               ; BIOS DUMMY (NULL) INTERRUPT RETURN
1F53 CF                                 IRET
                                ;-----  PRINT SCREEN
                                ;;-     ORG     0FF54H
1F54                                    ORG     01F54H
= 1F54                          PRINT_SCREEN    EQU     $
1F54 E9 0000 E                          JMP     PRINT_SCREEN_1          ; VECTOR ON TO MOVED BIOS CODE
                                .LIST                                   ; TUTOR
                                ;----------------------------------------
                                ;                                       :
                                ;       POWER ON RESET VECTOR           :
                                ;                                       :
                                ;----------------------------------------
                                ;;-     ORG     0FFF0H
1FF0                                    ORG     01FF0H
                                ;-----  POWER ON RESET
1FF0                            P_O_R   LABEL   FAR                     ; POWER ON RESTART EXECUTION LOCATION
1FF0 EA                                 DB      0EAH                    ; HARD CODE FAR JUMP TO SET
1FF1 005B R                             DW      OFFSET  RESET           ;  OFFSET
1FF3 F000                               DW      0F000H                  ;   SEGMENT
1FF5 30 36 2F 31 30 2F                  DB      '06/10/85'              ; RELEASE MARKER
     38 35
1FFE                                    ORG     01FFEH
1FFE FC                                 DB      MODEL_BYTE              ; THIS PC'S ID ( MODEL BYTE )
1FFF                            CODE    ENDS                            ; CHECKSUM AT LAST LOCATION
                                        END
```

SECTION 6. INSTRUCTION SET

Contents

Notes:

80286 Instruction Set

Data Transfer

MOV = move

Register to Register/Memory

1000100w	mod reg r/w

Register/Memory to Register

1000101w	mod reg r/w

Immediate to Register/Memory

1100011w	mod 000 r/w	data	data if w = 1

Immediate to Register

1011wreg	data	data if w = 1

Memory to Accumulator

1010000w	addr-low	addr-high

Accumulator to Memory

1010001w	addr-low	addr-high

Register/Memory to Segment Register

10001110	mod0reg r/w reg ≠ 01

Segment Register to Register/Memory

10001100	mod0reg r/w

PUSH = Push

Memory

11111111	mod110 r/w

Register

01010reg

Segment Register

000reg110

Immediate

011010s0	data	data if s = 0

PUSHA = Push All

01100000

POP = Pop

Memory

10001111	mod000 r/m

Register

01011reg

Segment Register

000reg111 reg ≠ 01

POPA = Pop All

01100001

XCHG = Exchange

Register/Memory with Register

1000011w	mod reg r/m

Register with Accumulator

10010reg

IN = Input From

Fixed Port

1110010w	port

Variable Port

1110110w

OUT = Output To

Fixed Port

1110011w	port

Variable Port

1110111w

XLAT = Translate Byte to AL

11010111

LEA = Load EA to Register

10001101	mod reg r/m

LDS = Load Pointer to DS

11000101	mod reg r/m mod ≠ 11

LES = Load Pointer to ES

11000100	mod reg r/m mod ≠ 11

LAHF = Load AH with Flags

10011111

SAHF = Store AH with Flags

10011110

PUSHF = Push Flags

10011100

POPF = Pop Flags

10011101

Arithmetic

ADD = Add

Register/Memory with Register to Either

0000000w	mod reg r/m

Immediate to Register Memory

100000sw	mod000 r/m	data	data if sw = 01

Immediate to Accumulator

0000010w	data	data if w = 1

ADC = Add with Carry

Register/Memory with Register to Either

000100dw	mod reg r/m

Immediate to Register/Memory

100000sw	mod000 r/m	data	data if sw = 01

Immediate to Accumulator

0001010w	data	data if w = 1

INC = Increment

Register/Memory

1111111w	mod000 r/m

Register

01000reg

SUB = Subtract

Register/Memory with Register to Either

001010dw	mod reg r/m

Immediate from Register/Memory

100000sw	mod101 r/m	data	data if sw = 01

Immediate from Accumulator

0010110w	data	data if w = 1

SBB = Subtract with Borrow

Register/Memory with Register to Either

000110dw	mod reg r/m

Immediate to Register/Memory

100000sw	mod011 r/m	data	data if sw = 01

Immediate to Accumulator

0001110w	data	data if w = 1

DEC = Decrement

Register/Memory

1111111w	mod001 r/m

Register

01001reg

CMP = Compare

Register/Memory with Register

0011101w	mod reg r/m

Register with Register/Memory

0011100w	mod reg r/m

Immediate with Register/Memory

100000sw	mod111 r/m	data	data if sw = 01

Immediate with Accumulator

0001110w	data	data if w = 1

NEG = Change Sign

1111011w	mod011 r/m

AAA = ASCII Adjust for Add

00110111

DEC = Decimal Adjust for Add

00100111

AAS = ASCII Adjust for Subtract

00111111

DAS = Decimal Adjust for Subtract

00110111

MUL = Multiply (Unsigned)

1111011w	mod100 r/m

IMUL = Integer Multiply (Signed)

1111011w	mod101 r/m

IIMUL = Integer Immediate Multiply (Signed)

011010s1	mod reg r/m	Data	Data if s = 0

DIV = Divide (Unsigned)

1111011w	mod110 r/m

IDIV = Integer Divide (Signed)

1111011w	mod111 r/m

AAM = ASCII Adjust for Multiply

11010100	00001010

AAD = ASCII Adjust for Divide

11010101	00001010

CBW = Convert Byte to Word

10011000

CWD = Convert Word to Double Word

10011001

Logic

Shift/Rotate Instructions

Register/Memory by 1

1101000w	mod TTT r/m

Register/Memory by CL

1101001w	mod TTT r/m

Register/Memory by Count

1100000w	mod TTT r/m	count

T T T	Instruction
000	ROL
001	ROR
010	RCL
011	RCR
100	SHL/SAL
101	SHR
111	SAR

AND = And

Register/Memory and Register to Either

001000dw	mod reg r/m

Immmediate to Register/Memory

1000000w	mod000 r/m	data	data if w = 1

Immediate to Accumulator

0010010w	data	data if w = 1

TEST = AND Function to Flags; No Result

Register/Memory and Register

1000010w	mod reg r/m

Immediate Data and Register/Memory

1111011w	mod000 r/m	data	data if w = 1

Immediate to Accumulator

0000110w	data	data if w = 1

Or = Or

Register/Memory and Register to Either

0000 0dw	mod reg r/m

Immediate to Register/Memory

1000000w	mod001 r/m	data	data if w = 1

Immediate to Accumulator

0000110w	data	data if w = 1

XOR = Exclusive OR

Register/Memory and Register to Either

001100dw	mod reg r/m

Immediate to Register/Memory

1000000w	mod110 r/m	data	data if w = 1

Immediate to Accumulator

0010010w	data	data if w = 1

NOT = Invert Register/Memory

1111011w	mod010 r/m

String Manipulation

MOVS = Move Byte Word

1010010w

CMPS = Compare Byte Word

1010011w

SCAS = Scan Byte Word

1010111w

LODS = Load Byte Word to AL/AX

1010110w

STOS = Store Byte Word from AL/AX

1010101w

INS = Input Byte from DX Port

0110110w

OUTS = Output Byte Word to DX Port

0110111w

REP/REPNE, REPZ/REPNZ = Repeat String

Repeat Move String

11110011	1010010w

Repeat Compare String (z/Not z)

1111001z	1010011w

Repeat Scan String (z/Not z)

1111001z	1010111w

Repeat Load String

11110011	1010110w

Repeat Store String

11110011	1010101w

Repeat Input String

11110011	0110110w

Repeat Output String

11110011	1010011w

Control Transfer

CALL = Call

Direct Within Segment

11101000	disp-low	disp-high

Register/Memory Indirect Within Segment

11111111	mod010 r/m

Direct Intersegment

10011010	Segment Offset	Segment Selector

Indirect Intersegment

11111111	mod011 r/m (mod ≠ 11)

JMP = Unconditional Jump

Short/Long

11101011	disp-low

Direct within Segment

11101001	disp-low	disp-high

Register/Memory Indirect Within Segment

11111111	mod100 r/m

Direct Intersegment

11101010	Segment Offset	Segment Selector

Indirect Intersegment

11111111	mod101 r/m (mod ≠ 11)

RET = Return from Call

Within Segment

11000011

Within Segment Adding Immediate to SP

11000010	data-low	data-high

Intersegment

11001011

Intersegment Adding Immediate to SP

11001010	data-low	data-high

JE/JZ = Jump on Equal/Zero

01110100	disp

JL/JNGE = Jump on Less/Not Greater, or Equal

01111100	disp

JLE/JNG = Jump on Less, or Equal/Not Greater

01111110	disp

JB/JNAE = Jump on Below/Not Above, or Equal

01110010	disp

JBE/JNA = Jump on Below, or Equal/Not Above

01110110	disp

JP/JPE = Jump on Parity/Parity Even

01111010	disp

JO = Jump on Overflow

01110000	disp

JS = Jump on Sign

01111000	disp

JNE/JNZ = Jump on Not Equal/Not Zero

01110101	disp

JNL/JGE = Jump on Not Less/Greater, or Equal

01111101	disp

JNLE/JG = Jump on Not Less, or Equal/Greater

01111111	disp

JNB/JAE = Jump on Not Below/Above, or Equal

01110011	disp

JNBE/JA = Jump on Not Below, or Equal/Above

01110111	disp

JNP/JPO = Jump on Not Parity/Parity Odd

01111011	disp

JNO = Jump on Not Overflow

01110001	disp

JNS = Jump on Not Sign

01111011	disp

LOOP = Loop CX Times

11100010	disp

LOOPZ/LOOPE = Loop while Zero/Equal

11100001	disp

LOOPNZ/LOOPNE = Loop while Not Zero/Not Equal

11100000	disp

JCXZ = Jump on CX Zero

11100011	disp

ENTER = Enter Procedure

11001000	data-low	data-high

LEAVE = Leave Procedure

11001001

INT = Interrupt

Type Specified

11001101	Type

Type 3

11001100

INTO = Interrupt on Overflow

11001110

IRET = Interrupt Return

11001111

BOUND = Detect Value Out of Range

01100010	mod reg r/m

Processor Control

CLC = Clear Carry

11111000

CMC = Complement Carry

11110101

STC = Set Carry

11111001

CLD = Clear Direction

11111100

STD = Set Direction

11111101

CLI Clear Interrupt

11111010

STI = Set Interrupt

11111011

HLT = Halt

11110100

WAIT = Wait

10011011

LOCK = Bus Lock Prefix

11110000

CTS = Clear Task Switched Flag

00001111	00000110

ESC = Processor Extension Escape

11011TTT	modLLL r/m

Protection Control

LGDT = Load Global Descriptor Table Register

00001111	00000001	mod010 r/m

SGDT = Store Global Descriptor Table Register

00001111	00000001	mod000 r/m

LIDT = Load Interrupt Descriptor Table Register

00001111	00000001	mod011 r/m

SIDT = Store Interrupt Descriptor Table Register

00001111	00000001	mod001 r/m

LLDT = Load Local Descriptor Table Register from Register/Memory

00001111	00000000	mod010 r/m

SLDT = Store Local Descriptor Table Register from Register/Memory

00001111	00000000	mod000 r/m

LTR = Load Task Register from Register/Memory

00001111	00000000	mod011 r/m

STR = Store Task Register to Register/Memory

00001111	00000000	mod001 r/m

LMSW = Load Machine Status Word from Register/Memory

00001111	00000001	mod110 r/m

SMSW = Store Machine Status Word

00001111	00000001	mod100 r/m

LAR = Load Access Rights from Register/Memory

00001111	00000010	mod reg r/m

LSL = Load Segment Limit from Register/Memory

00001111	00000011	mod reg r/m

ARPL = Adjust Requested Privilege Level from Register/Memory

	01100011	mod reg r/m

VERR = Verify Read Access; Register/Memory

00001111	00000000	mod100 r/m

VERR = Verify Write Access

00001111	00000000	mod101 r/m

The effective address (EA) of the memory operand is computed according to the mod and r/m fields:

If mod = 11, then r/m is treated as a reg field.
If mod = 00, then disp = 0, disp-low and disp-high are absent.
If mod = 01, then disp = disp-low sign-extended to 16 bits, disp-high is absent.
If mod = 10, then disp = disp-high:disp-low.

If r/m = 000, then EA = (BX) + (SI) + DISP
If r/m = 001, then EA = (BX) + (SI) + DISP
If r/m = 010, then EA = (BP) + (SI) + DISP
If r/m = 011, then EA = (BP) + (DI) + DISP
If r/m = 100, then EA = (SI) + DISP
If r/m = 101, then EA = (DI) + DISP
If r/m = 110, then EA = (BP) + DISP
If r/m = 111, then EA = (BX) + DISP

DISP follows the second byte of the instruction (before data if required).

Note: An exception to the above statements occurs when mod=00 and r/m=110, in which case EA = disp-high; disp-low.

Segment Override Prefix

```
001reg001
```

The 2-bit and 3-bit reg fields are defined as follows:

2-Bit reg Field

reg	Segment Register	reg	Segment Register
00	ES	10	SS
01	CS	11	DS

3-Bit reg Field

16-bit (w = 1)	8-bit (w = 0)
000 AX	000 AL
001 CX	001 CL
010 DX	010 DL
011 BX	011 BL
100 SP	100 AH
101 BP	101 CH
110 SI	110 DH
111 DI	111 BH

The physical addresses of all operands addressed by the BP register are computed using the SS segment register. The physical addresses of the destination operands of the string primitive operations (those addressed by the DI register) are computed using the ES segment, which may not be overridden.

80287 Coprocessor Instruction Set

The following is an instruction set summary for the 80287 coprocessor. In the following, the bit pattern for escape is 11011.

