Customer Engineering Instruction-Reference

Standard Modular System

Preface

The purpose of this manual is to provide the Customer Engineer with consolidated information on SMS: standard packaging, electrical connections, wiring, tools, and service techniques.

This edition, Form 223-6900-2, is a minor revision of, but does not obsolete, the previous edition, Form 223-6900-1.

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Contents

Safety

1. Remember that 208 volts, 400 cycles, and 120 volts, 60 cycles, are present inside the SMS frame on a normal OFF. If it is necessary to work near power connectors, convenience outlets, or any high voltage, perform an emergency OFF or disconnect the power cables.

2. Always turn power off before replacing any fuse.

3. Remember that there may be no bleeder resistors in the standard DC supply in SMS frames. The DC voltages present are not dangerous, but condensers should be discharged before working on the supply.

4. The spider capacitors (P/N 596557) located on back panels of SMS modules, and electrolytic capacitors used on some SMS cards have occasionally exploded. Be alert to this possible hazard; wear safety glasses while working in the panel areas. A slight crack in a spider capacitor may lead to an explosion. If one of these capacitors is found cracked, it should be replaced. Be careful when wire-wrapping the capacitor to the panel, to avoid cracking the capacitor where the lead enters the ceramic.

5. Tailgates should not be lowered unless absolutely necessary. If it is necessary to lower a tailgate, two men must perform the operation. Always close the slide before lowering a tailgate.

6. Wear safety glasses when soldering, or when working with SMS cards that have power on them.

Expanding business and growing competition have vividly shown the need for more automation in the production of machines. Automation, however, depends largely on the standardization of products and methods. Significant progress has been made in this direction.

To achieve automation of computer design and production, it is essential to have standard logic diagrams and a standard method of packaging. The packaging need is met by the Standard Modular System (SMS). The SMS packaging scheme provides a moderate number of standard building blocks to be used in the design and manufacture of solid-state data processing equipment. Some important advantages of SMS packaging are:

1. Standardization of circuits and packaging methods to reduce stocks of parts in the field and parts handling in the manufacturing process.
2. Increased serviceability by allowing rapid access to cards and test points and eliminating cover removal and storage problems.
3. Use of latest production techniques such as wire-wrapped connections and automated production lines.
4. Reduced requirements for space, power, and air conditioning.

SMS Packaging

SMS packaging provides a moderate number of standard building blocks that can be produced with a high degree of automation. Five physical configurations are provided by SMS. These are:

1. 29.5-inch sliding gate frame
2. 20-inch sliding gate frame
3. Rack and panel module
4. Swinging gate cube
5. Double cube

The frame is the largest physical breakdown of SMS packaged equipment. The basic SMS component is the printed circuit card. Any SMS printed card may be used in any of the SMS frames.

Electrical Connections

Most repairing of SMS will be replacing the printed circuit cards. Occasionally, a more permanent electrical connection will require service. Four types of electrical connections are used:

1. Mechanical connectors (plug-in)
2. Crimped connections
3. Wrapped connections
4. Soldered connections

29.5-Inch Sliding Gate Frame

This sliding gate frame (SMS Module II) is for large data processing systems. The frames are 29.5 inches wide, 56 deep, and 69 high (Figure 1). Each frame consists of four vertical sliding gates (Figures 2 and 3) that hold the printed circuit cards, and tailgates E and F for interconnections between towers of a frame and between frames. Note that tailgate F is inverted with respect to tailgate E.

Sliding Gates

The four sliding gates, A, B, C, and D, are attached to slides that allow a tower of two gates to pull out horizontally. Each pair of gates (tower) has the wiring side out. Once free of the frame, the two gates in the tower can be separated like the covers of a book, giving access to the printed circuit cards (Figure 3). An SMS power supply at the rear of each tower provides all power to the two gates (A and B or C and D).

Panels

Four panels (chassis) are mounted on each gate for a total of 16 panels per frame (Figure 4).

Each panel consists of 280 SMS card sockets, arranged in a 10 x 28 matrix. The rows of sockets are labeled with letters from top to bottom and columns are numbered from the hinge side out (Figure 4). This system of numbering permits a socket location to be determined easily from either the wiring side or the card side of the panel.

A panel can be completely wired before it is installed in a gate. This is made possible by standard wiring connections for input and output lines to the panels.

Panel Connectors

Four sets of input and output line connectors are used for the panels:

1. Edge connectors
2. Hinge connectors
3. Panel connectors
4. T-connectors

Edge connectors, hinge connectors, and panel connectors are SMS card sockets and modified printed circuit cards. The card sockets used for these connector purposes are part of the 280 available sockets on each panel. Cable wires are soldered to modified printed circuit cards that plug into the connector sockets. Figure 5 shows the location of card sockets used for

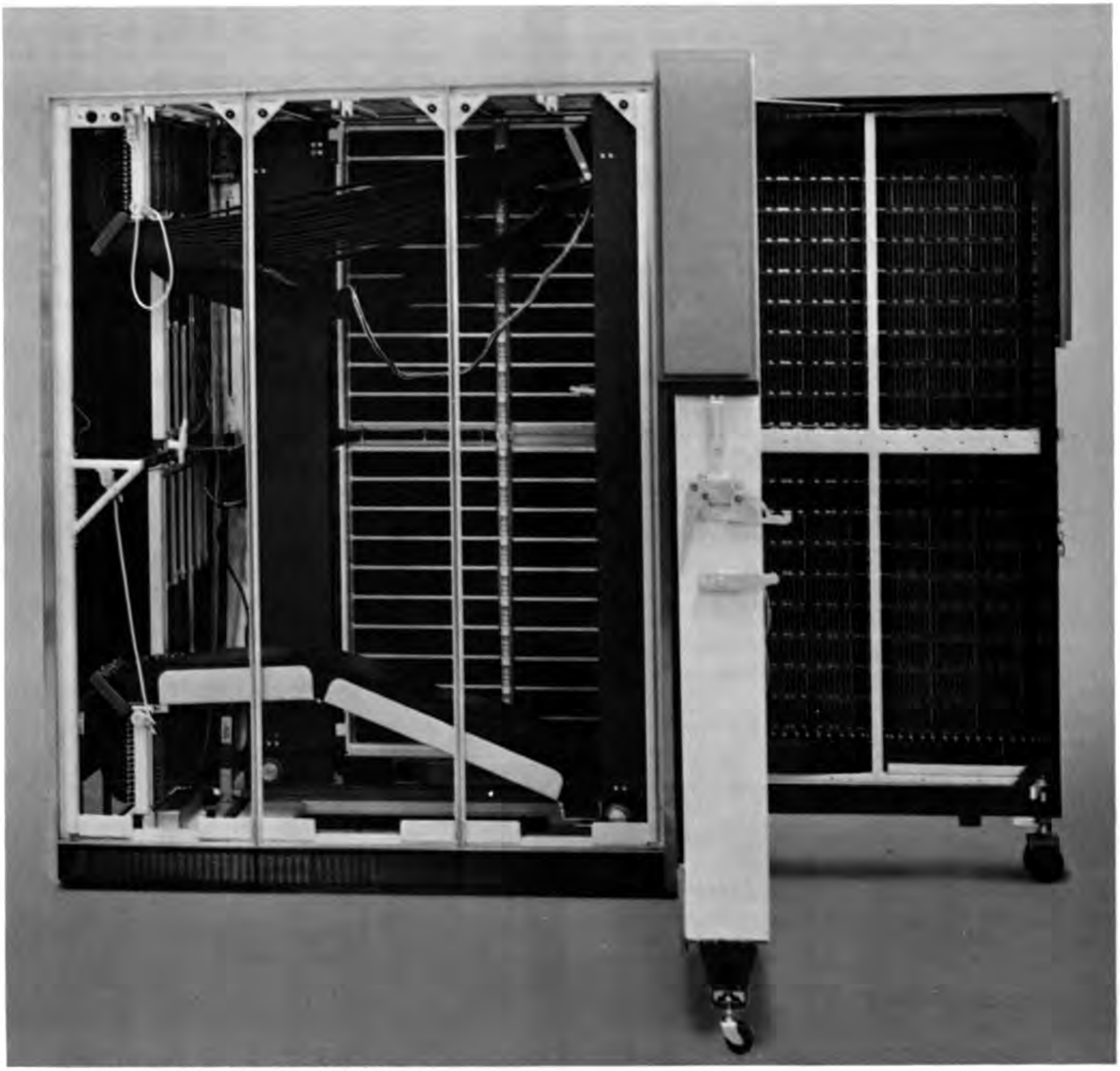


Figure 1. 29.5-Inch Sliding Gate Frame, Side View

edge connectors, hinge connectors, and panel connectors. T-connectors are wire-wrapping terminal blocks on the wiring side of the gate. They are arranged in two horizontal rows in the center of the gate (between panels 1, 2 and 3, 4).

Edge connectors occupy row A of panels 1 and 2 and row K of panels 3 and 4 as shown in Figure 5. These connectors route signals to and from the tailgate assemblies through drape cables. Each panel connector jumpers 16 lines from panel to panel. Twelve lines carry signal voltages, and four lines are grounded to serve as shields.

Hinge connectors occupy columns 1 and 2 of panels 1 and 3 of each gate (Figure 5). These connectors are used for signal routing between the two gates of a tower. Short cables, fitted with modified SMS cards, connect corresponding hinge connector terminals of the two gates. All hinge connector terminals are jumpered, regardless of whether they are used.

Two horizontal rows of T-connectors (Figure 6) provide vertical signal paths for interconnecting the panels of a gate. The two rows of T-connectors are adjacent across the center of the gate on the wiring side. All

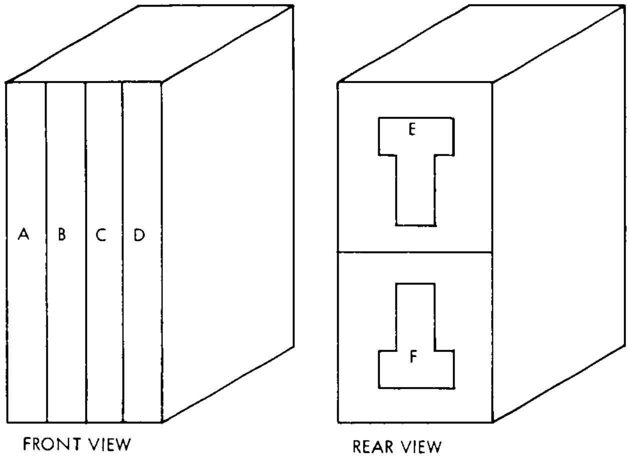


Figure 2. 29.5-Inch Sliding Gate Frame

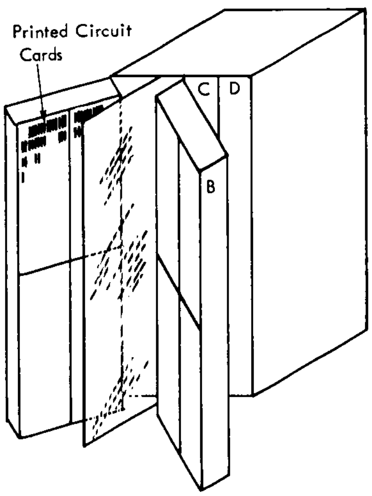


Figure 3. Sliding Gates

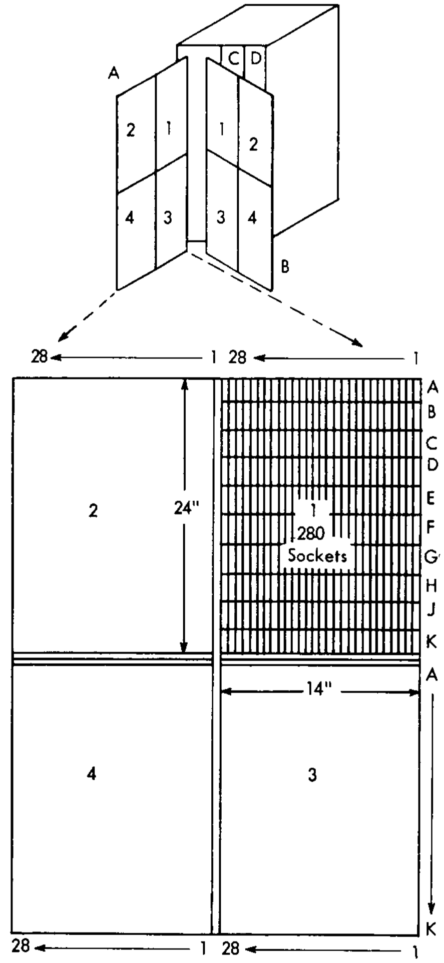


Figure 4. Sliding Gate Panels

corresponding terminals of the two rows are jumpered together by solid wire and wrapped connections.

The following table summarizes the use of all SMS card sockets on a gate. See also Figures 7 and 8.

	Panel 1	Panel 2	Panel 3	Panel 4
SMS Cards				
Rows	B-K	B-K	A-J	A-J
Columns	3-27	2-28	3-27	2-28
Edge Connectors				
Rows	A	A	K	K
Columns	1-28	1-28	1-28	1-28
Hinge Connectors				
Rows	B-K	None	A-J	None
Columns	1-2	None	1-2	None
Panel Connectors				
Rows	B-K	B-K	A-J	A-J
Columns	28	1	28	1

Note: Specific columns used are: 1, 2, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27 and 28. The columns not used for edge connectors are not used for any function due to space limitations.

Tailgates

The tailgate assembly consists of two T-shaped gates, gate E on top and gate F on bottom. Tailgates connect the I-O cables to the sliding gates and provide interconnections between gates. Access to the tailgates is from the rear of the frame. Both gates swing down for servicing.

Each gate has both SMS sockets and special cable sockets, arranged in nine columns labeled A through J (Figure 9). In the top of gate E and the bottom of gate F are located 16 SMS sockets in each column except in column E, gate F. These sockets are used for slide connectors that provide cable connections to the gates.

In the bottom part of gate E and the top of gate F are positions for 50 cable connectors used for interconnection between frames. These cable connectors are either the 40- or 20-position type.

For numbering purposes the tailgate is considered a rectangular block nine SMS sockets wide and 56 sockets deep. Rows are numbered 1 through 56 from

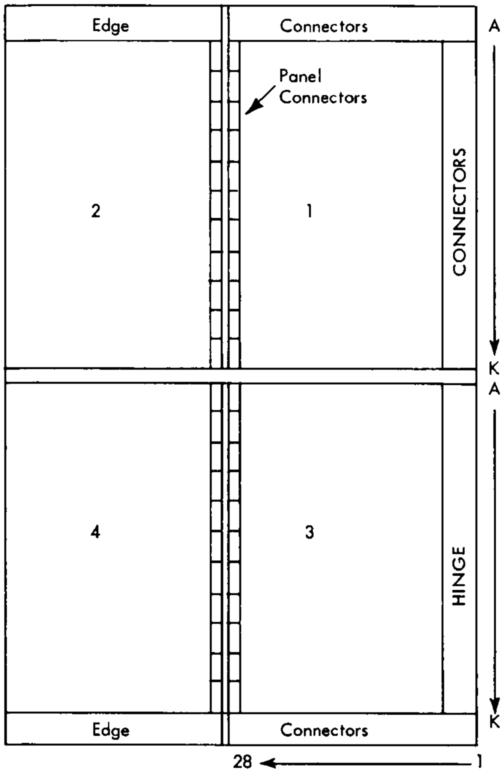


Figure 5. Panel Input-Output Connectors

the hinge up. Because the cable connectors are equivalent to four SMS sockets in width, the numbering on gate E is 1, 5, 9, and so on, and on gate F is 17, 21, 25 and so on.

LOCATION AND NUMBERING DESIGNATION

To properly locate pins, cards, or components in a system using Module II type packaging, the following identification system is assigned.

	IDENTIFICATION ASSIGNED	EXAMPLE
Machine type	3 or 4 digit number	7070
Frame	01 to 99	03
Gate	A through D	A
Chassis	1 through 4	2
Row	A through K (omitting I)	J
Column	1 through 28	20
Pin	A through R (omitting I and O)	D

Cable Routing

The edge connectors provide external connections for the gate, which mate with terminations of the drape cables.

The drape cables are terminated with soldered connections to modified printed circuit cards. One end of each drape cable is plugged into an edge connector; the other end is plugged into an SMS card socket mounted in the tailgate assembly. The drape cables connect corresponding terminals of the two SMS card sockets, regardless of whether all terminals are used. Figure 10

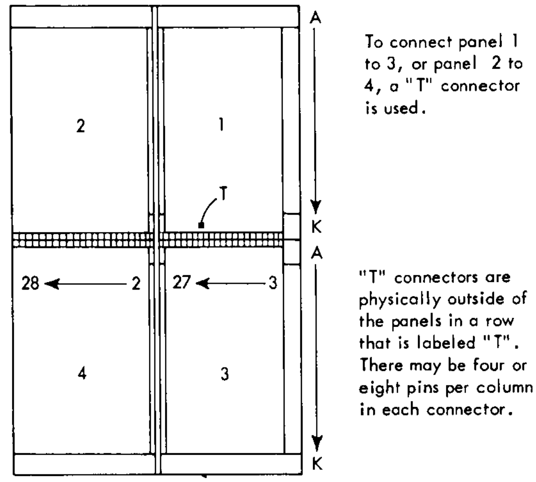


Figure 6. T-Connectors

shows the physical layout of the drape cables and the tailgate assemblies. The SMS card sockets are in the upper part of gate E and the lower part of gate F and are called slide connectors. The remaining portion of the tailgate contains cable connectors. These may be either coaxial connectors (16 or 20 position) or open-wire connectors (32 or 40 position). Both tailgates swing down to provide access to the wiring side.

A signal routed between the two towers of a frame must pass through one or both tailgate assemblies. Figure 11 shows an approved signal path between gates C and A of a frame. The circled numbers in the figure refer to the following paragraphs:

1. A signal is generated on SMS card X on panel 1 of gate C. Printed wiring carries the signal into a terminal of the card socket. A wrapped connection on the wiring side of the socket connects the signal into a jumper wire that is terminated with another wrapped connection on an edge connector socket terminal.
2. A drape cable connector picks up the signal on the card side of the panel, and a soldered connection passes the signal to a coaxial conductor in the drape cable. The opposite end of the drape cable plugs into a tailgate slide connector.
3. A wrapped connection on the wiring side of the tailgate connects the signal into a jumper wire that is terminated with a crimped connection and plugged into a cable connector.
4. A jumper cable is plugged into the opposite side of the cable connector on tailgate E and also into a cable connector of tailgate F.
5. A jumper on the wiring side of tailgate F joins the cable connector terminal to a slide connector terminal.
6. A drape cable carries the signal from the slide connector to an edge connector on gate A.
7. A back panel jumper wire completes the route by connecting the edge connector terminal to a terminal on card socket Y.

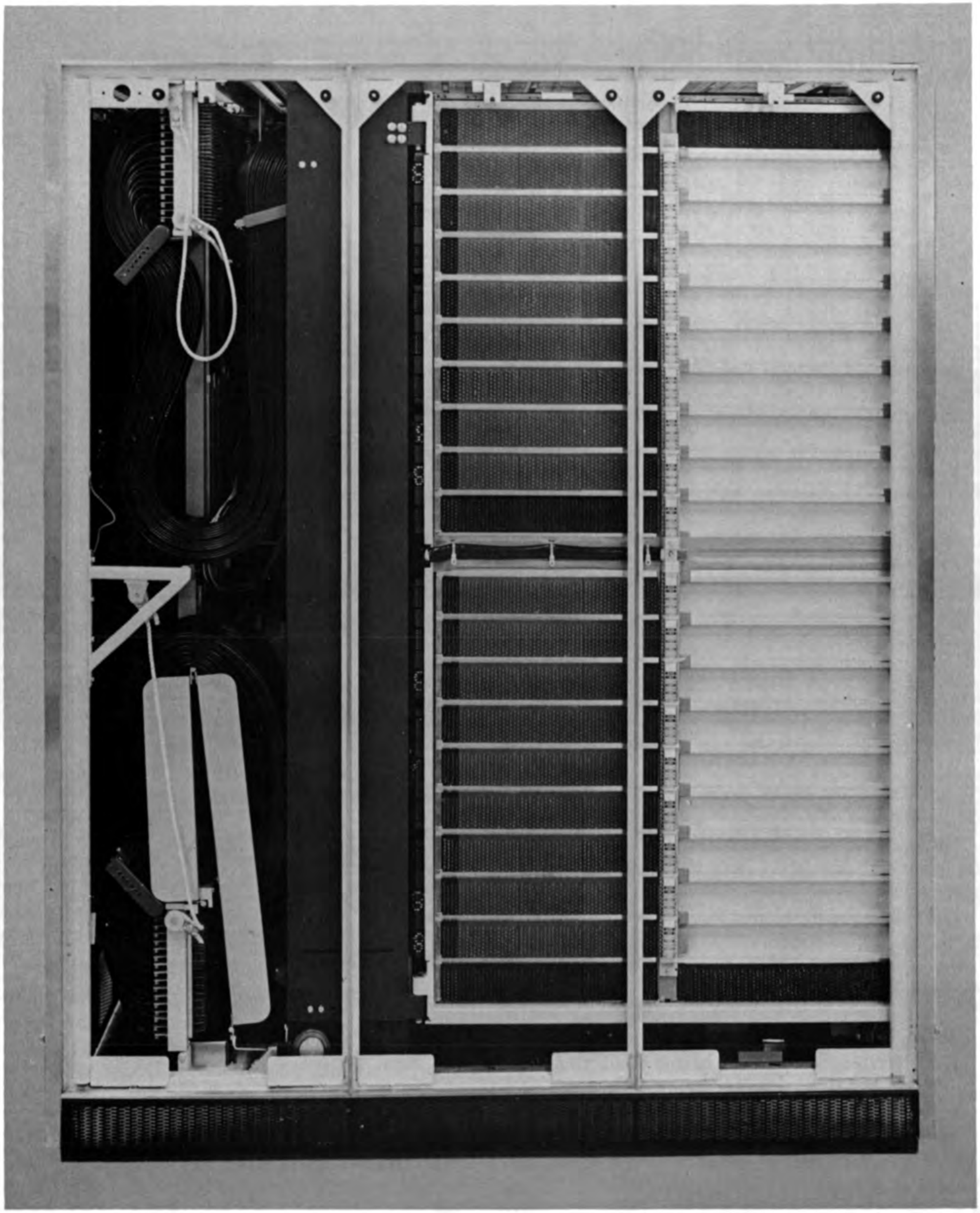


Figure 7. 29.5-Inch Frame – Sliding Gate

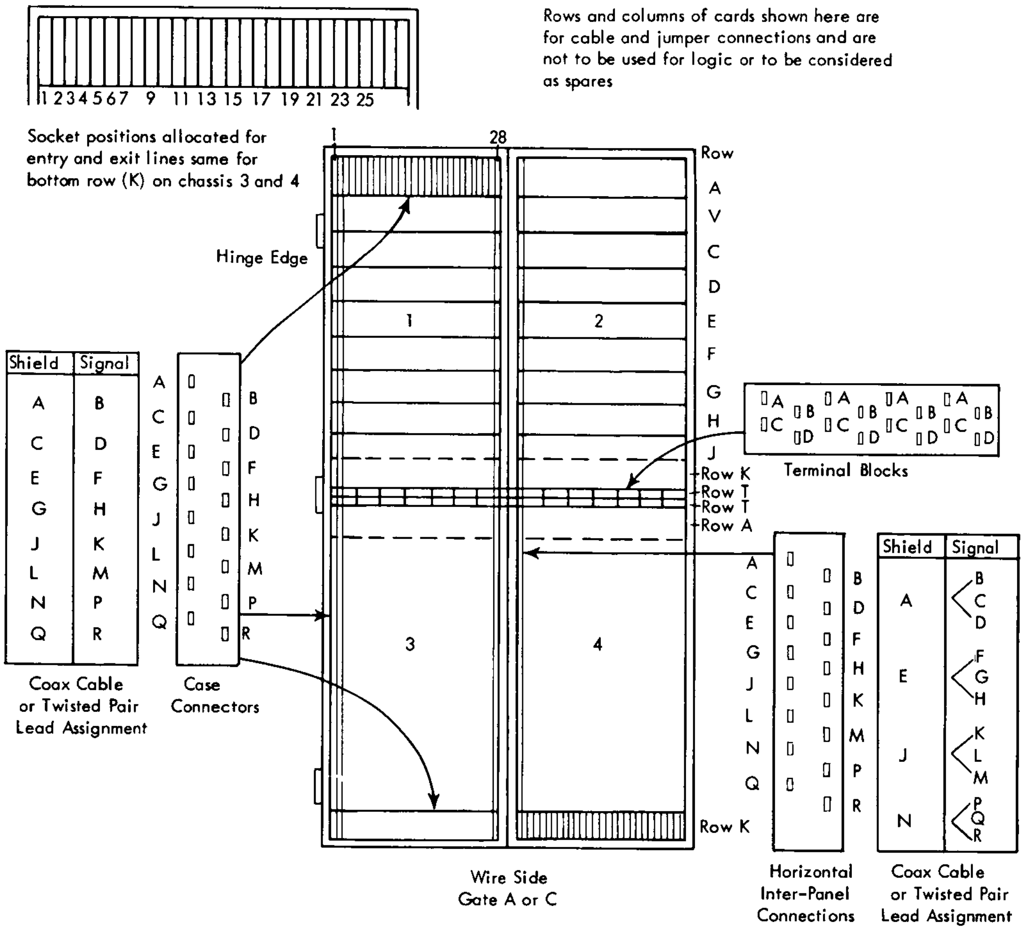


Figure 8. Connector Terminals

Signal routing between frames is accomplished by cables between tailgates.

Figure 12 shows the power distribution to the card sockets. Circled numbers refer to the following paragraphs:

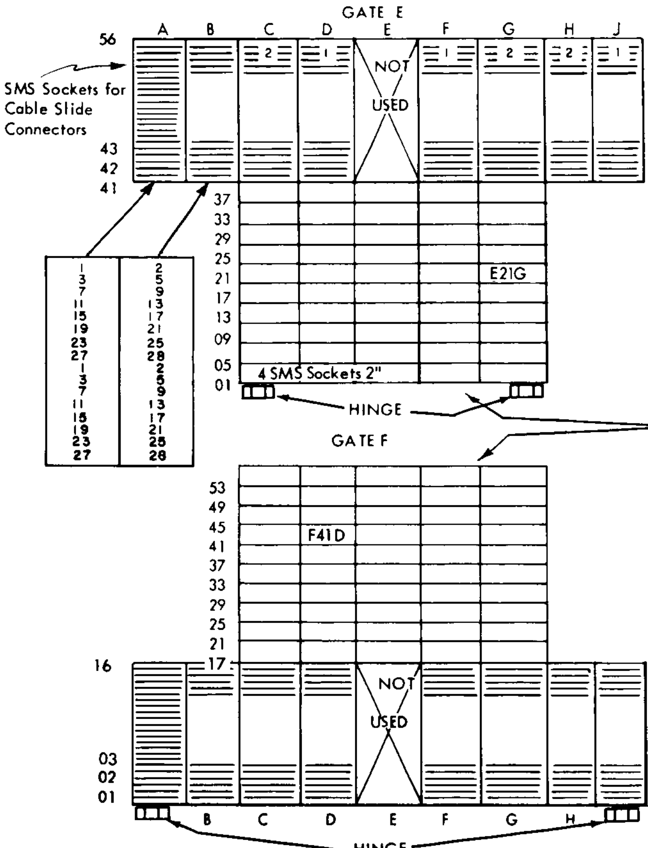
1. Voltages are developed in the power supply unit on the rear of the tower.
2. A cable connects the voltages to a barrier strip on the hinge edge of the gate.
3. A horizontal, insulated laminar bus passes the power on to a vertical laminar bus (Figure 13).
4. The vertical laminar bus has terminals to accept spring crimped connectors for each card row.
5. Jumper wires connect the laminar bus terminals to card socket terminals.
6. The card socket terminals (jumpered to the laminar bus terminals) are connected to all other terminals of the panel that lie in the same horizontal row. These connections are made by printed conductors on a card (overlay) or by flat conducting strips (voltage chains). In either case (overlay or voltage chain), the horizontal conductors are soldered to the card socket terminals.

20-Inch Sliding Gate Frame

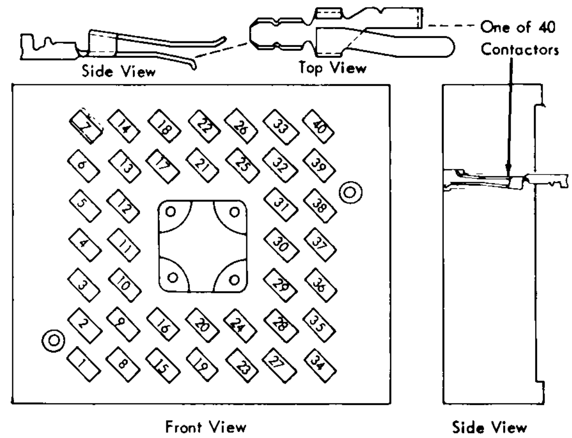
The 20-inch sliding gate frame, like the 29.5-inch frame, is intended for large data processing systems. This frame is 20 inches wide, 56 inches deep and 69 inches high. One two-gate tower is housed in the 20-inch frame, which allows greater clearance for cabling than two towers in a 29.5-inch frame.

The sliding gates are identical to those of the 29.5-inch frame except that more edge connector sockets are available due to the additional cable clearance. The available edge connector columns are 1, 2, 3, 5, 7, 8, 9, 11, 12, 13, 15, 16, 17, 19, 20, 21, 24, 25, 27, and 28.

