IBM Field Engineering

Theory of Operation

Monolithic System Technology

Packaging

Tools

Wiring Change Procedure

SY22-6739-3

Preface

This manual describes the basic elements of MST (Monolithic System Technology). The reader should also refer to the following publications:

Component Circuits and ALD's–SLT, SLD, ASLT, MST, Field Engineering Theory of Operation, SY22-2798

Power Supplies–SLT, SLD, ASLT, MST, Field Engineering Theory of Operation, SY22-2799

Solid Logic Technology–Packaging, Tools, Wiring Change Procedure, Field Engineering Theory of Operation, SY22-2800

A description of MST tools and a detailed explanation of engineering changes are included. This manual describes the use of MST tools; however, for a complete list of tools and part numbers, refer to the Illustrated Parts Catalog, *Tools and Test Equipment,* S123-0330.

Previous experience with SLT (Solid Logic Technology) tools and engineering changes will aid in understanding this material.

Eighth Edition (October, 1970)
This edition, SY22-6739-3 is a major revision of, and obsoletes, SY22-6739-2 and all previous editions. Changes to the text are indicated by a vertical line to the left of the change; where a substantial amount of material has been added, the symbol • appears to the left of the heading. Changes or added illustrations are denoted by the symbol • to the left of the caption.

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Chapter 3. MST Wiring Change Procedures

Abbreviations

ALD	automated logic diagram
ASLT	Advanced Solid Logic Technology
avail	available
AWG	American Wire Gage
B/M	bill of material
BDWEL	board discrete wire equivalent list
C	card side printed connection
CS	card side
EC	engineering change
ECR	engineering change request
ID	identification
I/O	input/output
mA	milliampere
mm	millimeter
MST	Monolithic System Technology
No.	number
ns	nanosecond
P	probe side printed connection
PS	pin side
repl	replacement
SLD	Solid Logic Dense
SLT	Solid Logic Technology
T	terminating resistor
V	volt
W	other discrete wire types
Y	yellow discrete wire
0*	visually check for discrete wire
■	dedicated I/O pin
*	I/O logic pin

Personal safety cannot be overemphasized. To ensure your own safety, make an effort to become familiar with and use the safety practices outlined in *CE Safety Practices,* S229-1264, a pocket-size card issued to all customer engineers.

CE SAFETY PRACTICES

All Customer Engineers are expected to take every safety precaution possible and observe the following safety practices while maintaining IBM equipment:

1. You should not work alone under hazardous conditions or around equipment with dangerous voltage. Always advise your manager if you MUST work alone.
2. Remove all power AC and DC when removing or assembling major components, working in immediate area of power supplies, performing mechanical inspection of power supplies and installing changes in machine circuitry.
3. Wall box power switch when turned off should be locked or tagged in off position. "Do not Operate" tags, form 229-1266, affixed when applicable. Pull power supply cord whenever possible.
4. When it is absolutely necessary to work on equipment having exposed operating mechanical parts or exposed live electrical circuitry anywhere in the machine, the following precautions must be followed:
   a. Another person familiar with power off controls must be in immediate vicinity.
   b. Rings, wrist watches, chains, bracelets, metal cuff links, shall not be worn.
   c. Only insulated pliers and screwdrivers shall be used.
   d. Keep one hand in pocket.
   e. When using test instruments be certain controls are set correctly and proper capacity, insulated probes are used.
   f. Avoid contacting ground potential (metal floor strips, machine frames, etc. — use suitable rubber mats purchased locally if necessary).
5. Safety Glasses must be worn when:
   a. Using a hammer to drive pins, riveting, staking, etc.
   b. Power hand drilling, reaming, grinding, etc.
   c. Using spring hooks, attaching springs.
   d. Soldering, wire cutting, removing steel bands.
   e. Parts cleaning, using solvents, sprays, cleaners, chemicals, etc.
   f. All other conditions that may be hazardous to your eyes. REMEMBER, THEY ARE **YOUR** EYES.
6. Special safety instructions such as handling Cathode Ray Tubes and extreme high voltages, must be followed as outlined in CEM's and Safety Section of the Maintenance Manuals.
7. Do not use solvents, chemicals, greases or oils that have not been approved by IBM.
8. Avoid using tools or test equipment that have not been approved by IBM.
9. Replace worn or broken tools and test equipment.
10. Lift by standing or pushing up with stronger leg muscles — this takes strain off back muscles. Do not lift any equipment or parts weighing over 60 pounds.
11. All safety devices such as guards, shields, signs, ground wires, etc. shall be restored after maintenance.

KNOWING SAFETY RULES IS NOT ENOUGH
AN UNSAFE ACT WILL INEVITABLY LEAD TO AN ACCIDENT
USE GOOD JUDGMENT — ELIMINATE UNSAFE ACTS

229-1264-1

12. Each Customer Engineer is responsible to be certain that no action on his part renders product unsafe or exposes hazards to customer personnel.
13. Place removed machine covers in a safe out-of-the-way place where no one can trip over them.
14. All machine covers must be in place before machine is returned to customer.
15. Always place CE tool kit away from walk areas where no one can trip over it (i.e., under desk or table).
16. Avoid touching mechanical moving parts (i.e., when lubricating, checking for play, etc.).
17. When using stroboscope — do not touch ANYTHING — it may be moving.
18. Avoid wearing loose clothing that may be caught in machinery. Shirt sleeves must be left buttoned or rolled above the elbow.
19. Ties must be tucked in shirt or have a tie clasp (preferably nonconductive) approximately 3 inches from end. Tie chains are not recommended.
20. Before starting equipment, make certain fellow CE's and customer personnel are not in a hazardous position.
21. Maintain good housekeeping in area of machines while performing and after completing maintenance.