Data Transfer

FLD = Load

Integer/Real Memory to ST(0)

escape MF 1	mod 000 r/m

Long Integer Memory to ST(0)

escape 111	mod 101 r/m

Temporary Real Memory to ST(0)

escape 011	mod 101 r/m

BCD Memory to ST(0)

escape 111	mod 100 r/m

ST(i) to ST(0)

escape 001	11000ST(i)

FST = Store

ST(0) to Integer/Real Memory

escape MF 1	mod 010 r/m

ST(0) to ST(i)

escape 101	11010 ST(i)

FSTP = Store and Pop

ST(0) to Integer/Real Memory

escape MF 1	mod 011 r/m

ST(0) to Long Integer Memory

escape 111	mod 111 r/m

ST(0) to Temporary Real Memory

escape 011	mod 111 r/m

ST(0) to BCD Memory

escape 111	mod 110 r/m

ST(0) to ST(i)

escape 101	11011 ST(i)

FXCH = Exchange ST(i) and ST(0)

escape 001	11001 ST(i)

Comparison

FCOM = Compare

Integer/Real Memory to ST(0)

escape MF 0	mod 010 r/m

ST(i) to ST(0)

escape 000	11010 ST(i)

FCOMP = Compare and Pop

Integer/Real Memory to ST(0)

escape MF 0	mod 011 r/m

ST(i) to ST(0)

escape 000	11010 ST(i)

FCOMPP = Compare ST(i) to ST(0) and Pop Twice

escape 110	11011001

FTST = Test ST(0)

escape 001	11100100

FXAM = Examine ST(0)

escape 001	11100101

Constants

FLDZ = Load + 0.0 into ST(0)

escape 000	11101110

FLD1 = Load + 1.0 into ST(0)

escape 001	11101000

FLDP1 = Load π into ST(0)

escape 001	11101011

FLDL2T = Load $\log_2 10$ into ST(0)

escape 001	11101001

FLDLG2 = Load $\log_{10} 2$ into ST(0)

escape 001	11101100

FLDLN2 = Load $\log_e 2$ into ST(0)

escape 001	11101101

Arithmetic

FADD = Addition

Integer/Real Memory with ST(0)

escape MF 0	mod 000 r/m

ST(i) and ST(0)

escape dP0	11000 ST(i)

FSUB = Subtraction

Integer/Real Memory with ST(0)

escape MF 0	mod 10R r/m

ST(i) and ST(0)

escape dP0	1110R r/m

FMUL = Multiplication

Integer/Real Memory with ST(0)

escape MF 0	mod 001 r/m

ST(i) and ST(0)

escape dP0	11001 r/m

FDIV = Division

Integer/Real Memory with ST(0)

escape MF 0	mod 11R r/m

ST(i) and ST(0)

escape dP0	1111R r/m

FSQRT = Square Root of ST(0)

escape 001	11111010

FSCALE = Scale ST(0) by ST(1)

escape 001	11111101

FPREM = Partial Remainder of ST(0) ÷ ST(1)

escape 001	11111000

FRNDINT = Round ST(0) to Integer

escape 001	11111100

FXTRACT = Extract Components of ST(0)

escape 001	11110100

FABS = Absolute Value of ST(0)

escape 001	11100001

FCHS = Change Sign of ST(0)

escape 001	11100000

Transcendental

FPTAN = Partial Tangent of ST(0)

escape 001	11110010

FPATAN = Partial Arctangent of ST(0) ÷ ST(1)

escape 001	11110011

F2XM1 = $2^{ST(0)} - 1$

escape 001	11110000

FYL2X = ST(1) x Log_2 [ST(0)]

escape 001	11110001

FYL2XP1 = ST(1) x Log_2 [ST(0) + 1]

escape 001	11111001

FINIT = Initialize NPX

escape 011	11100011

FSETPM = Enter Protected Mode

escape 011	11100100

FSTSWAX = Store Control Word

escape 111	11100000

FLDCW = Load Control Word

escape 001	mod 101 r/m

FSTCW = Store Control Word

escape 001	mod 111 r/m

FSTSW = Store Status Word

escape 101	mod 101 r/m

FCLEX = Clear Exceptions

escape 011	11100010

FSTENV = Store Environment

escape 001	mod 110 r/m

FLDENV = Load Environment

escape 001	mod 100 r/m

FSAVE = Save State

escape 101	mod 110 r/m

FRSTOR = Restore State

escape 101	mod 100 r/m

FINCSTP = Increment Stack Pointer

escape 001	11110111

FDECSTP = Decrement Stack Pointer

escape 001	111100110

FFREE = Free ST(i)

escape 101	11000ST(i)

FNOP = No Operation

escape 101	11010000

MF is assigned as follows:

MF	Memory Format
00	32-bit Real
01	32-bit Integer
10	64-bit Real
11	16-bit Integer

The other abbreviations are as follows:

Term	Definition	Bit = 0	Bit ≠ 0
ST	Stack top	Stack top	(i)= ith register from the top
d	Destination	Dest. is ST(0)	Dest. is ST(i)
P	Pop	No pop	Pop
R	Reverse*	Dest. (op) source	Source (op) dest.
* When d=1, reverse the sense of R.			

Notes:

SECTION 7. CHARACTERS, KEYSTROKES, AND COLORS

Contents

Notes:

Character Codes

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
00	0	Blank (Null)	Ctrl 2		Black	Black	Non-Display
01	1	☺	Ctrl A		Black	Blue	Underline
02	2	☻	Ctrl B		Black	Green	Normal
03	3	♥	Ctrl C		Black	Cyan	Normal
04	4	♦	Ctrl D		Black	Red	Normal
05	5	♣	Ctrl E		Black	Magenta	Normal
06	6	♠	Ctrl F		Black	Brown	Normal
07	7	•	Ctrl G		Black	Light Grey	Normal
08	8	◘	Ctrl H, Backspace, Shift Backspace		Black	Dark Grey	Non-Display
09	9	○	Ctrl I		Black	Light Blue	High Intensity Underline
0A	10	◙	Ctrl J, Ctrl ↵		Black	Light Green	High Intensity
0B	11	♂	Ctrl K		Black	Light Cyan	High Intensity
0C	12	♀	Ctrl L		Black	Light Red	High Intensity
0D	13	♪	Ctrl M, ↵, Shift ↵		Black	Light Magenta	High Intensity
0E	14	♫	Ctrl N		Black	Yellow	High Intensity
0F	15	☼	Ctrl O		Black	White	High Intensity
10	16	►	Ctrl P		Blue	Black	Normal
11	17	◄	Ctrl Q		Blue	Blue	Underline
12	18	↕	Ctrl R		Blue	Green	Normal
13	19	‼	Ctrl S		Blue	Cyan	Normal
14	20	¶	Ctrl T		Blue	Red	Normal
15	21	§	Ctrl U		Blue	Magenta	Normal
16	22	▬	Ctrl V		Blue	Brown	Normal
17	23	↨	Ctrl W		Blue	Light Grey	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
18	24	↑	Ctrl X		Blue	Dark Grey	High Intensity
19	25	↓	Ctrl Y		Blue	Light Blue	High Intensity Underline
1A	26	→	Ctrl Z		Blue	Light Green	High Intensity
1B	27	←	Ctrl [, Esc, Shift Esc, Crtl Esc		Blue	Light Cyan	High Intensity
1C	28	∟	Ctrl \		Blue	Light Red	High Intensity
1D	29	⟷	Ctrl]		Blue	Light Magenta	High Intensity
1E	30	▲	Ctrl 6		Blue	Yellow	High Intensity
1F	31	▼	Ctrl —		Blue	White	High Intensity
20	32	Blank Space	Space Bar, Shift, Space, Ctrl Space, Alt Space		Green	Black	Normal
21	33	!	!	Shift	Green	Blue	Underline
22	34	"	"	Shift	Green	Green	Normal
23	35	#	#	Shift	Green	Cyan	Normal
24	36	$	$	Shift	Green	Red	Normal
25	37	%	%	Shift	Green	Magenta	Normal
26	38	&	&	Shift	Green	Brown	Normal
27	39	'	'		Green	Light Grey	Normal
28	40	(	(	Shift	Green	Dark Grey	High Intensity
29	41	)	)	Shift	Green	Light Blue	High Intensity Underline
2A	42	*	*	Note 1	Green	Light Green	High Intensity
2B	43	+	+	Shift	Green	Light Cyan	High Intensity
2C	44	,	,		Green	Light Red	High Intensity
2D	45	-	-		Green	Light Magenta	High Intensity
2E	46	.	.	Note 2	Green	Yellow	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
2F	47	/	/		Green	White	High Intensity
30	48	0	0	Note 3	Cyan	Black	Normal
31	49	1	1	Note 3	Cyan	Blue	Underline
32	50	2	2	Note 3	Cyan	Green	Normal
33	51	3	3	Note 3	Cyan	Cyan	Normal
34	52	4	4	Note 3	Cyan	Red	Normal
35	53	5	5	Note 3	Cyan	Magenta	Normal
36	54	6	6	Note 3	Cyan	Brown	Normal
37	55	7	7	Note 3	Cyan	Light Grey	Normal
38	56	8	8	Note 3	Cyan	Dark Grey	High Intensity
39	57	9	9	Note 3	Cyan	Light Blue	High Intensity Underline
3A	58	:	:	Shift	Cyan	Light Green	High Intensity
3B	59	;	;		Cyan	Light Cyan	High Intensity
3C	60	<	<	Shift	Cyan	Light Red	High Intensity
3D	61	=	=		Cyan	Light Magenta	High Intensity
3E	62	>	>	Shift	Cyan	Yellow	High Intensity
3F	63	?	?	Shift	Cyan	White	High Intensity
40	64	@	@	Shift	Red	Black	Normal
41	65	A	A	Note 4	Red	Blue	Underline
42	66	B	B	Note 4	Red	Green	Normal
43	67	C	C	Note 4	Red	Cyan	Normal
44	68	D	D	Note 4	Red	Red	Normal
45	69	E	E	Note 4	Red	Magenta	Normal
46	70	F	F	Note 4	Red	Brown	Normal
47	71	G	G	Note 4	Red	Light Grey	Normal
48	72	H	H	Note 4	Red	Dark Grey	High Intensity
49	73	I	I	Note 4	Red	Light Blue	High Intensity Underline
4A	74	J	J	Note 4	Red	Light Green	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
4B	75	K	K	Note 4	Red	Light Cyan	High Intensity
4C	76	L	L	Note 4	Red	Light Red	High Intensity
4D	77	M	M	Note 4	Red	Light Magenta	High Intensity
4E	78	N	N	Note 4	Red	Yellow	High Intensity
4F	79	O	O	Note 4	Red	White	High Intensity
50	80	P	P	Note 4	Magenta	Black	Normal
51	81	Q	Q	Note 4	Magenta	Blue	Underline
52	82	R	R	Note 4	Magenta	Green	Normal
53	83	S	S	Note 4	Magenta	Cyan	Normal
54	84	T	T	Note 4	Magenta	Red	Normal
55	85	U	U	Note 4	Magenta	Magenta	Normal
56	86	V	V	Note 4	Magenta	Brown	Normal
57	87	W	W	Note 4	Magenta	Light Grey	Normal
58	88	X	X	Note 4	Magenta	Dark Grey	High Intensity
59	89	Y	Y	Note 4	Magenta	Light Blue	High Intensity Underline
5A	90	Z	Z	Note 4	Magenta	Light Green	High Intensity
5B	91	[	[		Magenta	Light Cyan	High Intensity
5C	92	\	\		Magenta	Light Red	High Intensity
5D	93	]	]		Magenta	Light Magenta	High Intensity
5E	94	^	^	Shift	Magenta	Yellow	High Intensity
5F	95	—	—	Shift	Magenta	White	High Intensity
60	96	‘	‘		Brown	Black	Normal
61	97	a	a	Note 5	Brown	Blue	Underline
62	98	b	b	Note 5	Brown	Green	Normal
63	99	c	c	Note 5	Brown	Cyan	Normal
64	100	d	d	Note 5	Brown	Red	Normal
65	101	e	e	Note 5	Brown	Magenta	Normal
66	102	f	f	Note 5	Brown	Brown	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
67	103	g	g	Note 5	Brown	Light Grey	Normal
68	104	h	h	Note 5	Brown	Dark Grey	High Intensity
69	105	i	i	Note 5	Brown	Light Blue	High Intensity Underline
6A	106	j	j	Note 5	Brown	Light Green	High Intensity
6B	107	k	k	Note 5	Brown	Light Cyan	High Intensity
6C	108	l	l	Note 5	Brown	Light Red	High Intensity
6D	109	m	m	Note 5	Brown	Light Magenta	High Intensity
6E	110	n	n	Note 5	Brown	Yellow	High Intensity
6F	111	o	o	Note 5	Brown	White	High Intensity
70	112	p	p	Note 5	Light Grey	Black	Reverse Video
71	113	q	q	Note 5	Light Grey	Blue	Underline
72	114	r	r	Note 5	Light Grey	Green	Normal
73	115	s	s	Note 5	Light Grey	Cyan	Normal
74	116	t	t	Note 5	Light Grey	Red	Normal
75	117	u	u	Note 5	Light Grey	Magenta	Normal
76	118	v	v	Note 5	Light Grey	Brown	Normal
77	119	w	w	Note 5	Light Grey	Light Grey	Normal
78	120	x	x	Note 5	Light Grey	Dark Grey	Reverse Video
79	121	y	y	Note 5	Light Grey	Light Blue	High Intensity Underline
7A	122	z	z	Note 5	Light Grey	Light Green	High Intensity
7B	123	{	{	Shift	Light Grey	Light Cyan	High Intensity
7C	124	¦	¦	Shift	Light Grey	Light Red	High Intensity
7D	125	}	}	Shift	Light Grey	Light Magenta	High Intensity
7E	126	~	~	Shift	Light Grey	Yellow	High Intensity
7F	127	△	Ctrl ←		Light Grey	White	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
* * * * 80 to FF Hex are Flashing in both Color & IBM Monochrome * * * *							
80	128	Ç	Alt 128	Note 6	Black	Black	Non-Display
81	129	ü	Alt 129	Note 6	Black	Blue	Underline
82	130	é	Alt 130	Note 6	Black	Green	Normal
83	131	â	Alt 131	Note 6	Black	Cyan	Normal