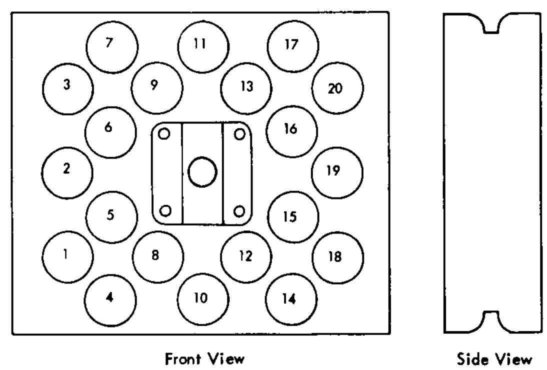
The tailgates of the frames do not contain slide connectors. Coaxial connectors (16 and 20 position) and open-wire connectors (32 and 40 position) fill all positions on the two tailgates. Individual conductors of the drape cables terminate with crimped connections on the wiring side of the tailgate cable connectors. Note that tailgate G is identical to tailgate H (Figure 14).



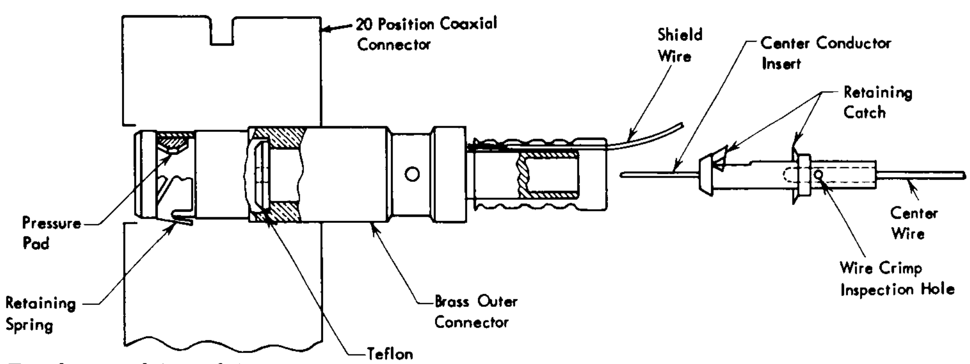
Tail Gate Assembly, Module II



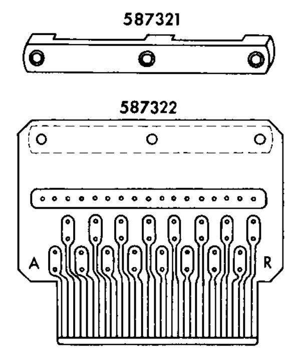
40-Pin Coaxial Connector



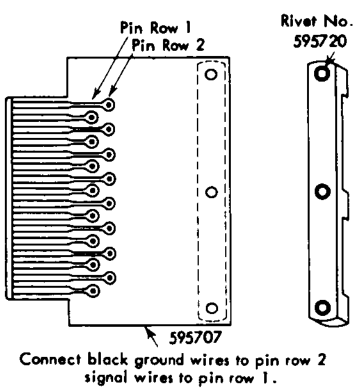
20-Pin Coaxial Connector



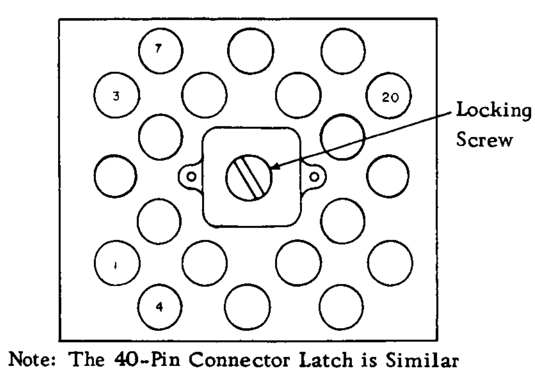
Female Coaxial (Burndy) Connector



Coaxial Slide Cable Connector



Slide Cable Connector



20-Pin Connector Latch Assembly

Figure 9. Tailgate Assembly, Module II

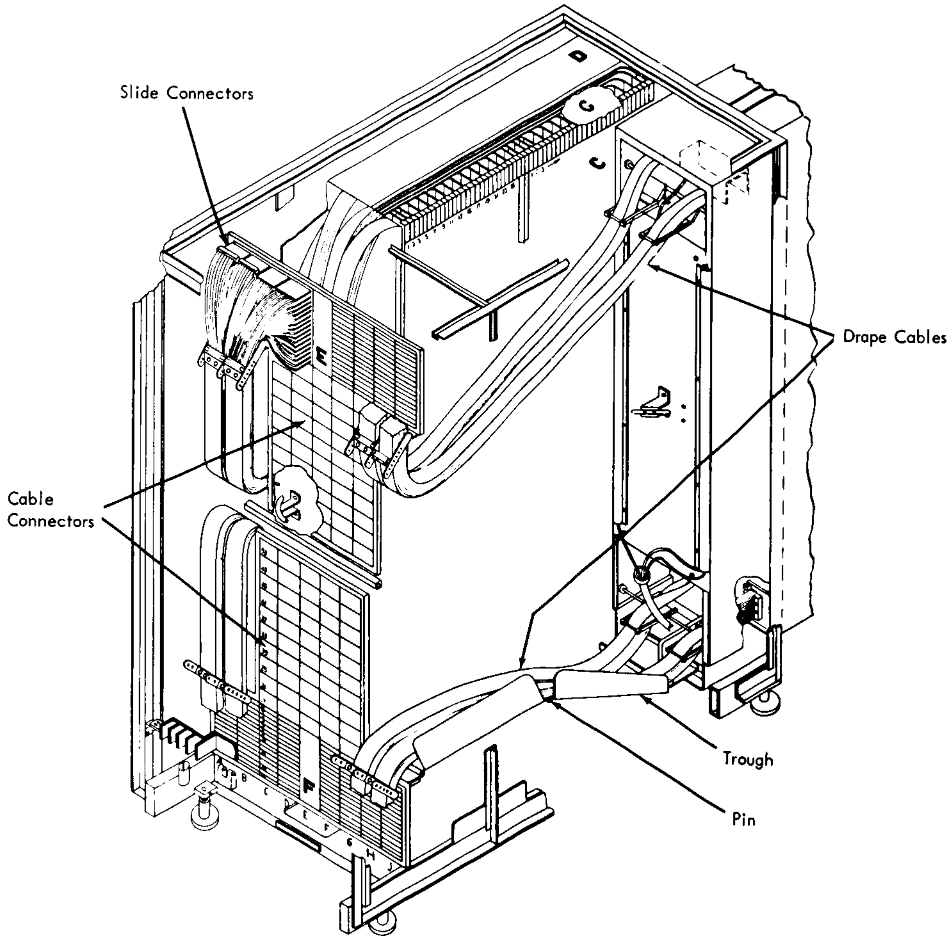


Figure 10. Cable Routing to Tailgates

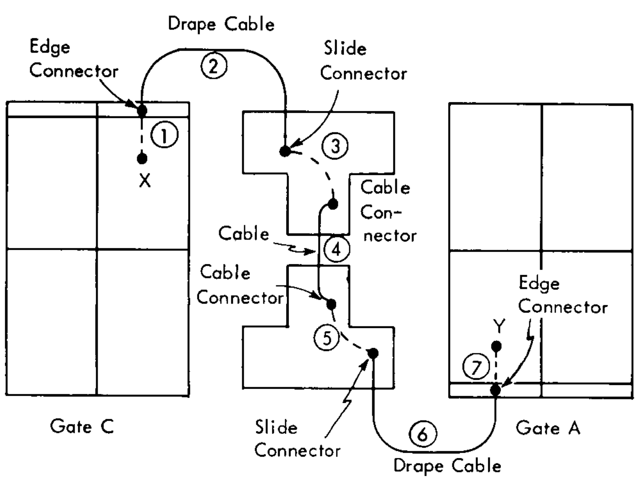


Figure 11. Example of Signal Routing Between Towers

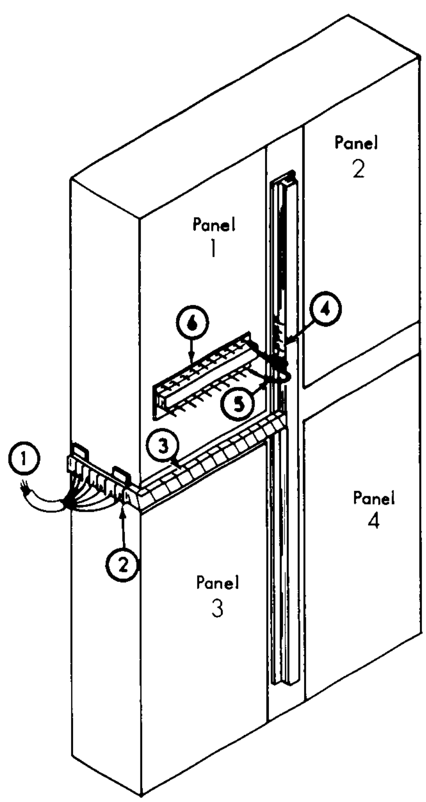


Figure 12. Sliding Gate Power Distribution

Figure 13. Vertical Laminar Bus

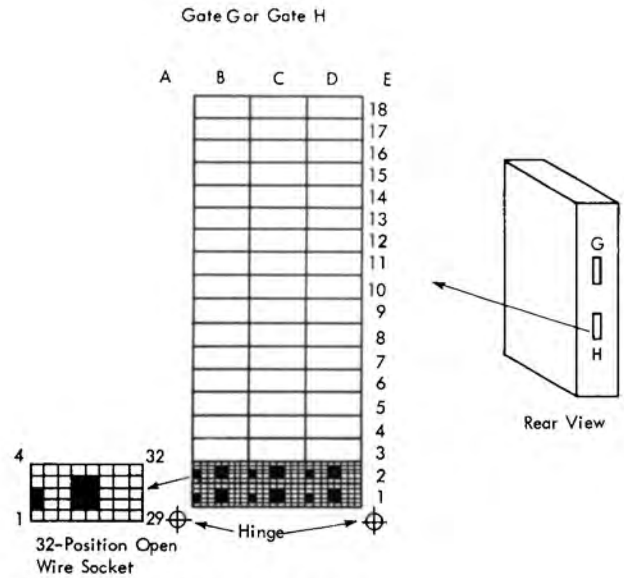


Figure 14. 20-Inch Frame Tailgates

Rack and Panel Module

A rack and panel module (SMS Module IV) has a rectangular base with a vertical superstructure, forming an inverted T. Components are mounted on a frame within the module. There are two types of frames: the fixed gate frame accepts four 10 x 28 card chassis assemblies; the universal basic frame holds standard power supplies, memories, card chassis, and so forth. Figure 15 shows a rack and panel module with covers. Figure 16 is a rear view of a fixed gate frame assembly. Figure 17 is a front view of a universal basic frame with power supplies mounted.

Outside dimensions of the module are: height, 70 inches; width, 36; and depth, 29. These dimensions include casters, but not covers.

COOLING

Housed in the base are blowers, air filters, and input-output (I-O) cable connectors. Part number (P/N) 760159 is the single phase, 60-cycle blower assembly used in a rack and panel module.

Figure 15. SMS Module IV

Figure 16. Fixed Gate Frame Assembly Rear

Figure 17. Universal Frame, Power Supply Mounting (Front View)

When troubleshooting the card side of the module with the inner card doors open, hot spots will develop in the upper card chassis; the inner doors should be left open as little as possible.

LAYOUT

Figure 18 shows the frame layout and numbering for a four-chassis frame. Paddle card jumpers connect chassis and modules. Columns 1 and 2, 27 and 28 are reserved for inter-chassis jumper cards or cable cards. Vertical communication is by edge connectors in the T rows. Chassis 7 contains two rows of I-O connectors. Each row can contain 52 SMS card sockets, or 13 standard 40-position biscuit connectors.

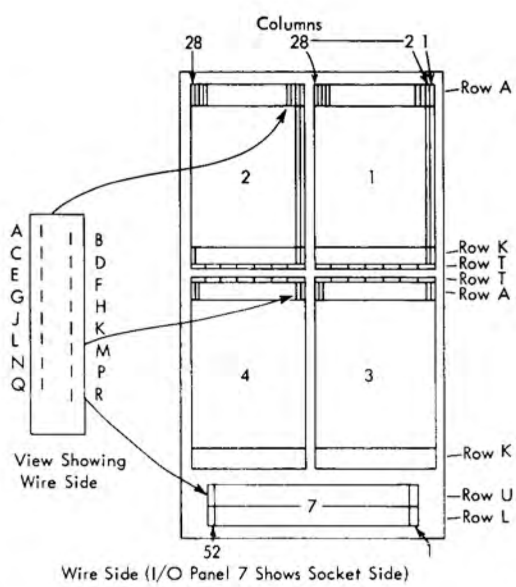


Figure 18. Logical Frame Layout – Four 10 x 28 Chassis

POWER DISTRIBUTION

A laminar bus with a terminal at one end can be mounted at the top of the frame. The frame has two raceways: the front raceway contains DC voltages; the rear raceway normally contains AC voltages, and other cabling from module to module.

COVERS

All front and rear outer covers of a rack and panel module are interchangeable, and may be removed by lifting them off their hinges. Name plate doors are on the extreme right end, front and back. End covers are bolted on, and require a wrench for removal.

Swinging Gate Cube

Swinging Gate

The vertical swinging gate frame is designed for smaller data processing systems. Each frame consists of two basic cubes (SMS MODULE I), 29 inches wide, 30⅝ deep, and 27 high without casters. A module may be used alone or stacked with another module to form a frame.

Each module contains eight gates, numbered as shown in Figure 19. Gates 1 to 4 open to the front of the module, and gates 5 to 8 open to the rear of the module. The gates in module B swing up to open; those of module A swing down (Figure 20).

A gate may contain 156 card sockets arranged in six columns and 26 rows (Figure 20). Normally, the card sockets of rows 1 and 2 of module B and rows 25 and 26 of module A are used for cable connectors. One gate of the frame houses the power supply, which may be in either module A or Module B.

There are no tailgates associated with a swinging gate frame; regular gate positions are used for input and output cable connections. The gate contains a maximum of three cable connectors, which are any combination of summary punch connectors and 200-position cable connectors. Cable connector gates are in module B; the connectors are designated as shown in Figure 21.

Wiring between gates of a swinging gate frame is made through card sockets used as edge connectors. Cables connecting edge connectors may be between any two gates within the frame. Unlike the sliding gate frame, the location and number of cables depend on the requirements of an individual frame; there is no standard set of interconnecting cables.

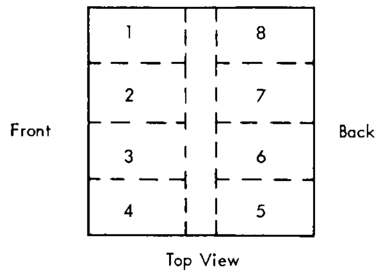


Figure 19. Vertical Swinging Gate Numbering

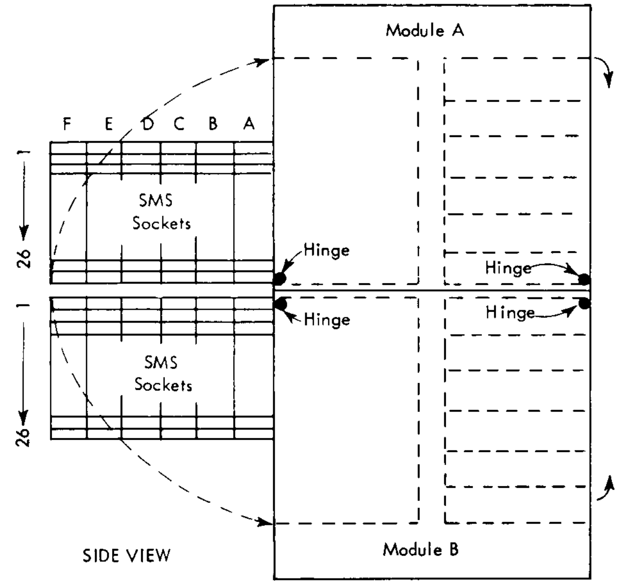
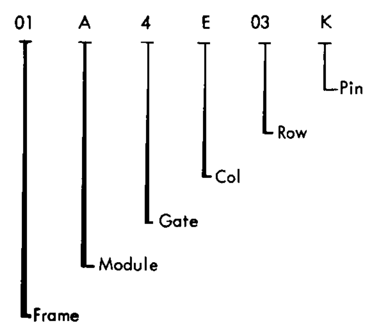


Figure 20. Swinging Gate Frame

Identification of locations within a swinging gate module is:



Open-Wire Connector, 200-Position

The 200-position open-wire, low-voltage multiple connector is used in the SMS swinging gate frames and on auxiliary devices such as tape units. A complete connector is made up of a cable-half and a machine-half (Figure 22).

COMPONENTS

The Terminal Board is the basic unit of the connector. Identical terminal boards are used in the cable-half and in the machine-half. Two boards mate together by a tongue and groove arrangement when opposite sides of the board face each other. A board can be mounted in any one of eight positions (four positions 90° apart, with either side out), allowing eight different connectors to be assembled.

Mountings: The machine-half board is mounted by means of two mounting guides (Figure 22). Two types

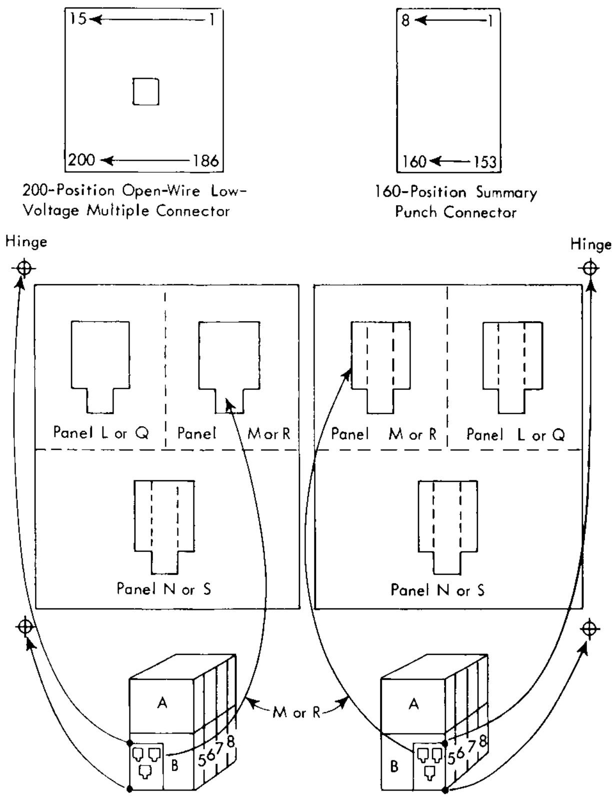


Figure 21. I-O Cable Connector Gates

of shells can be used for mounting the cable-half: one has a 90° cable entrance into the shell; the other has a 45° cable entrance into the shell.

Strain Relief: Figure 23 shows the correct assembly of the strain relief components that are located in the strain relief well of the cable-half shell. For large cables, the metal adapter is omitted. New rubber collets are for 1¾ inch cables. If the cable diameter is less than 1¾ inch, the rubber collet must be cut to fit.

Terminals: The AMP open-wire connector terminals are sometimes called dual contact terminals because of their dual mating surfaces. Complete information on these terminals and the procedures for their use are stated under "Crimped Termination Procedures."

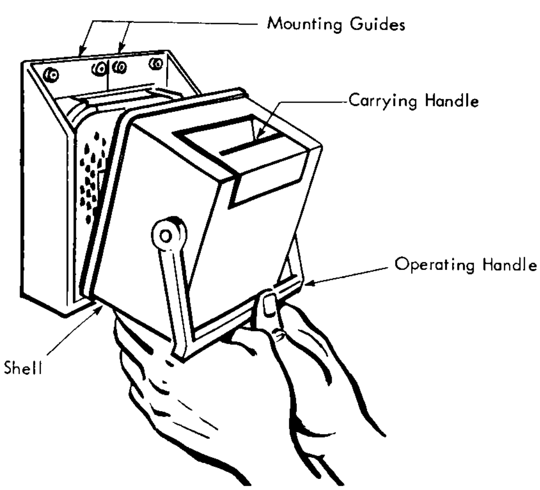


Figure 22. Mating Cable-Half of Connector to Machine-Half

Latching Mechanism: Mating dual contact terminals must be held together under pressure to form an electrical connection. This is accomplished by a latching mechanism that holds the connector halves together.

The mechanism consists of a latch and two keeper plates. One keeper plate is attached to the center of each terminal board. A latch is operated by the operating handle (Figure 22) on the cable-half shell and extends through the keeper plate of the cable-half terminal board. The latch has a notch that fits over a lip in the keeper plate of the machine-half. When the operating handle is moved upward, the latch retracts, forcing the connector halves together.

Three positions of the operating handle are used: the extreme up position forces the connector halves to mate completely; the normal down position allows the connector halves to be mechanically latched, with no electrical connection (the latch is hooked over keeper plate lip); the extreme down position (spring-loaded) lifts the latch so that the connector halves can be separated.

Mating Cable Halves: The latching mechanism allows two cable halves to be mated, if the terminal blocks are properly oriented. An example of this application is found on tape units connected to a computer system. One cable from the system is connected to one tape unit; a second tape unit is connected to the first; a third connected to the second. . . . When one tape unit is removed from the chain for off-line testing or repair, the remaining cable-halves can be mated to allow all other units to be used in the system.

When mating two cable-halves, care must be taken to prevent breaking one of the keeper plates. Note that a latch from each half is locked in the opposite keeper plate. If the operating handles are in different posi-

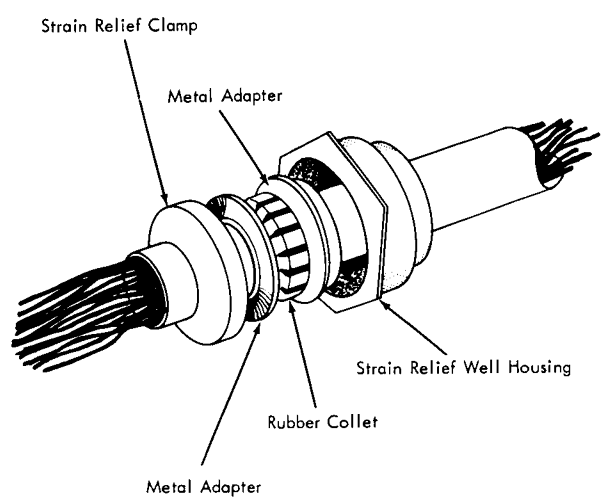


Figure 23. Strain Relief

tions the latches will be pulling against each other. To prevent breaking a keeper plate, move both handles together when engaging or disengaging the cable-halves.

DISASSEMBLY

The machine-half is disassembled by removing the bolts from the mounting guides. Terminals can be removed from the board by raising the claw over the raised lip of the board. Do not use any metal tool directly on the terminals.

To disassemble the cable-half, use a 3/32-inch Allen wrench to remove a screw in the keeper plate. Slide the terminal board and strain relief from the shell as an assembly. The strain relief may be disassembled by removing two 5/32-inch Allen screws located near the cable entrance.

When installing the terminal board and strain relief assembly into the shell, hold the operating handle in the extreme downward position to allow the latch to slide through the keeper plate. Make sure that the cable wires are clear of the latching mechanism before installing the keeper plate Allen screw.

Double Cube

The double cube (Module v) is a welded frame having a 16-gate capacity equivalent to the bolted-together double Module I. The double cube (Figure 24) is 60 inches high including casters, an increase of two inches that allows more room for cables; it is 29 inches wide and 30⅝ deep.

Figure 24. Module v, Double Cube

Sliding Gate Cooling System

The cooling assemblies for a sliding gate frame consist of a motor, a blower-assembly, and a set of filters. One assembly is mounted at the bottom of each gate.

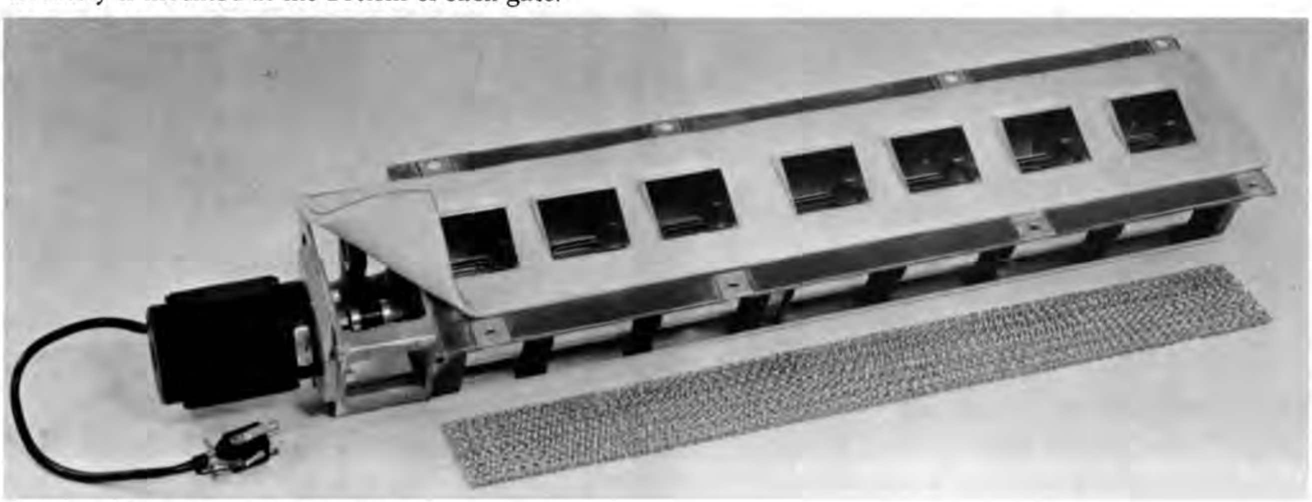


Figure 25. Blower Assembly, 7-Scroll, 1/30 HP

Figure 25 illustrates assembly, P/N 598593, equipped with a 1/30 HP motor. Units available are:

HP	No. of Scrolls	Volts	Phase	Cycle	RPM
1/30	7	230	3	60	3500
1/9	5	208/220	3	60/50	3500/2900
1/8	7	230	3	60	6600
1/4	4	208	3	400	5400

The direction of blower shaft rotation is indicated by an arrow stamped on the front of the blower housing. The 1/9 and 1/4 HP blowers are available in both directions of rotation: clockwise for gates A and C, counterclockwise for gates B and D, viewed looking at the front of the gate.

All the blower assemblies have a direct drive system except the 1/8 HP 7-scroll assembly, which has a belt transmission.

CAUTION: The motor cable must be disconnected if a gate is opened: beyond the 45° stop for SMS frames delivered before December 1960; beyond 70° for those delivered after December 1960. If not disconnected, the cable may break.

SMS Printed Wiring Cards

Standard printed wiring cards are used in the module I and module II types of packaging. These SMS printed wiring cards facilitate the manufacturing process and permit standardization of circuits. The pluggable printed circuit cards contain all the components and printed wiring necessary for the particular electronic function or functions. A special program cap on some SMS printed circuit cards gives additional flexibility to this form of packaging, and reduces the number of component cards required for field servicing. Other printed wiring cards are used as cable connectors and back panel voltage distribution buses.

Standard Card

The SMS single card (Figure 26) is made of an epoxy paper laminate material and is 0.062 inch thick, 4½

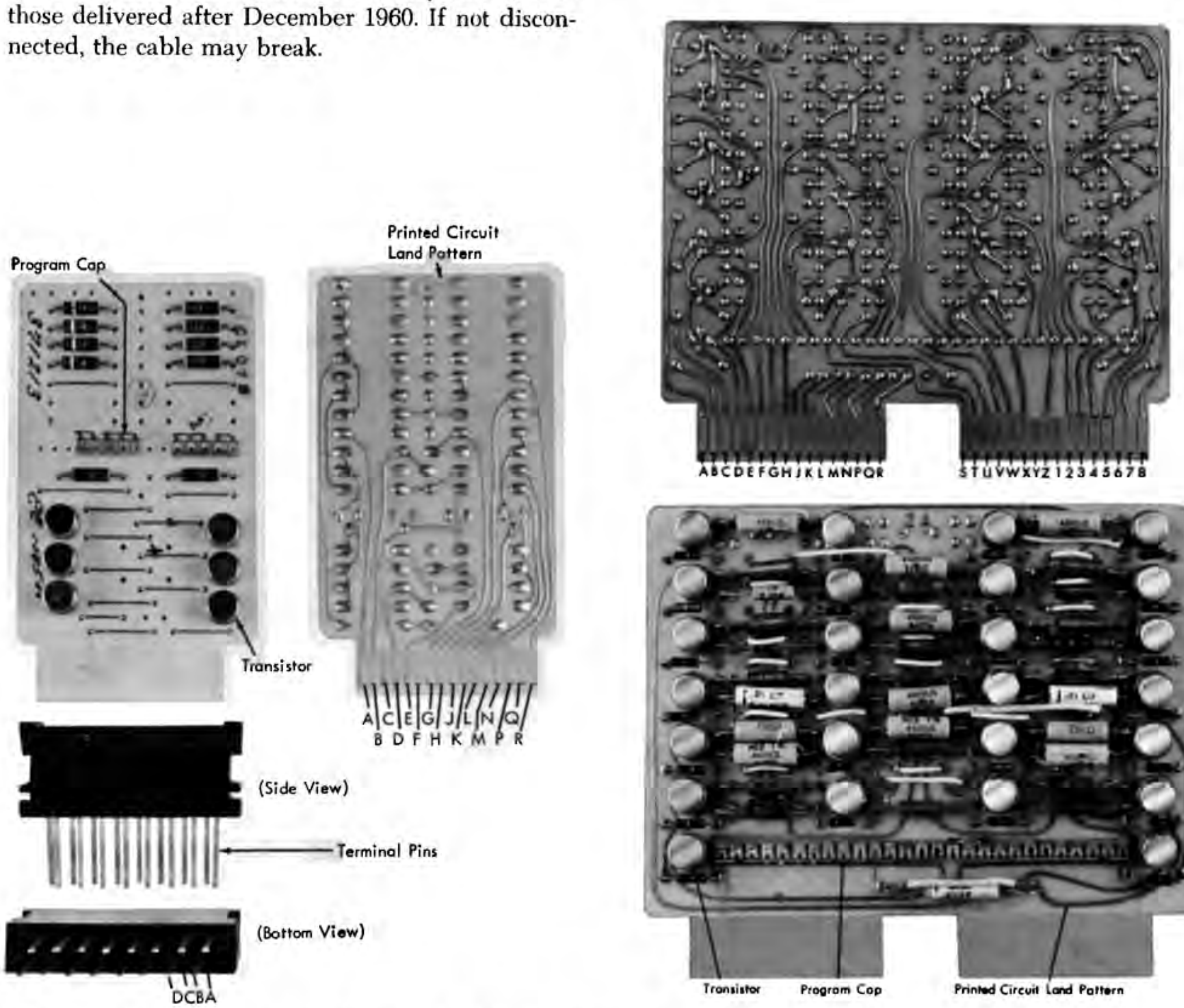


Figure 26. SMS Printed Wiring Cards (Single Card and Socket, and Double Card)

inches long, and 2½ inches wide. All of the electronic components and the program cap, if used, are mounted on the front side of the standard SMS card form. Connections to the components and program cap are made on the back side of the SMS card form by printed wiring patterns which terminate at 16 possible contacts at the bottom of the card. These contacts, labeled A through R as shown, couple the signal and standard service voltages to the circuit components when the card is inserted in the SMS socket. The printed circuit wiring or land pattern is dependent on the circuitry used.