84	132	ä	Alt 132	Note 6	Black	Red	Normal
85	133	à	Alt 133	Note 6	Black	Magenta	Normal
86	134	å	Alt 134	Note 6	Black	Brown	Normal
87	135	ç	Alt 135	Note 6	Black	Light Grey	Normal
88	136	ê	Alt 136	Note 6	Black	Dark Grey	Non-Display
89	137	ë	Alt 137	Note 6	Black	Light Blue	High Intensity Underline
8A	138	è	Alt 138	Note 6	Black	Light Green	High Intensity
8B	139	ï	Alt 139	Note 6	Black	Light Cyan	High Intensity
8C	140	î	Alt 140	Note 6	Black	Light Red	High Intensity
8D	141	ì	Alt 141	Note 6	Black	Light Magenta	High Intensity
8E	142	Ä	Alt 142	Note 6	Black	Yellow	High Intensity
8F	143	Å	Alt 143	Note 6	Black	White	High Intensity
90	144	É	Alt 144	Note 6	Blue	Black	Normal
91	145	æ	Alt 145	Note 6	Blue	Blue	Underline
92	146	Æ	Alt 146	Note 6	Blue	Green	Normal
93	147	ô	Alt 147	Note 6	Blue	Cyan	Normal
94	148	ö	Alt 148	Note 6	Blue	Red	Normal
95	149	ò	Alt 149	Note 6	Blue	Magenta	Normal
96	150	û	Alt 150	Note 6	Blue	Brown	Normal
97	151	ù	Alt 151	Note 6	Blue	Light Grey	Normal
98	152	ÿ	Alt 152	Note 6	Blue	Dark Grey	High Intensity
99	153	Ö	Alt 153	Note 6	Blue	Light Blue	High Intensity Underline
9A	154	Ü	Alt 154	Note 6	Blue	Light Green	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
9B	155	¢	Alt 155	Note 6	Blue	Light Cyan	High Intensity
9C	156	£	Alt 156	Note 6	Blue	Light Red	High Intensity
9D	157	¥	Alt 157	Note 6	Blue	Light Magenta	High Intensity
9E	158	Pt	Alt 158	Note 6	Blue	Yellow	High Intensity
9F	159	ƒ	Alt 159	Note 6	Blue	White	High Intensity
A0	160	á	Alt 160	Note 6	Green	Black	Normal
A1	161	í	Alt 161	Note 6	Green	Blue	Underline
A2	162	ó	Alt 162	Note 6	Green	Green	Normal
A3	163	ú	Alt 163	Note 6	Green	Cyan	Normal
A4	164	ñ	Alt 164	Note 6	Green	Red	Normal
A5	165	Ñ	Alt 165	Note 6	Green	Magenta	Normal
A6	166	ª	Alt 166	Note 6	Green	Brown	Normal
A7	167	º	Alt 167	Note 6	Green	Light Grey	Normal
A8	168	¿	Alt 168	Note 6	Green	Dark Grey	High Intensity
A9	169	⌐	Alt 169	Note 6	Green	Light Blue	High Intensity Underline
AA	170	¬	Alt 170	Note 6	Green	Light Green	High Intensity
AB	171	½	Alt 171	Note 6	Green	Light Cyan	High Intensity
AC	172	¼	Alt 172	Note 6	Green	Light Red	High Intensity
AD	173	¡	Alt 173	Note 6	Green	Light Magenta	High Intensity
AE	174	<<	Alt 174	Note 6	Green	Yellow	High Intensity
AF	175	>>	Alt 175	Note 6	Green	White	High Intensity
B0	176	░	Alt 176	Note 6	Cyan	Black	Normal
B1	177	▒	Alt 177	Note 6	Cyan	Blue	Underline
B2	178	▓	Alt 178	Note 6	Cyan	Green	Normal
B3	179	│	Alt 179	Note 6	Cyan	Cyan	Normal
B4	180	┤	Alt 180	Note 6	Cyan	Red	Normal
B5	181	╡	Alt 181	Note 6	Cyan	Magenta	Normal
B6	182	╢	Alt 182	Note 6	Cyan	Brown	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
B7	183	╖	Alt 183	Note 6	Cyan	Light Grey	Normal
B8	184	╕	Alt 184	Note 6	Cyan	Dark Grey	High Intensity
B9	185	╣	Alt 185	Note 6	Cyan	Light Blue	High Intensity Underline
BA	186	║	Alt 186	Note 6	Cyan	Light Green	High Intensity
BB	187	╗	Alt 187	Note 6	Cyan	Light Cyan	High Intensity
BC	188	╝	Alt 188	Note 6	Cyan	Light Red	High Intensity
BD	189	╜	Alt 189	Note 6	Cyan	Light Magenta	High Intensity
BE	190	╛	Alt 190	Note 6	Cyan	Yellow	High Intensity
BF	191	┐	Alt 191	Note 6	Cyan	White	High Intensity
C0	192	└	Alt 192	Note 6	Red	Black	Normal
C1	193	┴	Alt 193	Note 6	Red	Blue	Underline
C2	194	┬	Alt 194	Note 6	Red	Green	Normal
C3	195	├	Alt 195	Note 6	Red	Cyan	Normal
C4	196	─	Alt 196	Note 6	Red	Red	Normal
C5	197	┼	Alt 197	Note 6	Red	Magenta	Normal
C6	198	╞	Alt 198	Note 6	Red	Brown	Normal
C7	199	╟	Alt 199	Note 6	Red	Light Grey	Normal
C8	200	╚	Alt 200	Note 6	Red	Dark Grey	High Intensity
C9	201	╔	Alt 201	Note 6	Red	Light Blue	High Intensity Underline
CA	202	╩	Alt 202	Note 6	Red	Light Green	High Intensity
CB	203	╦	Alt 203	Note 6	Red	Light Cyan	High Intensity
CC	204	╠	Alt 204	Note 6	Red	Light Red	High Intensity
CD	205	═	Alt 205	Note 6	Red	Light Magenta	High Intensity
CE	206	╬	Alt 206	Note 6	Red	Yellow	High Intensity
CF	207	╧	Alt 207	Note 6	Red	White	High Intensity
D0	208	╨	Alt 208	Note 6	Magenta	Black	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
D1	209	╤	Alt 209	Note 6	Magenta	Blue	Underline
D2	210	╥	Alt 210	Note 6	Magenta	Green	Normal
D3	211	╙	Alt 211	Note 6	Magenta	Cyan	Normal
D4	212	╘	Alt 212	Note 6	Magenta	Red	Normal
D5	213	╒	Alt 213	Note 6	Magenta	Magenta	Normal
D6	214	╓	Alt 214	Note 6	Magenta	Brown	Normal
D7	215	╫	Alt 215	Note 6	Magenta	Light Grey	Normal
D8	216	╪	Alt 216	Note 6	Magenta	Dark Grey	High Intensity
D9	217	┘	Alt 217	Note 6	Magenta	Light Blue	High Intensity Underline
DA	218	┌	Alt 218	Note 6	Magenta	Light Green	High Intensity
DB	219	█	Alt 219	Note 6	Magenta	Light Cyan	High Intensity
DC	220	▄	Alt 220	Note 6	Magenta	Light Red	High Intensity
DD	221	▌	Alt 221	Note 6	Magenta	Light Magenta	High Intensity
DE	222	▐	Alt 222	Note 6	Magenta	Yellow	High Intensity
DF	223	▀	Alt 223	Note 6	Magenta	White	High Intensity
E0	224	α	Alt 224	Note 6	Brown	Black	Normal
E1	225	β	Alt 225	Note 6	Brown	Blue	Underline
E2	226	Γ	Alt 226	Note 6	Brown	Green	Normal
E3	227	π	Alt 227	Note 6	Brown	Cyan	Normal
E4	228	Σ	Alt 228	Note 6	Brown	Red	Normal
E5	229	σ	Alt 229	Note 6	Brown	Magenta	Normal
E6	230	μ	Alt 230	Note 6	Brown	Brown	Normal
E7	231	τ	Alt 231	Note 6	Brown	Light Grey	Normal
E8	232	Φ	Alt 232	Note 6	Brown	Dark Grey	High Intensity
E9	233	θ	Alt 233	Note 6	Brown	Light Blue	High Intensity Underline
EA	234	Ω	Alt 234	Note 6	Brown	Light Green	High Intensity
EB	235	δ	Alt 235	Note 6	Brown	Light Cyan	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
EC	236	∞	Alt 236	Note 6	Brown	Light Red	High Intensity
ED	237	φ	Alt 237	Note 6	Brown	Light Magenta	High Intensity
EE	238	ϵ	Alt 238	Note 6	Brown	Yellow	High Intensity
EF	239	∩	Alt 239	Note 6	Brown	White	High Intensity
F0	240	≡	Alt 240	Note 6	Light Grey	Black	Reverse Video
F1	241	±	Alt 241	Note 6	Light Grey	Blue	Underline
F2	242	≥	Alt 242	Note 6	Light Grey	Green	Normal
F3	243	≤	Alt 243	Note 6	Light Grey	Cyan	Normal
F4	244	⌠	Alt 244	Note 6	Light Grey	Red	Normal
F5	245	⌡	Alt 245	Note 6	Light Grey	Magenta	Normal
F6	246	÷	Alt 246	Note 6	Light Grey	Brown	Normal
F7	247	≈	Alt 247	Note 6	Light Grey	Light Grey	Normal
F8	248	°	Alt 248	Note 6	Light Grey	Dark Grey	Reverse Video
F9	249	●	Alt 249	Note 6	Light Grey	Light Blue	High Intensity Underline
FA	250	•	Alt 250	Note 6	Light Grey	Light Green	High Intensity
FB	251	√	Alt 251	Note 6	Light Grey	Light Cyan	High Intensity
FC	252	ⁿ	Alt 252	Note 6	Light Grey	Light Red	High Intensity
FD	253	²	Alt 253	Note 6	Light Grey	Light Magenta	High Intensity
FE	254	■	Alt 254	Note 6	Light Grey	Yellow	High Intensity
FF	255	BLANK	Alt 255	Note 6	Light Grey	White	High Intensity

Notes

1. Asterisk (*) can be typed using two methods: press the (*) key or, in the shift mode, press the 8 key.

2. Period (.) can be typed using two methods: press the . key or, in the shift or Num Lock mode, press the Del key.

3. Numeric characters 0-9 can be typed using two methods: press the numeric keys on the top row of the keyboard or, in the shift or Num Lock mode, press the numeric keys in the keypad portion of the keyboard.

4. Uppercase alphabetic characters (A-Z) can be typed in two modes: the shift mode or the Caps Lock mode.

5. Lowercase alphabetic characters (a-z) can be typed in two modes: in the normal mode or in Caps Lock and shift mode combined.

6. The three digits after the Alt key must be typed from the numeric keypad. Character codes 1-255 may be entered in this fashion (with Caps Lock activated, character codes 97-122 will display uppercase).

Quick Reference

DECIMAL VALUE	➡	0	16	32	48	64	80	96	112
⬇	HEXA-DECIMAL VALUE	0	1	2	3	4	5	6	7
0	0	BLANK (NULL)	►	BLANK (SPACE)	0	@	P	‘	p
1	1	☺	◄	!	1	A	Q	a	q
2	2	☻	↕	"	2	B	R	b	r
3	3	♥	‼	#	3	C	S	c	s
4	4	♦	¶	$	4	D	T	d	t
5	5	♣	§	%	5	E	U	e	u
6	6	♠	▬	&	6	F	V	f	v
7	7	•	↨	'	7	G	W	g	w
8	8	◘	↑	(	8	H	X	h	x
9	9	○	↓	)	9	I	Y	i	y
10	A	◙	→	*	:	J	Z	j	z
11	B	♂	←	+	;	K	[	k	{
12	C	♀	∟	,	<	L	\	l	¦
13	D	♪	↔	—	=	M	]	m	}
14	E	♫	▲	.	>	N	^	n	~
15	F	☼	▼	/	?	O	_	o	△

DECIMAL VALUE	➡	128	144	160	176	192	208	224	240
⬇	HEXA-DECIMAL VALUE	8	9	A	B	C	D	E	F
0	0	Ç	É	á	░	└	╨	∝	≡
1	1	ü	æ	í	▒	┴	╤	β	±
2	2	é	Æ	ó	▓	┬	╥	Γ	≥
3	3	â	ô	ú	│	├	╙	π	≤
4	4	ä	ö	ñ	┤	─	╘	Σ	⌠
5	5	à	ò	Ñ	╡	┼	╒	σ	⌡
6	6	å	û	ª	╢	╞	╓	µ	÷
7	7	ç	ù	º	╖	╟	╫	ϒ	≈
8	8	ê	ÿ	¿	╕	╚	╪	Φ	°
9	9	ë	Ö	⌐	╣	╔	┘	Θ	∙
10	A	è	Ü	¬	║	╩	┌	Ω	·
11	B	ï	¢	½	╗	╦	█	δ	√
12	C	î	£	¼	╝	╠	▄	∞	ⁿ
13	D	ì	¥	¡	╜	═	▌	φ	²
14	E	Ä	₧	«	╛	╬	▐	∈	■
15	F	Å	ƒ	»	┐	╧	▀	∩	BLANK 'FF'

Notes:

SECTION 8. COMMUNICATIONS

Contents

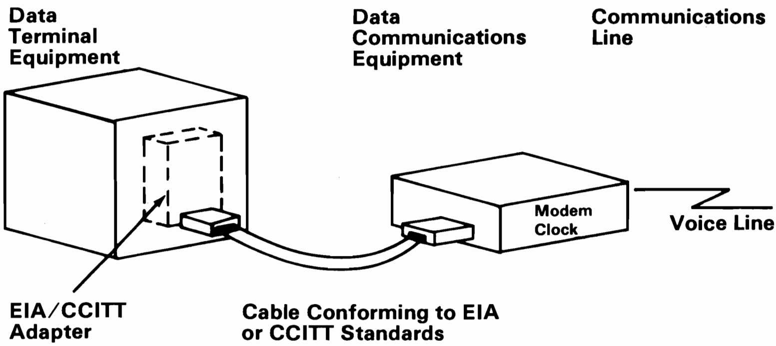
SECTION 8

Notes:

Hardware

Information-processing equipment used for communication is called data terminal equipment (DTE.) Equipment used to connect the DTE to the communication line is called data communication equipment (DCE.)

An adapter connects the data terminal equipment to the data communication line as shown in the following figure:



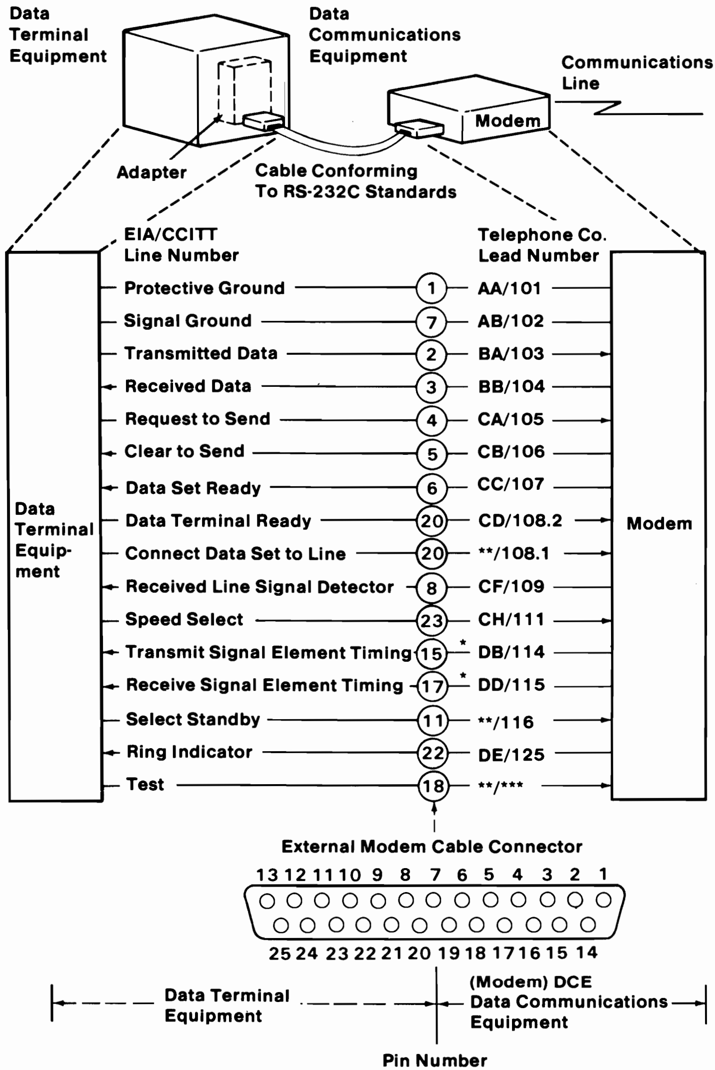
The EIA/CCITT adapter allows the data terminal equipment to be connected to the data communications equipment using EIA or CCITT standardized connections. An external modem is shown in the figure; however, other types of data communications equipment also can be connected to the data terminal equipment using EIA or CCITT standardized connections.

EIA standards are labeled RS-x (recommended standards-x), and CCITT standards are labeled V.x or X.x, where x is the number of the standard.

The EIA RS-232 interface standard defines the connector type, pin numbers, line names, and signal levels used to connect data terminal equipment to data communications equipment for the purpose of transmitting and receiving data. Since the RS-232 standard was developed, it has been revised three times. The three revised standards are RS-232A, RS-232B, and the presently used RS-232C.

The CCITT V.24 interface standard is equivalent to the RS-232C standard; therefore, the descriptions of the EIA standards also apply to the CCITT standards.

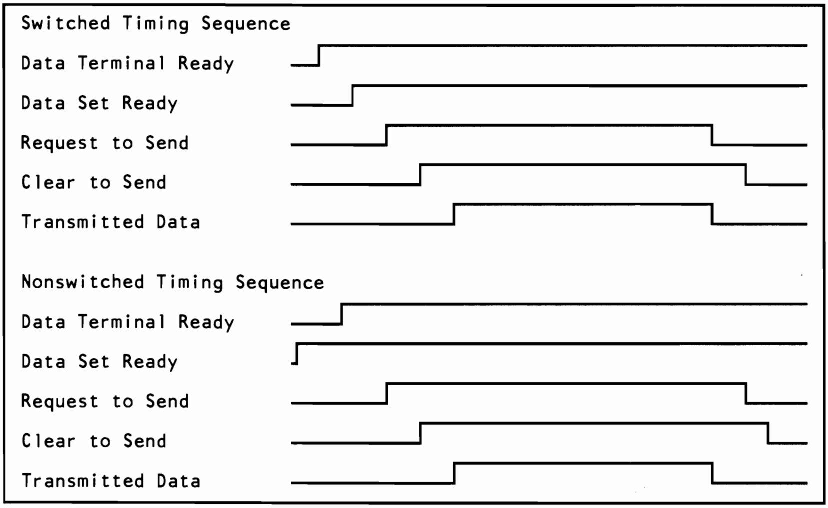
The following is an illustration of data terminal equipment connected to an external modem using connections defined by the RS-232C interface standard:



*Not used when business machine clocking is used.