The SMS double card (Figure 26) is made of the same laminated material used in the single card. The double card is 5⅜ inches wide, with other dimensions the same as for the single card. The electronic components and the program cap are mounted on the front side of the card. Connections to components and program cap are on both sides of the card and are made by printed wiring patterns that terminate at 32 possible contacts on the back side. These contacts couple the signal and service voltages to the circuit components when the card is inserted into two vertically adjacent SMS card sockets. Figure 26 identifies the contacts as A through Z and 1 through 8. This designation is not used on all machines, and may appear instead as A through R for each socket.

The double card accommodates up to 26 transistors and their associated components. To facilitate mounting, components are usually stacked in two layers on the front side of the card.

The use of the double card results in more circuitry in a given space, compared to single cards. The double card is desirable in high-speed circuitry because more logical operations can be performed before the resultant signal must be directed to other cards by way of connectors and back-panel wiring. This eliminates much line capacitance that is often a limiting factor.

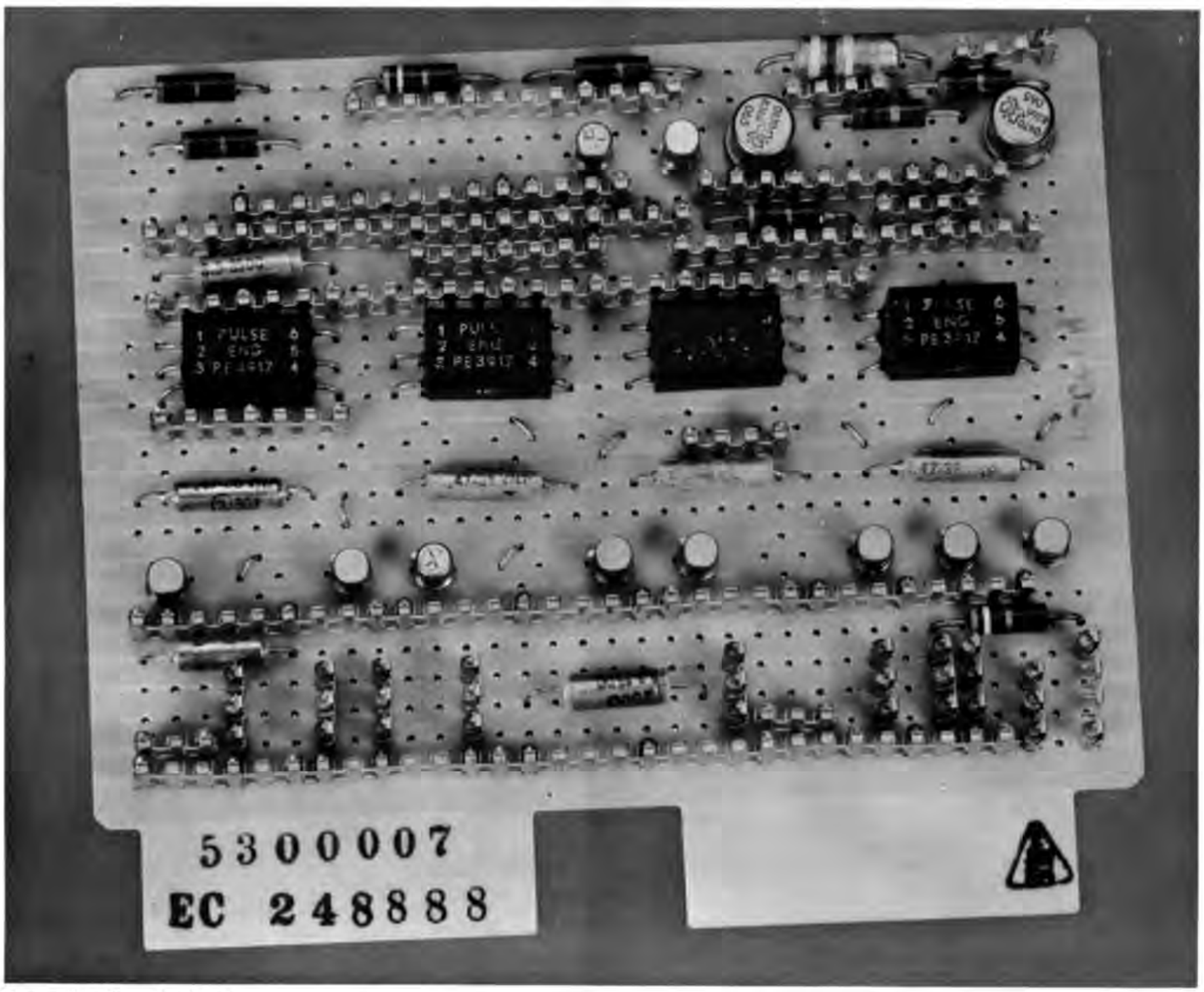


Figure 27. Stan-Pac Card

Stan-Pac Card

The Stan-Pac card (Figure 27) is identified by its vertically mounted components. Resistors, diodes, chokes, and so forth have their top terminal welded to a component mounting strip, P/N 5301505, which clamps to the body of the component for mechanical strength. This strip also provides an electrical path to the adjacent component. Bottom terminals of the components pass through a hole in the card and are soldered to a land pattern on the reverse side of the card.

A card extraction tool, P/N 461103, should be used to extract Stan-Pac cards from their sockets.

Program Cap

The program cap located on the front of some of the SMS cards consists of two conductor rails which, in the pre-cut state, connect to 15 tabs on the printed circuit land pattern. By cutting the program cap, various jumpering connections are made to the tabs to allow one SMS card having a definite land pattern to be used in several different circuit configurations. The jumpering of these connections on the program cap are referred to as "cap connections." See "Field Replacement Cards."

Card Identification

A four-letter code is assigned each card to identify it among the large number of SMS cards required for packaging all the electrical circuits required in data processing equipment. The first two letters designate a card code that is assigned from AA to ZZ, in alphabetical order. The last two digits refer to a specific cap connection made on the SMS cards that have program caps. The cap connection code is assigned from ZZ to AA in this order. If all cap connections are cut, or if a card does not have a program cap, -- will be

Double Cards			
Single Cards			
A	Signal	S	Signal
B	"	T	"
C	"	U	"
D	"	V	"
E	"	W	"
F	"	X	"
G	"	Y	"
H	"	Z	"
J	Ground	1	Ground
K	-6v	2	Signal
L	+6v	3	"
M	-12v	4	"
N	+30 or +12M	5	"
P	-36 or -20	6	"
Q	+6M or +12	7	"
R	-12M	8	"

Figure 28. Commonly Used Pin Connections, Single and Double Cards

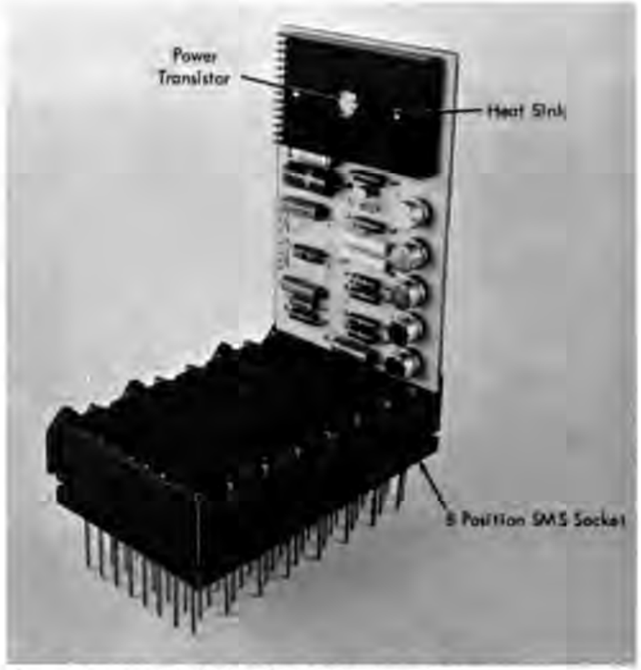


Figure 29. SMS Single Card and 8-Position Socket

used in place of the code letters for cap connection (e.g., AK--). Both a card code and a cap connection code are required to identify a card properly. On the component side of each card is stamped the assembly part number.

SMS Card Receptacles

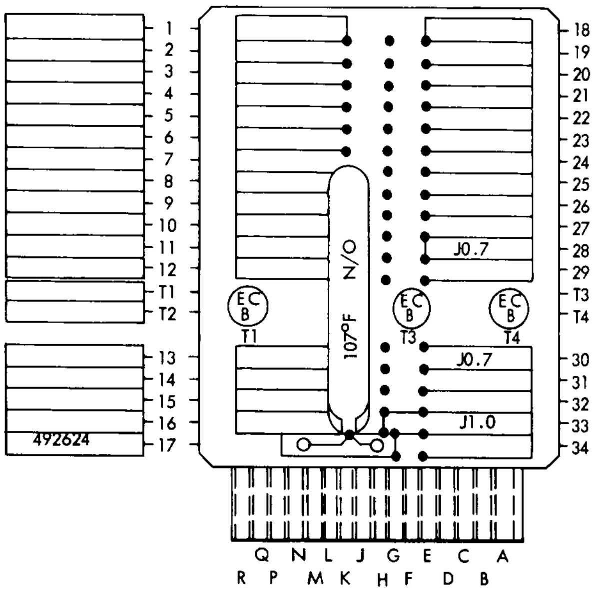
The pluggable printed circuit cards are inserted into SMS receptacles as shown in Figure 26. Although the contacts are all in line on the card insertion side of the SMS receptacle, they pass through the receptacle in a staggered arrangement as noted in the figure. This staggering allows additional room for wire-wrapping or soldering of signal and voltage wires (Figure 28) to the terminal pins. Figure 28 shows commonly used pin connections; other configurations are also used, depending on the circuit family — for example: CTDL, alloy, drift, etc. Figure 29 shows an 8-position socket also used in the SMS packages.

Special Printed Wiring Cards

Modified pluggable SMS cards are used as inter-chassis cable connectors to facilitate the manufacturing and servicing processes; they are inserted into the SMS receptacles.

Thermal Cards

Figure 30 illustrates a thermal card, normally located at the top of the gate to sense an excessive air temperature. The 107°F thermal card is used in all machines containing diffused transistors, while the 122°F thermal



Temperature	Contacts	Part Number	Card Type
107F	N/O	371696	UX--
107F	N/C	371697	UY--
122F	N/O	371698	RD--
122F	N/C	371699	RE--

Figure 30. Thermal Card

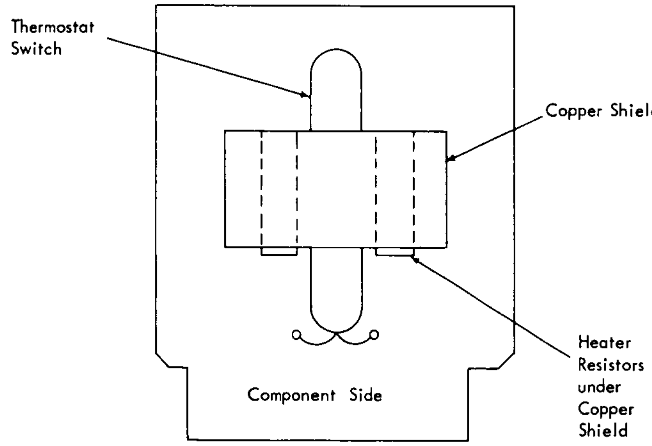
card is used in gates containing alloy junction transistors. The thermal switches on the cards are connected to the bias winding of the magnetic amplifier in the power supply. Operation of the switch by a rise in temperature drops power to the power supply.

Air Flow Cards

Air flow cards (Figure 31) are similar to thermal cards, but have two heating resistors. Air flow cards are located at the bottom of the gates, over the blowers. As long as the blower is running properly, the flow of air is sufficient to carry away the heat generated by the resistors. If the blower should stop, the resistors would heat the thermal switch on the card, causing the switch to open and drop power, as with the thermal cards. The switch opens within two minutes starting at an ambient temperature of 65°F, or within 30 seconds starting at an ambient temperature of 80°F.

Baffle Cards (P/N 598225)

Baffle cards simply divert the air flow for more efficient cooling. The baffle card is a gray plastic card with two adjustable flaps that may be swung down from a vertical position to any angle between 0 and about 90 degrees. By reversing the card, these flaps may be



Part Number	Ambient	Blower
371751	80F	1/30 hp
371752	80F	1/8 hp
327888	90F	1/8 or 1/30 hp

Figure 31. Air Flow Card

swung right or left. The baffle card assembly can be attached to the eight 8-32 studs in the neoprene card cover retaining strip on the vertical center channel of the gate.

Short card guides should be positioned adjacent to the baffle card. A full complement of eight baffle cards is recommended for gates of high wattage dissipation. None need be used on gates having a maximum wattage per column less than ⅓ the rated wattage. Otherwise the recommended minimum is two baffle cards for two horizontal panels, and four for the complete gate of four panels. It is preferable to locate the four baffle cards on the 1st, 3rd, 5th, and 7th studs from the bottom. The cards should be oriented so that the flaps swing toward the printed side of the circuit cards rather than the component side, except in areas at the vertical edge of a panel where baffles are needed. The card flap may be adjusted to block the air flow from one through four columns by resting the end of the flap against a circuit card or gate wall. If a baffle card is removed, be sure to reinstall it in the same position.

Dummy Cards (P/N 598081)

Dummy cards are black plastic, blank cards having no components, used to mark the extent of occupied socket positions, or to indicate unused sockets. Before removing isolated SMS circuit cards, flank the cards to be removed with dummy cards to insure putting the circuit cards back in their proper sockets.

Soldered Connections

Soldering is one of the most popular methods of joining conductors because of the excellent physical and electrical qualities of a properly made soldered connection. One disadvantage of the soldered connection is that the quality of the connection depends greatly on the skill of the individual. SMS soldering requires even greater than normal skill; this is especially true for printed circuit repair.

This section contains general soldering information that applies to any soldered connection. Special considerations, necessary for the repair of printed circuit cards, are given under "Service Techniques."

Soldering Theory

Metal is, to a small degree, like a sponge. Under a powerful microscope, it does not look as smooth as when it is observed with the naked eye. A metal can absorb a gas just as water absorbs gas. It can, to a lesser degree, absorb moisture.

When heated metal is brought into contact with liquid solder, the metal actually absorbs some of the solder. When cooled, the solder solidifies or freezes in the pores of the metal, and has tentacles into the metal which fasten it securely. The solder has actually penetrated the metal, but only for less than a thousandth of an inch.

If the metal is cooler than the temperature needed to melt the solder, the solder freezes across the pores instead of filling the holes in the metal. When this happens, the solder does not stick to the metal and can be easily removed. To make a strong joint, the work must be hot enough to keep the solder melted and allow it to penetrate.

When exposed to air, all metals become covered with a layer of oxide. Often this layer is so thin that it cannot be seen; however, it acts like a blanket, preventing the soldering iron from properly heating the metal. This oxide layer also prevents the liquid solder from penetrating the metal, and, therefore, it must be removed. This oxide removal is accomplished by the flux.

The following sequence occurs whenever a good soldered connection is made:

1. Heat is transferred from the soldering iron to the work.
2. As the temperature of the work rises, solder and flux are applied.
3. At a temperature of about 300°F, flux reaction begins. The flux flows over the work and chemically removes the oxide coating.
4. When the work reaches a temperature of about 361°F, the solder begins to melt.
5. The liquid solder penetrates the pores of the work, displacing the flux.
6. When the source of heat is removed, the work and solder begin to cool.
7. As cooling progresses, the solder solidifies, completing the process.

Steps in the Soldering Process

The soldering process involves six steps: selection of materials, preparing the soldering iron and tip, preparing the work, heating the work, applying the flux and solder, and cooling.

Selection of Materials

Selection of the proper materials is essentially limited to the soldering iron and tiplet. Recommended items are:

1. Soldering iron transformer
   a. Single tap – P/N 460818
   b. Four tap – P/N 460976
2. Soldering iron handle – P/N 454332
3. Soldering iron thread element – P/N 454333
4. Pencil Tiplet – P/N 454334

The solder supplied to the field is similar to a piece of spaghetti; the hollow center is filled with flux that flows over the work when heated to a moderate temperature. This temperature is below the melting point of the solder. The flux becomes active upon further heating, but prolonged exposure to heat causes it to decompose.

CAUTION: Do not use acid-core solder.

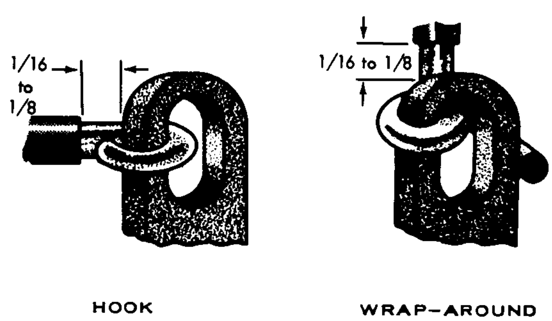


Figure 32. Terminal Connections

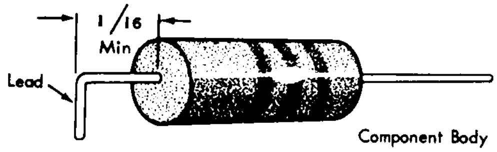


Figure 33. Axial Lead Connections

Preparing the Soldering Iron and Tip

The soldering iron is used only to transmit heat to the work. Before using the iron, heat it to operating temperature and tin it: wipe the tip with a clean cloth or canvas; then apply flux and solder, giving the tip a clean, shiny coat of solder. Tinning is done to insure good heat transfer and, at the same time, to keep the connection area free of contamination. Subsequent accumulation of flux residue and solder dross can be removed in the same manner.

Preparing the Work

In an electrical connection, metal-to-metal bond is the basic mechanism. Foreign materials must be removed from the surfaces of the metal to be joined. No grease, wax, paint, or dust should be present. Preferably, the surfaces to be soldered should be pretinned. Pretinning means the application of a thin layer of solder over the surfaces of the metals to be joined, using the same process as for tinning the soldering iron tip.

Use extreme care when stripping insulation from wire. The stripping tools should be adjusted so that no metal is removed from the wire during the stripping operation. Cutting the strands in stranded wire reduces the cross-sectional area, which decreases current carrying capacity and presents a mechanically weak spot. A nick in solid wire has much the same effect.

Unless otherwise specified, insulation should be stripped so that not more than ⅛ inch nor less than 1/16 inch of wire will be exposed between the soldered terminal and the insulation (Figure 32). Leads of an axial lead component should not be formed closer than 1/16 inch from the component body (Figure 33).

Heating the Work

Before applying solder, the joint must be thoroughly heated. Efficient heat transfer from the iron to the work depends on the cleanliness of the surfaces and the size of the contact area. A small amount of clean solder on the iron tip will insure effective heat transfer.

The majority of poor solder connections are the result of insufficient heat. Use reasonable care to protect components, but remember that a destroyed component is less expensive than a cold soldered joint that causes intermittent failures.

Applying the Flux and Solder

If the surfaces are clean and are at the correct temperature, flux and solder will flow freely over the surfaces and wet the metal. This wetting action is the basic solder bond. After the solder solidifies, it will remain adhered to the surface and will provide electrical continuity.

The proper amount of solder is important. The solder bond occurs on the surfaces and excessive solder does not improve the joint but can introduce undesirable side effects. For best results, use enough solder to cover the parts to be joined, but leave the outlines visible.

Cooling

Once the solder has been applied, withdraw the soldering iron and allow the joint to cool. Solidification of solder is not instantaneous, and any movement during this time may cause a solder bond of unacceptable quality. It is essential to keep the parts perfectly still until the solder is frozen. With a little practice, an operator can tell by the way the solder melts and cools whether a good bond has been made.

Visual Inspection of Soldered Joints

A good soldered connection is bright and smooth. The solder feathers out to a thin edge from the main body of solder in the joint. It also approximately outlines the wire and terminal. Figure 34 illustrates good soldered connections.

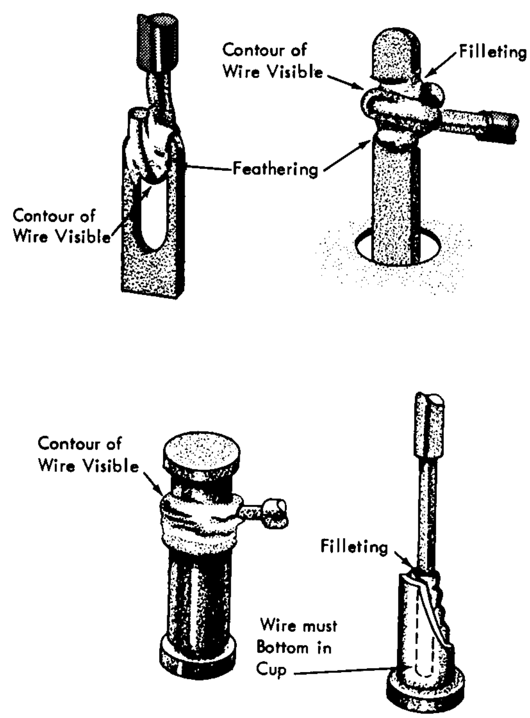


Figure 34. Good Soldered Connections

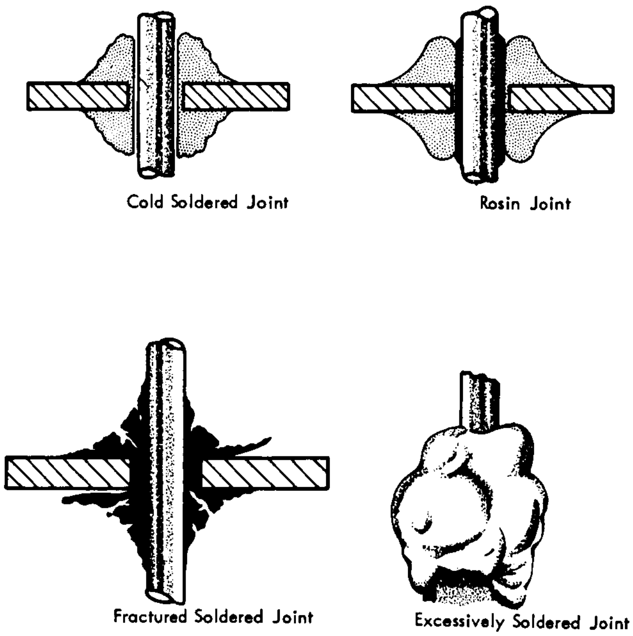


Figure 35. Defective Soldered Connections

The Cold Soldered Joint has a dull, granular appearance. It is caused by insufficient heating, or movement of the work during cooling. Figure 35 illustrates a cold soldered connection.

The Rosin Joint has a rosin inclusion. Rosin joints can be due to insufficient heat to permit the rosin to be displaced by the solder, or insufficient heat to permit adequate melting of the flux (Figure 35).

The Excessively Soldered Joint hides the outline of the joint components with an excessive amount of solder (Figure 35).

The Fractured Soldered Joint is one in which small cracks are present. This condition can be due to stress applied before the solder is completely solidified (Figure 35).

Soldering Summary

The following points are of primary importance in making good soldered connections.

1. The work must be clean.
2. The iron tip must be clean and bright.
3. The iron should heat the work enough to cause the work to melt the solder and allow it to penetrate.
4. The solder should be applied to the work, not to the iron.
5. The joint must not be moved until the solder is completely solid.

A crimped connection is a union of two electrical conductors formed by pressure. The electrical properties of a good crimped connection are comparable to those of soldered connections and are less dependent upon the operator's skill. Crimped connections can be produced rapidly with a high degree of uniformity. Automatic crimping machines are used on high-speed production lines to produce several thousand connections per hour.

A crimped connection is usually made with a terminal that has a barrel or trough to accept a short length of wire. The wire is inserted in the terminal, which is then formed to compress and restrict the wire inside the terminal barrel (Figure 36). If the correct pressure is applied during the forming process, a homogeneous mass will result in the crimped area.

The critical factor in making a crimped connection is the extent to which the terminal and conductor are formed. Pressure produced in the process must be high enough to cause a bond between the terminal and conductor materials, yet low enough to prevent embrittlement of the formed parts. The major ingredient of the wire and terminal is copper, which readily breaks after it has been embrittled by rapid deformation. This is exactly what occurs when a piece of copper wire is rapidly bent back and forth.

To obtain the correct pressure during a crimping operation, four factors must be considered: the wire, the terminal, the crimping die, and the crimping procedure.

Vast assortments of wires are presently manufactured differing in size, material, and shape. To successfully terminate one of these wires with a crimped connection, a specific terminal and crimping die must be used. Each terminal is designed for a specific wire or group of wires and each die is designed for a specific terminal or group of terminals. It is unlikely that a tool manufactured by one firm will successfully crimp a terminal manufactured by another firm.

The increasing popularity of crimped connections presents the repair problem of finding the correct combination of terminal, wire, and tool for each application. This section aids in this association and gives the procedures for the use and maintenance of crimping tools.

Crimping Tools

Three manufacturing firms supply the tools used to make crimped connections for SMS equipment. The companies are Burndy, AMP Inc., and Winchester Electronics. In general, the tools manufactured by a firm are used to crimp terminals manufactured by the same firm.

Crimping tools are precision instruments manufactured to close tolerances. Never use these tools for any purpose other than crimping the specific terminals for which they are designed. Tools should be cleaned, lubricated, and checked for wear and proper adjustment when contamination is apparent. Use a clean cloth moistened with IBM cleaning fluid, P/N 450608, to remove contamination from the tools. Lubricate all pivot points with a drop of IBM 6 oil after cleaning. Discard any tool that becomes damaged or worn.

Crimping tools are of two types; ratchet and nonratchet. The ratchet tools are designed to prevent opening the die-set until the dies have been fully mated. The ratchet is especially important when crimping the new family of gold plated terminals that carry low-level signals used in SMS circuitry. The nonratchet tools depend on the operator to apply enough pressure to cause the die halves to mate; and are rapidly becoming obsolete because the ratchet insures better connections.

Burndy Tools

Three crimping tools manufactured by Burndy are presently available to field installations that have SMS equipment (Figure 37).

Burndy tool M8ND (Figure 38) is a handle and ratchet mechanism that will accept a number of different die-sets. Eight die-sets and the M8ND handle are supplied in a Burndy crimping tool kit, P/N 461034. The complete contents of the kit are given in Figure 39.

The M8ND tool should be adjusted as outlined under "M8ND Die Replacement." A tool that cannot be properly adjusted is worn or damaged and should be replaced.

Figure 36. Crimped Connection, Cross Section

Burndy P/N	IBM P/N	Description
M8ND	461036	Basic Handtool Mechanism Without Dies
MR8-1A	460294	Plier-Type Ratchet Handtool With Nonreplaceable 4-Groove Die-Set
MR8EC-16	461071	Plier-Type Ratchet Handtool With Nonreplaceable 2-Groove * Die-Set

*Older style tool has three-groove die-set

Figure 37. Burndy Crimping Tools

Burndy tools MR8-1A and MR8EC-16 are plier-type, ratchet tools (Figure 40). The die-sets of these tools are not replaceable, and no adjustments are provided. Wear of plier-type tools is generally indicated by a decreasing amount of pressure necessary to release the ratchet.

M8ND DIE REPLACEMENT

Eight die-sets are provided for the M8ND tool, and it is necessary to change the die-set frequently. Good quality connections can be made with the M8ND tool only if the correct die-set is properly installed and adjusted. To change a die-set, refer to Figure 41 and proceed as follows:

1. Remove the installed die-set by removing the two die holding screws.
2. Select the correct die-set to match the terminal and wire to be crimped. The correlation of Burndy die-sets to terminals and wires is given under "Connectors and Terminals."
3. Loosen the die holder lock screw by using a 3/32-inch Allen wrench.
4. Turn the coupler bushing so that the ram moves to its fully down position.

Burndy P/N	IBM P/N	Description
M8ND	461036	Basic Tool Without Dies
	461053	Metal Toolbox
N20RT-2	461037	Die-Set
N22RVT-1	461038	Die-Set
N16RT-1 N16RT-15	461039	Die-Set
N14RT-3	461040	Die-Set
N10RT-2	461041	Die-Set
N14RT-5	461042	Die-Set
N12RT-3	461121	Die-Set
N12ECT	461122	Die-Set

Figure 39. Contents of Crimping Tool Kit, P/N 461034

5. Insert the selected die-set so that the threaded holes for the die holding screws are aligned with the holes in the head and the ram. The die-set may be inserted from either side of the tool, but the stamped lettering on upper and lower dies must face the same direction. The lettering should be right side up with the tool in the position shown in Figure 41.
6. Install and hand tighten the die holding screws.
7. Close the handles and align the two parts of the die-set. Turn the coupler bushing so that the ram moves up to the full extent, butting the dies.
8. Release the handles slightly and turn the coupler bushing one-fourth turn more (to move the ram upward).
9. Remove the lower die by removing its holding screw. Tighten the die holder lockscrew.

Figure 38. M8ND Tool with Die-Set Installed

Figure 40. Burndy Plier-Type Crimping Tool

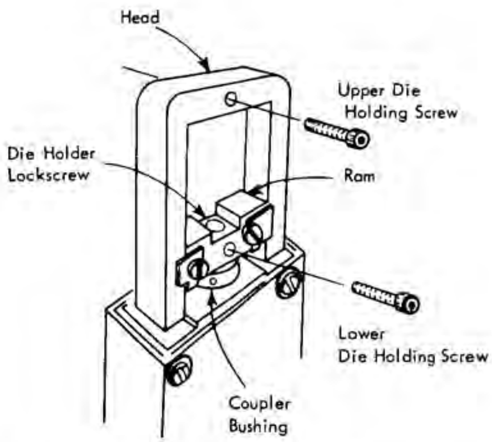


Figure 41. M8ND Die Holding Mechanism

10. Replace the lower die and its holding screw. Close the handles until the dies butt, and tighten both die holding screws.

11. Actuate the tool several times to check the force required to release the ratchet. If properly adjusted, the tool will require 45 to 55 pounds of pressure on the handles to release the ratchet. A rough check for proper adjustment may be made by inserting a piece of paper between the two dies. The paper should not be bound until the last ratchet position (one step before the ratchet releases). With the tool in the last ratchet position, the paper should tear without slipping from between the dies.

JAMMED TOOLS

In normal use, the ratchet on Burndy tools insures that a crimp is carried to completion before the die-set can be opened. A problem arises, however, if a crimp is attempted on a terminal that is too large for the die-set. In this case, the tool becomes jammed because the terminal will not compress enough to allow the dies to completely mate, and the ratchet will not allow the die-set to be opened. This situation can also occur if a terminal slips out of the die-set groove and becomes wedged between the flat surfaces that normally butt tightly together.

Never attempt to force a jammed tool. Forcing merely causes tighter jamming until enough force is applied to break the tool.

To restore a jammed tool, it is necessary to disengage the spring loaded tooth (pawl) from the rack. This can be done on all Burndy tools with a stiff piece of wire, such as a straightened paper clip. To locate the ratchet mechanism, hold the tool horizontal, with the movable handle up. The ratchet is between the handles, slightly forward of the center of the tool (Figures 38 and 40). Proceed as follows:

1. Insert the piece of wire between the pawl and the rack either from underneath the movable handle if the tool is nearly open, or from alongside the movable handle if the tool is nearly closed.

2. Squeeze the handles while sliding the wire farther into the tool to release the pawl.

3. Release the handles. The movable handle will return to its open position if the pawl was released.

EXTRACTION TOOLS

Figure 42 illustrates typical Burndy extraction tools. These tools are used to remove terminals from connector blocks.

Most Burndy terminals are designed to snap-lock into an insulated block. The terminals inserted into one block will be sockets, and those inserted into a mating block will be pins. When mated together, the two blocks become a multiposition connector.

The extraction tools allow removal of individual terminals (pins or sockets) from a connector block. Thus, Burndy connectors can be repaired by replacing individual terminals rather than by replacing an entire connector-half.

Figure 43 gives the part numbers for the five Burndy extraction tools used in SMS repair. Specific applications for each tool are given under "Connectors and Terminals."

Figure 42. Typical Extraction Tools

Burndy P/N	IBM P/N
RX20-10	461043
RX4-1	461044
RX12-3 or RX12-20	461046
RX16-5	461072
RX20-18 or RX16-1	461073

Figure 43. Burndy Extraction Tools

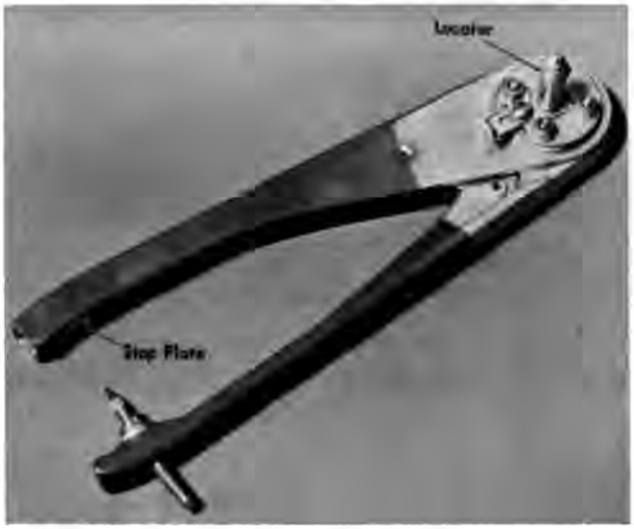


Figure 44. Winchester Crimping Tool, P/N 461059

Winchester Tools

One crimping tool (P/N 461059, Figure 44), supplied by Winchester Electronics, Inc., crimps all Winchester terminals used in the SMS. The handles must be fully closed to release the adjustable ratchet. The tool must be properly adjusted for each size connector. Note that a contact locator (P/N 461058, installed on the tool in Figure 44) is required to locate the terminal connector for crimping.

CRIMP LIMIT ADJUSTMENT

The Winchester crimping tool uses four moving plungers to form the terminal barrel (Figure 45). The plungers move toward the center of the terminal barrel as the handles of the tool are squeezed together. Each plunger indents the terminal barrel to form and restrict the wire inside the barrel. A ratchet mechanism prevents opening the tool until the limit screw (Figure 45) makes contact with the stop plate. The stop plate (Figure 44) moves in slightly to release the pawl from the rack in the ratchet mechanism. After this slight movement of the stop plate, the limit screw prevents further closing of the handles.

ADJUSTING RATCHET FOR CRIMPING DEPTH

1. Loosen lock nut and limit screw with a small Allen or Bristol wrench.
2. Turn limit screw to adjust plunger opening.
3. Close tool fully to trip ratchet.
4. Select two wire gage drills for use as GO and NO-GO gages. The correct drill sizes for the terminal to be crimped are given under "Connectors and Terminals."
5. Adjust limit screw so GO drill will easily slide in plunger opening (Figure 46) and the NO-GO drill will not.
6. Lock limit screw in position with the lock nut. *Do not overtighten.*
7. Check adjustment with GO and NO-GO drills, and readjust if necessary.

LOCATOR ADJUSTMENT

The locator, P/N 461058, can be used to aid in crimping all Winchester terminals used in SMS equipment. A depth adjustment on the locator (Figure 47) must be set to conform to a particular terminal to be crimped. To make the depth adjustment:

1. Loosen locking screw. Slide latch to open position.
2. Insert contact locator, P/N 461058, in well, and slide latch to closed position. Tighten locking screw.
3. Open the tool and loosen the depth screw locknut.
4. Insert a terminal, of the type to be crimped, into the locator.
5. Close the tool until the plungers are in contact with but not binding the terminal barrel.
6. Adjust depth screw until the plungers are centered on the barrel surface midway between the inspection hole and the insulation end of the terminal.
7. Complete the crimp and remove the terminal. Check for a centered crimp of the terminal barrel. If the crimp is not centered, repeat procedure from 4.
8. Tighten the depth screw locknut.

The locator is easily removed from the Winchester tool. Refer to Figure 47 and:

1. loosen the latch lock screw;
2. slide the latch away from the locator body;
3. lift the locator from the tool.

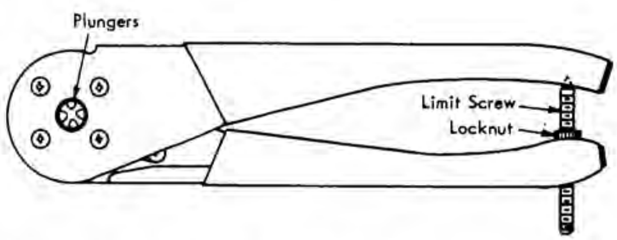


Figure 45. Winchester Tool Adjustments

CRIMPING A WINCHESTER TERMINAL

1. Be sure the tool is adjusted for the proper terminal and wire size.
2. Strip $\frac{3}{16}$ inch of insulation from the wire.

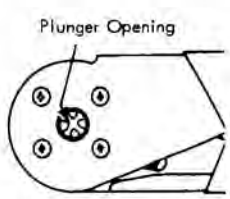


Figure 46. Adjusting Ratchet for Crimping Depth

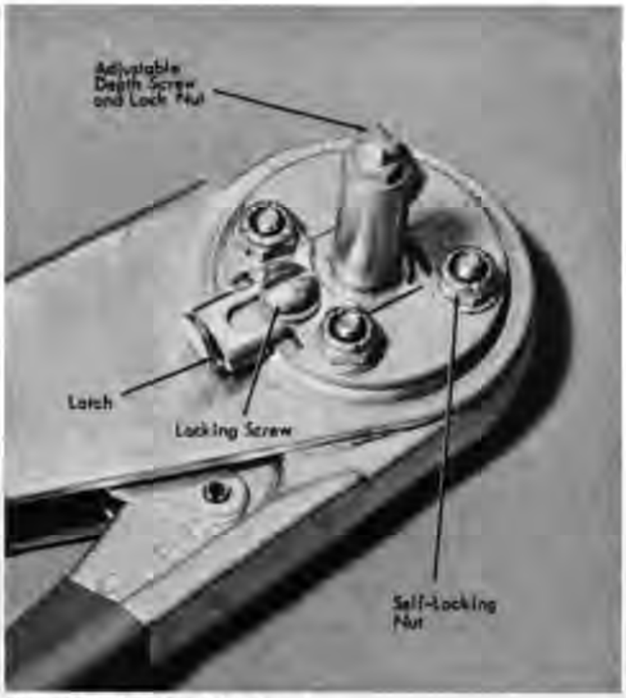


Figure 47. Locator Adjustments

3. Place the stripped wire in the terminal (Figure 48) and the terminal into the plunger opening of the tool.

4. Fully close the handle until the limit screw releases the ratchet.

NOTE: The handles must be fully closed to open the tool. Do not try to open the handles without completing the cycle. Do not attempt to disassemble the tool, nor move the elastic stop nuts on the back of the tool.

Do not attempt to force the Winchester tool if it jams. To restore a jammed tool, use a screwdriver to depress the stop plate. If the tool does not restore when the stop plate is depressed, the pawl should be tripped from the rack. Access to the pawl can be obtained from the top of the red plastic covering of the handle that contains the stop plate.

EXTRACTION TOOL

A Winchester extraction tool, P/N 461060, is used to remove any pin or socket from a Winchester connector block. The tool is constructed similiarly to the Burndy extraction tools and is used in the same manner.

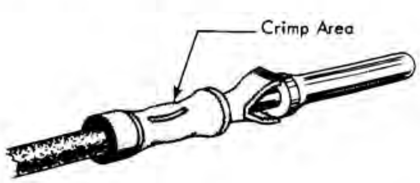


Figure 48. Installing a Winchester Terminal

AMP Tools

Several crimping tools are supplied by AMP Inc. For SMS repair, however, only two of these tools are presently significant. These are AMP 59501 (P/N 461070) and AMP 47745 (P/N 450898). Do not use AMP tool 47106 (P/N 460806) as a substitute for either 59501 or 47745. *Tool 47106 is designed for insulation piercing terminals and has no application in SMS repair.*

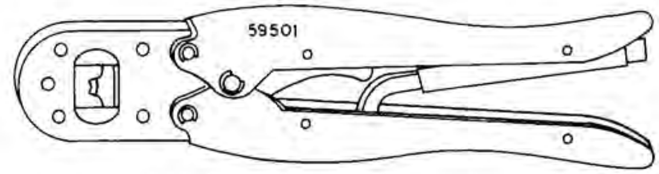


Figure 49. AMP Ratchet Tool

RATCHET TOOL

Tool 59501 (Figure 49) is a ratchet crimping tool to be used with 22-24 AWG solid or stranded wire only. The die-set is not replaceable, and no adjustments are provided on the tool.

Terminals used with the AMP ratchet tool have a two-section crimping barrel. The tool crimps one section on the conductor and the other section on the insulation. Make certain to insert terminals into the die so that the larger die opening crimps the insulation.

Discard the AMP ratchet tool if it becomes worn or damaged. Wear is usually indicated by a decreasing amount of pressure required to butt the dies and release the ratchet.

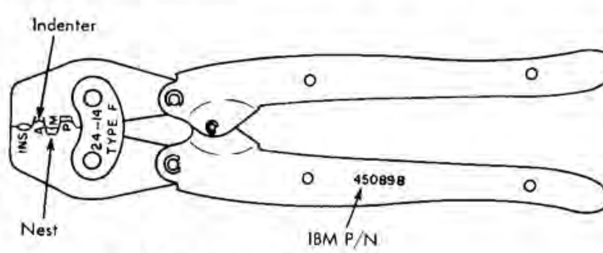


Figure 50. AMP Crimping Tool

NONRATCHET TOOL

Tool 47745 (Figure 50) is a nonratchet crimping tool with a four-groove die-set. This tool requires no adjustments, but should be checked for wear by noting the die-set alignment.

Take care to crimp terminals in the correct groove of the die-set. Notice that the four grooves are labeled INS (insulation), A, M, and P. The correct groove for each terminal is given under "Connectors and Terminals."

Considerable care must be taken to insure high quality connections when using a nonratchet crimping tool. Use this tool only in applications for which no ratchet tool is available.

Figure 51 illustrates a typical AMP terminal. To crimp this type of terminal in the AMP nonratchet tool, proceed as follows:

1. Determine the wire strip length and die-set groove from Figure 54. Strip the wire.

2. Center the wire crimp portion of the terminal in the INS groove, with the open side of the barrel facing the INS letters on the tool. Do not insert the wire.

3. Close the tool, exerting enough pressure to completely mate the die-set. Remove the terminal from the tool.

4. Insert the stripped wire into the terminal so that the insulation ends in the first window and the wire ends in the second window (Figure 51).

5. Center the wire crimp portion of the terminal in the proper tool groove (A, M, or P). The bottom of the terminal (opposite the open side) must be adjacent to the stamped letter (A, M, or P) on the die-set.

6. Close the handles, taking care that the terminal does not turn. Exert enough pressure to completely mate the die-set. Remove the terminal from the tool.

7. Center the insulation crimp portion of the terminal in the INS groove of the tool, with the open side facing the stamped letters, INS.

8. Close the tool, exerting enough pressure to completely mate the die-set.

9. Remove and inspect the finished termination

INSERTION AND EXTRACTION TOOLS

The assembled tools are used to insert taper pins into sockets. Although taper pin terminals are not used in SMS frames, these pins are still used in some of the auxiliary equipment used in SMS systems.

Two tools are manufactured by AMP to install and remove the laminar bus terminals, P/N 259009. The extraction tool, P/N 461074, is available for field use. The insertion tool has no IBM part number at this time; this tool is AMP 380-306-5 and may be released in the future.

Even if these special tools are used, use care when installing or removing the laminar bus terminals to prevent breaking the soldered connection that joins the fixed part of the connector to the laminar bus. At present, there is no available crimping tool for the laminar bus terminal (P/N 259009). When a repair of one of these terminals is necessary, replace the assembly, which consists of a terminal and jumper wire, with the crimped connection already made. The assembly is installed by making a wrapped connection to the proper card socket terminal. The part numbers of the laminar bus jumper assemblies are 532078 through 532085. The eight assemblies differ from each other only in the wire insulation color

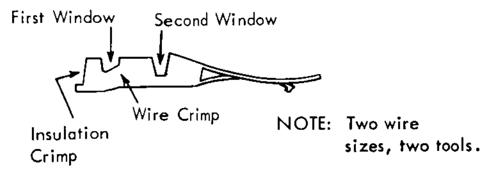


Figure 51. Open-Wire Connector Terminal

Connectors and Terminals

Many kinds of connectors and terminals that involve crimped connections are used in SMS. The three firms (Burndy, Winchester, and AMP) that supply crimping tools also supply most of the connectors and terminals.

Connectors and terminals are classified by manufacturer and in two other ways. One classification is the type of wire barrel on the terminal; this may be either open or closed. The second classification is by the use of the terminal: either power, or signal (sometimes called low-loss).

The signal terminals, with few exceptions, are gold-plated. For crimped connections in signal wiring, the resistance introduced by each termination must be of the order of 1 to 9 milliohms depending on the wire size. To obtain this low resistance, factors such as contact area, crimp shape, and crimp pressure must be closely controlled. These terminations are truly precision connections and must be attempted only with a combination of wire, tool, and terminal that have been proved to produce the desired connection. All gold-plated connectors and terminals should be obtained from IBM stock. A similar item purchased through electronic distributors is usually gold-flashed, not gold-plated. Gold flashing has a limited life, resulting in intermittent contact problems.

The power terminals are normally constructed of copper, coated with a thin layer of tin to impede corrosion. These terminals are usually larger than the signal terminals and are normally used with stranded wire. Because power connections are less critical than signal connections, there are no special tools supplied to the field for crimping the majority of the power terminals. When it is necessary to attach one of these terminals and the proper crimping tool is not available, use the following procedure:

1. Strip the wire to approximately the length required. Insert the wire into the terminal barrel and adjust the strip length as necessary.

2. Use the area just behind the pivot of a pair of pliers or diagonal cutters to crimp the terminal barrel enough to hold the wire. Do not deform the terminal barrel enough to embrittle the terminal or the wire.

3. Solder the wire in the terminal. Make sure that the solder flows freely into the terminal barrel.

The following sections list Burndy, Winchester, and AMP terminals and provide information on the correct tools and wire to be used with each terminal listed. Power terminals for which there are no special tools are not listed.

Burndy

Most Burndy terminals have the following characteristics:

1. Gold-plated pin or socket for a single solid conductor.
2. Closed wire barrel.
3. Snap-locks into an insulated block to form a connector.
4. Removable from connector block by means of an extraction tool.

The following descriptions apply to Figure 52:

Pin: A male terminal that snaps into a connector body. A pin mates with a socket.

Socket: A female terminal that snaps into a connector body. A socket mates with a pin.

Connector Plug Body: The male half of a connector. A connector plug body mates with a connector receptacle body to form a complete connector. Sockets only, or pins only, can be snapped into some plug bodies, but other plug bodies accept either sockets or pins.

Connector Receptacle Body: The female half of a connector. A connector receptacle body mates with a connector plug body to form a complete connector. Many connector bodies are available as either a plug or a receptacle.

To use Figure 52, proceed as follows:

1. Locate the connector involved by means of the drawings and part numbers. Terminals that may be used with the connector are listed directly below the drawing and description of the connector.

2. Locate the correct terminal from the drawings, part numbers, and wire sizes listed below the connector.

3. Use the strip length, crimping tool, and extraction tool listed in the columns in the same horizontal row as the terminal.

The Burndy part numbers listed are useful in determining the IBM part number of a connector, terminal, or tool, because these numbers are often stamped on the item. IBM part numbers, however, should be used if known. It is important to use the IBM part numbers because Burndy part numbers often change as a result of a minor change in the part. In these cases, the IBM part numbers do not change because the application remains the same.

IBM P/N 550560

Burndy P/N MEBP-2
8-Conductor HYFEN*
Connector Plug Body. Accepts HYFEN Pins Only.

IBM P/N 550074

Burndy P/N MEBP-1
8-Conductor HYFEN* Connector Plug Body.
Accepts HYFEN Sockets Only.

					Crimping Tool				Extraction Tool	
					Handle		Die			
Description	IBM P/N	Burndy P/N	Wire Size	Strip Length (Inches)	IBM P/N	Burndy P/N	IBM P/N	Burndy P/N	IBM P/N	Burndy P/N
	368596	RM14Z-2F33	14 AWG	7/32	461036	M8ND	461042	N14RT-5	461046	RX12-3 RX12-20
HYFEN pins for P/N 550560	535087	RM10Z-3F33	10 AWG	5/16	461036	M8ND	461041	N10RT-2	461046	RX12-3 RX12-20
	535583	RM12Z-3F33 MRM12Z-3F33	12 AWG	5/16	461036	M8ND	To be Released	N12RT-3	461046	RX12-3 RX12-20
	368594	RC14Z-2F33	14 AWG	7/32	461036	M8ND	461042	N14RT-5	461046	RX12-3 RX12-20
HYFEN sockets for P/N 55074	535086	RC10Z-3F33	10 AWG	5/16	461036	M8ND	461041	N10RT-2	461046	RX12-3 RX12-20
	535561	RC12Z-3F33 MRC12Z-3F33	12 AWG	5/16	461036	M8ND	To be Released	N12RT-3	461046	RX12-3 RX12-20

* Trademark of Burndy Corp.

Figure 52A. Burndy Connectors and Terminals

IBM P/N 535079, 535081, 550561, 526517

Burndy P/N ME13R-1, ME13R-2, ME13P-4, ME13R-5
13-conductor HYFEN connector body, receptacle or Plug. Accepts HYFEN pins only.

IBM P/N 535078, 535080, 556101, 526516

Burndy P/N ME13P-1, ME13P-2, ME13R-4, ME13P-5
13-conductor HYFEN connector body, receptacle or plug. Accepts HYFEN sockets only.

					Crimping Tool				Extraction Tool	
					Handle		Die			
Description	IBM P/N	Burndy P/N	Wire Size	Strip Length (Inches)	IBM P/N	Burndy P/N	IBM P/N	Burndy P/N	IBM P/N	Burndy P/N
HYFEN pins for P/N 535079, 535081, 550561, 526517	535083	RM16M-7F33	16-18 AWG	7/32	461036	M8ND	461039	N16RT-1 N16RT-15	461073	RX16-1 RX20-18
	535085	RM14M-3F33	14-16 AWG	7/32	461036	M8ND	461040	N14RT-3	461073	RX16-1 RX20-18
	535679	RM14M-7F33	14-16 AWG	7/32	461036	M8ND	461040	N14RT-3	461073	RX16-1 RX20-18
	368596	RM14Z-2F33	14 AWG	7/32	461036	M8ND	461042	N14RT-5	461046	RX12-3 RX12-20
	535087	RM10Z-3F33	10 AWG	5/16	461036	M8ND	461041	N10RT-2	461046	RX12-3 RX12-20
	368597	RM20M-1F33	20-22 AWG	7/32	461036	M8ND	461039	N16RT-1 N16RT-15	461073	RX16-1 RX20-18
	535583	RM12Z-3F33 MRM12Z-3F33	12 AWG	5/16	461036	M8ND	461121	N12RT-3	461046	RX12-3 RX12-20
HYFEN sockets for P/N 535078, 535080, 556101, and 526516	535082	RC16M-7F33	16-18 AWG	7/32	461036	M8ND	461039	N16RT-1 N16RT-15	461072	RX16-5
	535084	RC14M-3F33	14-16 AWG	7/32	461036	M8ND	461040	N14RT-3	461072	RX16-5
	368594	RC14Z-2F33	14 AWG	7/32	461036	M8ND	461042	N14RT-5	461046	RX12-3 RX12-20
	535086	RC10Z-3F33	10 AWG	5/16	461036	M8ND	461041	N10RT-2	461046	RX12-3 RX12-20
	535561	RC12Z-3F33	12 AWG	5/16	461036	M8ND	461121	N12RT-3	461046	RX12-3 RX12-20

Figure 52B. Burndy Connectors and Terminals

IBM P/N 551727, 550559

Burndy P/N ME26R-1, ME26P-2
26-conductor HYFEN connector body, receptacle or plug. Accepts HYFEN pins only.

IBM P/N 550557, 550558

Burndy P/N ME26P-1, ME26R-2
26-conductor HYFEN connector body, receptacle or plug. Accepts HYFEN sockets only.

					Crimping Tool				Extraction Tool	
					Handle		Die			
Description	IBM P/N	Burndy P/N	Wire Size	Strip Length (Inches)	IBM P/N	Burndy P/N	IBM P/N	Burndy P/N	IBM P/N	Burndy P/N
HYFEN pins for P/N 551727, 550559	550615	RM14M-10F45	14-16 AWG	5/16	461036	M8ND	461040	N14RT-3	461073	RX20-18 RX16-1
	535083	RM16M-7F33 MRM16M-7F33	16-18 AWG	7/32	461036	M8ND	461039	N16RT-1 N16RT-15	461073	RX20-18 RX16-1
	368597	RM20M-1F33 MRM20M-1F33	20-22 AWG	7/32	461036	M8ND	461039	N16RT-1 N16RT-15	461073	RX20-18 RX16-1
HYFEN sockets for P/N 550557, 550558	535082	RC16M-7F33	16-18 AWG	7/32	461036	M8ND	461039	N16RT-1 N16RT-15	461072	RX16-5
	551560	RC14M-10F45	14-16 AWG	5/16	461036	M8ND	461040	N14RT-3	461072	RX16-5
 45 degree hood and latch assembly for 26 conductor connector bodies	535077	ME13-1KC								

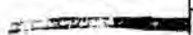
Figure 52C. Burndy Connectors and Terminals

IBM P/N 524483

Burndy P/N DP37-1C,
37-conductor HYFEN plug body.
Will accept HYFEN pins or sockets.

IBM P/N 524484

Burndy P/N DE37-1
37-conductor HYFEN receptacle body.
Will accept HYFEN pins or sockets.

Description	IBM P/N	Burndy P/N	Wire Size	Strip Length (Inches)	Crimping Tool: Handle IBM P/N	Crimping Tool: Handle Burndy P/N	Crimping Tool: Die IBM P/N	Crimping Tool: Die Burndy P/N	Extraction Tool IBM P/N	Extraction Tool Burndy P/N
	524476	RM10Z-1	10 AWG	5/16	461036	M8ND	461041	N10RT-2	461046	RX12-33 RX12-20
	524534	RM14Z-1	14-16 AWG							
HYFEN pins	524478	RM14M-1	Note 1	7/32	461036	M8ND	461041	N10RT-2	461073	RX16-1 RX20-18
	524477	RF10Z-1	10 AWG	5/16	461036	M8ND	461041	N10RT-2	461046	RX12-3 RX12-20
	524535	RF14Z-1	14-16 AWG							
HYFEN sockets	524479	RF14M-1	Note 1	7/32	461036	M8ND	461041	N10RT-2	461072	RX16-5

Note 1. 14-16 AWG, one conductor
18 AWG, two conductors
20 AWG, three conductors

Figure 52D. Burndy Connectors and Terminals

IBM P/N 368589, 368598

Burndy P/N MA37P-1, MA37R-3
37-conductor HYFEN connector body, receptacle or plug.
Accepts HYFEN pins only.

IBM P/N 368592, 368593

Burndy P/N MA37R-1, MA37P-3
37-conductor HYFEN connector body, receptacle or plug.
Accepts HYFEN sockets only.