**Not standardized by EIA (Electronics Industry Association).
***Not standardized by CCITT

Establishing a Communications Link

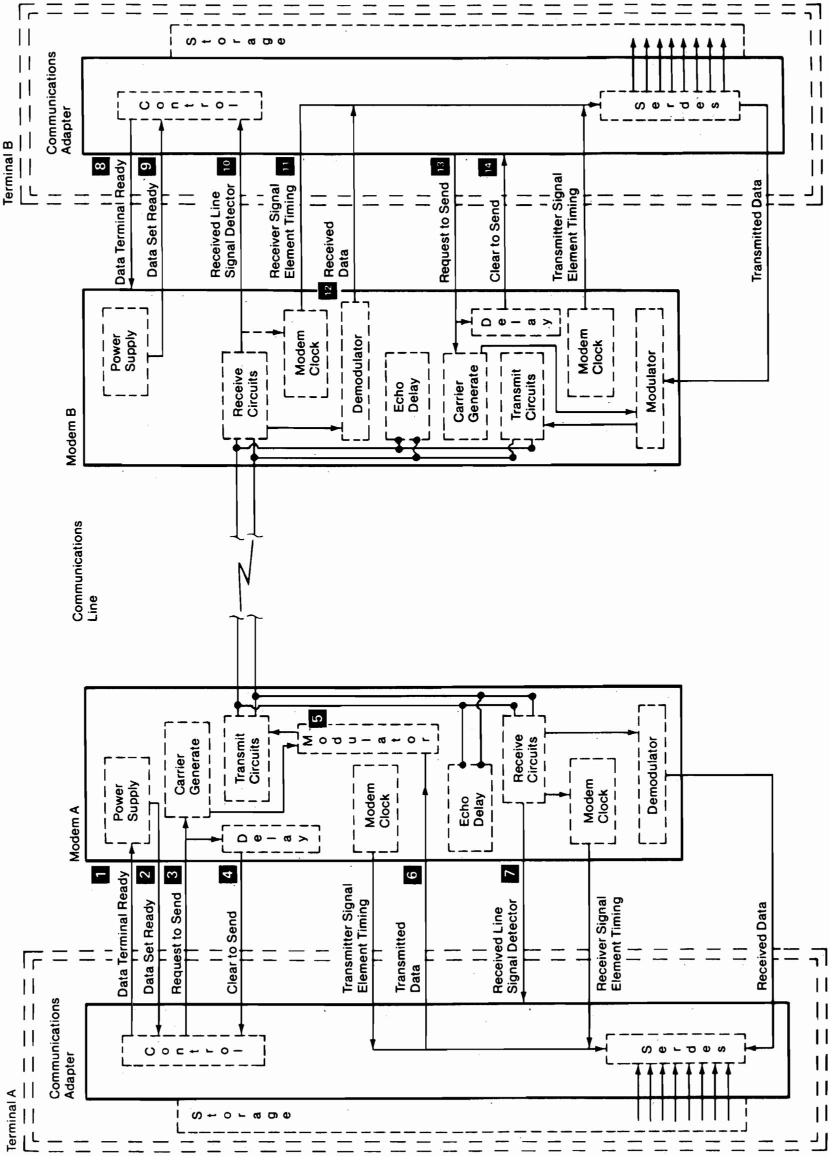
The following bar graphs represent normal timing sequences of operation during the establishment of communication for both switched (dial-up) and nonswitched (direct line) networks.



The following examples show how a link is established on a nonswitched point-to-point line, a nonswitched multipoint line, and a switched point-to-point line.

Establishing a Link on a Nonswitched Point-to-Point Line

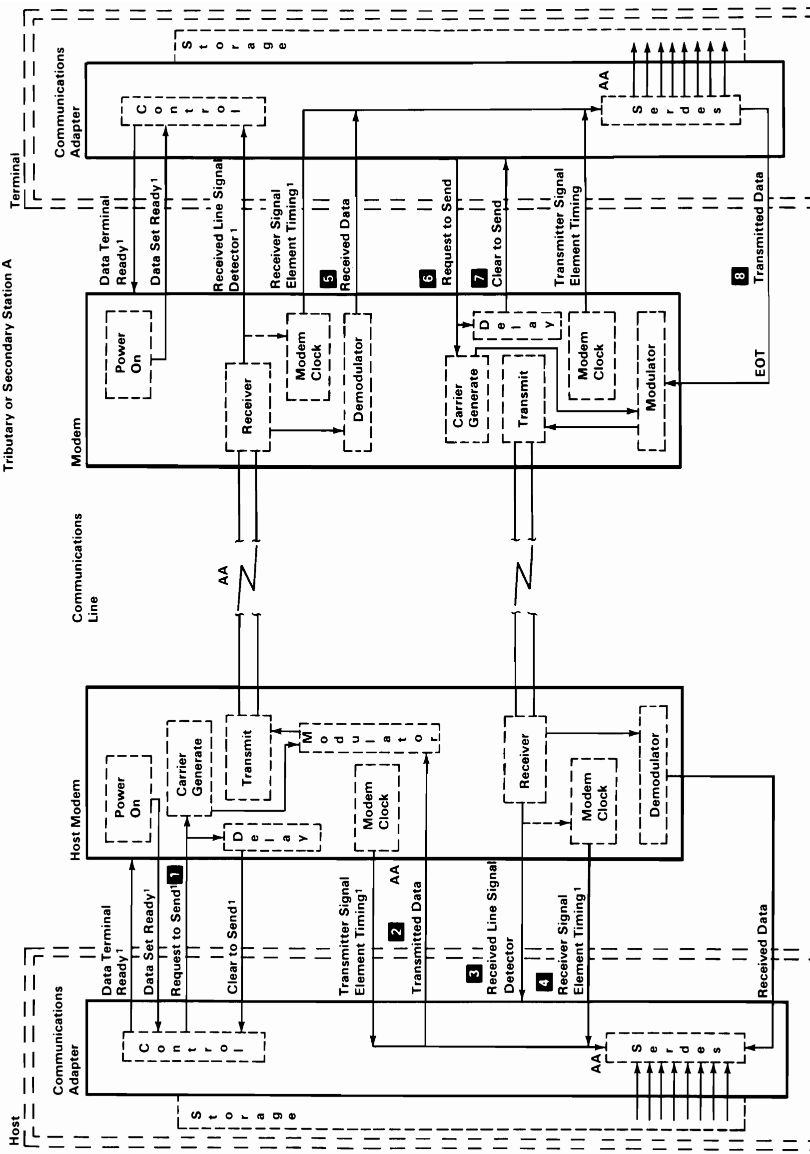
1. The terminals at both locations activate the 'data terminal ready' lines **1** and **8**.
2. Normally the 'data set ready' lines **2** and **9** from the modems are active whenever the modems are powered on.
3. Terminal A activates the 'request to send' line **3**, which causes the modem at terminal A to generate a carrier signal.
4. Modem B detects the carrier, and activates the 'received line signal detector' line (sometimes called data carrier detect) **10**. Modem B also activates the 'receiver signal element timing' line (sometimes called receive clock) **11** to send receive clock signals to the terminal. Some modems activate the clock signals whenever the modem is powered on.
5. After a specified delay, modem A activates the 'clear to send' line **4**, which indicates to terminal A that the modem is ready to transmit data.
6. Terminal A serializes the data to be transmitted (through the serdes) and transmits the data one bit at a time (synchronized by the transmit clock) onto the 'transmitted data' line **6** to the modem.
7. The modem modulates the carrier signal with the data and transmits it to the modem B **5**.
8. Modem B demodulates the data from the carrier signal and sends it to terminal B on the 'received data' line **12**.
9. Terminal B deserializes the data (through the serdes) using the receive clock signals (on the 'receiver signal element timing' line) **11** from the modem.
10. After terminal A completes its transmission, it deactivates the 'request to send' line **3**, which causes the modem to turn off the carrier and deactivate the 'clear to send' line **4**.
11. Terminal A and modem A now become receivers and wait for a response from terminal B, indicating that all data has reached terminal B. Modem A begins an echo delay (50 to 150 milliseconds) to ensure that all echoes on the line have diminished before it begins receiving. An echo is a reflection of the transmitted signal. If the transmitting modem changed to receive too soon, it could receive a reflection (echo) of the signal it just transmitted.
12. Modem B deactivates the 'received line signal detector' line **10** and, if necessary, deactivates the receive clock signals on the 'receiver signal element timing' line **11**.
13. Terminal B now becomes the transmitter to respond to the request from terminal A. To transmit data, terminal B activates the 'request to send' line **13**, which causes modem B to transmit a carrier to modem A.
14. Modem B begins a delay that is longer than the echo delay at modem A before turning on the 'clear to send' line. The longer delay (called request-to-send to clear-to-send delay) ensures that modem A is ready to receive when terminal B begins transmitting data. After the delay, modem B activates the 'clear to send' line **14** to indicate that terminal B can begin transmitting its response.
15. After the echo delay at modem A, modem A senses the carrier from modem B (the carrier was activated in step 13 when terminal B activated the 'request to send' line) and activates the 'received line signal detector' line **7** to terminal A.
16. Modem A and terminal A are now ready to receive the response from terminal B. Remember, the response was not transmitted until after the request-to-send to clear-to-send delay at modem B (step 14).


Terminal B
Communications Adapter
Control
Storage
Serdes
8 Data Terminal Ready
9 Data Set Ready
10 Received Line Signal Detector
11 Receiver Signal Element Timing
12 Received Data
13 Request to Send
14 Clear to Send
Transmitter Signal Element Timing
Transmitted Data
Modem B
Power Supply
Receive Circuits
Modem Clock
Demodulator
Echo Delay
Carrier Generate
Delay
Transmit Circuits
Modem Clock
Modulator
Communications Line
Modem A
Power Supply
Carrier Generate
Transmit Circuits
5 Modulator
Delay
Modem Clock
Echo Delay
Receive Circuits
Modem Clock
Demodulator
1 Data Terminal Ready
2 Data Set Ready
3 Request to Send
4 Clear to Send
Transmitter Signal Element Timing
6 Transmitted Data
7 Received Line Signal Detector
Receiver Signal Element Timing
Received Data
Terminal A
Communications Adapter
Control
Serdes
Storage

SECTION 8

Establishing a Link on a Nonswitched Multipoint Line

1. The control station serializes the address for the tributary or secondary station (AA) and sends its address to the modem on the 'transmitted data' line **2**.
2. Since the 'request to send' line and, therefore, the modem carrier, is active continuously **1**, the modem immediately modulates the carrier with the address, and, thus, the address is transmitted to all modems on the line.
3. All tributary modems, including the modem for station A, demodulate the address and send it to their terminals on the 'received data' line **5**.
4. Only station A responds to the address; the other stations ignore the address and continue monitoring their 'received data' line. To respond to the poll, station A activates its 'request to send' line **6** which causes the modem to begin transmitting a carrier signal.
5. The control station's modem receives the carrier and activates the 'received line signal detector' line **3** and the 'receiver signal element timing' line **4** (to send clock signals to the control station). Some modems activate the clock signals as soon as they are powered on.
6. After a short delay to allow the control station modem to receive the carrier, the tributary modem activates the 'clear to send' line **7**.
7. When station A detects the active 'clear to send' line, it transmits its response. (For this example, assume that station A has no data to send; therefore, it transmits an EOT **8**.)
8. After transmitting the EOT, station A deactivates the 'request to send' line **6**. This causes the modem to deactivate the carrier and the 'clear to send' line **7**.
9. When the modem at the control station (host) detects the absence of the carrier, it deactivates the 'received line signal detector' line **3**.
10. Tributary station A is now in receive mode waiting for the next poll or select transmission from the control station.



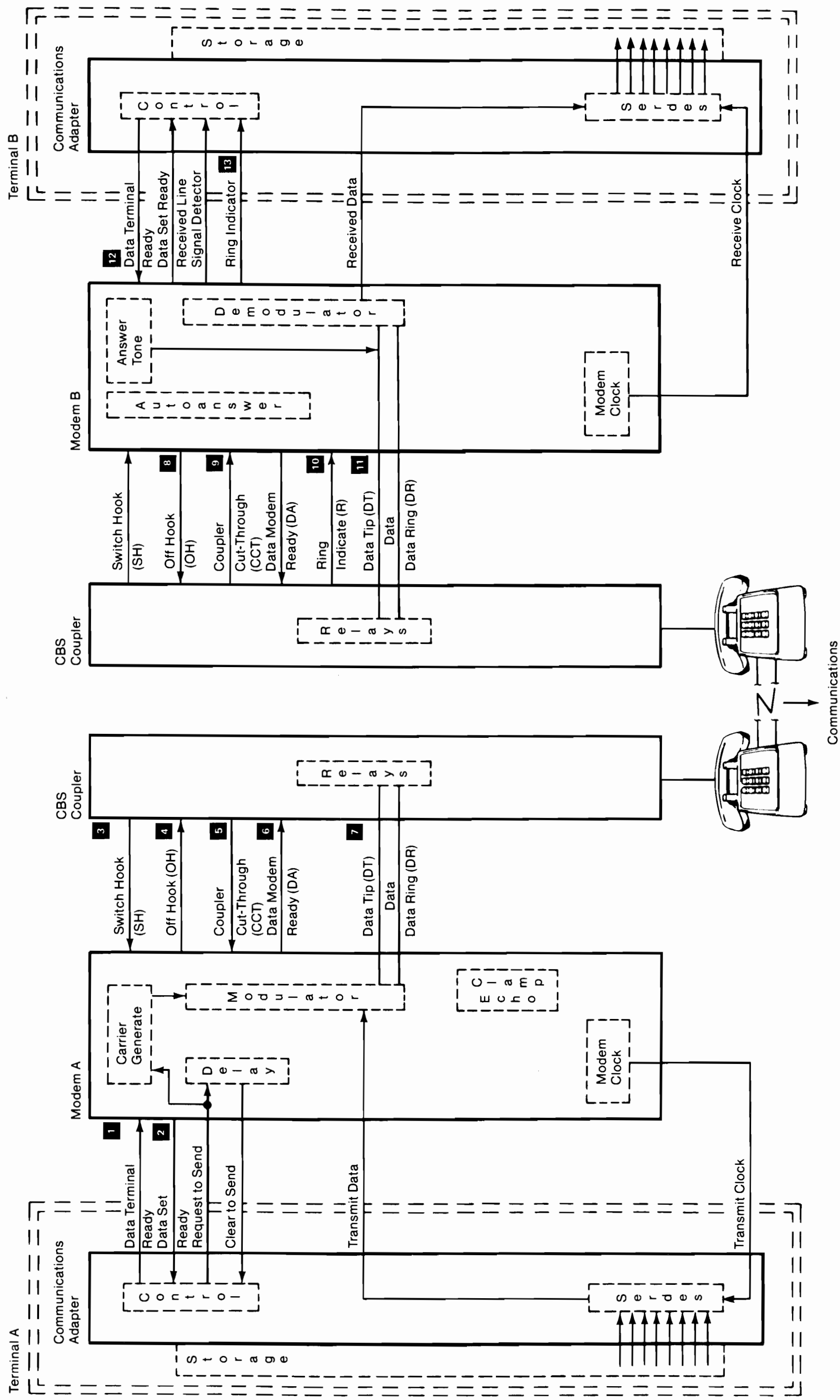
¹These lines are active continuously.

SECTION 8

Establishing a Link on a Switched Point-to-Point Line

1. Terminal A is in communications mode; therefore, the 'data terminal ready' line **1** is active. Terminal B is in communication mode waiting for a call from terminal A.
2. When the terminal A operator lifts the telephone handset, the 'switch hook' line from the coupler is activated **3**.
3. Modem A detects the 'switch hook' line and activates the 'off hook' line **4**, which causes the coupler to connect the telephone set to the line and activate the 'coupler cut-through' line **5** to the modem.
4. Modem A activates the 'data modem ready' line **6** to the coupler (the 'data modem ready' line is on continuously in some modems).
5. The terminal A operator sets the exclusion key or talk/data switch to the talk position to connect the handset to the communications line. The operator then dials the terminal B number.
6. When the telephone at terminal B rings, the coupler activates the 'ring indicate' line to modem B **10**. Modem B indicates that the 'ring indicate' line was activated by activating the 'ring indicator' line **13** to terminal B.
7. Terminal B activates the 'data terminal ready' line to modem B **12**, which activates the autoanswer circuits in modem B. (The 'data terminal ready' line might already be active in some terminals.)
8. The autoanswer circuits in modem B activate the 'off hook' line to the coupler **8**.
9. The coupler connects modem B to the communications line through the 'data tip' and 'data ring' lines **11** and activates the 'coupler cut-through' line **9** to the modem. Modem B then transmits an answer tone to terminal A.