Description	IBM P/N	Burndy P/N	Wire Size	Strip Length (Inches)	Crimping Tool: Handle IBM P/N	Crimping Tool: Handle Burndy P/N	Crimping Tool: Die IBM P/N	Crimping Tool: Die Burndy P/N	Extraction Tool IBM P/N	Extraction Tool Burndy P/N
	535083	RM16M-7F33	16-18 AWG	7/32	461036	M8ND	461039	N16RT-1 N16RT-15	461073	RX16-1 RX20-18
	535085	RM14M-3F33	14-16 AWG	7/32	461036	M8ND	461040	N14RT-3	461073	RX16-1 RX20-18
	535679	RM14M-7F33	14-16 AWG	7/32	461036	M8ND	461040	N14RT-3	461073	RX16-1 RX20-18
HYFEN pins for P/N 368589, 368598	368596	RM14Z-2F33	14 AWG	7/32	461036	M8ND	461042	N14RT-5	461046	RX12-3 RX12-20
	535087	RM10Z-3F33	10 AWG	5/16	461036	M8ND	461041	N10RT-2	461046	RX12-3 RX12-20
	535583	RM12Z-3F33	12 AWG	5/16	461036	M8ND	461121	N12RT-3	461046	RX12-3 RX12-20
	368597	RM20M-1F33	20-22 AWG	7/32	461036	M8ND	461039	N16RT-1 N16RT-15	461073	RX16-1 RX20-18
	535082	RC16M-7F33 MRC16M-7F33	16-18 AWG	7/32	461036	M8ND	461039	N16RT-1 N16RT-15	461072	RX16-5
	535084	RC14M-3F33	14-16 AWG	7/32	461036	M8ND	461040	N14RT-3	461072	RX16-5
	368594	RC14Z-2F33	14 AWG	7/32	461036	M8ND	461042	N14RT-5	461046	RX12-3 RX12-20
HYFEN sockets for P/N 368592, 368593	535086	RC10Z-3F33	10 AWG	5/16	461036	M8ND	461041	N10RT-2	461046	RX12-3 RX12-20
	535561	RC12Z-3F33	12 AWG	5/16	461036	M8ND	461121	N12RT-3	461046	RX12-3 RX12-20

Straight hood	368590	MAH37-1
90° hood	556143	MAK37-1
Hood extender	368595	Not Burndy
Cable clamp	368591	MA40SR1625-3

Figure 52E. Burndy Connectors and Terminals

IBM P/N 530622, 538729, 530624

Burndy P/N MS20P-1, MS42P-1, MS50P-1

Conductors 20, 42, 50
Plug bodies will accept HYFEN pins or sockets

IBM P/N 530621, 528728, 530623

Burndy P/N MS20R-1, MS42R-1, MS50R-1

Conductors 20, 42, 50
Receptacle bodies; will accept HYFEN pins or sockets

Description	IBM P/N	Burndy P/N	Wire Size	Strip Length (Inches)	Crimping Tool: Handle IBM P/N	Crimping Tool: Handle Burndy P/N	Crimping Tool: Die IBM P/N	Crimping Tool: Die Burndy P/N	Extraction Tool IBM P/N	Extraction Tool Burndy P/N
	538732	RM24W-1F45	24-26 AWG	7/32	461036	M8ND	461037	N20RT-2	461043	RX20-10
	530620	RM20W-2F45	20-22 AWG							
HYFEN pins	530618	RM18W-10F45	18 AWG							
	538730	RC24W-1F45	24-26 AWG	7/32	461036	M8ND	461037	N20RT-2	461043	RX20-10
	538731	RC20W-1F45	20-22 AWG							
	530619	RC20W-2F45	20-22 AWG							
HYFEN sockets	530617	RC18W-10F45	18 AWG							

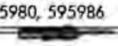
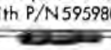
Figure 52F. Burndy Connectors and Terminals

IBM P/N 595986

Burndy P/N RMX109-1F45
Outer coaxial plug body for use in the 16- and 20-position coaxial cable connector blocks.

IBM P/N 595980

Burndy P/N RCX109-1F45
Outer coaxial receptacle body for use in the 16- and 20-position coaxial cable connector blocks.

Description	IBM P/N	Burndy P/N	Wire Size	Strip Length (Inches)	Crimping Tool: Handle IBM P/N	Crimping Tool: Handle Burndy P/N	Crimping Tool: Die IBM P/N	Crimping Tool: Die Burndy P/N	Extraction Tool IBM P/N	Extraction Tool Burndy P/N
Non-insulated HYRING used with P/N 595986	595981	YOC128-L	Coaxial cable shield	7/32	461036	M8ND	461038	N22RVT-1	461044 Note 2	RX4-1
Coax HYFEN insulation boot to cover exposed part of P/N 595980	596227	CRX-1								
Insulated HYRING used with P/N 595980, 595986	596226	YOE112-L	Coaxial cable shield	5/16	461071	MR8EC-16	Non-Replaceable Die Use 120 Groove for Barrel Crimp and 110 Groove for Cable Crimp		461044 Note 2	RX4-1
	595985	RM22W-6F45	22-24 AWG	7/32	461036	M8ND	461038	N22RVT-1	461083 Note 3	Not Burndy
Inner pins for use with P/N 595980	598661	RM26W-1F45	26-29 AWG	7/32	461036	M8ND	461038	N22RVT-1	461083 Note 3	Not Burndy
	595987	RC22W-6F45	22-24 AWG	7/32	461036	M8ND	461083	N22RVT-1	461083 Note 3	Not Burndy
Inner sockets for use with P/N 595986	598662	RC26W-2F45	26-29 AWG	7/32	461036	M8ND	461038	N22RVT-1	461083 Note 3	Not Burndy

Note 2. Extraction tool removes outer bodies (595986 and 595980) from connector block only.
Note 3. Insertion and extraction tool for inner pins and sockets when using twisted pair wire only.

Figure 52G. Burndy Connectors and Terminals

Description	IBM P/N	Burndy P/M	Wire Size	Strip Length (Inches)	Crimping Tool: Handle IBM P/N	Handle Burndy P/N	Die IBM P/N	Die Burndy P/N	Color
 Insulated UNIRING	535640	YEC120	Insulation Dia. 2/32-3/32		461036	M8ND	461122	N12ECT	Green
 Inner HYRING Non-insulated	595725	YIC109	Coaxial Insulation (Inner)	Not Crimped - Outer HYRING is Crimped Over Inner HYRING					Red
 Outer HYRING Insulated	595726	YEC110G1	Coaxial cable shield	5/16	461036	M8ND	461122	N12ECT	Blue
 INSULUG	510453	YAE14-N4	14-16 AWG	7/32	460294	MR8-1A	Non-Replaceable Die		Blue
	335009	YAE18-N	16-22 AWG	7/32	460294	MR8-1A	Non-Replaceable Die		Red
	335971	YAEVIOT-3	10-12 AWG	5/16	460294	MR8-1A	Non-Replaceable Die		Yellow
 INSULINK	596383	YSE14-H	14-16 AWG	1/4	460294	MR8-1A	Non-Replaceable Die		Blue

Figure 52H. Burndy Connectors and Terminals

Winchester

Figure 53 gives the pins and sockets for Winchester connectors. Any of these terminals can be used in any Winchester connector block. The Winchester terminals have the same characteristics as those listed for the Burndy terminals. The Winchester crimping tool, P/N 461059, and the Winchester extraction tool, P/N 461060, are used for all terminals listed. The two wire gage drills listed for each terminal are used as GO and NO-GO gages for adjusting the crimping tool. This adjustment procedure is given under "Winchester Tools."

Description	AWG Wire Size	GO Wire Gage Drill Size	NO-GO Wire Gage Drill Size	Strip Length Inches
Socket, P/N 532901, and Mating Pin, P/N 532902	14	53	52	3/16
	16	54	53	3/16
	18	55	54	3/16
Socket, P/N 532904, And Mating Pin, P/N 532903	18	53	52	3/16
	20	54	53	3/16
	22	55	54	3/16

Figure 53. Winchester Terminals

AMP

Figure 54 lists terminals crimped with AMP tools. These terminals serve a variety of functions, as can be seen by the description column.

Terminal 596230, called a stuffer, is used to adapt terminal 597591 to 26 AWG wire. Two separate crimping operations are required when the stuffer is used. The complete procedure for terminating a 26 AWG wire with P/N 596230 and P/N 597591 is given under "Crimped Termination Procedures."

The dual contact terminals used in the 32, 40, and 200-position low-voltage connectors will accommodate AWG wire sizes 16 to 24. To insure good wire-to-terminal contact, the proper terminal must be used for a specific wire size:

DUAL CONTACT P/N	WIRE SIZE (AWG)
598041	20 to 24 solid or stranded
596224	16 and 18 stranded

P/N 596224 is also used for crimping to #26 solid wire of coaxial cable. Wire collar, P/N 596230, is first crimped to the AWG 26 wire. The collar and wire are

Description	Terminal P/N	Tool P/N	Groove Note 1	Wire Size	Barrel	Strip Length Inches
Terminal For Open Wire Connectors (Dual Contact)	597590 598041 (Note 6)	461070 (Note 2)	A	24 AWG	Open	5/32
		450898 (Note 3)	M	20 AWG		
Terminal For Open Wire Connectors (Dual Contact)	597591 596224 (Note 6)	450898	P	16-18 AWG 22-24, 2 Wires 26 AWG Stuffer	Open	5/32
Stuffer For Open Wire Connector Terminal (Note 4)	596230	450898	A	26 AWG	Open	5/32
Butt Connector	216230	461070 (Note 2)	A	24 AWG	Closed	1/8
		450898 (Note 3)	M	20-22 AWG		
Spade Clip Terminal	450902	461070 (Note 2) 450898 (Note 3)	M	20-24 AWG	Open	3/16
Large Taper Pin (Note 5)	450901	461070 (Note 2) 450898 (Note 3)	M	20-24 AWG	Open	3/16
Small Taper Pin (Note 5)	450904	461070 (Note 2) 450898 (Note 3)	A	20-24 AWG	Open	3/16

Note 1. Applies to P/N 450898 Only
Note 2. For 22-24 AWG Solid and Stranded Wire
Note 3. Where Applications Overlap, P/N 461070 is the Preferred Tool
Note 4. See Text for Specific Application of Stuffer
Note 5. Insert Pin with Tool P/N 461064 Equipped with Tip P/N 461065
Note 6. Top P/N is for Loose Pieces. Bottom P/N is the Same Terminal in Strip Form for Production Line Use.

Figure 54. AMP Terminals

then crimped into the dual contact terminal (Figure 55). Crimping tool, P/N 461070, is used with the above terminals.

The following points should be borne in mind to insure contact reliability with dual contact terminals.

1. Identical terminal P/N's must be used in the same positions of the two connector halves being mated.

2. When a terminal is inserted into the terminal board, be certain that the claw of the terminal is snapped over the raised lip of the terminal board. The ski (protruding contact face of the terminal) should be no more than 0.005 inch from the terminal board wall.

3. The following procedure should be used to re-form a ski that has been deflected more than the specified 0.005 inch:

   a. Remove the dual contact from the terminal board (see 5).
   b. Hold dual contact at its crimped area in an upright position.
   c. Push top end of ski toward formed tip of claw. Release and allow to spring back.
   d. Reinsert dual contact into terminal board and inspect for 0.005-inch clearance (see 2).

4. Gold plating is used on the terminals to reduce contact resistance and corrosion. A wiping action assures final contact on a clean surface. Should it be necessary to remove dust or other particles from the dual contacts or terminal board, use only clean, lint-free cloth.

CAUTION: Do not use any cleaning fluid, of any type, for this purpose. Cleaning fluids, including IBM P/N's 450608, 451053, and 517690, will damage the terminal board and will remove lubricant petroleum jelly applied to the dual contact terminals.

5. No special tools are required to remove the dual contact terminals from the terminal board.

CAUTION: To prevent damage to the finish of the gold plated contact surface and to the raised lip of the terminal board, do not use a metal tool for contact removal. A nylon or plastic probe, or fiber screwdriver, P/N 460811, is recommended.

6. Do not attempt repairs to dual contact terminals while they are inserted in the terminal board.

Slip-On Terminal

A slip-on terminal, P/N 216265, may be used to connect wiring to SMS terminal pins. This terminal may be crimped to solid or stranded wire of AWG size 20 to 24. The maximum current carrying capacity is 8 amperes. Use tubing, P/N 216309, to prevent close terminals from shorting.

Crimped Termination Procedures

The following paragraphs describe the complete termination procedures for the two most commonly used crimped connectors in SMS equipment. These are the Burndy coaxial cable connector and the AMP terminal for open-wire connector blocks.

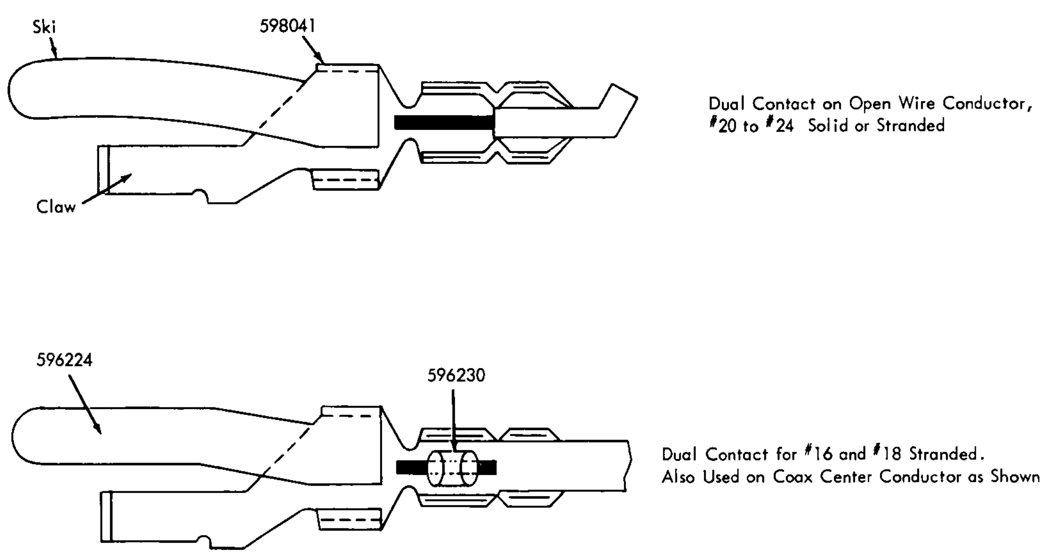


Figure 55. Dual Contact Terminals

Coaxial Cable Connector

The Burndy coaxial cable connector is used in 16- and 20-position connector blocks in the sliding gate frames. Coaxial cable and twisted-pair wire are used with these connectors.

COAXIAL CABLE

To attach coaxial cable to the outer plug body, P/N 595986, refer to Figure 56 and proceed:

1. Strip the cable following the dimensions shown in Figure 56.
2. Use die-set N22RVT-1 (P/N 461038) in Burndy tool M8ND (P/N 461036) to crimp inner socket, P/N 598662, to the cable center conductor. Make certain that the wire is visible through the small hole in the socket barrel, and that the socket barrel is butted against the coax inner insulation.
3. Slide an insulated HYRING, P/N 596226, over the cable. (Earlier machine units used a noninsulated HYRING, P/N 595981, crimped with die-set N22RVT-1, P/N 461038.)
4. Snap-lock the inner socket into the outer plug body, making sure that coax braid slides over the outer plug barrel.
5. Slide the HYRING over the coax braid and insulation so that it butts against the connector body.
6. Make two crimps on the HYRING with a Burndy tool MR8EC-16, P/N 461071. Use the die-set groove marked 120 to crimp the HYRING to the connector barrel. Make certain that the outside edges of the die-set are aligned with the end of the HYRING that is butted against the connector body. You may insert the connector from either side of the die-set, but make sure that the die-set edges do not overlap the large part of the connector body. If these parts do overlap, the connector body will be crimped when the tool is closed. Use the die-set groove marked 110 to make the second crimp near the opposite end of the HYRING.

To attach coaxial cable to the outer receptacle body, P/N 595980, refer to Figure 56 and proceed:

1. Strip the cable, following the dimensions shown in Figure 56.
2. Use die-set N22RVT-1, P/N 461038, in Burndy tool M8ND, P/N 461036, to crimp inner pin, P/N 598661, to the cable center conductor. Make certain that the wire is visible through the small hole in the pin barrel, and that the barrel is butted against the coax inner insulation.
3. Slide an insulated HYRING, P/N 596226, over the cable.
4. Snap-lock the inner pin into the outer receptacle body making sure that the coax braid slides over the outer receptacle barrel.
5. Slide the insulated HYRING over the coax braid and insulation so that it butts against the connector body.

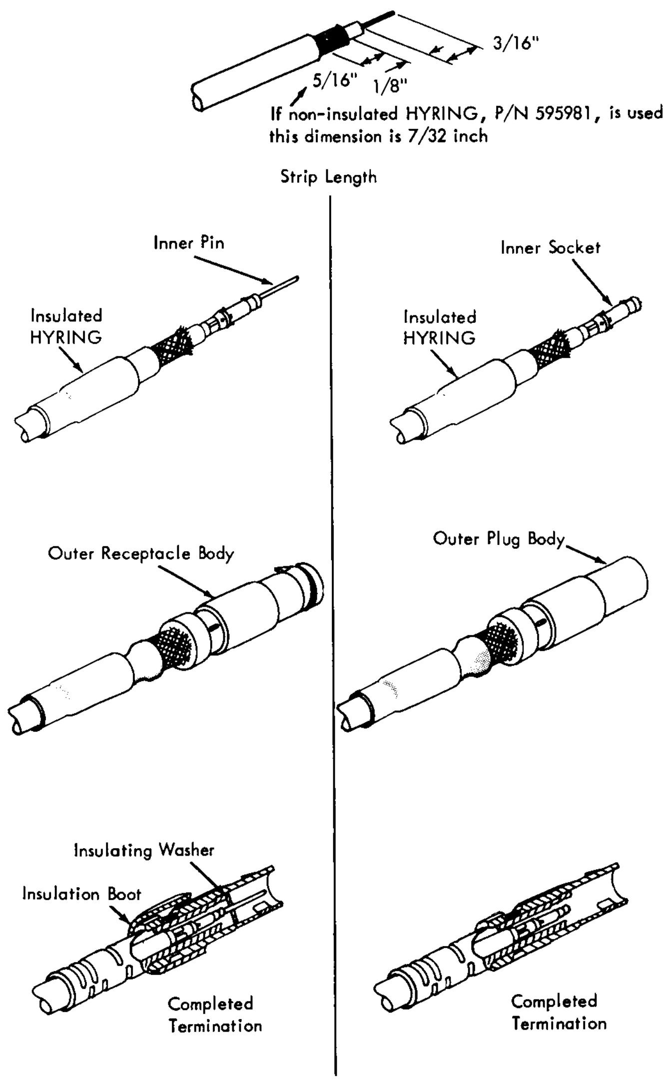


Figure 56. Coaxial Cable Connector Assembly

6. Make two crimps on the HYRING with Burndy tool MR8EC-16, P/N 461071, following the same procedure used for the outer plug body (step 6).
7. Slide the small white insulating washer over the inner pin, and place insulation boot P/N 596227, over the outer receptacle body.

The completed assemblies are snap-locked into the connector blocks. The assemblies may be removed from the connector blocks by using Burndy extraction tool RX4-1 (P/N 461044).

TWISTED-PAIR

When twisted-pair wire is routed to the plug-half of a coaxial cable connector, perform the termination as follows:

1. Cut the black wire 5/16 inch shorter than the yellow wire. Strip 3/16 inch of insulation from the yellow wire and ⅜ inch of insulation from the black wire.

2. Use die-set N22RVT-1, P/N 461038, in Burndy tool M8ND, P/N 461036, to crimp inner socket, P/N 595987, on the stripped end of the yellow wire.

3. Slide a blue, insulated HYRING, P/N 595726, over the twisted-pair wire. (Earlier machine units used non-insulated HYRING, P/N 595981, crimped with die-set N22RVT-1, P/N 461038.)

4. Use insert tool, P/N 461083, to snap-lock the inner socket into the outer plug body.

5. Slide the HYRING over the barrel of the outer plug so that the stripped portion of the black wire is between the HYRING and the barrel. Crimp the HYRING with the circular shaped groove of die-set N12ECT, P/N 461122, in Burndy tool M8ND.

It is not probable that twisted-pair wire will be routed to the receptacle-half of the coaxial connector. If this case arises, however, the procedure for the termination is the same as for the plug-half with the following exceptions:

1. Substitute inner pin, P/N 595985, for inner socket, P/N 595987.

2. Place insulation boot, P/N 596227, over the receptacle body when the assembly is completed.

Should it be necessary to remove the center conductor of a coaxial connector, clip off the entire coax connector and crimp on a new one.

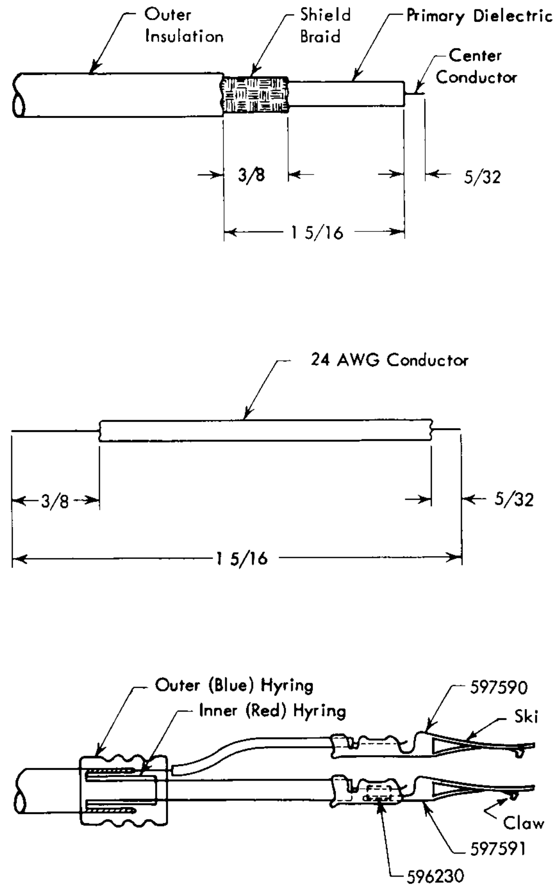


Figure 57. Coaxial Termination at Open-Wire Connectors

Open-Wire Connector Terminals

Open-wire connector terminals are used in 32-, 40-, and 200-position connectors. Terminals are identical for all sizes of connectors. Each terminal serves both a pin and socket function; a terminal mates with an identical terminal. The connector blocks are also universal in that two identical blocks are mated to form a connector. Refer to "Service Techniques" for additional details of the 200-position connector.

Use only a clean, lint-free cloth to clean the open-wire connectors. Cleaning fluid of any type will damage the connector block and will remove a lubricant that has been applied to the contact surfaces.

The open-wire connector terminals may be used with single wire, twisted-pair wire, or coaxial cable.

SINGLE WIRE AND TWISTED-PAIR

Single wire is stripped 5/32 inch and crimped in the proper terminal before insertion into the block. For 20-24 AWG wire, P/N 597590 terminal is used, and the crimp is performed with AMP tool 59501, P/N 461070. For 16-18 AWG wire, P/N 597591 terminal is used and the crimp is made with the groove marked P of AMP tool 47745, P/N 450898. Follow the procedure given under "AMP Tools" when using tool 47745.

The open-wire connector terminals are inserted into the connector block after the crimped termination is complete. The terminal claw (Figure 57) must snap over the raised lip on the block. The terminal ski must not be raised more than 0.005 inch from the block. If this condition is not met, the terminal may be re-formed by removing it from the block and pushing the free end of the ski toward the tip of the claw. The terminals are easily removed from the block without special tools by sliding the claw over the raised lip and pulling the contact out. Never use a metallic object to aid in this removal; the gold-plated terminal surfaces are easily damaged.

Twisted-pair wire is terminated by using two terminals and treating each wire of the pair as a single conductor.

COAXIAL CABLE

To terminate a coaxial cable in an open-wire connector, refer to Figure 57 and proceed:

1. Strip the cable to be terminated according to the dimensions in Figure 57.

2. Cut and strip a length of 24 AWG solid conductor (black insulation) to the dimensions shown in Figure 57.

3. Slide a blue, insulated outer HYRING, P/N 595726, over the cable outer insulation. Install a red, nonin-

sulated, inner HYRING, P/N 595725, underneath the stripped braid of the cable.

4. Center the outer HYRING over the inner HYRING with the ⅜-inch stripped end of the 24 AWG wire between the coax braid and the outer HYRING.

5. Crimp the outer HYRING with die-set N12ECT installed in Burndy tool M8ND.

6. Use AMP tool 59501, P/N 461070, to crimp an open-wire terminal, P/N 597590, to the free end of the black wire.

7. Use AMP tool 47745, P/N 450898, to crimp stuffer, P/N 596230, to the coax center conductor. Use the die-set groove marked A, and follow the crimping procedure given under "AMP Tools" for the nonratchet tool.

8. Use the die-set groove marked P of AMP tool 47745 to crimp terminal 597591 over the stuffer.

Insert the completed terminations into the connector block, following the same procedure as used for single-wire and twisted-pair terminations into open-wire connector terminals.

Crimped Connection Quality

As previously mentioned, the quality of crimped connections depends largely on the correct combination of wire, terminal, and tool for each application. Finding this combination is usually more difficult than performing the actual crimping procedure. It is important to control the factors that affect the quality of a connection because of the difficulty in determining the quality after a connection is complete.

Inspection

Visually inspect all completed connections for the following:

1. Stripped portion of the wire centrally located under the crimp.

2. No deformation of the terminal outside of the crimp area.

3. No fractures of the terminal or wire.

Do not use a connection that does not meet these criteria.

Tests

Test connections with no visual defects as follows:

1. Grip the wire between the thumb and forefinger of one hand and the terminal between the thumb and forefinger of the other hand.

2. Pull the wire, exerting only enough pressure to make the wire taut. Check for any movement of the wire within the terminal barrel (see Note).

3. Bend the wire about 30° and repeat step 2. Bend the wire 30°, from center, in the opposite direction and again repeat step 2.

NOTE: Wire movement in the terminal barrel can often be heard, but not seen. Such a connection is called a clicker and must not be used.

Wrapped Connections

The wire-wrapped connection is a precision pressure junction. It consists of wrapping a conductor (wire) tightly around a stationary terminal. High local residual stresses are produced (Figure 58).

A special wrapping tool wraps a length of stripped wire tightly around the square corners of a terminal. The resulting connection is one of the most reliable permanent connections available and is readily adaptable to production line manufacturing. Power tools for making wrapped connections are available as branch office tools to offices that have installed systems using wrapped wire junctions.

Theory of Wrapped Connections

A good wrapping terminal has sharp edges over which the wire can be tightly stretched. When the wire is wound around the terminal, the sharp edges dig into the comparatively soft wire, crush and shear the oxide covering on both wire and terminal, and form a continuous uncontaminated contact area. This area is gas tight and relies for its effectiveness on the continuing high pressure (stress) that the edge of the terminal and the wire surface exert against each other.

Once the metal particles are tightly interlocked, a reduction in contact force, a stress relaxation, occurs. The stress remaining is high enough, however, to maintain the required contact area. In time, another action, solid state diffusion, takes over. This process is caused by the migration of one material of the connection into the other. This migration tends to eliminate the individual surfaces between the wire and the terminal and actually fuses the two together.

The wrap must not be moved after it is completed; the bond between wire and terminal is destroyed by any movement between these parts.

Wrapping Tools

The wrapping tool is a metal rod containing two axial holes: a small hole for receiving the bare end of the wire, and a larger hole for receiving the terminal (Figure 59). The metal rod, called the wrapping bit, accepts a length of stripped wire. The bit is placed on the terminal, and rotated, forming a tightly wrapped coil of wire around the terminal.

Keller Power Wrapping Tool

The Keller wrapping tool has an electric motor that drives a wrapping bit. The complete tool consists of the electrically operated wrapping gun, and wrapping bits and sleeves for the various wire sizes (Figure 60). The wrapping gun, P/N 461012, is equipped with a 20-foot, three-wire power cord. The gun must be grounded.

The wrapping bit turns within a sleeve that contains a wire anchoring notch on each side. The notch holds the insulated portion of the lead to anchor the wire.

Wrapping bits and sleeves for use with the gun are as follows:

Wire Size	Wrapping Bits		Sleeves	
AWG	IBM P/N	Keller P/N	IBM P/N	Keller P/N
26	461063	A-27611	461014	17611-2
24	461235	A-26237	461015	17611-2
22	461010	A-18632	461015	18840
20	461011	A-18633	461016	18285

Manual Wrapping Tools

The manual wrapping tool consists of a wrapping bit attached to a screwdriver type handle. Two assemblies are available:

1. P/N 451140 is used with 20-22 AWG wire and has

Figure 58. Wrapped Connection

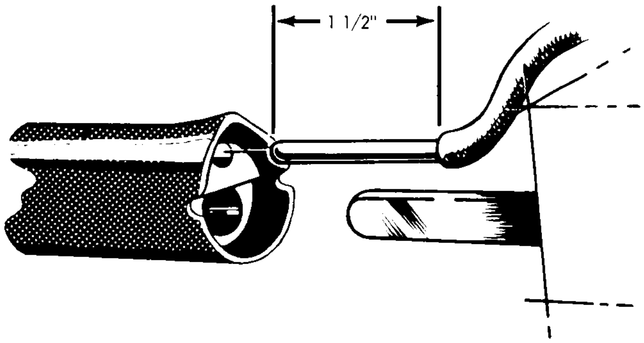


Figure 59. End of Wrapping Bit

an amber colored handle.

2. P/N 451142 is used with 24-26 AWG wire and has a blue handle.

Squeeze-Type Wrapping Tool

A manual, squeeze-type wire-wrap tool, P/N 451572, is available for field use. The bits and sleeves are identical to those used with the electrically powered gun:

Wire Size AWG	Wrapping Bit	Sleeve
26	461063	461014
24	461235	461015
22	461010	461015
20	461011	461016

Right and Left-Hand Unwrap Tool

An unwrap tool, P/N 451573, is available that will unwrap both the right and left-hand wraps.

Wrapping Procedure

CAUTION: Only nylon-jacketed or semi-rigid PVC (polyvinyl chloride-insulated) wire should be used for re-wiring back panels. Teflon-insulated wire, used in panels produced by automation, is unsuitable for re-wiring in the field due to the difficulty in stripping without damaging the conductor.

Electrically Operated Tool

1. Select the bit and sleeve for the wire size to be used.

2. Install bit and sleeve in the nose assembly of the power tool:

a. Loosen the collet nut on the nose assembly.

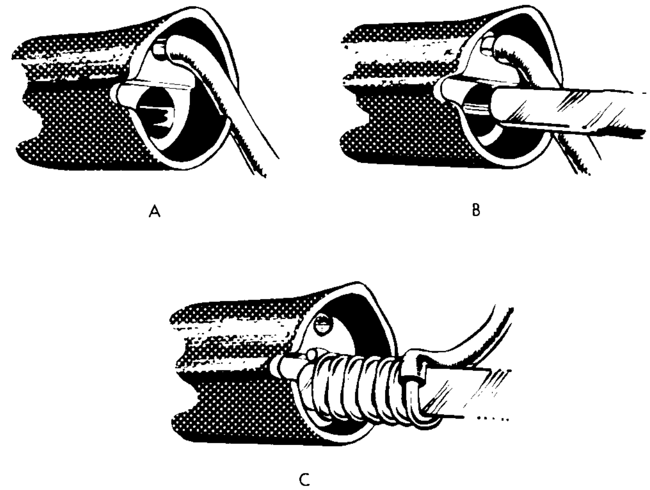


Figure 61. Wrapping Procedure

b. Insert the wrapping bit into the collet. Rotate the bit while applying slight pressure against the end until it seats itself. (To remove the bit, reverse this process.)

c. Place the sleeve over the bit and into the collet. Rotate until sleeve is seated and positioned. With tool running, apply slight pressure to the end of the sleeve and tighten collet nut.

3. Strip 1⅜ to 1½ inch of insulation from the wire to be wrapped. This will result in about six wraps around the terminal. The completed terminal must have at least five turns of bare wire. Be careful not to nick or scrape the wire. A nicked wire is subject to breaks that are difficult to detect. Areas where plating is removed will oxidize, causing an unreliable connection.

4. Insert the stripped wire into the small hole of the wrapping bit (Figure 61A) taking care to insert the wire up to the insulation. Do not bend the bare end of the wire; it may be difficult to slide into the bit. If the wire is not inserted in the wrapping bit up to the insulation, a "shiner" (bare wire between insulation and terminal) may result. There should be ¼ turn to ¾ turn of insulation at the beginning of each wrap, except for coaxial cable. Coaxial cable insulation should not be wrapped, but it must end no more than 1/16 inch from the terminal.

5. Hold the wire with the fingers and bend the insulated portion of the lead into the retaining notch in the sleeve (Figure 61B). Use the right or left notch

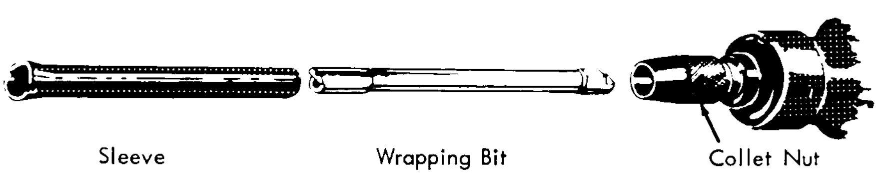


Figure 60. Wrapping Tool

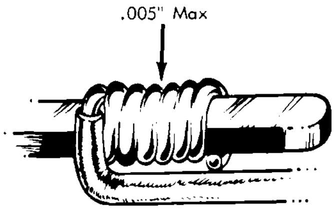


Figure 62. Wrap Spacing

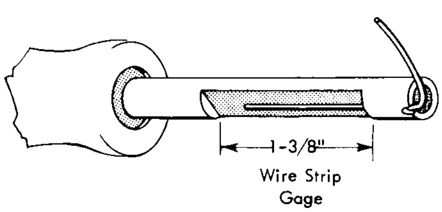
as determined by the direction of the approach (or exit) of the lead. Place the wrapping bit on the terminal. Be sure the terminal is inserted into the bit as far as it will go. Use reasonable care to hold the tool in line with the terminal.

6. Hold the tool on the terminal and squeeze the trigger to wrap the wire on the terminal. The tool will automatically recede as the wire coils on the terminal. Release trigger and remove tool from terminal. The wrapped connection is complete (Figure 61C).

NOTE: If too much pressure is used to push the tool on the terminal, a turn of wire will wrap over a previous turn. If too little pressure is exerted, the adjacent wraps of wire may not touch each other. Maximum separation between individual turns on the terminal must not exceed 0.005 inch, excluding the first and last wrap (Figure 62).

Screwdriver Handle Tools

1. Select the tool for the wire size to be used.
2. Strip 1½ inches of insulation from the wire. The flat portion of the shank of the tool is 1⅜ inch long and can be used as a wire strip gage (Figure 63).
3. Fully insert the stripped wire into the off-center retaining hole. Use enough force to cause the insulation to bind in the tapered portion of the hole.
4. Bend the insulated wire across the end of the tool, locating the wire in the sloped notch in the outer rim of the tool. Avoid pulling the insulation out of the tool, by holding the bare wire against the flat portion of the shank (Figure 63).
5. Insert the tool center-pilot-hole over the contact pin until the tool bottoms against the block or preceding wrap.



AWG	Tool	Color
20-22	451140	Amber
24-26	451142	Blue

Figure 63. Hand Operated Wrap/Unwrap Tool

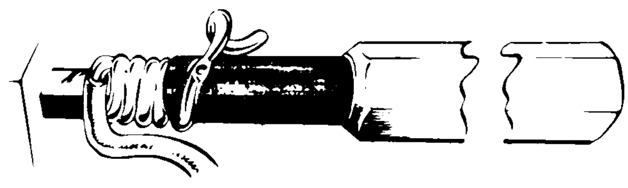


Figure 64. Hand Unwrap Tool, P/N 461013

6. Hold the loose end of wire and turn the tool to the right, applying light pressure to insure that the turns are against each other.

NOTE: Do not attempt to wrap a left-hand wrap. Although factory wired machines will have both left and right-hand wraps, the tool is designed to wrap right-hand only.

Unwrapping

Wires may be removed from a terminal by using the hand unwrap tool, P/N 461013 (Figure 64). The open end of the tool is placed over the terminal and rotated, screwing the tool under the wraps of wire.

The combination wrap/unwrap tools have a right and left-hand unwrap feature. The amber-handle tool, P/N 451140, is for 20 and 22 wire; the blue-handle tool, P/N 451142, is for 24 and 26 wire. Unwrapping is accomplished by catching the tail of the wire with the unwrap point and turning the tool in a direction opposite to that of the wrap. In some cases, it may be necessary to lift the wire tail away from the pin before the wire can be unwrapped. Apply only enough pressure to loosen turns. A left-right unwrap tool, P/N 451573, is available.

CAUTION: An unwrapped wire must never be rewrapped. A new wire must be used as a replacement, or a length of wire spliced to the existing wire by using a butt connector, P/N 216230 (Figure 65); strip wire ⅛ inch and crimp with bare wire crimping tool, P/N 461070.

CAUTION: Never slide a termination on a pin because this rounds the sharp corner of the pin and makes subsequent connections unreliable. As you unwrap a wire, watch to see that the first coil does not break off and drop into the panel. This breakage is often caused by the lip of the tool not engaging the tail of the wire. Terminals may be wrapped ten times before replacement is necessary.

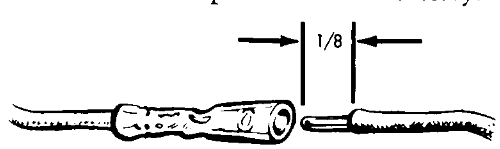


Figure 65. Butt Connector, P/N 216230

Wrapped Connection Quality

The nature of the wrapped connection makes it extremely difficult to determine if a good quality junction has been made. This is primarily due to the destruction of the connection if the wrap is disturbed in any manner. The most common factors causing poor quality wraps are:

1. Incorrect wrapping bit for the wire size in use.
2. Worn or damaged wrapping bit.
3. Dirty wrapping bit.

A defective wrapped connection may be either too tight or too loose. If the wrap is made too tight, the wire is deformed to such an extent that it becomes brittle. The wire may then break under vibration and handling. A loose wrap will not have sufficient pressure to bond the wire to the terminal.

SMS back panel wires are frequently routed around, but not attached to, an intermediate terminal. If a wire is pulled too tight or excessive pressure is exerted at the point of contact with the intermediate terminal, insulation damage may result, allowing the wire to short to the terminal. *This short may be intermittent.* When wiring back panels, be extremely careful not to pull wires tightly around intermediate terminals, or to allow a wire to rub along a terminal pin.

Wire Size

A good quality wrap cannot be made unless the wrapping bit and sleeve are of compatible size. The wire size to be used must be determined by whatever means are available. When the wire size has been determined, the part number of the correct wrapping tool may be located under "Wrapping Tools."

AWG	Strands	Strand Diameter (in.)	AWG	Type	Insulation OD (in.) Min.	Max.
22	7	0.010	22	PVC	0.063	0.075
	19	0.0063		Teflon	0.046	0.054
20	7	0.0126	20	PVC	0.071	0.084
	19	0.0080		Teflon	0.054	0.062
18	7	0.0159	18	PVC	0.082	0.095
	19	0.010		Teflon	0.064	0.074
16			16	PVC	0.091	0.105
	19	0.0113		Teflon	0.073	0.087
14			14	PVC	0.106	0.120
	19	0.0142		Teflon	0.098	0.114
12			12	PVC	0.127	0.142
	19	0.0179		Teflon	0.113	0.132
10			10	PVC	0.147	0.167
	37	0.0159		Teflon	0.135	0.151

Figure 66. Wire Sizes

Checking Wire Size

To determine wire size accurately, measure the diameter of an individual strand with a micrometer, and compare with Figure 66. For an approximate check, measure the diameter of the insulation.

Wrapping Tool Maintenance

To produce wire-wrap of the highest quality, keep the bit and sleeve free of foreign matter. To clean a sleeve: dip surgical cotton or a clean, lint-free cloth in IBM cleaning fluid, P/N 450608, and pass this through the barrel at least twice. Follow with a clean, dry cloth to remove all foreign matter and cleaning fluid.

To clean a bit: dip a clean, lint-free cloth in cleaning fluid and clean the outside of the bit, paying attention to the wrap end. Clean the wire groove from collet end to wrap end, paying attention to the wrap end. Lubricate the collet end of the bit with a cloth dampened in IBM 6 oil. Do not let oil enter the wire groove. The foregoing cleaning procedure should be performed every eight hours of use, and prior to using after prolonged storage of the tool.

CAUTION: Do not use a bit that has been dropped. Do not use a bit that is damaged or worn. Do not store a bit in a gun. Be careful when storing bits to prevent their being damaged. If there is any doubt about the condition of the tool, send the bit to Customer Engineering Department, Poughkeepsie.

Test Wraps

It is not advisable to perform any tests on a wrapped connection that is intended for use. A wrap can be made, however, for the specific purpose of testing. Test wraps should be made immediately prior to the operational wraps, using the tools and materials to be used for the operational wraps.

Test wraps should be subjected to the following tests:

Wire Breakage: Unwrap the wire from the terminal; the wire must not break when unwound with reasonable care. Avoid twisting the wire when unwinding, and avoid contact with other wraps during the unwrapping process. A wrap that does not pass this check was wrapped too tight.

Stripping Test: Apply a stripping force perpendicular to the terminal board to strip the wrap from the terminal. This test is designed to determine if the wrap is too loose. Experience must be relied upon to determine if the amount of pressure necessary to strip the wrap from the terminal is correct.

SMS Wiring Change Procedures

To insure standardization of wiring and maximum reliability, specific wiring procedures have been developed. These procedures must be followed for all wiring changes.

Automated Wiring Lists

Most wiring on SMS back panels is made according to automated wiring lists. Three automated lists are provided for each engineering change:

1. Automated Add List (Figure 67).
2. Automated Delete List.
3. Installation Sequence List.

Instructions for changing relays, switches, and back panel components are given on a manually prepared listing.

Note that the add and delete lists, produced through automation, are for panels only. There is no provision made for interpanel wiring changes. When a wire is added to a T-row, be sure there is a connecting wire to the adjacent panel. Figure 68 shows the abbreviations used on add and delete lists.

Whenever two Customer Engineers install an engineering change, each should check the other's work. Make a continuity check of the deletes and then the adds. Finding an error by this method is less time-consuming than troubleshooting with power on. Accuracy in performing the deletes and adds cannot be overemphasized.

SMS back panel wires are frequently routed around, but not attached to, an intermediate terminal. If the wire is pulled too tight, or excessive pressure is exerted at the point of contact with the intermediate terminal, insulation damage may result, allowing the wire to short to the terminal. This possibility should be considered when diagnosing hard-to-find troubles. When

INTERNATIONAL BUSINESS MACHINES

AUTOMATED ADD LIST PANEL 16A3 MACHINE 7301 09-16-59 PG 1

FIGURE 69 MACH. VERSION PART NO. 0536402 ENG. CHG. 246421 DATE - -

WIRE NUMBER PREVIOUS MACHINE VERSION PART NO. 0536402 ENG. CHG. 246331

	NET	LGTH	TYPE	FROM	VIA	VIA	TO	FROM	TO
1	340	4 1/8	Y	E27A			E28A		
2	311	3 5/8	Y	E28D			E28F		
3	304	4 5/8	Y	E25A			E26B		
4	133	4 0/8	Y	E23A			E23B		
5	302	4 1/8	Y	E25F			E26F		
6	299	4 4/8	Y	E27F			E28J		
7	135	5 2/8	Y	E25L			E27L		
8	138	5 7/8	Y	E24E			E24N		
9	132	5 7/8	Y	E26R			E28M		
10	101	5 7/8	Y	E08B			E10F		
11	107	8 4/8	Y	E01C			F01E		
12	245	6 7/8	Y	E01P			F02J		
13	312	5 1/8	Y	E02A			E02F		
14	146	4 4/8	Y	E02M			E03Q		
15	165	5 2/8	Y	F01P	F02P		F03P		
16	167	5 7/8	Y	E03K			E05F		
17	243	6 3/8	Y	F03C			F05F		
18	303	5 2/8	Y	F04Q			F06P		
19	106	7 1/8	Y	E04B	E05A	E07A	E07G		
20	134	6 5/8	Y	E05M	E05R	E06R	E07Q		
21	149	7 0/8	Y	F05D	F07G	F07P	F08P		
22	316	6 4/8	Y	E08Q	F08%	F09#	F09E		
23	281	8 4/8	Y	E10K	F10%	F10#	F09M		
24	298	6 3/8	Y	F25H	F23M		F23N		
25	300	5 1/8	Y	F24A	F24E		F24G		
26	109	6 6/8	T	F11C			F11Q	F11B	F11R
27	291	9 7/8	C	E23Q	F26#	G26%	F27R	E23H	F27J

END OF WIRING LIST

Figure 67. Automated Add List

making changes on back panels, be careful not to pull wires tightly around intermediate terminals or allow wires to rub along a terminal pin.

Automated Add List

The automated add list gives precise information for adding wiring to an SMS back panel. The following columns appear on the list (Figure 67):

NET — This column is used by the design program. It may also assist in servicing; wires with the same NET number are electrically common.

Primary Header Identification

MACH	- Machine	EC#	-	Engineering Change Number
FR	- Frame	MFI	-	Machine Features Index
GATE	- Gate	P.N.	-	Part Number of Listings
PL	- Panel			

Title Abbreviations

CBL ASM BFR #	-	Cable Assembly Buffer #
INT CD - CS	-	Integrator Card to Card Socket
INTGT JPR CBL	-	Intergate Jumper Cable
INTPL JPR CBL	-	Interpanel Jumper Cable
STD RIBBON CBL	-	Standard Ribbon Cable
T-ROW SIG JPR	-	T-Row Signal Jumper
VOLT JPRS	-	Voltage Jumpers Laminar Bus to Card Socket

Secondary Header Identification

NAME	-	Name of Component
PART NO.	-	Part Number
W/N	-	Wire Number
W/L	-	Wire Length to the Nearest Tenth
FROM	-	From Location
TO	-	To Location
GT	-	Gate and Panel
C/N	-	Component Number
TERM	-	Terminal or Location
T	-	Type of Terminal
CL	-	Classification

Type of Termination T

A	-	Small Single Taper Plug	N	-	Voltage Terminal Tab
B	-	Large Single Taper Plug	P	-	Two Way Insulated Connector
C	-	Small Double Taper Plug	Q	-	Coax Connector Female
D	-	Large Double Taper Plug	R	-	Male Burndy Connector
E	-	Ring Clip	S	-	Skin & Tin Solder
F	-	Spade Clip	T	-	Taper Tab
G	-	Amp Terminal	U	-	Splice Link
H	-	Female Taper Pin Terminal	V	-	Small Female Taper Tab
J	-	Horse Shoe Jumper Small	W	-	Wire Wrap
K	-	Horse Shoe Jumper Medium	X	-	Insulation on one end of Twisted Pair Reference Line
L	-	Horse Shoe Jumper Large			
M	-	Coax Termination Male	Y	-	Female Burndy Connector
			Z	-	Continuous Jumper

Classification CL

AS	-	Arc Suppressor	NE	-	Neon
C	-	Capacitor	PC	-	Printed Circuit
CS	-	Card Socket	PR	-	Permissive Make Relay
DB	-	Diode Block	QD	-	Quick Disconnect
EC	-	Edge Connector	R	-	Resistor
HR	-	Heavy Duty Relay	SC	-	Shoe Connector
IL	-	Incandescent Lamp	SW	-	Switch
IC	-	Integrator Card	SL	-	Solenoid
J	-	Jones Plug	TB	-	Terminal Block
KB	-	Keyboard	VB	-	Voltage Board
LB	-	Laminar Bus	WR	-	Wire Contact Relay

Figure 68. Abbreviations Used on Add and Delete Lists

LGTH — This column gives the wire length, in inches, including three inches for wrapped terminations. The length listed does not include the extra length necessary because of build-up of wires on a panel.

TYPE — This column gives the wire type to be used:

Y — single conductor solid copper 24 AWG, with yellow insulation. Part numbers are 216225 for nylon jacketed PVC insulation, and 532031 for Teflon insulation.

T — twisted-pair wires, solid copper 24 AWG, one lead with yellow insulation and one lead with black insulation. Part numbers are 216228 for nylon jacketed PVC insulation, and 532030 for Teflon insulation.

C — coaxial cable with 26 AWG center conductor, P/N 532029. The lead attached to coaxial cable shields is solid copper 24 AWG, with black insulation. Part numbers are 216284 for nylon jacketed PVC insulation, and 532032 for Teflon insulation.

P — printed wiring on back panel cards.

FROM — This column gives the location of the first terminating terminal. A wrapped connection is made to this terminal.

VIA-VIA — These two columns give routing information for the wire. A VIA terminal is listed for each bend in the wire. The wire is routed by forming it around the VIA terminals but no electrical connection is made.

TO — This column gives the location of the second terminating terminal. A wrapped connection is made to this terminal.

FROM-TO — These two columns give the location of the reference lead termination terminals when coaxial cable or twisted-pair wires are used. These columns are blank if single conductor wire is used or if a reference lead is *not* to be terminated.

To keep track of an add wire, cut two pieces of spaghetti, one inch long. Place one on the TO pin and the other on the FROM pin, as read from the add list. Remove the spaghetti just at the time you are ready to wire-wrap the pin. Alligator clips may be used instead of spaghetti.

Automated Delete List

Automated delete lists give the necessary information for removing wires from a back panel. The delete list format is identical to the add list format. All types of information provided by the add list are also provided by the delete list, except for wire length. The LGTH column of a delete list contains slash bars instead of wire lengths.

Engineering change automated delete lists call out the wires to be removed. Usually it will be necessary to remove other wires in order to gain access to the wires

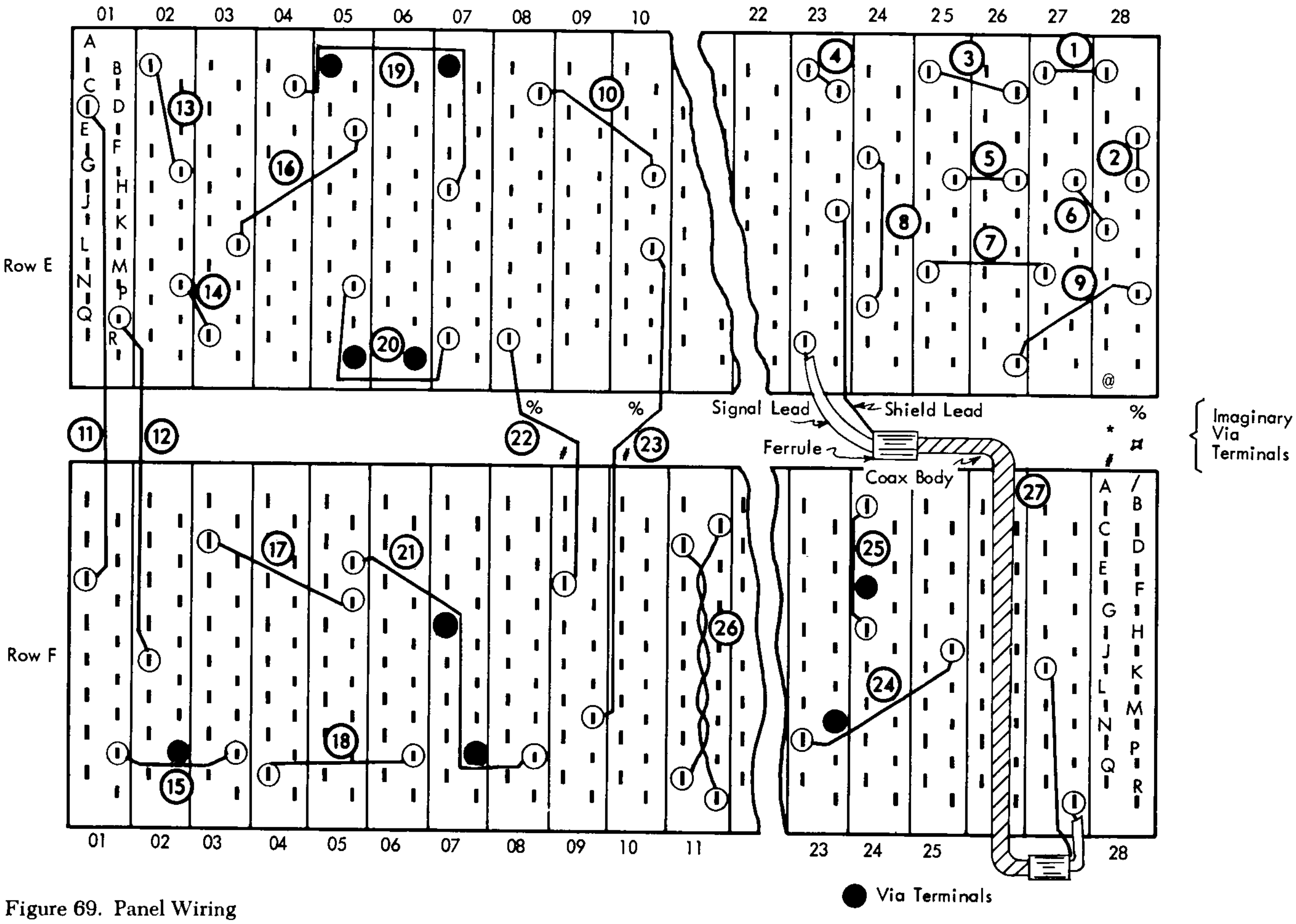


Figure 69. Panel Wiring

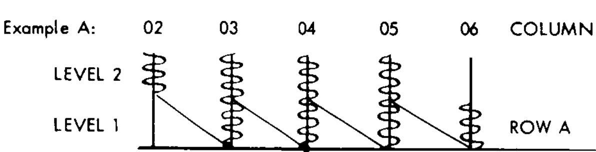
listed. The following illustrates recommended procedure (with reference to Figures 70 and 71):

1. Unwrap the level 2 wire on A03C.

2. By tracing this wire (visual or continuity check) determine that this is one end of the active wire (A03C to A04C).

3. Remove the level 2 wire on A04C. Checking will show that this is not the other end of the wire removed from A03C.

4. Unwrap the level 1 wire on A04C. This removes the active wire, A03C to A04C.



Automated Delete List Panel 16D3

Net	Length	Type	From	Via	Via	To
101	9 3/8	Y	A03C	---	---	A04C
125	9	Y	B06G	---	---	B09G

Figure 70. Two-Level Wrap

5. Cut the old wire wrap from the wire removed from level 2 of A04C. Use a butt connector, P/N 216230, to splice a new section onto this wire. Wrap this new section of wire back on A04C. The butt connector is used to eliminate the chain reaction of removing wires.

NOTE: The above condition should arise very seldom since wires in new machines will have the same wrap level on each end.

Installation Sequence List

The installation sequence list gives a complete wiring list for the panel, or panels, affected by the engineering change. The list is correct after the change has been installed. The sequence list starts with terminal A01A (or the first terminal containing a wire) and progresses through the panel, listing all terminals which have

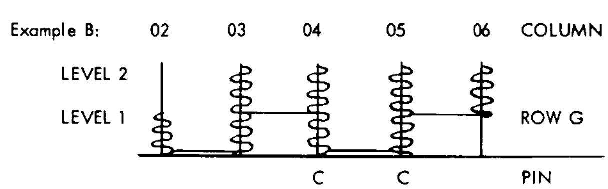


Figure 71. Same-Level Wrap

wrapped connections. The format of the sequence list is identical to the format of the add list. Although the installation sequence list is not necessary for installing an engineering change, it is ideal for locating wiring errors after the change has been installed.

Wiring Rules

Wiring procedures depend on the type of wire used. Rules apply in four categories:

1. Single wire and twisted pair.
2. Coaxial cable.
3. Laminar bus jumpers.
4. Back panel components.

Single Wire and Twisted Pair

The following rules apply for single-conductor (Y) and twisted-pair (T) wire when no VIA terminals are specified on the add list. Figure 69 illustrates the proper installation of wires listed in Figure 67.

Direct Route: A wire is routed in a straight line when there are no terminals to prevent this route. Figure 69, examples 1, 2, 3, 4, 5, 6, and 14 illustrate the direct route.

Horizontal Route: A wire connecting two terminals of the same letter in a card socket row must lie in the channel immediately above the two terminals (Figure 69, example 7). When one letter difference exists between card socket terminals, the wire is routed in the horizontal channel between the two pins (Figure 69, example 18).

Vertical Route: A wire connecting two terminals in the same SMS card socket column, and in line, must lie in the channel immediately to the right of the two terminals (Figure 69, examples 8 and 11). When one column number difference exists between the two terminals, the wire is routed in the vertical channel between the two terminals (Figure 69, examples 12 and 13).

Diagonal Route: A wire connecting two terminals on either diagonal, must lie in the diagonal channel immediately above the two terminals (Figure 69, examples 9 and 10). When a diagonal channel exists between the two terminating terminals, the wire is routed in this channel (Figure 69, examples 16 and 17).

Twisted Pair Reference: The black (reference) lead of a twisted pair must follow the signal (yellow) lead to within ½ inch of the signal lead termination terminal (Figure 69, example 26).

When VIA terminals are specified on the add list, the following rules apply:

Rule Reversal: When the two terminating terminals and a VIA terminal are in-line (horizontally, vertically, or diagonally) the wire is routed below or to the left of the terminals (Figure 69, examples 15, 24, and 25).

Channel Change: When a wire is routed in a combination of horizontal, vertical, and diagonal channels, a VIA terminal is designated for each bend in the wire. The wire is formed around the VIA terminal and each segment of the wire (horizontal, vertical, or diagonal) follows the wiring rules for wires where no VIA terminals are specified (Figure 69, examples 19, 20, and 21).

Imaginary VIA Terminals: For routing purposes, six terminals are assumed to lie in each column, between card socket rows. Figure 69, column 28 shows the placement of the imaginary VIA terminals, and the special characters used to designate these locations.

Coaxial Cable

Figure 69, example 27 illustrates a coaxial cable routed according to the following rules:

Coax Body: The coax body may be routed vertically or horizontally, but not diagonally. Horizontal routing must be between card socket rows.

Coax Signal Lead: The length of exposed insulation on the coax signal lead must be as short as possible. The maximum length allowed is 1½ inch. The signal lead is routed in a straight line from the coax body to the terminating terminal. The signal lead insulation must not wrap around the terminal but must be within 1/16 inch of the terminal.

Coax Shield Lead: The shield (black) lead is routed directly to the terminating terminals listed in the right hand FROM-TO columns of the wiring list. If no terminals are listed in these columns, the shield is not terminated.

Coax Ferrule: The ferrule must lie in the channel between card socket rows.

The imaginary VIA terminals shown in Figure 69 are used in programming the automatic wiring machine for wiring panels during manufacture.

Laminar Bus Jumpers

Laminar bus jumpers are solid copper wire, 22 AWG, with color coded insulation as shown in Figure 72.

Back Panel Components

Back panel components are mounted after other panel wiring is completed. The location of these components is designated by manually prepared lists and drawings. Back panel capacitors should be mounted in one

VOLTAGE	WIRE COLOR CODE	VOLTAGE	WIRE COLOR CODE	VOLTAGE	WIRE COLOR CODE
+82 IND	Red	+12M	White	-12	Violet
+60	White, red tracer	+6	Orange	-12M	Aqua
+48	White, black tracer	+6M	Tan	-18 IND	White, brown tracer
+30	Pink	Ground	Black	-20	White, violet tracer
+30M	Pink, black tracer	-6	Blue	-36	Brown
+12	Gray	-6 Sp	White, blue tracer	-48	White, orange tracer

Figure 72. Service Wiring Standard Color Code

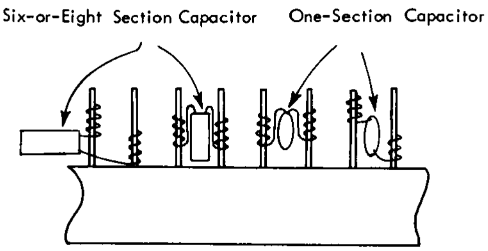


Figure 73. Component Mounting

of the four positions shown in Figure 73. Figure 74 gives the color codes necessary for identifying components.