10. The terminal A operator hears the tone and sets the exclusion key or talk/data switch to the data position (or performs an equivalent operation) to connect modem A to the communications line through the 'data tip' and 'data ring' lines **7**.
11. The coupler at terminal A deactivates the 'switch hook' line **3**. This causes modem A to activate the 'data set ready' line **2** indicating to terminal A that the modem is connected to the communications line.

The sequence of the remaining steps to establish the data link is the same as the sequence required on a nonswitched point-to-point line. When the terminals have completed their transmission, they both deactivate the 'data terminal ready' line to disconnect the modems from the line.


Terminal A
Communications Adapter
Storage
Control
Serdes
Data Terminal Ready
Data Set Ready
Request to Send
Clear to Send
Transmit Data
Transmit Clock
Modem A
Carrier Generate
Delay
Modulator
Echo Clamp
Modem Clock
1
2
3
4
5
6
7
CBS Coupler
Relays
Switch Hook (SH)
Off Hook (OH)
Coupler Cut-Through (CCT)
Data Modem Ready (DA)
Data Tip (DT)
Data
Data Ring (DR)
Communications Line
CBS Coupler
Relays
Switch Hook (SH)
Off Hook (OH)
Coupler Cut-Through (CCT)
Data Modem Ready (DA)
Ring Indicate (R)
Data Tip (DT)
Data
Data Ring (DR)
8
9
10
11
Modem B
Autoanswer
Answer Tone
Demodulator
Modem Clock
12
13
Data Terminal Ready
Data Set Ready
Received Line Signal Detector
Ring Indicator
Received Data
Receive Clock
Terminal B
Communications Adapter
Control
Serdes
Storage

Notes:

SECTION 9. IBM PERSONAL COMPUTER COMPATIBILITY

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Notes:

This section describes the differences among the members of the IBM Personal Computer family. It also contains information necessary to design hardware and programs that will be compatible with all members of the IBM Personal Computer family.

Hardware Considerations

To design compatible hardware or programs, you must consider hardware differences among the IBM Personal Computers. The following are hardware features of the IBM Personal Computer AT that are not supported by all of the IBM Personal Computer family.

System Board

The IBM Personal Computer AT system board uses an Intel 80286 Microprocessor. This microprocessor is compatible with the 80287 Math Coprocessor used in the Personal Computer AT, and is generally compatible with the Intel 8088 Microprocessor used in other IBM Personal Computers.

The following table identifies the microprocessor and describes the I/O channel used with each type of IBM Personal Computer.

System Name	System Unit Microprocessor	I/O Channel Description
Personal Computer	8088	5 62-Pin
PCjr	8088	Not Compatible
Personal Computer XT	8088	8 62-Pin
Portable Personal Computer	8088	8 62-Pin
Personal Computer AT	80286	2 62-pin 6 98-Pin (62 Pin + 36 Pin)

System Hardware Identification Chart

The faster processing capability of the 80286, compared to the 8088, creates special programming considerations, which are discussed later in this section under "Application Guidelines."

Some adapters use a 36-pin connector in addition to the 62-pin connector. Adapters designed to use the 36-pin connectors are not compatible with all members of the IBM Personal Computer family. Refer to the "System to Adapter Compatibility Chart" in the *Technical Reference Options and Adapters* manual, Volume 1, to identify the adapters supported by each system. The IBM Personal Computer AT does not support an expansion unit.

On the I/O channel:

- The system clock signal should be used only for synchronization and not for applications requiring a fixed frequency.
- The 14.31818-MHz oscillator is not synchronous with the system clock.
- The ALE signal is activated during DMA cycles.
- The -IOW signal is not active during refresh cycles.
- Pin B04 supports IRQ 9.

Fixed Disk Drive

Reading from and writing to this drive is initiated in the same way as with other IBM Personal Computers; however, the Fixed Disk and Diskette Drive Adapter may be addressed from different BIOS locations.

Diskette Drive Compatibility

The following chart shows the read, write, and format capabilities for each of the diskette drives used by IBM Personal Computers.

Diskette Drive Name	160/180K Mode	320/360K Mode	1.2M Mode
5-1/4 In. Diskette Drive:			
Type 1	R W F	---	---
Type 2	R W F	R W F	---
Type 3	R W F	R W F	---
Slimline Diskette Drive	R W F	R W F	---
Double Sided Diskette Drive	R W F	R W F	---
High Capacity Diskette Drive	R W*	R W*	R W F
R-Read W-Write F-Format W*-If a diskette is formatted in either 160/180K mode or 320/360K mode and written on by a High Capacity Drive, that diskette may be read by only a High Capacity Drive.			

Diskette Drive Compatibility Chart

> **Note:** Diskettes designed for the 1.2M mode may not be used in either a 160/180K or a 320/360K diskette drive.

Copy Protection

The following methods of copy protection may not work on systems using the High Capacity Diskette Drive:

- Bypassing BIOS

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- Diskette drive controls
- Write current control

Bypassing BIOS

Copy protection that tries to bypass the following BIOS routines will not work on the High Capacity Diskette Drive:

Track Density: The High Capacity Diskette Drive records tracks at a density of 96 TPI (tracks per inch). This drive has to double-step in the 48 TPI mode, which is performed by BIOS.

Data Transfer Rate: BIOS selects the proper data transfer rate for the media being used.

Disk__Base: Copy protection, which creates its own disk__base will not work on the High Capacity Diskette Drive.

Diskette Drive Controls

Copy protection that uses the following will not work on the High Capacity Diskette Drive:

Rotational Speed: The time between two events on a diskette is controlled by the Fixed Disk and Diskette Drive Adapter.

Access Time: Diskette BIOS routines must set the track-to-track access time for the different types of media used on the IBM Personal Computer AT.

Head Geometry: See "Diskette Drive Compatibility" on page 9-5

Diskette Change Signal: Copy protection may not be able to reset this signal.

Write Current Control

Copy protection that uses write current control will not work because the Fixed Disk and Diskette Drive Adapter selects the proper write current for the media being used.

Application Guidelines

The following information should be used to develop application programs for the IBM Personal Computer family.

High-Level Language Considerations

The IBM-supported languages of BASIC, FORTRAN, COBOL, Pascal, and APL are the best choices for writing compatible programs.

If a program uses specific features of the hardware, that program may not be compatible with all IBM Personal Computers. Specifically, the use of assembler language subroutines or hardware-specific commands (In, Out, Peek, Poke, ...) must follow the assembler language rules (see "Assembler Language Programming Considerations" on page 9-8).

Any program that requires precise timing information should obtain it through a DOS or language interface; for example, TIME$ in BASIC. If greater precision is required, the assembler techniques in "Assembler Language Programming Considerations" are available. The use of programming loops may prevent a program from being compatible with other IBM Personal Computers.

Assembler Language Programming Considerations

The following OP codes work differently on systems using the 80286 microprocessor than they do on systems using the 8088 microprocessor.

- If the system microprocessor executes a POPF instruction in either the real or the virtual address mode with CPL≤IOPL, then a pending maskable interrupt (the INTR pin active) may be improperly recognized after executing the POPF instruction even if maskable interrupts were disabled before the POPF instruction and the value popped had IF=0. If the interrupt is improperly recognized, the interrupt is still correctly executed. This errata has no effect when interrupts are enabled in either real or virtual address mode. This errata has no effect in the virtual address mode when CPL>IOPL.

  The POPF instruction may be simulated with the following code macro:

```
POPFF       Macro       ; use POPFF instead of POPF
                        ; simulate popping flags
                        ; using IRET
EB 01       JMP $+3     ; jump around IRET
CF          IRET        ; POP CS, IP, flags
0E          PUSH CS
E8 FB FF    CALL $-2    ; CALL within segment
                        ; program will continue here
```

- PUSH SP

  80286 microprocessor pushes the current stack pointer.

  8088 microprocessor pushes the new stack pointer.

- Single step interrupt (when TF=1) on the interrupt instruction (OP code hex CC,CD):

  80286 microprocessor does **not** interrupt on the INT instruction.

8088 microprocessor does interrupt on the INT instruction.

- The divide error exception (interrupt 0):

  80286 microprocessor pushes the CS:IP of the instruction, causing the exception.

  8088 microprocessor pushes the CS:IP **following** the instruction, causing the exception.

- Shift counts are masked to five bits. Shift counts greater than 31 are treated mod 32. For example, a shift count of 36, shifts the operand four places.

The following describes anomalies which may occur in systems which contain 80286 processors with 1983 and 1984 date codes (S40172, S54036, S40093, S54012).

In protected mode, the contents of the CX register may be unexpectedly altered under the following conditions:

Note: The value in parenthesis indicates the type of error code pushed onto the exception handler's stack.

Exception #NP() = Exception #11 = Not-present Fault
Exception #SS() = Exception #12 = Stack Fault
Exception #GP() = Exception #13 = General Protection Fault

- Exception #GP(0) from attempted access to data segment or extra segment when the corresponding segment register holds a null selector.

- Exception #GP(0) from attempted data read from code segment when code segment has the "execute only" attribute.

- Exception #GP(0) from attempted write to code segment (code segments are not writable in protected mode), or to data segment of extra segment if the data or extra segment has the read only attribute.

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- Exception #GP(0) from attempted load of a selector referencing the local descriptor table into CS, DS, ES or SS, when the LDT is not present.

- Exception #GP(0) from attempted input or output instruction when CPL > IOPL.

- Exception #GP(selector) from attempted access to a descriptor is GDT, LDT, or IDT, beyond the defined limit of the descriptor table.

- Exception #GP(0) from attempted read or write (except for "PUSH" onto stack) beyond the defined limit of segment.

- Exception #SS(0) from attempted "PUSH" below the defined limit of the stack segment.

Restarting applications which generate the above exceptions may result in errors.

In the protected mode, when any of the null selector values (0000H, 0001H, 0002H, 0003H) are loaded into the DS or ES registers via a MOV or POP instruction or a task switch, the 80286 always loads the null selector 0000H into the corresponding register.

If a coprocessor (80287) operand is read from an "executable and readable" and conforming (ERC) code segment, and the coprocessor operand is sufficiently near the segment's limit that the second or subsequent byte lies outside the limit, no protection exception #9 will be generated.

The following correctly describes the operation of all 80286 parts:

- Instructions longer than 10 bytes (instructions using multiple redundant prefixes) generate exception #13 (General Purpose Exception) in both the real and protected modes.

- If the second operand of an ARPL instruction is a null selector, the instruction generates an exception #13.

Assembler language programs should perform all I/O operations through ROM BIOS or DOS function calls.

- Program interrupts are used for access to these functions. This practice removes the absolute addressing from the program. Only the interrupt number is required.

- The coprocessor detects six different exception conditions that can occur during instruction execution. If the appropriate exception mask within the coprocessor is not set, the coprocessor sets its error signal. This error signal generates a hardware interrupt (interrupt 13) and causes the 'busy' signal to the coprocessor to be held in the busy state. The 'busy' signal may be cleared by an 8-bit I/O Write command to address hex F0 with D0 through D7 equal to 0.

  The power-on-self-test code in the system ROM enables hardware IRQ 13 and sets up its vector to point to a routine in ROM. The ROM routine clears the 'busy' signal latch and then transfers control to the address pointed to by the NMI interrupt vector. This allows code written for any IBM Personal Computer to work on an IBM Personal Computer AT. The NMI interrupt handler should read the coprocessor's status to determine if the NMI was caused by the coprocessor. If the interrupt was not generated by the coprocessor, control should be passed to the original NMI interrupt handler.

- Back to back I/O commands to the same I/O ports will not permit enough recovery time for I/O chips. To ensure enough time, a JMP SHORT $+2 must be inserted between IN/OUT instructions to the same I/O chip.

  Note: MOV AL,AH type instruction does not allow enough recovery time. An example of the correct procedure follows:

```
OUT  IO_ADD,AL
JMP  SHORT $+2
MOV  AL,AH
OUT  IO_ADD,AL
```

- In systems using the 80286 microprocessor, IRQ 9 is redirected to INT hex 0A (hardware IRQ 2). This insures

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that hardware designed to use IRQ 2 will operate in the IBM Personal Computer AT.

- The system can mask hardware sensitivity. New devices can change the ROM BIOS to accept the same programming interface on the new device.

- In cases where BIOS provides parameter tables, such as for video or diskette, a program may substitute new parameter values by building a new copy of the table and changing the vector to point to that table. However, the program should copy the current table, using the current vector, and then modify those locations in the table that need to be changed. In this way, the program will not inadvertently change any values that should be left the same.

- Disk__Base consists of 11 parameters required for diskette operation. They are pointed at by the data variable, Disk__Pointer, at absolute address 0:78. It is strongly recommended that the values supplied in ROM be used. If it becomes necessary to modify any of the parameters, build another parameter block and modify the address in Disk__Pointer to point to the new block.

  The parameters were established to operate both the High Capacity Diskette Drive and the Double Sided Diskette Drive. Three of the parameters in this table are under control of BIOS in the following situations.

  The Gap Length Parameter is no longer retrieved from the parameter block.

  The gap length used during diskette read, write, and verify operations is derived from within diskette BIOS.

  The gap length for format operations is still obtained from the parameter block.

  Special considerations are required for formatting operations. See the prolog of Diskette BIOS for the required details. If a parameter block contains a head settle time parameter value of 0 milliseconds, and a write operation is being performed, at least 15 milliseconds of head settle time will be enforced for a High Capacity Diskette Drive and 20 milliseconds will be enforced for a Double Sided Diskette Drive. If a parameter block contains a motor start wait parameter of less than 1 second for a write or format operation of 625 milliseconds for a read or verify operation, Diskette BIOS will enforce those times listed above.

- The following procedure is used to determine the type of media inserted in the High Capacity Diskette Drive:

  1. Read Track 0, Head 0, Sector 1 to allow diskette BIOS to establish the media/drive combination. If this is successful, continue with the next step.

  2. Read Track 0, Sector 15. If an error occurs, a double sided diskette is in the drive.

     Note: Refer to the *DOS Technical Reference* manual for the File Allocation Table (FAT) parameters for single- and double-sided diskettes.

     If a successful read occurs, a high capacity diskette is in the drive.

  3. If Step 1 fails, issue the reset function (AH=0) to diskette BIOS and retry. If a successful read cannot be done, the media needs to be formatted or is defective.

ROM BIOS and DOS do not provide for all functions. The following are the allowable I/O operations with which IBM will maintain compatibility in future systems.

- Control of the sound, using port hex 61, and the sound channel of the timer/counter. A program can control timer/counter channels 0 and 2, ports hex 40, 42, and 43. A program must not change the value in port hex 41, because this port controls the dynamic-memory refresh. Channel 0 provides the time-of-day interrupt, and can also be used for timing short intervals. Channel 2 of the timer/counter is the output for the speaker and cassette ports. This channel may also be used for timing short intervals, although it cannot interrupt at the end of the period.

- Control of the Game Control Adapter, port hex 201

  Note: Programs should use the timer for delay on the paddle input rather than a program loop.

- Interrupt Mask Register (IMR), port hex 21, can be used to selectively mask and unmask the hardware features.

The following information pertains to absolute memory locations.

- Interrupt Vectors Segment (hex 0)--A program may change these to point at different processing routines. When an interrupt vector is modified, the original value should be retained. If the interrupt, either hardware or program, is not directed toward this device handler, the request should be passed to the next item in the list.

- Video Display Buffers (hex B0000 and B8000)-- For each mode of operation defined in the video display BIOS, the memory map will remain the same. For example, the bit map for the 320 x 200 medium-resolution graphics mode of the Color/Graphics Monitor adapter will be retained on any future adapter that supports that mode. If the bit map is modified, a different mode number will be used.

- ROM BIOS Data Area (hex 40:0)--Any variables in this area will retain their current definition, whenever it is reasonable to do so. IBM may use these data areas for other purposes when the variable no longer has meaning in the system. In general, ROM BIOS data variables should be read or modified through BIOS calls whenever possible, and not with direct access to the variable.

A program that requires timing information should use either the time-of-day clock or the timing channels of the timer/counter. The input frequency to the timer will be maintained at 1.19 MHz, providing a constant time reference. Program loops should be avoided.

Programs that use copy protection schemes should use the ROM BIOS diskette calls to read and verify the diskette and should not be timer dependent. Any method can be used to create the diskette, although manufacturing capability should be considered.

The verifying program can look at the diskette controller's status bytes in the ROM BIOS data area for additional information about embedded errors. More information about copy protection may be found on page 9-5 under "Copy Protection".

Any DOS program must be relocatable and insensitive to the size of DOS or its own load addresses. A program's memory requirement should be identified and contiguous with the load module. A program should not assume that all of memory is available to it.

There are several 80286 instructions that, when executed, lock out external bus signals. DMA requests are not honored during the execution of these instructions. Consecutive instructions of this type prevent DMA activity from the start of the first instruction to the end of the last instruction. To allow for necessary DMA cycles, as required by the diskette controller in a multitasking system, multiple lock-out instructions must be seperated by JMP SHORT $+2.

Multitasking Provisions

The IBM Personal Computer AT BIOS contains a feature to assist multitasking implementation. "Hooks" are provided for a multitasking dispatcher. Whenever a busy (wait) loop occurs in the BIOS, a hook is provided for the program to break out of the loop. Also, whenever BIOS services an interrupt, a corresponding wait loop is exited, and another hook is provided. Thus a program may be written that employs the bulk of the device driver code. The following is valid only in the microprocessor's real address mode and must be taken by the code to allow this support.

> The program is responsible for the serialization of access to the device driver. The BIOS code is not reentrant.
>
> The program is responsible for matching corresponding wait and post calls.

Interfaces

There are four interfaces to be used by the multitasking dispatcher:

Startup

First, the startup code hooks interrupt hex 15. The dispatcher is responsible to check for function codes of AH= hex 90 or 91. The "Wait" and "Post" sections describe these codes. The dispatcher must pass all other functions to the previous user of interrupt hex 15. This can be done by a JMP or a CALL. If the function code is hex 90 or 91, the dispatcher should do the appropriate processing and return by the IRET instruction.

Serialization

It is up to the multitasking system to ensure that the device driver code is used serially. Multiple entries into the code can result in serious errors.

Wait (Busy)

Whenever the BIOS is about to enter a busy loop, it first issues an interrupt hex 15 with a function code of hex 90 in AH. This signals a wait condition. At this point, the dispatcher should save the task status and dispatch another task. This allows overlapped execution of tasks when the hardware is busy. The following is an outline of the code that has been added to the BIOS to perform this function.

```
MOV AX, 90XXH          ; wait code in AH and
                       ; type code in AL
INT 15H                ; issue call
JC  TIMEOUT            ; optional: for time-out or
                       ; if carry is set, time-out
                       ; occurred
NORMAL TIMEOUT LOGIC ; normal time-out
```

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Post (Interrupt)

Whenever the BIOS has set an interrupt flag for a corresponding busy loop, an interrupt 15 occurs with a function code of hex 91 in AH. This signals a post condition. At this point, the dispatcher should set the task status to "ready to run" and return to the interrupt routine. The following is an outline of the code added to BIOS that performs this function.

```
MOV AX, 91XXH          ; post code AH and
                       ; type code AL
INT 15H                ; issue call
```

Classes

The following types of wait loops are supported:

- The class for hex 0 to 7F is serially reusable. This means that for the devices that use these codes, access to the BIOS must be restricted to only one task at a time.

- The class for hex 80 to BF is reentrant. There is no restriction on the number of tasks that may access the device.
- The class for hex C0 to FF is non-interrupt. There is no corresponding interrupt for the wait loop. Therefore, it is the responsibility of the dispatcher to determine what satisfies this condition to exit the loop.

Function Code Classes

Type Code (AL)	Description
00H->7FH	Serially reusable devices; operating system must serialize access
80H->0BFH	Reentrant devices; ES:BX is used to distinguish different calls (multiple I/O calls are allowed simultaneously)
0C0H->0FH	Wait only calls; there is no complementary POST for these waits--these are time-out only. Times are function-number dependent.

Function Code Assignments

The following are specific assignments for the IBM Personal Computer AT BIOS. Times are approximate. They are grouped according to the classes described under "Function Code Classes".

Type Code (AL)	Time-out	Description
00H	yes (6 second)	fixed disk
01H	yes (2 second)	diskette
02H	no	keyboard
0FDH	yes (1 second-write)	diskette motor start

--	(625 ms-read)	--
0FEH	yes (18 second)	printer

The asynchronous support has been omitted. The Serial/Parallel Adapter will generate interrupts, but BIOS does not support it in the interrupt mode. Therefore, the support should be included in the multitasking system code if that device is to be supported.

Time-Outs

To support time-outs properly, the multitasking dispatcher must be aware of time. If a device enters a busy loop, it generally should remain there for a specific amount of time before indicating an error. The dispatcher should return to the BIOS wait loop with the carry bit set if a time-out occurrs.

Machine-Sensitive Code

Programs may select machine specific features, but they must test for specific machine type. Location of the specific machine identification codes can be found through interrupt 15 function code AH (See 'Configuration Parameters' in BIOS Listing). The code is two bytes. The first byte shows the machine type and the second byte shows the series type. They are as follows:

First Byte	Second Byte	Machine Identification
FF	00	IBM Personal Computer
FE	00	IBM Personal Computer XT
FE	00	IBM Portable Personal Computer
FD	00	IBM PCjr
FC	00	IBM Personal Computer AT

Machine Identification Code

IBM will define methods for uniquely determining the specific machine type or I/O feature for any new device.

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Notes:

Glossary

This glossary includes definitions developed by the American National Standards Institute (ANSI) and the International Organization for Standardization (ISO). This material is reproduced from the *American National Dictionary for Information Processing*, copyright 1977 by the Computer and Business Equipment Manufacturers Association, copies of which may be purchased from the American National Standards Institute, 1430 Broadway, New York, New York 10018.

μ. Prefix micro; 0.000 001.

μs. Microsecond; 0.000 001 second.

A. Ampere.

ac. Alternating current.

accumulator. A register in which the result of an operation is formed.

active high. Designates a signal that has to go high to produce an effect. Synonymous with positive true.

active low. Designates a signal that has to go low to produce an effect. Synonymous with negative true.

adapter. An auxiliary device or unit used to extend the operation of another system.

address bus. One or more conductors used to carry the binary-coded address from the processor throughout the rest of the system.

algorithm. A finite set of well-defined rules for the solution of a problem in a finite number of steps.

all points addressable (APA). A mode in which all points of a displayable image can be controlled by the user.

alphameric. Synonym for alphanumeric.

alphanumeric (A/N). Pertaining to a character set that contains letters, digits, and usually other characters, such as punctuation marks. Synonymous with alphameric.

alternating current (ac). A current that periodically reverses its direction of flow.

American National Standard Code for Information Interchange (ASCII). The standard code, using a coded character set consisting of 7-bit coded characters (8 bits including parity check), used for information exchange between data processing systems, data communication systems, and associated equipment. The ASCII set consists of control characters and graphic characters.

ampere (A). The basic unit of electric current.

A/N. Alphanumeric

analog. (1) Pertaining to data in the form of continuously variable physical quantities. (2) Contrast with digital.

AND. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the AND of P, Q, R,...is true if all statements are true, false if any statement is false.

AND gate. A logic gate in which the output is 1 only if all inputs are 1.

AND operation. The boolean operation whose result has the boolean value 1, if and only if, each operand has the boolean value 1. Synonymous with conjunction.

APA. All points addressable.

ASCII. American National Standard Code for Information Interchange.

assemble. To translate a program expressed in an assembler language into a computer language.

assembler. A computer program used to assemble.

assembler language. A computer-oriented language whose instructions are usually in one-to-one correspondence with computer instructions.

asynchronous transmission. (1) Transmission in which the time of occurrence of the start of each character, or block of characters, is arbitrary; once started, the time of occurrence of each signal representing a bit within a character, or block, has the same relationship to significant instants of a fixed time frame. (2) Transmission in which each information character is individually transmitted (usually timed by the use of start elements and stop elements).

audio frequencies. Frequencies that can be heard by the human ear (approximately 15 hertz to 20,000 hertz).

auxiliary storage. (1) A storage device that is not main storage. (2) Data storage other than main storage; for example, storage on magnetic disk. (3) Contrast with main storage.

BASIC. Beginner's all-purpose symbolic instruction code.

basic input/output system (BIOS). The feature of the IBM Personal Computer that provides the level control of the major I/O devices, and relieves the programmer from concern about hardware device characteristics.

baud. (1) A unit of signaling speed equal to the number of discrete conditions or signal events per second. For example, one baud equals one bit per second in a train of binary signals, one-half dot cycle per second in Morse code, and one 3-bit value per second in a train of signals each of which can assume one of eight different states. (2) In asynchronous transmission, the unit of modulation rate corresponding to one unit of interval per second; that is, if the duration of the unit interval is 20 milliseconds, the modulation rate is 50 baud.

BCC. Block-check character.

beginner's all-purpose symbolic instruction code (BASIC). A programming language with a small repertoire of commands and a simple syntax, primarily designed for numeric applications.

binary. (1) Pertaining to a selection, choice, or condition that has two possible values or states. (2) Pertaining to a fixed radix numeration system having a radix of 2.

binary digit. (1) In binary notation, either of the characters 0 or 1. (2) Synonymous with bit.

binary notation. Any notation that uses two different characters, usually the binary digits 0 and 1.

binary synchronous communications (BSC). A uniform procedure, using a standardized set of control characters and control character sequences for synchronous transmission of binary–coded data between stations.

BIOS. Basic input/output system.

bit. Synonym for binary digit

bits per second (bps). A unit of measurement representing the number of discrete binary digits transmitted by a device in one second.

block. (1) A string of records, a string of words, or a character string formed for technical or logic reasons to be treated as an entity. (2) A set of things, such as words, characters, or digits, treated as a unit.

block-check character (BCC). In cyclic redundancy checking, a character that is transmitted by the sender after each message block and is compared with a block-check character computed by the receiver to determine if the transmission was successful.

boolean operation. (1) Any operation in which each of the operands and the result take one of two values. (2) An operation that follows the rules of boolean algebra.

bootstrap. A technique or device designed to bring itself into a desired state by means of its own action; for example, a machine routine whose first few instructions are sufficient to bring the rest of itself into the computer from an input device.

bps. Bits per second.

BSC. Binary synchronous communications.

buffer. (1) An area of storage that is temporarily reserved for use in performing an input/output operation, into which data is read or from which data is written. Synonymous with I/O area. (2) A portion of storage for temporarily holding input or output data.

bus. One or more conductors used for transmitting signals or power.

byte. (1) A sequence of eight adjacent binary digits that are operated upon as a unit. (2) A binary character operated upon as a unit. (3) The representation of a character.

C. Celsius.

capacitor. An electronic circuit component that stores an electric charge.

CAS. Column address strobe.

cathode ray tube (CRT). A vacuum tube in which a stream of electrons is projected onto a fluorescent screen producing a luminous spot. The location of the spot can be controlled.

cathode ray tube display (CRT display). (1) A CRT used for displaying data. For example, the electron beam can be controlled to form alphanumeric data by use of a dot matrix.
(2) Synonymous with monitor.

CCITT. International Telegraph and Telephone Consultative Committee.

Celsius (C). A temperature scale. Contrast with Fahrenheit (F).

central processing unit (CPU). Term for processing unit.

channel. A path along which signals can be sent; for example, data channel, output channel.

character generator. (1) In computer graphics, a functional unit that converts the coded representation of a graphic character into the shape of the character for display. (2) In word processing, the means within equipment for generating visual characters or symbols from coded data.

character set. (1) A finite set of different characters upon which agreement has been reached and that is considered complete for some purpose. (2) A set of unique representations called characters. (3) A defined collection of characters.

characters per second (cps). A standard unit of measurement for the speed at which a printer prints.

check key. A group of characters, derived from and appended to a data item, that can be used to detect errors in the data item during processing.

clipping. In computer graphics, removing parts of a display image that lie outside a window.

closed circuit. A continuous unbroken circuit; that is, one in which current can flow. Contrast with open circuit.

CMOS. Complementary metal oxide semiconductor.

code. (1) A set of unambiguous rules specifying the manner in which data may be represented in a discrete form. Synonymous with coding scheme. (2) A set of items, such as abbreviations, representing the members of another set. (3) To represent data or a computer program in a symbolic form that can be accepted by a data processor. (4) Loosely, one or more computer programs, or part of a computer program.

coding scheme. Synonym for code.

collector. An element in a transistor toward which current flows.

color cone. An arrangement of the visible colors on the surface of a double-ended cone where lightness varies along the axis of the cone, and hue varies around the circumference. Lightness includes both the intensity and saturation of color.

column address strobe (CAS). A signal that latches the column addresses in a memory chip.

compile. (1) To translate a computer program expressed in a problem-oriented language into a computer-oriented language. (2) To prepare a machine-language program from a computer program written in another programming language by making use of the overall logic structure of the program, or generating more

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than one computer instruction for each symbolic statement, or both, as well as performing the function of an assembler.

complement. A number that can be derived from a specified number by subtracting it from a second specified number.

complementary metal oxide semiconductor (CMOS). A logic circuit family that uses very little power. It works with a wide range of power supply voltages.

computer. A functional unit that can perform substantial computation, including numerous arithmetic operations or logic operations, without human intervention during a run.

computer instruction code. A code used to represent the instructions in an instruction set. Synonymous with machine code.

computer program. A sequence of instructions suitable for processing by a computer.

computer word. A word stored in one computer location and capable of being treated as a unit.

configuration. (1) The arrangement of a computer system or network as defined by the nature, number, and the chief characteristics of its functional units. More specifically, the term configuration may refer to a hardware configuration or a software configuration. (2) The devices and programs that make up a system, subsystem, or network.

conjunction. Synonym for AND operation.

contiguous. Touching or joining at the edge or boundary; adjacent.

control character. A character whose occurrence in a particular context initiates, modifies, or stops a control operation.

control operation. An action that affects the recording, processing, transmission, or interpretation of data; for example, starting or stopping a process, carriage return, font change, rewind, and end of transmission.

control storage. A portion of storage that contains microcode.

coordinate space. In computer graphics, a system of Cartesian coordinates in which an object is defined.

cps. Characters per second.

CPU. Central processing unit.

CRC. Cyclic redundancy check.

CRT. Cathode ray tube.

CRT display. Cathode ray tube display.

CTS. Clear to send. Associated with modem control.

cursor. (1) In computer graphics, a movable marker that is used to indicate position on a display. (2) A displayed symbol that acts as a marker to help the user locate a point in text, in a system command, or in storage. (3) A movable spot of light on the screen of a display device, usually indicating where the next character is to be entered, replaced, or deleted.

cyclic redundancy check (CRC). (1) A redundancy check in which the check key is generated by a cyclic algorithm. (2) A system of error checking performed at both the sending and receiving station after a block-check character has been accumulated.

cylinder. (1) The set of all tracks with the same nominal distance from the axis about which the disk rotates. (2) The tracks of a disk storage device that can be accessed without repositioning the access mechanism.

daisy-chained cable. A type of cable that has two or more connectors attached in series.

data. (1) A representation of facts, concepts, or instructions in a formalized manner suitable for communication, interpretation, or processing by human or automatic means. (2) Any representations, such as characters or analog quantities, to which meaning is, or might be assigned.

data base. A collection of data that can be immediately accessed and operated upon by a data processing system for a specific purpose.

data processing system. A system that performs input, processing, storage, output, and control functions to accomplish a sequence of operations on data.

data transmission. Synonym for transmission.

dB. Decibel.

dBa. Adjusted decibels.

dc. Direct current.

debounce. (1) An electronic means of overcoming the make/break bounce of switches to obtain one smooth change of signal level. (2) The elimination of undesired signal variations caused by mechanically generated signals from contacts.