Laminar Bus Pin Identification

The laminar bus on the rear of a sliding gate frame distributes DC power from the SMS power supply on each gate. Jumpers from the laminar bus to the power distribution overlay provide power to each card socket.

The jumpers are wire wrapped to the overlay terminals and have spring connectors, P/N 259009, that slide over the terminals on the laminar bus.

Automated add and delete lists for voltage jumpers give a pin identification for the laminar bus (LB) instead of specifying the voltage. See Figure 75.

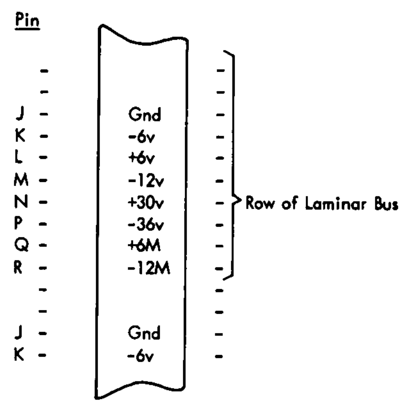


Figure 75. Laminar Bus Pin Identification

Color	First Ring - 1st Figure	Second Ring - 2nd Figure	Third Ring - Multiplier
Black	0	0	None
Brown	1	1	0
Red	2	2	00
Orange	3	3	000
Yellow	4	4	0,000
Green	5	5	00,000
Blue	6	6	000,000
Violet	7	7	0,000,000
Gray	8	8	00,000,000
White	9	9	000,000,000

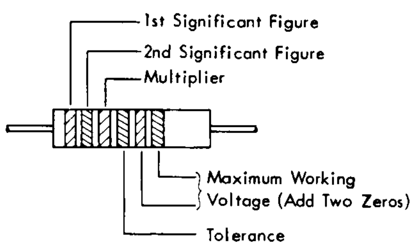
NOTE: A fourth colored ring on resistors determines tolerance ratings as follows:

Gold = ± 5 %
Silver = ± 10 %

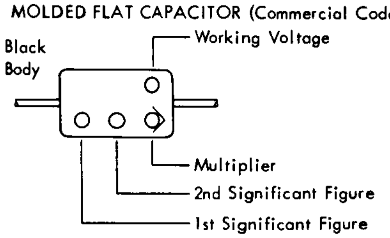
Absence of a fourth colored ring indicates ±20% tolerance.

MOLDED PAPER CAPACITORS

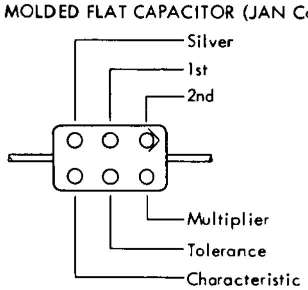
TUBULAR TYPE



MOLDED FLAT CAPACITOR (Commercial Code)



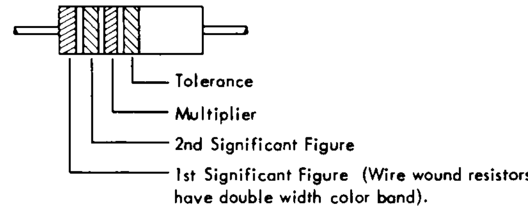
MOLDED FLAT CAPACITOR (JAN Code)



NOTE 1: Unless otherwise specified, the maximum working voltage rating of capacitors is obtained by multiplying the capacitor body color code value by 100.

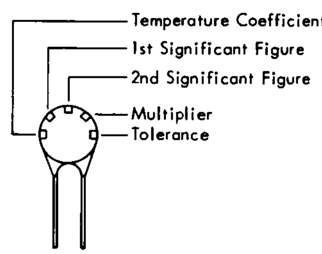
NOTE 2: The tolerance rating of capacitors is determined by the color code value in percent. For example, Green equals ±5%.

AXIAL LEAD RESISTOR

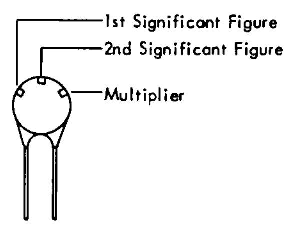


Resistor wattage rating is determined by physical size. However, resistors most commonly used at IBM are one-half watt and higher rated; resistors are progressively larger.

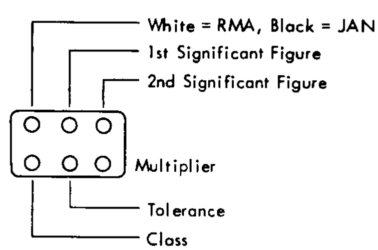
FIVE DOT DISK CERAMIC CAPACITOR



DISK CERAMIC CAPACITORS



MOLDED MICA CAPACITORS



BUTTON SILVER MICA CAPACITOR

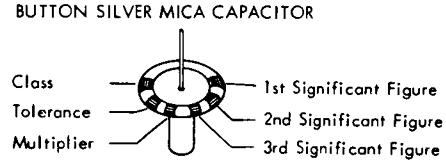


Figure 74. Component Color Codes

The many innovations of SMS equipment require new troubleshooting and repair techniques. New tools permit faster troubleshooting and higher quality repairs. Tools and techniques associated with soldered, crimped, and wrapped connections are presented in the previous sections of this manual. This section covers other tools and techniques used in both troubleshooting and repair of SMS equipment.

Wire Stripping Tool

The IDEAL* wire stripping tool, P/N 461075, can be used to remove insulation from either solid or stranded wire, size 16 through 26 AWG. The tool is easy to operate and gives, in most cases, clean strips without nicking the wire. A stop, P/N 461076, can be attached to the stripping tool to allow quick measurement of wire stripped for wrapped connections.

Unlike many similar hand tools, the operating handles of this stripping tool will completely close; thus, it is extremely easy to pinch your fingers when operating this tool. One solution to this problem is to tape a small piece of rubber to one of the handles. Install the piece of rubber so that it stops the handles when they are about ½ inch apart. This simple stop will not interfere with the normal operation of the tool.

To use the IDEAL wire stripping tool:

1. Determine the size of the wire to be stripped and the length of insulation to be stripped from the wire.

NOTE: The feasibility of providing a gage for measuring wire size is under investigation. At this time, use the part number of the wire to find the wire size in the parts catalog.

2. Insert the wire into the stripping die groove that corresponds to the wire size. If the wire is to be used for a wrapped connection, butt the end of the wire against the upright portion of the stop, to provide a 1½ inch strip length. If the wire is to be used for other than a wrapped connection, set the correct strip length by measuring from the stripping die to the end of the wire.

3. Close the operating handles, taking care not to catch your fingers between the handles.

4. Release the handles and remove the stripped wire. Inspect the results for a clean break of the insulation and no nicks in the wire.

*Trademark of Ideal Industries Inc.

Card Pullers

Three card pullers facilitate insertion and removal of SMS cards, reducing the possibility of dropping cards and damaging components. Figure 76 shows the single card puller, P/N 451030. P/N 461110 is similar but is used to remove or insert double-sized SMS cards. P/N 461103 is for stan-pac cards.

In operation, the card puller fits over the edges of an SMS card. When the tool is properly positioned, a tooth on the spring-loaded latch seats in a hole in the card. The card is released by depressing the latch.

CAUTION: Before removing an SMS card, insert an IBM card between the card to be removed and adjacent SMS cards. Damage to SMS cards or components may be eliminated in this manner.

Oscilloscope Probe Tips

Special oscilloscope probe tips fit the back panel wire-wrapping terminals to free the operator's hands from holding the test probe. The following parts are released for use with test probes:

P/N 461118 – Back panel scope probe tiplet, threaded 10-32 for use with P410 and P510 series probes (Figure 77). This tiplet replaces P/N 451062, which is no longer available. Two or more tiplets should be available with each oscilloscope used in servicing SMS machines. Should the overlay prevent a tiplet from

Figure 76. SMS Single Card Puller, P/N 451030

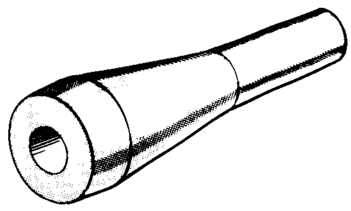


Figure 77. Backpanel Scope Probe Tiplet, P/N 461118 and 461119

being inserted onto a back panel pin, remove a small portion of the rubber insulation with a sharp knife.

P/N 461119 – Back panel scope probe tiplet, similar to P/N 461118 but with 6-32 thread for use with a P6000 probe. This tiplet is a rubber-covered coil spring (Figure 77).

P/N 451060 – Ground wire for use with P410 and P510 probes (Figure 78). The slotted tip fits the ground pin on any SMS card socket. For accurately measuring voltage noise or ripple, connect the attenuator probe to the circuit ground.

P/N 461085 – Oscilloscope attenuator probe, type P6000, with a 9-foot cable (Figure 79). This is a lightweight probe for use with Tektronix types 531A, 535A, and 545A oscilloscopes. The P410, P510, and P6000 series probes have been discontinued and are no longer available, except for replacement parts; they are replaced by P/N 451215.

Frequency compensation of the P/N 461085 probe is accomplished as follows:

1. Hold the nose-and-body assembly A and loosen locking stop B.

2. Rotate A while holding C until a flat-topped square wave is obtained when the probe is connected to the calibrator output.

3. Hold nose-and-body assembly A and tighten locking stop B.

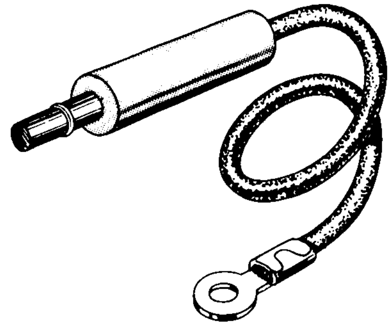


Figure 78. Ground Wire, P/N 451060

Components of the probe which will most likely require field replacement are the following:

461086	Pincher Tip Assembly	461090	Hook Tip Assembly
461087	Holder–Probe	461091	Straight Tip Assembly
461088	Nose Assembly	461092	Ground Lead Assembly
461089	Body Assembly	461093	Locking Stop

P/N 451215 – Oscilloscope probe, type P6017 (Figure 80) replaces the Tektronix type 510A probe, P/N 450857, and Tektronix type P6000 probe, P/N 461085. Both are discontinued and unavailable, although replacement parts may be obtained.

All oscilloscope types 310A, 531A, 535A, 545A, and 551 will include the P6017 probe, which is similar to the P6000 but has the compensating capacitor at the scope end of the cable. Accessories included with the P6017 probe are shown in Figure 80.

Card Extender

SMS card extender, P/N 451075 (Figure 81), allows access to the components and wiring of an SMS card while the card is connected into the system. Waveforms can be taken at points within the circuitry of a card by use of the extender. Two card extenders should be used if access to a double SMS card is desired. The socket end of the tool can be rotated on the support to any of six positions. The support can be removed by unscrewing it from the card end of the tool. These features make it possible to check cards in any machine location.

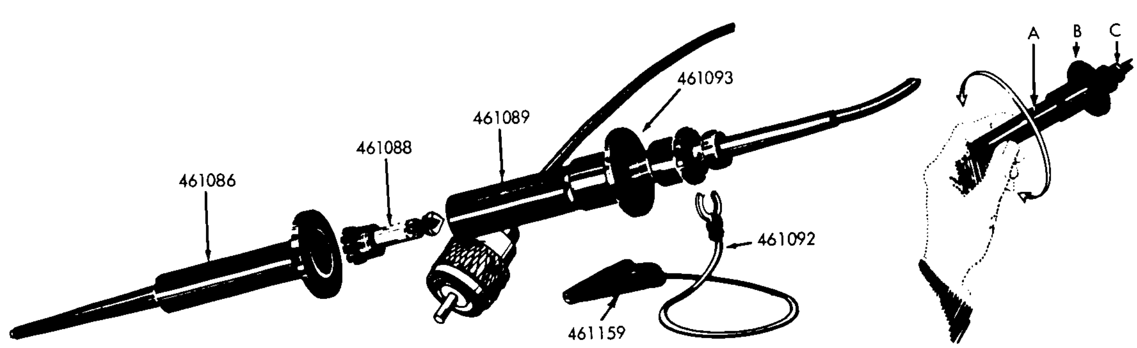


Figure 79. Oscilloscope Probe, P/N 461085

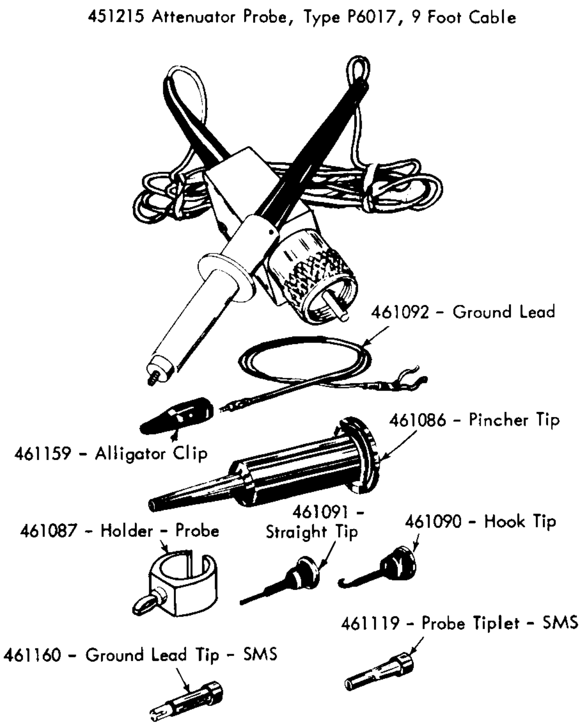


Figure 80. Oscilloscope Probe, P/N 451215

The wires from the card end connect to the socket with slip-on connectors, which can be removed or interchanged when checking circuitry.

Card Socket Terminal Extractor

A special soldering iron tip, P/N 451111, is used to remove SMS card socket terminals. The tip is used in thread element, P/N 454333, and must be heated only if the terminal to be removed is soldered to a printed circuit overlay or a voltage chain. See Figure 82. In use, the tool is inserted over the terminal after wrapped connections have been removed. If a soldered connection is involved, the tip of the tool will melt the solder. A plunger, extending from the rear of the tool, is tapped to drive the terminal out of the socket. A new terminal is installed by inserting it into the socket from the card side of the panel.

If an overlay or voltage chain is involved, the extraction tool is used to solder the new terminal to the conductor. Removed wiring must be repaired by installing butt connectors (Figure 54), by installing new wires, or by wrapping new portions of the original wires.

A plunger, P/N 451113, and an insulator sleeve, P/N 451114, are available as spare parts for the card socket terminal extractor.

CAUTION: Apply just enough heat to release the pin or to resolder the connection. If damage to the land pattern occurs, repair by wrapped wire connections between the pins affected.

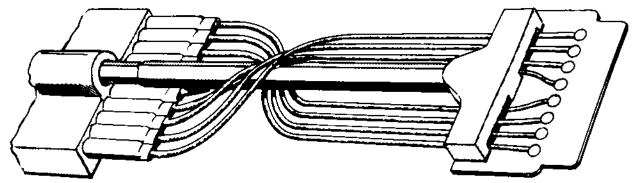


Figure 81. Card Extender, P/N 451075

Laminar Bus Terminal Extraction Tool

This tool, P/N 461074, is described under "Insertion and Extraction Tools" in the section on AMP tools for crimped connections. In addition to its normal use in the installation and extraction of laminar bus terminals, this tool may be used to "hook out" panel lamps for replacement (see "Lamp Removal Tools").

Precision DC Voltmeter

P/N 461079 is a precision DC voltmeter that permits rapid, accurate measurement of voltages or percent deviation from a central voltage. Some features of the meter are:

1. Self-powered with built-in battery check.
2. Rapid measurement of voltages by use of test probes, or auxiliary cable and selector switch.
3. DC voltage measurement accurate to 2% of total scale on two ranges: ±100 volts or ±200 volts.
4. Percent deviation measurement accurate to ±0.25% between 5 and 200 volts; from 0 to 5 volts the accuracy is ±(0.25% + 20 millivolts).

Lamp Removal Tools

To facilitate insertion and removal of incandescent lamps, use lamp extraction tool, P/N 461163, and clip insertion pliers, P/N 461158. The pliers will remove the retaining clip from lamps on the operator's console. The extraction tool removes the lamp from the indicator.

Pin Identification Panel

Pin identification panel, P/N 216250, slips over back panel pins of a sliding gate module for rapid pin identification in areas of dense wiring. The panel covers an area 8 card sockets wide by 10 card sockets long.

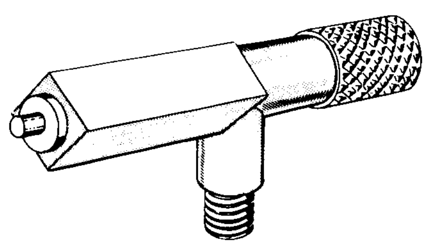


Figure 82. Card Socket Terminal Extractor, P/N 451111

New techniques used with soldered, crimped, and wrapped connections are given in earlier sections of this manual. This section describes other techniques used in troubleshooting and repairing SMS components.

Visual Inspection

Inspection of SMS Components

Check the following items during scheduled maintenance or after emergency repairs:

1. Wires and cables – for signs of physical damage, fraying, breakage.
2. Drape cables in SMS frames – for nicking by sharp metal edges. Be careful when handling these cables and watch for rubbing or damage. If a sliding gate must be pulled beyond the latch point during power supply servicing, check for correct hinge movement of the cable trough while closing the gate. If the gate is pushed in without this check, the hinged trough may bend where attached to the gate, and may damage the drape cable.
3. Cables and coaxial lines – for proper support, lacing into cables, and sufficient slack for servicing.
4. Metallic chips, ends of wires, and improper wire wraps that may cause short circuits.
5. Bent pins in the rear of SMS card receptacles.

Inspection of SMS Cards

SMS cards must be firmly seated in their sockets, and removed only when necessary for troubleshooting. If a suspected card has been removed, check the following:

1. Components on the card – for physical damage or overheating.
2. Printed conductors and contacts – for tightness to the card and freedom from cracks. Gold-plated contacts should be smooth, with no sign of copper or nickel breakthrough.
3. Cold, rosin, or fractured solder joints.
4. Solder splashes, which may short-circuit printed wiring.
5. Damaged card sockets or guides.
6. Base-to-base shorts between adjacent transistors. On SMS cards, adjacent transistors have sufficient lead length to permit contact and an intermittent base-to-base short. See Figure 83.

CAUTION: Pencils are not to be used for marking SMS cards. Troubles have been traced to pencil markings, which can act as conductors.

SMS Card Maintenance

Scheduled maintenance consists of cleaning and lubricating the card terminals of both single and double cards. Corrective maintenance usually consists of discarding the defective card and replacing it with a new one. Occasions may arise, however, where a new card is not immediately available, and a defective card must be repaired.

Tests of SMS cards show that fingerprints can cause failures: oil or moisture from the fingers can critically decrease the insulation resistance on the land pattern side of the card. Cards should be handled carefully, by the edges only. Use a card puller for all card removals and insertions. The single card puller is P/N 451030; the double, P/N 461110; the stan-pac, P/N 461103.

Cleaning and Lubricating

When SMS card is removed from its socket, the card contacts should be cleaned and lubricated before the card is reinstalled if either of the following conditions exists:

1. The card contacts are visibly contaminated.
2. The card contacts have been handled. If there is any doubt about the contamination of the contacts, clean and relubricate them.

The following cleaning and lubricating procedure insures low contact resistance and reduces wear of the gold-plated contact surfaces. The procedure may be performed any number of times without affecting contact reliability. To clean and lubricate the contacts:

1. Apply lubricant, P/N 451053, either directly to the contacts or indirectly with a saturated, clean, lint-free cloth or tissue.

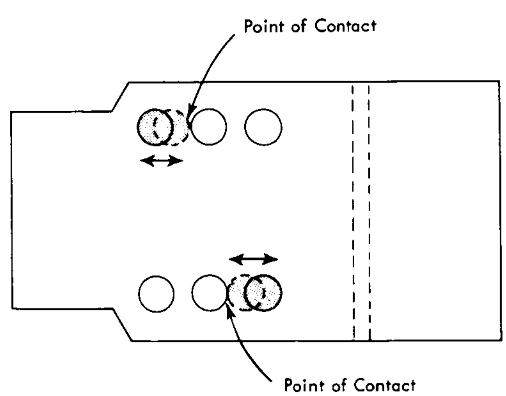


Figure 83. Base-to-Base Shorts

2. Wipe the contacts *toward* the component section of the card with a cloth or tissue moistened with the lubricant.

CAUTION: Use extreme care so that the lubricant does not contact the clear plastic coating on the component portion of the card. The solvents in the lubricant can dissolve the plastic coating, which will act as an insulator if rubbed on the contacts.

3. Rub the contacts with a clean, dry piece of cloth or tissue until there is no visible trace of the lubricant. The cloth or tissue will darken if further cleaning is necessary. Repeat the procedure from step 1 if further cleaning is needed.

Card Repair

Repair of printed circuit cards primarily consists of soldering and unsoldering operations. The specific jobs involved are:

1. Removal of defective components.
2. Installation of replacement components.
3. Joining broken printed conductors.

Care must be taken to avoid damage to the card assembly during the repair process. The card assembly is easily damaged in two ways:

1. Heat damage to the card or to components on the card.
2. Physical damage.

The card is made of an insulating material that will withstand a dip-solder temperature of about 515°F for 30 seconds. This compares with a minimum solder melting temperature of 361°F and an average soldering iron temperature of 750°F. This means that the soldering iron must contact the card for only a short interval of time. Excessive heat may damage a card in two ways by:

1. destroying the bond between the insulated board and a printed conductor, resulting in a raised conductor;
2. scorching or burning the board.

Excessive heat may also damage components on the card. Semiconductors are especially sensitive to heat. Use of the soldering tools recommended under "Soldered Connections" will help avoid heat damage.

Physical damage in the form of a raised conductor is easily inflicted if stress is applied in a direction that tends to separate the conductor from the board (Figure 84).

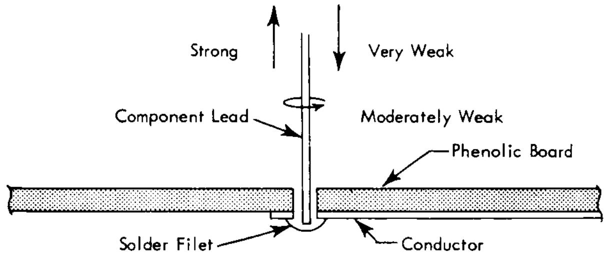


Figure 84. Stress Applied to Component Leads

COMPONENT REMOVAL

Single Cards: When the leads of the defective component must be saved, use the following procedure to remove the component:

1. Straighten the component leads that are bent over on the wiring side of the board. Figure 85 illustrates a method of using the soldering iron tip as a wedge to prevent pulling the land away from the board. A pair of long-nose pliers may be used on the component side of the card to prevent downward movement of the lead.
2. Heat the component leads and pull them through the holes from the component side of the board.

If the leads of the defective component may be destroyed, use the following removal procedure:

1. Cut the leads of the defective component as close as possible to the board on the component side of the card. Be careful not to damage the board or adjacent components.
2. Hold the card in your hand and use a clean, tinned soldering iron to heat the solder connection between the remaining portion of the leads and the conductor pattern.
3. When the solder starts to flow, rap the hand holding the card on the work surface. Repeat steps 2 and 3 if the solder and piece of lead fail to leave the hole.

Double Cards: SMS double cards have a conductor pattern on both sides of the board. Small tips, known as Berg wraps, are placed on most component leads and inserted through plated holes in the board. The Berg wraps insure electrical continuity through the holes in the board and anchor the component leads.

During manufacture, the Berg wraps are installed by machine. These wraps should not be removed or disturbed in any manner. To remove components that are installed with Berg wraps (Figure 86):

1. Cut leads as close as possible to the component body.
2. Straighten the leads so that they are perpendicular to the card. (The new component will be attached to

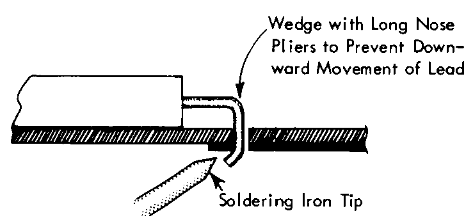


Figure 85. Component Removed

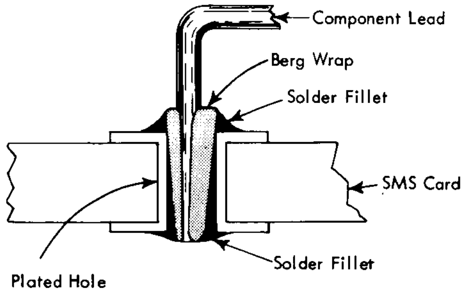


Figure 86. Berg Wraps

these leads.) Certain double card components are installed without Berg wraps and should be removed as described for single cards.

COMPONENT INSTALLATION

Single Cards: This installation procedure applies to components not installed with Berg wraps.

1. Insert component leads through the holes in the board. Cut the leads so that about 1/16 inch remains to bend over on the conductor pattern. Bend the leads parallel to the component body and toward each other. Axial lead components, such as resistors, are mounted flush against the surface of the board.

CAUTION: Do not bend leads close to components (see "Soldered Connections" for technique). The leads on tantalum capacitors are particularly subject to damage.

2. Solder the component leads to the conductor pattern. Avoid excessive heat and solder, particularly with transistors and diodes. If space permits, heat shunts, P/N 460846, may be used to draw heat away from the component being installed. It is not desirable to fill the hole in the board with solder.

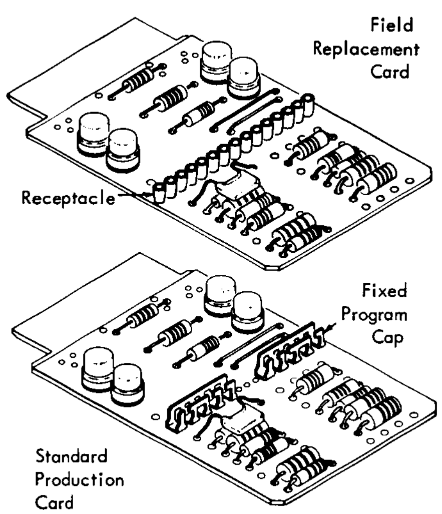


Figure 87. Field Replacement Card and Standard Production Card

3. Wash the general area of repair using a typewriter cleaning brush and IBM cleaning fluid, P/N 450608. Dry the affected area by wiping with a clean piece of cloth or tissue.

Double Cards: Use the following installation procedure for components employing Berg wraps.

1. Wrap the leads of the new component one turn around the perpendicular wires that remained after defective component removal. Adjust the height of the installed component so that it is the same distance from the board as the other components of the same (first or second) level.
2. Solder the connections. Use heat shunts, P/N 460846, if space permits.
3. Clip off the excess portion of component leads and perpendicular wires.

PRINTED CONDUCTOR REPAIR

Two printed conductor defects may be found: broken conductor, or delaminated conductor (raised land).

To repair a broken conductor, solder a 24 AWG solid wire jumper across the break. The wire should overlap the printed conductor at least 1/16 inch on each end. If the break is long, and the possibility of a short exists, use insulated wire stripped on each end.

To repair a delaminated conductor, cut both ends of the loose section at a point where the bond is not broken. After the loose section is removed, repair the conductor using the same method used for a broken conductor.

Field Replacement Cards

Field replacement cards are multipurpose SMS pluggable cap cards that may be used to replace approximately eight types of production cards of similar function, permitting a substantial reduction in field stock. Field replacement cards differ from production cards in the following respects:

1. Each field replacement card contains a full complement of components.
2. Field replacement cards have barrel-type program receptacles, P/N 216258, assembled on each card, in contrast to the factory programmed cap used on production cards. Programming is accomplished by selectively cutting a pluggable contact strip, P/N 216259, to obtain the specific jumpering required. The strips are inserted into the barrel receptacles. Figure 87 shows a field replacement card and a factory card. Figure 88 shows an index and a cap code template from cap kit, B/M 451271. Use the index to select the proper field replacement card; use the template for the cap code desired. The cap kit and the pluggable contact strip, P/N 216259, are all that is necessary to use field replacement cards.

INDEX-"ALLOY" FIELD REPLACEMENT CARD PART NUMBERS
FAMILY -I- SINGLE CAP CARDS

PRODUCTION ASM. P/N	CARD CODE	FIELD REPL. PART NO.	CAP CODE
371200	AM	370904	ZZ
371201	AM	370904	ZY
371202	AM	370904	ZX
371203	AM	370904	--
371204	AA	370900	ZW
371205	AA	370900	ZV
371206	AA	370900	ZU
371207	AA	370900	--
371208	AM	370904	WX
371209	AN	370905	ZZ
371210	AN	370905	ZY
371211	AN	370905	ZX
371212	AN	370905	--
371213	AB	370901	ZW

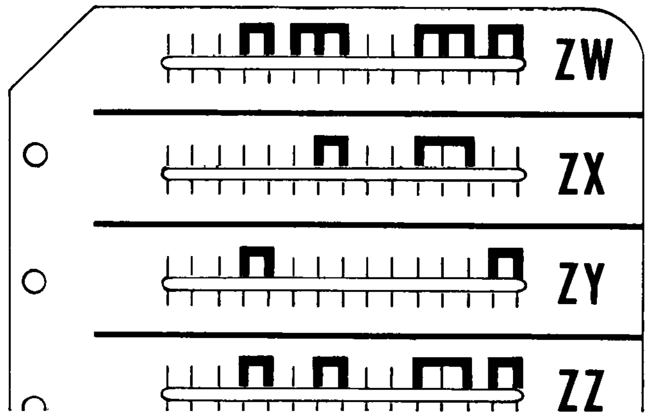


Figure 88. Cap Code Index and Template

Measurements

Component Testing

Most defective components can be located by using an ohmmeter to check for an open or shorted condition. Be sure to consider parallel components when testing with an ohmmeter. An excellent method of determining the correct readings is to compare the readings of an identical, good card with those of the defective card. Specific component checks follow.

DIODES

Check the forward and reverse resistance with an ohmmeter adjusted to the × 100 ohm scale. If the resistance is high in both directions, the diode is open. If the resistance is low in both directions, the diode is shorted. Reverse resistance should read at least ten times the forward resistance.

NOTE: Before removing and discarding the diode as a result of this test, check the printed circuit card to establish that a back-circuit is not responsible for a low back-resistance reading. The × 100 ohm scale of the ohmmeter is used to protect the diode from excessive current.

TRANSISTORS

A good-bad test, to indicate open or shorted transistor junctions, may be performed on a transistor without removing it from the printed circuit card. For this test, transistors are considered back-to-back diodes, arranged in NPN or PNP configurations. Check the forward and reverse resistance of each diode with an ohmmeter adjusted to the × 100 ohm scale (Figure 89). If the resistance is high in both directions, the transistor is open. If the resistance is low in both directions, the transistor is shorted.

NOTE: Before removing and discarding the transistor as a result of this test, check the printed card to establish that a shorted transistor junction is not the result of its being shunted by a low-resistance component. The × 100 scale of the ohmmeter should always be used to protect transistors from excessive currents.

FUSES

An effective way to locate a blown fuse is to connect a voltmeter across it. If the fuse is blown, the terminal voltage of the power supply will indicate on the meter. If there is no meter indication, and the power supply is operating properly, the fuse is good. Be sure to use the proper scale on the meter.

TANTALUM CAPACITORS

Observe polarity and voltage rating when testing tantalum capacitors. Maximum voltage allowed on some units may be as low as three volts.

Pulse Measurements

These measurements require an oscilloscope with a calibrated time base and a frequency response high and low enough to pass all frequencies in the pulse

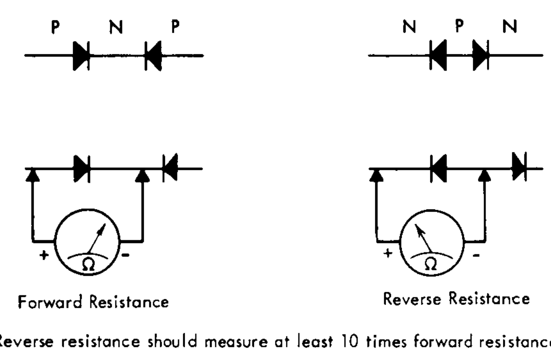


Figure 89. Transistor Testing

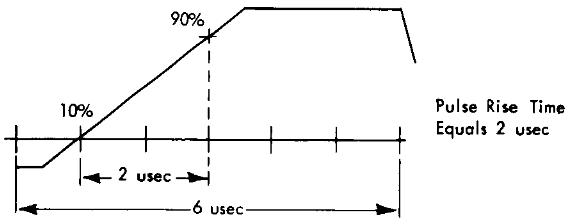


Figure 90. Pulse Rise Time

spectrum to be measured. A high impedance (10:1 attenuating) probe is usually used in this type of measurement to avoid distorting the pulse. Refer to *Customer Engineering Manual of Instruction, Tektronix Oscilloscopes,* Form 223-6725, for details of oscilloscope operation.

RISE TIME AND DECAY TIME

A pulse rise time is the time required for the leading edge of a pulse to complete 80 per cent of its change in level as measured between the 10 per cent and 90 per cent points. Calibrate the oscilloscope sweep time for a slightly greater time than the rise time to be measured. The pulse rise time can be read directly from the oscilloscope (Figure 90).

Pulse decay time is the same as pulse rise time, except that it occurs on the trailing edge of the pulse.

PULSE DURATION

Pulse duration is the time between a 50 per cent point on the pulse rise time and a 50 per cent point on the pulse decay time (Figure 91). This quantity can be measured using the same techniques as for measuring pulse rise time.

DROOP AND OVERSHOOT

Pulse droop and pulse overshoot are measured as a percentage of total pulse amplitude (Figure 92).

PHASE SHIFT AND TIME DELAY

Phase shift is a time delay of less than one cycle of the fundamental frequency of the measured waveform and is usually expressed in cycle degrees. Time delay is a delay of more than one cycle. Phase shift and time delay are measured in the same way, using an oscilloscope.

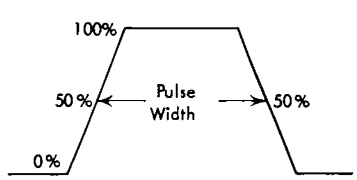


Figure 91. Pulse Duration

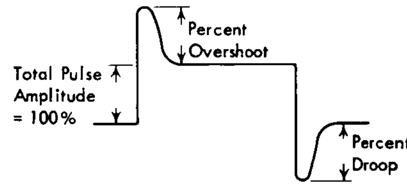


Figure 92. Pulse Droop and Overshoot

Signal Level Measurements

Use the oscilloscope for point-to-point P and N line measurements. A special 5-inch oscilloscope face (Figure 93) is available to show P and N line levels and tolerance limits:

Line Voltage	Tolerance Limits
+N +0.6v	+0.8 to +0.4v
0v Ground (N-line reference)	
−N −0.6v	−0.4 to −0.8v
+P −5.4v	−5.2 to −5.6v
−6v (P-line reference)	
−P −6.6v	−6.4 to −6.8v

Although the foregoing are the design limits and expected voltages, circuits may operate properly with voltages slightly beyond these limits.

Cooling System

Lubrication

1/8 and 1/30 HP *Blowers:* Lubricate the three blower shaft bearings with IBM 6 every 400 hours. Saturate the wicks, which may be reached by removing the left filter; check the filters.

1/9 and 1/4 HP Blowers: Lubricate the four blower shaft bearings with IBM 9 every 600 hours. Saturate the oil wicks and press them in so that they bottom on the bearing (Figure 94). Check the filters.

Blowers shipped as spare parts are not lubricated prior to shipment. Lubricate all new blowers at the time of installation. Initial production blowers have oil cups that can cause an air lock and prevent proper lubrication. Remove and discard these oil cups.

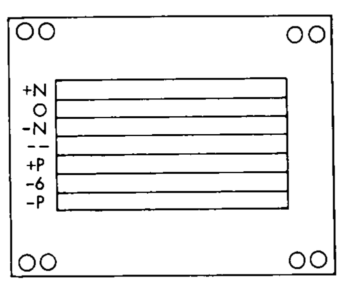


Figure 93. Oscilloscope Graticule, P/N 461098

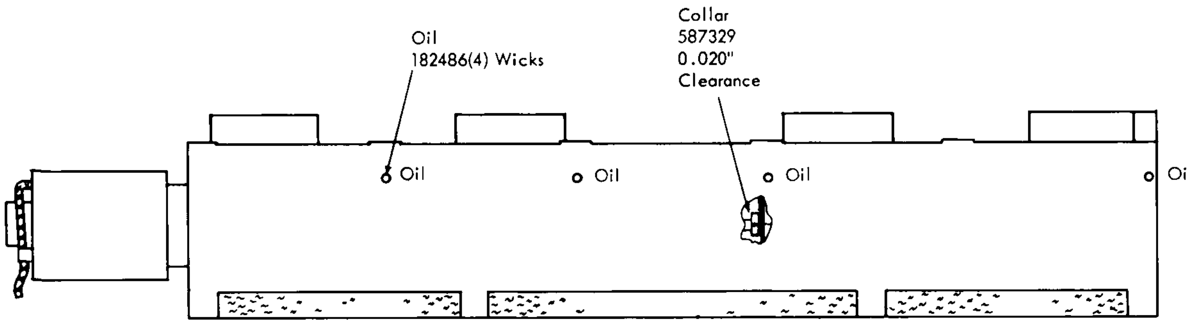


Figure 94. Blower Lubrication, 1/9 and 1/4 HP

NOTE: Saturating a wick may be done more easily by removing the wick from the blower assembly. To remove a wick, twist a spring, P/N 150395, to engage the felt wick; then pull both the spring and wick out.

Motors

Both the 1/30 HP and the 1/8 HP motors require 60-cycle, 208/230-volt, three-phase power input. Check the motors periodically for excessive noise, heat, or vibration. Motor bearings are sealed and require no periodic lubrication.

The 1/30 HP motor runs at 3,400 RPM and is directly coupled to the blower assembly shaft. The three motor mounting screws must be tight to insure proper alignment between the motor and blower shafts.

The 1/8 HP motor runs at 7,000 RPM and drives the blower shaft by means of two belts. Periodically check the pulley setscrews for tightness and inspect the drive belts for wear and proper adjustment. Belt tension should allow 0.18 ± 0.02 inch of deflection midway between the two pulleys. If adjustment is necessary:

1. Adjust the tension of the belt between the transmission and blower pulleys by loosening the four transmission casting mounting screws and shifting this casting.

2. Adjust the tension of the belt between the motor and transmission pulleys by loosening the four motor mounting screws and shifting the motor.

Blower Assemblies

Periodically determine the performance of the blowers by checking for good air flow at the top of the frame, and by checking for excessive noise or vibration of the blower. If abnormal operation is indicated:

1. Check for proper direction of rotation of the blower. One-quarter and 1/9 HP, four-scroll blowers turn clockwise in gates A and C, viewed looking at the front of the gate; and counterclockwise in gates B and D. One-eighth and 1/30 HP, seven-scroll blowers turn counterclockwise.

On new installations, any blower unit turning in the wrong direction should be reworked as follows:

a. Remove power from the system.
b. Disconnect, at the circuit breaker box, the cable to the blower. The Jones plug is accessible upon removal of the rear top module cover. There is no need to lower the tailgate.
c. Reverse the leads on pins 1 and 2 of the Jones plug and re-insert the plug.
d. correct the wiring diagram.

NOTE: When a blower is replaced or the CB assembly is worked on, check blower rotation.

2. Check the blower shaft for freedom of rotation. The rotor assembly, including the motor, should turn when a force (given below) is applied to the periphery of any one blower wheel.

ASSEMBLY	SCROLLS	P/N	FORCE (inch-grams)
1/30	7	598593	30
1/8	7	598594	60
1/8	9	594976	—
1/9	5	594638 (gates A, C)	42
		594639 (gates B, D)	42
1/4	4	594683 (gates A, C)	42
		594684 (gates B, D)	42

If the proper force does not turn the blower, the following should be checked:

a. Lack of lubrication.
b. Improper endplay of the blower shaft. Remove all endplay in the flexible coupling and set a clearance of 0 to 0.040 inch between the collar, P/N 587329, and the adjacent sleeve bearing face. After the endplay is adjusted, be sure that each rotor clears the bell-shaped portion of the housing by 1/32 to 1/16 inch throughout the complete rotation of the blower.
c. Misalignment of the blower shaft. Blower assemblies are designed to float on the gate. Protrusions of more than 3/64 inch below the bottom surface of the gate can warp the frame and cause pressure on the blower assembly. Incorrect adjustment of a gate caster can deform the gate and bind the blower shaft.

3. Check for loose pulley setscrews, which may be a source of noise.

4. Check for worn belts or improper belt tension. These can cause noise. Apply a force of four pounds midway between the pulleys; the belt should deflect 0.18 ± 0.02 inch. Adjust the primary belt by loosening the four motor mounting screws and shifting the motor. Adjust the secondary belt by shifting the transmission casting.

CAUTION: On earlier machines, blower cables must be disconnected if a gate is opened beyond 45 degrees. A redesigned SMS frame now permits a gate to be opened to 70 degrees with the blower cables connected. In addition, components on the blower assembly may now be replaced.

Filters

Two aluminum air filters are used on each blower assembly. When lubricating the blowers, check the air filters and replace those that are dirty.

To change filters, turn power off, open the gate, and slide the old filter forward out of its holder.

CAUTION: The filters bend easily; when sliding in a new filter, use care not to damage it.

On 1/8 and 1/30 HP blower assemblies, if necessary, replace the blower filters every 400 hours of operation; first remove the kickplate. On 1/9, 1/12, and 1/4 HP blower assemblies, replace or clean and recharge the filters every 600 hours.

Vibration Technique

Vibration should be performed only as a last resort in troubleshooting intermittent failures. Confine vibration to those areas of the machine that are suspect. The following methods of vibration should be used in conjunction with an applicable diagnostic:

1. Remove covers and rake lightly across the exposed SMS cards with the edge of a dummy card.

CAUTION: do not apply a lateral force sufficient to cause the adjacent cards to touch, thereby shorting components.

2. Rake back panel pins with a dummy card to detect loose pins.

3. Lightly tap the perimeter of the tailgate frame with a plastic hammer.

4. Gently shake the external cables plugged into the tailgate. Be careful of single-wire conductors.

5. Pull out each slide; open and close each gate, and close the slide – all while a diagnostic is running.

Backpanel Power Circuits

Short circuits and some opens are usually difficult to locate and sometimes difficult to repair. The chief aim of the following paragraphs is to suggest methods that may help in locating a short circuit and to recommend a repair method that has been used successfully for shorts underneath the printed power distribution laminate.

Location

A power short circuit may be between a voltage line and ground or between two voltage lines. The first step in the repair of a short circuit is to isolate the source of trouble to as small an area as possible.

The power from the power supplies goes to a laminar bus on the rear of each gate. Jumpers from each laminar bus connect to terminals on a power distribution laminate overlay. A separate overlay is provided for each row of SMS card sockets. The card socket pins are soldered to the printed circuit on the overlay.

When the particular frame and gate having the short are known, connect an ohmmeter to the laminar bus terminals of the shorted line (or to line and ground). Remove the laminar bus jumpers one at a time. If no increase in resistance is noted after all jumpers are removed, the short is in the laminar bus or the power supply itself. If there is an increase in resistance as a jumper is removed, the short is in the particular row of cards.

Reconnect the ohmmeter across the short at the overlay terminals. Remove cards in the shorted row one at a time. If the short is in a card, an increase in resistance will be noted when the defective card is removed. If all cards are removed and the short remains, the short is in the overlay.

Shorts in Power Distribution Overlay

Remove all the laminar bus jumpers from a row, as well as the cards in the row. Repair of a shorted pin is made difficult by the many soldered connections to the socket pins. The procedure to be described will save dismantling or replacing a panel; also see "Short Circuits in Laminar Buses."

The short may have occurred at any of the socket pins for the power supply in question. Examine the socket pins for foreign matter. Look for a wire with insufficient insulation to protect it from shorting to an adjacent pin or to the ground plane. Move wires slightly if necessary to check thoroughly. If the short still exists, the specific pin or pins must be located by using a device, such as a Wheatstone bridge, that will measure very low resistances. Use the device to determine the card socket pin (or pins) having the lowest resistance.

When the pin (or pins) causing the short is determined, and there is no visible cause for the short, it is likely that the source of the short is underneath the printed power distribution laminate.

During production, the printed overlay is placed over the card receptacle pins that supply power to the cards, and then soldered to each pin. A small gap remains between the overlay and the card receptacles into which small pieces of wire, solder, or other foreign material may fall, shorting two pins or shorting a pin to a printed circuit ground plane. The removal of this foreign material is a difficult problem because the overlay has many soldered connections and also has wires routed over it. The following section describes a method that has been successful in removing these short circuits.

Overlay Drilling

A short caused by foreign material underneath the printed circuit overlay may be eliminated by drilling away the phenolic material around the affected pin or pins. The foreign material that causes the short is drilled away at the same time.

The drilling tool is manufactured by altering an unwrapping tool. Use a jeweler's file to make small notches so that the unwrapping tool is converted to a small hole saw. Check the inside surface of the tool and remove any burrs that could catch on the pin during the drilling operation. Mark the tool in some way to indicate the maximum depth to drill. The depth is determined by the distance to the card socket, which must not be drilled into.

Connect an ohmmeter between the shorted row of pins and ground or between the shorted rows of pins so that you may stop drilling as soon as the short is removed. Install the tool in an electric drill and guide the tool over the affected pin. Drill through the overlay or overlays until the ohmmeter indicates an open circuit. *Be careful not to drill into the card receptacle.* Drill slowly and take care to remove all chips so that additional shorts are not caused at other locations.

The drilling process will cause an open circuit in one row of the printed overlay. This must be repaired by short jumpers wrapped to the appropriate terminals.

Open Circuits in Power Distribution Overlay

An overload can cause an open circuit in the printed circuit on the power distribution overlay. Do not attempt to repair the overlay. Use a voltage chain, P/N 212822, to bypass the damaged area. The chain should be coupled, from a point two pins beyond the defect, to the beginning of the voltage distribution for the particular chassis. Solder the voltage chain to each pin.

Short Circuits in Laminar Buses

The laminar power distribution bus within sliding gates consists of strips of copper alternated with strips of plastic film. Many of the supply voltages are applied to two strips of copper in each bus, using the capacitance thus created between the copper strips for filtering.

The edges of the bus are open, exposed to abrasion and short-circuits. Burrs on the edges of the copper strips can cut through the plastic strips and cause short circuits, if the bus is subjected to undue pressure or flexing.

To locate a short circuit in a laminar bus:

1. Disconnect the suspected bus from all power supply lines and jumpers to printed-circuit overlays.
2. Using an ohmmeter, determine the two shorted strips and connect the ohmmeter to them.
3. Carefully flex small areas of the bus. If necessary, remove the bus from the gate. Flexing may cause the short to open and close intermittently as the area of the short is manipulated, and thus localize the defective area.
4. Inspect the defective area to locate the short. Repair by inserting plastic electrical tape between the copper strips at the shorted point.

A likely source of trouble is in the horizontal section of the bus, where connections are made to the terminal board for the power supply cable. Sharp bends in the copper strips where connected to the terminal board can cause a burr that will penetrate the plastic film. It may be necessary to separate the strips where they feed the terminals, and insert electrical tape between all layers. Wrap the outside of the bus wherever a strip leaves the bus. This wrapping not only provides extra insulation, but guards the edges against abrasion and contamination.

200-Position Low Voltage Connector

Assembly instructions follow for the 90° cable half, P/N 598254, and 45° cable half, P/N 598255. See Figure 95 (A through I). Tools required are:

5/32" Allen wrench, for strain relief well assembly.

3/32" Allen wrench, for board to shell assembly, and keeper to board assembly.

1. Disassemble connector:
   a. Remove the protective cover.
   b. Remove the screw (in keeper) that holds the board.
   c. Slide the board and strain relief well from the shell assembly.
   d. Disassemble the strain relief well by removing the two hex head socket screws at the rear of well housing.

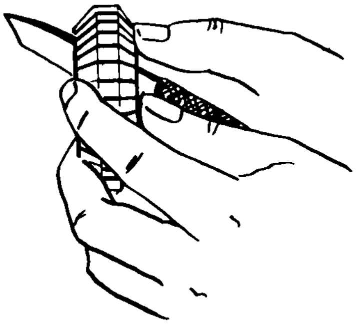


Figure 95A. Assembly of 200-Position Connector

2. Cut rubber collet to fit cable [Figure 95(A)]. For 1¾ inch diameter cable, use the rubber collet as received. For cables smaller than 1¾ inch diameter, cut the rubber collet between the arrow and the 1¾ inch mark. Next, cut the collet to the length desired, *leaving the numbered lug that has the nominal cable diameter mark.* Check the fit of the collet on the cable. Cut off a lug if the collet is too large.

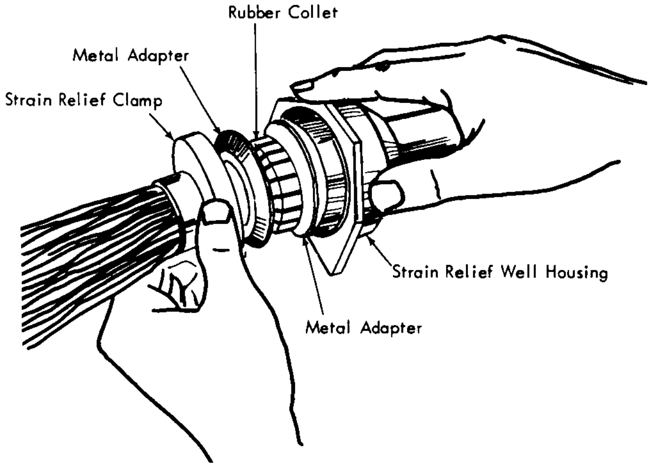


Figure 95B.

3. Use a pair of metal adapters (B) for cable sizes from ¾ to 1-7/16 inch. Because some cables are larger than the inside diameter of the adapter, it may be necessary to ream or split the adapter.

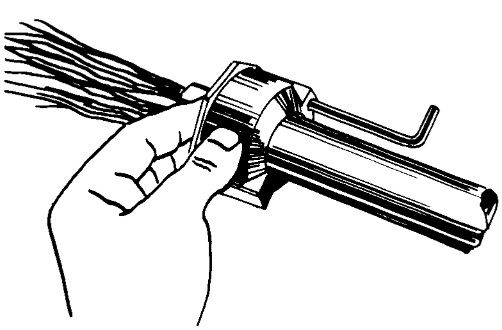


Figure 95C.

4. Slide strain relief well assembly back on cable, out of the way.

5. Using prepared cable, apply proper terminals (C). Snap the terminals into the correct numbered holes in the board (D).

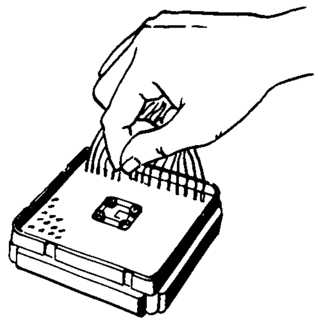


Figure 95D.

6. Slide strain relief well assembly into place. Tighten the Allen screws until the rubber collet holds the cable without slipping.

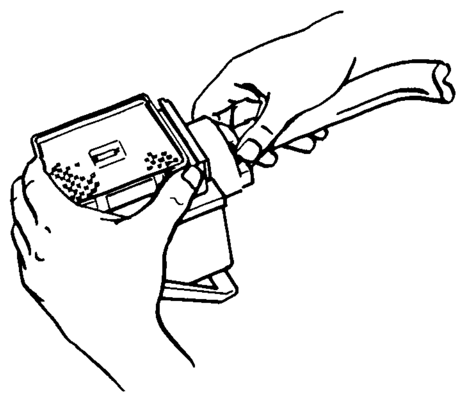


Figure 95E.

7. Move handle of shell assembly to open position (E). Slide strain relief well, board, and cable assembly into shell (F). When using 45° well assembly, check orientation of the well.

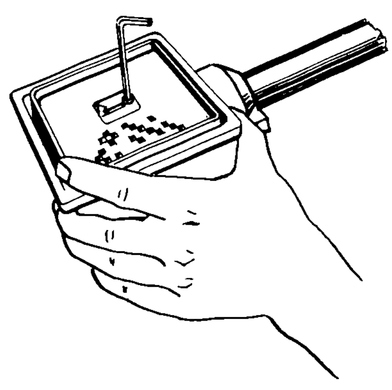


Figure 95F.

8. Seat board in position in the shell. Place screw through hole of keeper plate, and tighten (F).

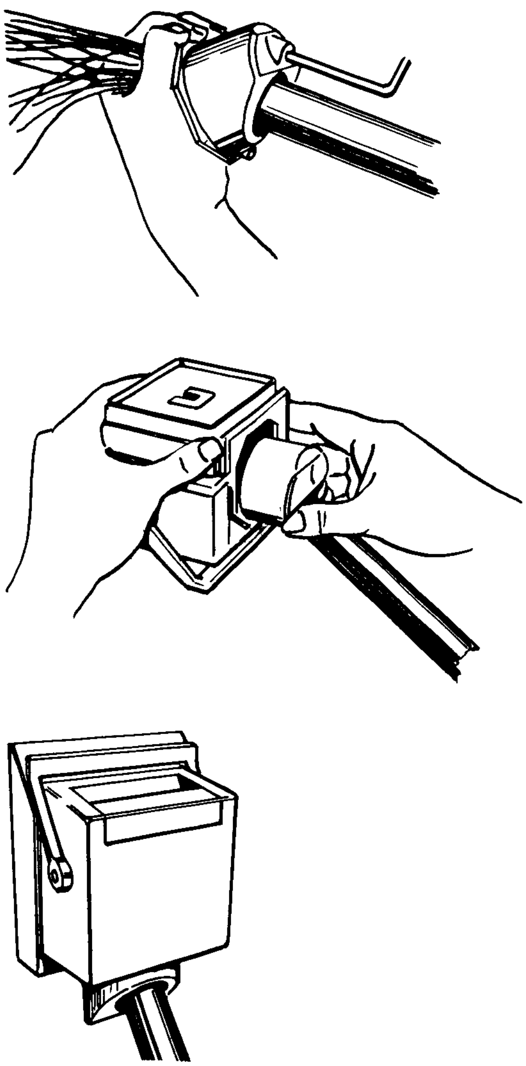


Figure 95G. Assembly of 200-Position Connector

Checks

Check for looseness at all 200-position connectors resulting from shimming of the keeper plate, P/N 598239, on the machine half of the 200-position connector. The shims or washers should be removed and reinstalled behind the head of the keeper plate mounting screw, thus preventing the screw from protruding too far through the keeper plate.

External cables equipped with this connector can be connected without the use of a junction box, provided the boards are assembled to accept each other.

CAUTION: After *mechanically* latching the two external cable units together, close both operating handles simultaneously. Do not attempt to make this junction with one operating handle; the keeper plate may break. Also move both operating handles simultaneously when disconnecting the external cable halves.

Cleaning

Whenever a connector has been opened, and before reconnecting it, use the following cleaning procedure: moisten a clean piece of cheesecloth or industrial tissue with IBM cleaning fluid, P/N 450608. Wipe the contacts from the leading edge toward the plastic base; then dry them with a piece of cloth or tissue.

CAUTION: Do not use cleaning fluid, P/N 450608, to clean plastic parts.

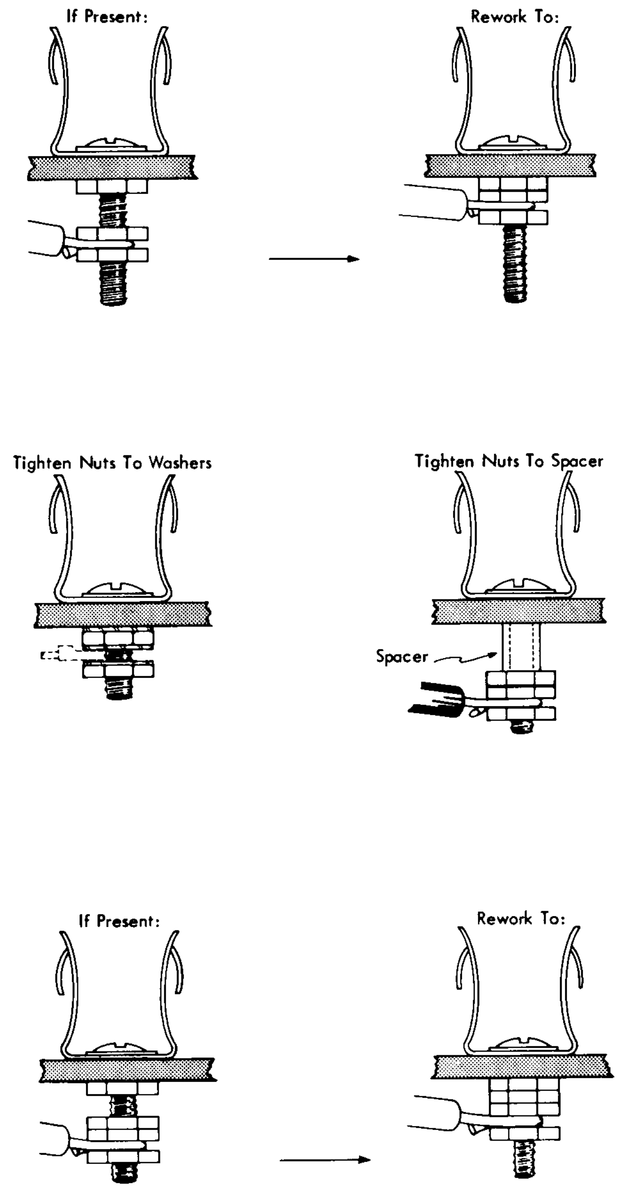


Figure 96. Power Supply Connections

Power Supplies

Fuse Clips

Loose fuse clips are a source of trouble in frame power supplies. In no case should a power supply be adjusted until the fuse clips have been checked for tightness.

DANGER: Turn power off.

Do not turn the screw holding the fuse clip. Tighten a loose fuse clip by turning the nuts behind the mounting board while preventing the screw from turning. See that the leads behind the mounting plate do not short to each other.

Connections

Figure 96 shows the different connections used on power supplies, and the recommended method of tightening each. Always lower the fuse panel to gain access to the nuts.

Connectors

Twist Lock Electrical Connector

Individual manufacturers of twist lock connectors are careful to design so that their own connectors mate in only one manner. However, a 3-prong Hubbel male plug can be inserted into a Rodale female plug in three different ways. As a result, machine covers could be placed at *line potential* instead of ground.

DANGER: Be certain that twist lock connectors are correctly mated when inserted into a power receptacle.

Jones Plug Cable Connector

Although a fiber insulator is used internally to prevent shorts to the shield, the shield is *not grounded.* When you rework a plug, always re-insert the insulator. Add electrical tape if there is a possibility of a wire-to-shield short. In addition, fasten loosely-mated plugs with electrical tape or an elastic band.

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