decibel. (1) A unit that expresses the ratio of two power levels on a logarithmic scale. (2) A unit for measuring relative power.

decoupling capacitor. A capacitor that provides a low impedance path to ground to prevent common coupling between circuits.

Deutsche Industrie Norm (DIN). (1) German Industrial Norm. (2) The committee that sets German dimension standards.

digit. (1) A graphic character that represents an integer; for example, one of the characters 0 to 9. (2) A symbol that represents one of the non-negative integers smaller than the radix. For example, in decimal notation, a digit is one of the characters 0 to 9.

digital. (1) Pertaining to data in the form of digits. (2) Contrast with analog.

DIN. Deutsche Industrie Norm.

DIN connector. One of the connectors specified by the DIN committee.

DIP. Dual in-line package.

DIP switch. One of a set of small switches mounted in a dual in-line package.

direct current (dc). A current that always flows in one direction.

direct memory access (DMA). A method of transferring data between main storage and I/O devices that does not require processor intervention.

disable. To stop the operation of a circuit or device.

disabled. Pertaining to a state of a processing unit that prevents the occurrence of certain types of interruptions. Synonymous with masked.

disk. Loosely, a magnetic disk.

diskette. A thin, flexible magnetic disk and a semirigid protective jacket, in which the disk is permanently enclosed. Synonymous with flexible disk.

diskette drive. A device for storing data on and retrieving data from a diskette.

display. (1) A visual presentation of data. (2) A device for visual presentation of information on any temporary character imaging device. (3) To present data visually. (4) See cathode ray tube display.

display attribute. In computer graphics, a particular property that is assigned to all or part of a display; for example, low intensity, green color, blinking status.

display element. In computer graphics, a basic graphic element that can be used to construct a display image; for example, a dot, a line segment, a character.

display group. In computer graphics, a collection of display elements that can be manipulated as a unit and that can be further combined to form larger groups.

display image. In computer graphics, a collection of display elements or display groups that are represented together at any one time in a display space.

display space. In computer graphics, that portion of a display surface available for a display image. The display space may be all or part of a display surface.

display surface. In computer graphics, that medium on which display images may appear; for example, the entire screen of a cathode ray tube.

DMA. Direct memory access.

dot matrix. (1) In computer graphics, a two-dimensional pattern of dots used for constructing a display image. This type of matrix can be used to represent characters by dots. (2) In word processing, a pattern of dots used to form characters. This term normally refers to a small section of a set of addressable points; for example, a representation of characters by dots.

dot printer. Synonym for matrix printer.

dot-matrix character generator. In computer graphics, a character generator that generates character images composed of dots.

drawing primitive. A group of commands that draw defined geometric shapes.

DSR. Data set ready. Associated with modem control.

DTR. In the IBM Personal Computer, data terminal ready. Associated with modem control.

dual in-line package (DIP). A widely used container for an integrated circuit. DIPs have pins in two parallel rows. The pins are spaced 1/10 inch apart. See also DIP switch.

duplex. (1) In data communication, pertaining to a simultaneous two-way independent transmission in both directions. (2) Contrast with half-duplex.

duty cycle. In the operation of a device, the ratio of on time to idle time. Duty cycle is expressed as a decimal or percentage.

dynamic memory. RAM using transistors and capacitors as the memory elements. This memory requires a refresh (recharge) cycle every few milliseconds. Contrast with static memory.

EBCDIC. Extended binary-coded decimal interchange code.

ECC. Error checking and correction.

edge connector. A terminal block with a number of contacts attached to the edge of a printed-circuit board to facilitate plugging into a foundation circuit.

EIA. Electronic Industries Association.

electromagnet. Any device that exhibits magnetism only while an electric current flows through it.

enable. To initiate the operation of a circuit or device.

end of block (EOB). A code that marks the end of a block of data.

end of file (EOF). An internal label, immediately following the last record of a file, signaling the end of that file. It may include control totals for comparison with counts accumulated during processing.

end-of-text (ETX). A transmission control character used to terminate text.

end-of-transmission (EOT). A transmission control character used to indicate the conclusion of a transmission, which may have included one or more texts and any associated message headings.

end-of-transmission-block (ETB). A transmission control character used to indicate the end of a transmission block of data when data is divided into such blocks for transmission purposes.

EOB. End of block.

EOF. End of file.

EOT. End-of-transmission.

EPROM. Erasable programmable read-only memory.

erasable programmable read-only memory (EPROM). A PROM in which the user can erase old information and enter new information.

error checking and correction (ECC). The detection and correction of all single-bit errors, plus the detection of double-bit and some multiple-bit errors.

ESC. The escape character.

escape character (ESC). A code extension character used, in some cases, with one or more succeeding characters to indicate by some convention or agreement that the coded representations following the character or the group of characters are to be interpreted according to a different code or according to a different coded character set.

ETB. End-of-transmission-block.

ETX. End-of-text.

extended binary-coded decimal interchange code (EBCDIC). A set of 256 characters, each represented by eight bits.

F. Fahrenheit.

Fahrenheit (F). A temperature scale. Contrast with Celsius (C).

falling edge. Synonym for negative-going edge.

FCC. Federal Communications Commission.

fetch. To locate and load a quantity of data from storage.

FF. The form feed character.

field. (1) In a record, a specified area used for a particular category of data. (2) In a data base, the smallest unit of data that can be referred to.

field-programmable logic sequencer (FPLS). An integrated circuit containing a programmable, read-only memory that responds to external inputs and feedback of its own outputs.

FIFO (first-in-first out). A queuing technique in which the next item to be retrieved is the item that has been in the queue for the longest time.

fixed disk drive. In the IBM Personal Computer, a unit consisting of nonremovable magnetic disks, and a device for storing data on and retrieving data from the disks.

flag. (1) Any of various types of indicators used for identification. (2) A character that signals the occurrence of some condition, such as the end of a word. (3) Deprecated term for mark.

flexible disk. Synonym for diskette.

flip-flop. A circuit or device containing active elements, capable of assuming either one of two stable states at a given time.

font. A family or assortment of characters of a given size and style; for example, 10 point Press Roman medium.

foreground. (1) In multiprogramming, the environment in which high-priority programs are executed. (2) On a color display screen, the characters as opposed to the background.

form feed. (1) Paper movement used to bring an assigned part of a form to the printing position. (2) In word processing, a function that advances the typing position to the same character position on a predetermined line of the next form or page.

form feed character. A control character that causes the print or display position to move to the next predetermined first line on the next form, the next page, or the equivalent.

format. The arrangement or layout of data on a data medium.

FPLS. Field-programmable logic sequencer.

frame. (1) In SDLC, the vehicle for every command, every response, and all information that is transmitted using SDLC procedures. Each frame begins and ends with a flag. (2) In data transmission, the sequence of contiguous bits bracketed by and including beginning and ending flag sequences.

g. Gram.

G. (1) Prefix giga; 1,000,000,000. (2) When referring to computer storage capacity, 1,073,741,824. (1,073,741,824 = 2 to the 30th power.)

gate. (1) A combinational logic circuit having one output channel and one or more input channels, such that the output channel state is completely determined by the input channel states. (2) A signal that enables the passage of other signals through a circuit.

Gb. 1,073,741,824 bytes.

general-purpose register. A register, usually explicitly addressable within a set of registers, that can be used for different purposes; for example, as an accumulator, as an index register, or as a special handler of data.

giga (G). Prefix 1,000,000,000.

gram (g). A unit of weight (equivalent to 0.035 ounces).

graphic. A symbol produced by a process such as handwriting, drawing, or printing.

graphic character. A character, other than a control character, that is normally represented by a graphic.

half-duplex. (1) In data communication, pertaining to an alternate, one way at a time, independent transmission. (2) Contrast with duplex.

hardware. (1) Physical equipment used in data processing, as opposed to programs, procedures, rules, and associated documentation. (2) Contrast with software.

head. A device that reads, writes, or erases data on a storage medium; for example, a small electromagnet used to read, write, or erase data on a magnetic disk.

hertz (Hz). A unit of frequency equal to one cycle per second.

hex. Common abbreviation for hexadecimal.

hexadecimal. (1) Pertaining to a selection, choice, or condition that has 16 possible different values or states. These values or states are usually symbolized by the ten digits 0 through 9 and the six letters A through F. (2) Pertaining to a fixed radix numeration system having a radix of 16.

high impedance state. A state in which the output of a device is effectively isolated from the circuit.

highlighting. In computer graphics, emphasizing a given display group by changing its attributes relative to other display groups in the same display field.

high-order position. The leftmost position in a string of characters. See also most-significant digit.

hither plane. In computer graphics, a plane that is perpendicular to the line joining the viewing reference point and the view point and that lies between these two points. Any part of an object between the hither plane and the view point is not seen. See also yon plane.

housekeeping. Operations or routines that do not contribute directly to the solution of the problem but do contribute directly to the operation of the computer.

Hz. Hertz

image. A fully processed unit of operational data that is ready to be transmitted to a remote unit; when loaded into control storage in the remote unit, the image determines the operations of the unit.

immediate instruction. An instruction that contains within itself an operand for the operation specified, rather than an address of the operand.

index register. A register whose contents may be used to modify an operand address during the execution of computer instructions.

indicator. (1) A device that may be set into a prescribed state, usually according to the result of a previous process or on the occurrence of a specified condition in the equipment, and that usually gives a visual or other indication of the existence of the prescribed state, and that may in some cases be used to determine the selection among alternative processes; for example, an overflow indicator. (2) An item of data that may be interrogated to determine whether a particular condition has been satisfied in the execution of a computer program; for example, a switch indicator, an overflow indicator.

inhibited. (1) Pertaining to a state of a processing unit in which certain types of interruptions are not allowed to occur. (2) Pertaining to the state in which a transmission control unit or an audio response unit cannot accept incoming calls on a line.

initialize. To set counters, switches, addresses, or contents of storage to 0 or other starting values at the beginning of, or at prescribed points in, the operation of a computer routine.

input/output (I/O). (1) Pertaining to a device or to a channel that may be involved in an input process, and, at a different time, in an output process. In the English language, "input/output" may be used in place of such terms as "input/output data," "input/output signal," and "input/output terminals," when such usage is clear in a given context. (2) Pertaining to a device whose parts can be performing an input process and an output process at the same time. (3) Pertaining to either input or output, or both.

instruction. In a programming language, a meaningful expression that specifies one operation and identifies its operands, if any.

instruction set. The set of instructions of a computer, of a programming language, or of the programming languages in a programming system.

intensity. In computer graphics, the amount of light emitted at a display point

interface. A device that alters or converts actual electrical signals between distinct devices, programs, or systems.

interleave. To arrange parts of one sequence of things or events so that they alternate with parts of one or more other sequences of the same nature and so that each sequence retains its identity.

interrupt. (1) A suspension of a process, such as the execution of a computer program, caused by an event external to that process, and performed in such a way that the process can be resumed. (2) In a data transmission, to take an action at a receiving station that causes the transmitting station to terminate a transmission. (3) Synonymous with interruption.

I/O. Input/output.

I/O area. Synonym for buffer.

irrecoverable error. An error that makes recovery impossible without the use of recovery techniques external to the computer program or run.

joystick. In computer graphics, a lever that can pivot in all directions and that is used as a locator device.

k. Prefix kilo; 1000.

K. When referring to storage capacity, 1024. (1024 = 2 to the 10th power.)

Kb. 1024 bytes.

key lock. A device that deactivates the keyboard and locks the cover on for security.

kg. Kilogram; 1000 grams.

kHz. Kilohertz; 1000 hertz.

kilo (k). Prefix 1000

kilogram (kg). 1000 grams.

kilohertz (kHz). 1000 hertz

latch. (1) A simple logic-circuit storage element. (2) A feedback loop in sequential digital circuits used to maintain a state.

least-significant digit. The rightmost digit. See also low-order position.

LED. Light-emitting diode.

light-emitting diode (LED). A semiconductor device that gives off visible or infrared light when activated.

load. In programming, to enter data into storage or working registers.

look-up table (LUT). (1) A technique for mapping one set of values into a larger set of values. (2) In computer graphics, a table that assigns a color value (red, green, blue intensities) to a color index.

low power Schottky TTL. A version (LS series) of TTL giving a good compromise between low power and high speed. See also transistor-transistor logic and Schottky TTL.

low-order position. The rightmost position in a string of characters. See also least-significant digit.

luminance. The luminous intensity per unit projected area of a given surface viewed from a given direction.

LUT. Look-up table.

m. (1) Prefix milli; 0.001. (2) Meter.

M. (1) Prefix mega; 1,000,000. (2) When referring to computer storage capacity, 1,048,576. (1,048,576 = 2 to the 20th power.)

mA. Milliampere; 0.001 ampere.

machine code. The machine language used for entering text and program instructions onto the recording medium or into storage and which is subsequently used for processing and printout.

machine language. (1) A language that is used directly by a machine. (2) Deprecated term for computer instruction code.

magnetic disk. (1) A flat circular plate with a magnetizable surface layer on which data can be stored by magnetic recording. (2) See also diskette.

main storage. (1) Program-addressable storage from which instructions and other data can be loaded directly into registers for subsequent execution or processing. (2) Contrast with auxiliary storage.

mark. A symbol or symbols that indicate the beginning or the end of a field, of a word, of an item of data, or of a set of data such as a file, a record, or a block.

mask. (1) A pattern of characters that is used to control the retention or elimination of portions of another pattern of characters. (2) To use a pattern of characters to control the retention or elimination of portions of another pattern of characters.

masked. Synonym for disabled.

matrix. (1) A rectangular array of elements, arranged in rows and columns, that may be manipulated according to the rules of matrix algebra. (2) In computers, a logic network in the form of an array of input leads and output leads with logic elements connected at some of their intersections.

matrix printer. A printer in which each character is represented by a pattern of dots; for example, a stylus printer, a wire printer. Synonymous with dot printer.

Mb. 1,048,576 bytes.

mega (M). Prefix 1,000,000.

megahertz (MHz). 1,000,000 hertz.

memory. Term for main storage.

meter (m). A unit of length (equivalent to 39.37 inches).

MFM. Modified frequency modulation.

MHz. Megahertz; 1,000,000 hertz.

micro (μ). Prefix 0.000,001.

microcode. (1) One or more microinstructions. (2) A code, representing the instructions of an instruction set, implemented in a part of storage that is not program-addressable.

microinstruction. (1) An instruction of microcode. (2) A basic or elementary machine instruction.

microprocessor. An integrated circuit that accepts coded instructions for execution; the instructions may be entered, integrated, or stored internally.

microsecond (μs). 0.000,001 second.

milli (m). Prefix 0.001.

milliampere (mA). 0.001 ampere.

millisecond (ms). 0.001 second.

mnemonic. A symbol chosen to assist the human memory; for example, an abbreviation such as "mpy" for "multiply."

mode. (1) A method of operation; for example, the binary mode, the interpretive mode, the alphanumeric mode. (2) The most frequent value in the statistical sense.

modeling transformation. Operations on the coordinates of an object (usually matrix multiplications) that cause the object to be rotated about any axis, translated (moved without rotating), and/or scaled (changed in size along any or all dimensions). See also viewing transformation.

modem (modulator-demodulator). A device that converts serial (bit by bit) digital signals from a business machine (or data communication equipment) to analog signals that are suitable for transmission in a telephone network. The inverse function is also performed by the modem on reception of analog signals.

modified frequency modulation (MFM). The process of varying the amplitude and frequency of the 'write' signal. MFM pertains to the number of bytes of storage that can be stored on the recording media. The number of bytes is twice the number contained in the same unit area of recording media at single density.

modulation. The process by which some characteristic of one wave (usually high frequency) is varied in accordance with another wave or signal (usually low frequency). This technique is used in modems to make business-machine signals compatible with communication facilities.

modulation rate. The reciprocal of the measure of the shortest nominal time interval between successive significant instants of the modulated signal. If this measure is expressed in seconds, the modulation rate is expressed in baud.

module. (1) A program unit that is discrete and identifiable with respect to compiling, combining with other units, and loading.

(2) A packaged functional hardware unit designed for use with other components.

modulo check. A calculation performed on values entered into a system. This calculation is designed to detect errors.

modulo-N check. A check in which an operand is divided by a number N (the modulus) to generate a remainder (check digit) that is retained with the operand. For example, in a modulo-7 check, the remainder will be 0, 1, 2, 3, 4, 5, or 6. The operand is later checked by again dividing it by the modulus; if the remainder is not equal to the check digit, an error is indicated.

modulus. In a modulo-N check, the number by which the operand is divided.

monitor. Synonym for cathode ray tube display (CRT display).

most-significant digit. The leftmost (non-zero) digit. See also high-order position.

ms. Millisecond; 0.001 second.

multiplexer. A device capable of interleaving the events of two or more activities, or capable of distributing the events of an interleaved sequence to the respective activities.

multiprogramming. (1) Pertaining to the concurrent execution of two or more computer programs by a computer. (2) A mode of operation that provides for the interleaved execution of two or more computer programs by a single processor.

n. Prefix nano; 0.000,000,001.

NAND. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the NAND of P, Q ,R,... is true if at least one statement is false, false if all statements are true.

NAND gate. A gate in which the output is 0 only if all inputs are 1.

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nano (n). Prefix 0.000,000,001.

nanosecond (ns). 0.000,000,001 second.

negative true. Synonym for active low.

negative-going edge. The edge of a pulse or signal changing in a negative direction. Synonymous with falling edge.

non-return-to-zero change-on-ones recording (NRZI). A transmission encoding method in which the data terminal equipment changes the signal to the opposite state to send a binary 1 and leaves it in the same state to send a binary 0.

non-return-to-zero (inverted) recording (NRZI). Deprecated term for non-return-to-zero change-on-ones recording.

NOR. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the NOR of P, Q, R,... is true if all statements are false, false if at least one statement is true.

NOR gate. A gate in which the output is 0 only if at least one input is 1.

NOT. A logical operator having the property that if P is a statement, then the NOT of P is true if P is false, false if P is true.

NRZI. Non-return-to-zero change-on-ones recording.

ns. Nanosecond; 0.000,000,001 second.

NUL. The null character.

null character (NUL). A control character that is used to accomplish media-fill or time-fill, and that may be inserted into or removed from, a sequence of characters without affecting the meaning of the sequence; however, the control of the equipment or the format may be affected by this character.

odd-even check. Synonym for parity check.

offline. Pertaining to the operation of a functional unit without the continual control of a computer.

one-shot. A circuit that delivers one output pulse of desired duration for each input (trigger) pulse.

open circuit. (1) A discontinuous circuit; that is, one that is broken at one or more points and, consequently, cannot conduct current. Contrast with closed circuit. (2) Pertaining to a no-load condition; for example, the open-circuit voltage of a power supply.

open collector. A switching transistor without an internal connection between its collector and the voltage supply. A connection from the collector to the voltage supply is made through an external (pull-up) resistor.

operand. (1) An entity to which an operation is applied. (2) That which is operated upon. An operand is usually identified by an address part of an instruction.

operating system. Software that controls the execution of programs; an operating system may provide services such as resource allocation, scheduling, input/output control, and data management.

OR. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the OR of P, Q, R,...is true if at least one statement is true, false if all statements are false.

OR gate. A gate in which the output is 1 only if at least one input is 1.

output. Pertaining to a device, process, or channel involved in an output process, or to the data or states involved in an output process.

output process. (1) The process that consists of the delivery of data from a data processing system, or from any part of it. (2) The return of information from a data processing system to an end user, including the translation of data from a machine language to a language that the end user can understand.

overcurrent. A current of higher than specified strength.

overflow indicator. (1) An indicator that signifies when the last line on a page has been printed or passed. (2) An indicator that is set on if the result of an arithmetic operation exceeds the capacity of the accumulator.

overrun. Loss of data because a receiving device is unable to accept data at the rate it is transmitted.

overvoltage. A voltage of higher than specified value.

parallel. (1) Pertaining to the concurrent or simultaneous operation of two or more devices, or to the concurrent performance of two or more activities. (2) Pertaining to the concurrent or simultaneous occurrence of two or more related activities in multiple devices or channels. (3) Pertaining to the simultaneity of two or more processes. (4) Pertaining to the simultaneous processing of the individual parts of a whole, such as the bits of a character and the characters of a word, using separate facilities for the various parts. (5) Contrast with serial.

parameter. (1) A variable that is given a constant value for a specified application and that may denote the application. (2) A name in a procedure that is used to refer to an argument passed to that procedure.

parity bit. A binary digit appended to a group of binary digits to make the sum of all the digits either always odd (odd parity) or always even (even parity).

parity check. (1) A redundancy check that uses a parity bit. (2) Synonymous with odd-even check.

PEL. Picture element.

personal computer. A small home or business computer that has a processor and keyboard and that can be connected to a television or some other monitor. An optional printer is usually available.

phototransistor. A transistor whose switching action is controlled by light shining on it.

picture element (PEL). The smallest displayable unit on a display.

polling. (1) Interrogation of devices for purposes such as to avoid contention, to determine operational status, or to determine readiness to send or receive data. (2) The process whereby stations are invited, one at a time, to transmit.

port. An access point for data entry or exit.

positive true. Synonym for active high.

positive-going edge. The edge of a pulse or signal changing in a positive direction. Synonymous with rising edge.

potentiometer. A variable resistor with three terminals, one at each end and one on a slider (wiper).

power supply. A device that produces the power needed to operate electronic equipment.

printed circuit. A pattern of conductors (corresponding to the wiring of an electronic circuit) formed on a board of insulating material.

printed-circuit board. A usually copper-clad plastic board used to make a printed circuit.

priority. A rank assigned to a task that determines its precedence in receiving system resources.

processing program. A program that performs such functions as compiling, assembling, or translating for a particular programming language.

processing unit. A functional unit that consists of one or more processors and all or part of internal storage.

processor. (1) In a computer, a functional unit that interprets and executes instructions. (2) A functional unit, a part of another unit such as a terminal or a processing unit, that interprets and executes instructions. (3) Deprecated term for processing program. (4) See microprocessor.

program. (1) A series of actions designed to achieve a certain result. (2) A series of instructions telling the computer how to handle a problem or task. (3) To design, write, and test computer programs.

programmable read-only memory (PROM). A read-only memory that can be programmed by the user.

programming language. (1) An artificial language established for expressing computer programs. (2) A set of characters and rules with meanings assigned prior to their use, for writing computer programs.

programming system. One or more programming languages and the necessary software for using these languages with particular automatic data-processing equipment.

PROM. Programmable read-only memory.

propagation delay. (1) The time necessary for a signal to travel from one point on a circuit to another. (2) The time delay between a signal change at an input and the corresponding change at an output.

protocol. (1) A specification for the format and relative timing of information exchanged between communicating parties. (2) The set of rules governing the operation of functional units of a communication system that must be followed if communication is to be achieved.

pulse. A variation in the value of a quantity, short in relation to the time schedule of interest, the final value being the same as the initial value.

radio frequency (RF). An ac frequency that is higher than the highest audio frequency. So called because of the application to radio communication.

radix. (1) In a radix numeration system, the positive integer by which the weight of the digit place is multiplied to obtain the weight of the digit place with the next higher weight; for example, in the decimal numeration system the radix of each digit place is 10. (2) Another term for base.

radix numeration system. A positional representation system in which the ratio of the weight of any one digit place to the weight of the digit place with the next lower weight is a positive integer (the radix). The permissible values of the character in any digit place range from 0 to one less than the radix.

RAM. Random access memory. Read/write memory.

random access memory (RAM). Read/write memory.

RAS. In the IBM Personal Computer, row address strobe.

raster. In computer graphics, a predetermined pattern of lines that provides uniform coverage of a display space.

read. To acquire or interpret data from a storage device, from a data medium, or from another source.

read-only memory (ROM). A storage device whose contents cannot be modified. The memory is retained when power is removed.

read/write memory. A storage device whose contents can be modified. Also called RAM.

recoverable error. An error condition that allows continued execution of a program.

red-green-blue-intensity (RGBI). The description of a direct-drive color monitor that accepts input signals of red, green, blue, and intensity.

redundancy check. A check that depends on extra characters attached to data for the detection of errors. See cyclic redundancy check.

register. (1) A storage device, having a specified storage capacity such as a bit, a byte, or a computer word, and usually intended for a special purpose. (2) A storage device in which specific data is stored.

retry. To resend the current block of data (from the last EOB or ETB) a prescribed number of times, or until it is entered correctly or accepted.

reverse video. A form of highlighting a character, field, or cursor by reversing the color of the character, field, or cursor with its background; for example, changing a red character on a black background to a black character on a red background.

RF. Radio frequency.

RF modulator. The device used to convert the composite video signal to the antenna level input of a home TV.

RGBI. Red-green-blue-intensity.

rising edge. Synonym for positive-going edge.

ROM. Read-only memory.

ROM/BIOS. The ROM resident basic input/output system, which provides the level control of the major I/O devices in the computer system.

row address strobe (RAS). A signal that latches the row address in a memory chip.

RS-232C. A standard by the EIA for communication between computers and external equipment.

RTS. Request to send. Associated with modem control.

run. A single continuous performance of a computer program or routine.

saturation. In computer graphics, the purity of a particular hue. A color is said to be saturated when at least one primary color (red, blue, or green) is completely absent.

scaling. In computer graphics, enlarging or reducing all or part of a display image by multiplying the coordinates of the image by a constant value.

schematic. The representation, usually in a drawing or diagram form, of a logical or physical structure.

Schottky TTL. A version (S series) of TTL with faster switching speed, but requiring more power. See also transistor-transistor logic and low power Schottky TTL.

SDLC. Synchronous Data Link Control.

sector. That part of a track or band on a magnetic drum, a magnetic disk, or a disk pack that can be accessed by the magnetic heads in the course of a predetermined rotational displacement of the particular device.

SERDES. Serializer/deserializer.

serial. (1) Pertaining to the sequential performance of two or more activities in a single device. In English, the modifiers serial and parallel usually refer to devices, as opposed to sequential and consecutive, which refer to processes. (2) Pertaining to the sequential or consecutive occurrence of two or more related activities in a single device or channel. (3) Pertaining to the sequential processing of the individual parts of a whole, such as the bits of a character or the characters of a word, using the same facilities for successive parts. (4) Contrast with parallel.

serializer/deserializer (SERDES). A device that serializes output from, and deserializes input to, a business machine.

setup. (1) In a computer that consists of an assembly of individual computing units, the arrangement of interconnections between the units, and the adjustments needed for the computer to operate. (2) The preparation of a computing system to perform a job or job step. Setup is usually performed by an operator and often involves performing routine functions, such as mounting tape reels. (3) The preparation of the system for normal operation.

short circuit. A low-resistance path through which current flows, rather than through a component or circuit.

signal. A variation of a physical quantity, used to convey data.

sink. A device or circuit into which current drains.

software. (1) Computer programs, procedures, and rules concerned with the operation of a data processing system. (2) Contrast with hardware.

source. The origin of a signal or electrical energy.

square wave. An alternating or pulsating current or voltage whose waveshape is square.

square wave generator. A signal generator delivering an output signal having a square waveform.

SS. Start-stop.

start bit. (1) A signal to a receiving mechanism to get ready to receive data or perform a function. (2) In a start-stop system, a signal preceding a character or block that prepares the receiving device for the reception of the code elements.

start-of-text (STX). A transmission control character that precedes a text and may be used to terminate the message heading.

start-stop system. A data transmission system in which each character is preceded by a start bit and is followed by a stop bit.

start-stop (SS) transmission. (1) Asynchronous transmission such that a group of signals representing a character is preceded by a start bit and followed by a stop bit. (2) Asynchronous transmission in which a group of bits is preceded by a start bit that prepares the receiving mechanism for the reception and registration of a character and is followed by at least one stop bit that enables the receiving mechanism to come to an idle condition pending the reception of the next character.

static memory. RAM using flip-flops as the memory elements. Data is retained as long as power is applied to the flip-flops. Contrast with dynamic memory.

stop bit. (1) A signal to a receiving mechanism to wait for the next signal. (2) In a start-stop system, a signal following a character or block that prepares the receiving device for the reception of a subsequent character or block.

storage. (1) A storage device. (2) A device, or part of a device, that can retain data. (3) The retention of data in a storage device. (4) The placement of data into a storage device.

strobe. An instrument that emits adjustable-rate flashes of light. Used to measure the speed of rotating or vibrating objects.

STX. Start-of-text.

symbol. (1) A conventional representation of a concept. (2) A representation of something by reason of relationship, association, or convention.

synchronization. The process of adjusting the corresponding significant instants of two signals to obtain the desired phase relationship between these instants.

Synchronous Data Link Control (SDLC). A protocol for management of data transfer over a data link.

synchronous transmission. (1) Data transmission in which the time of occurrence of each signal representing a bit is related to a fixed time frame. (2) Data transmission in which the sending and receiving devices are operating continuously at substantially the same frequency and are maintained, by means of correction, in a desired phase relationship.

syntax. (1) The relationship among characters or groups of characters, independent of their meanings or the manner of their interpretation and use. (2) The structure of expressions in a language. (3) The rules governing the structure of a language. (4) The relationships among symbols.

text. In ASCII and data communication, a sequence of characters treated as an entity if preceded and terminated by one STX and one ETX transmission control character, respectively.

time-out. (1) A parameter related to an enforced event designed to occur at the conclusion of a predetermined elapsed time. A time-out condition can be cancelled by the receipt of an appropriate time-out cancellation signal. (2) A time interval allotted for certain operations to occur; for example, response to polling or addressing before system operation is interrupted and must be restarted.

track. (1) The path or one of the set of paths, parallel to the reference edge on a data medium, associated with a single reading or writing component as the data medium moves past the component. (2) The portion of a moving data medium such as a drum, or disk, that is accessible to a given reading head position.

transistor-transistor logic (TTL). A popular logic circuit family that uses multiple-emitter transistors.

translate. To transform data from one language to another.

transmission. (1) The sending of data from one place for reception elsewhere. (2) In ASCII and data communication, a series of characters including headings and text. (3) The dispatching of a signal, message, or other form of intelligence by wire, radio, telephone, or other means. (4) One or more blocks or messages. For BSC and start-stop devices, a transmission is terminated by an EOT character. (5) Synonymous with data transmission.

TTL. Transistor-transistor logic.

typematic key. A keyboard key that repeats its function when held pressed.

V. Volt.

vector. In computer graphics, a directed line segment.

video. Computer data or graphics displayed on a cathode ray tube, monitor, or display.

view point. In computer graphics, the origin from which angles and scales are used to map virtual space into display space.

viewing reference point. In computer graphics, a point in the modeling coordinate space that is a defined distance from the view point.

viewing transformation. Operations on the coordinates of an object (usually matrix multiplications) that cause the view of the object to be rotated about any axis, translated (moved without rotating), and/or scaled (changed in size along any or all dimensions). Viewing transformation differs from modeling transformation in that perspective is considered. See also modeling transformation.

viewplane. The visible plane of a CRT display screen that completely contains a defined window.

viewport. In computer graphics, a predefined part of the CRT display space.

volt. The basic practical unit of electric pressure. The potential that causes electrons to flow through a circuit.

W. Watt.

watt. The practical unit of electric power.

window. (1) A predefined part of the virtual space. (2) The visible area of a viewplane.

word. (1) A character string or a bit string considered as an entity. (2) See computer word.

write. To make a permanent or transient recording of data in a storage device or on a data medium.

write precompensation. The varying of the timing of the head current from the outer tracks to the inner tracks of the diskette to keep a constant 'write' signal.

yon plane. In computer graphics, a plane that is perpendicular to the line joining the viewing reference point and the view point, and that lies beyond the viewing reference point. Any part of an object beyond the yon plane is not seen. See also hither plane.

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