Artificial Respiration

GENERAL CONSIDERATIONS

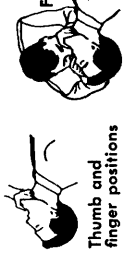
1. **Start Immediately, Seconds Count**
   Do not move victim unless absolutely necessary to remove from danger. Do not wait or look for help or stop to loosen clothing, warm the victim or apply stimulants.
2. **Check Mouth for Obstructions**
   Remove foreign objects — Pull tongue forward.
3. **Loosen Clothing — Keep Warm**
   Take care of these items after victim is breathing by himself or when help is available.
4. **Remain in Position**
   After victim revives, be ready to resume respiration if necessary.
5. **Call a Doctor**
   Have someone summon medical aid.
6. **Don't Give Up**
   Continue without interruption until victim is breathing without help or is certainly dead.

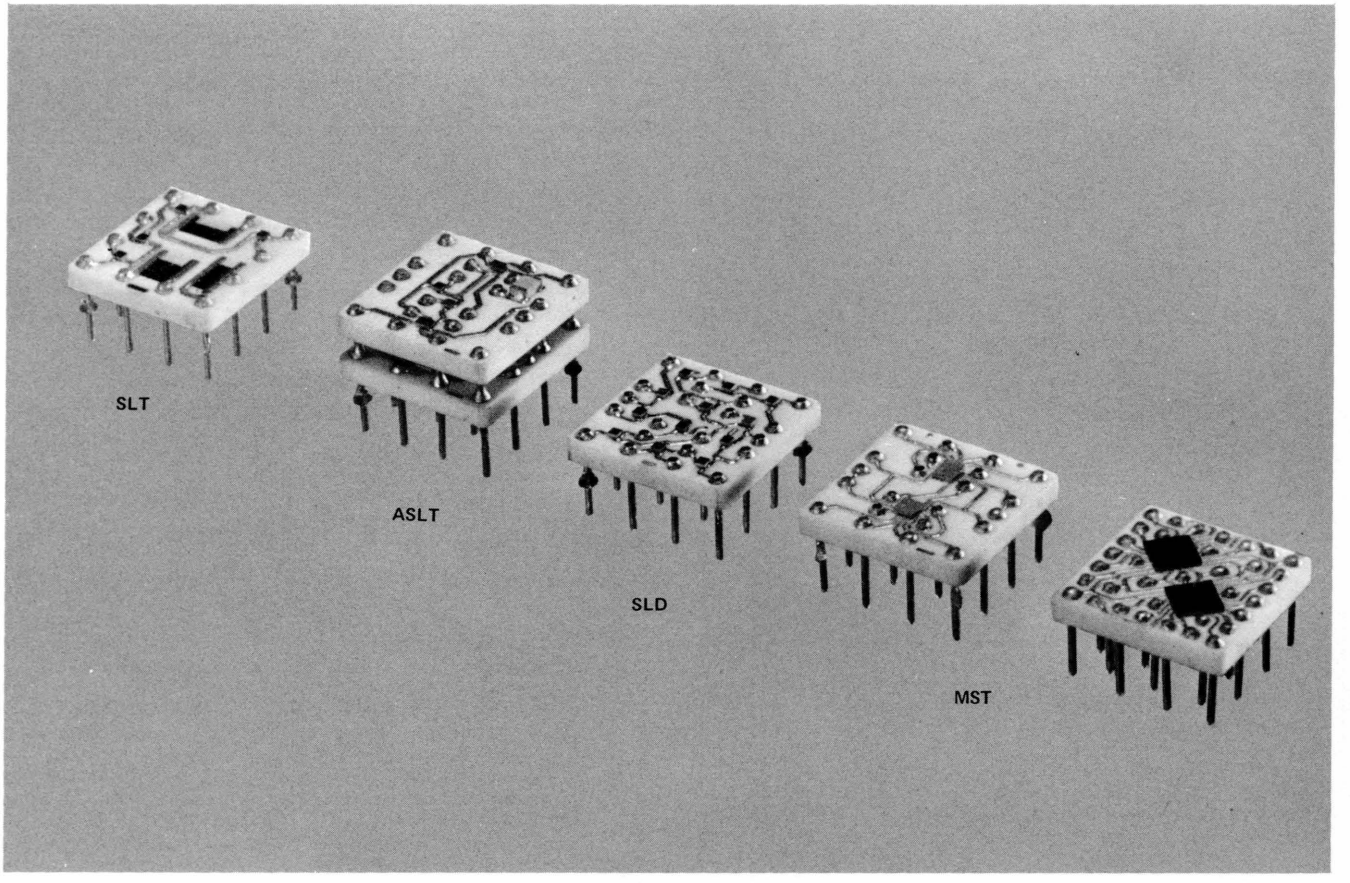
Reprint Courtesy Mine Safety Appliances Co.

Rescue Breathing for Adults
Victim on His Back Immediately

1. **Clear throat** of water, food, or foreign matter.
2. **Tilt head back** to open air passage.
3. **Lift jaw up** to keep tongue out of air passage.
4. **Pinch nostrils** to prevent air leakage when you blow.
5. **Blow** until you see chest rise.
6. **Remove your lips** and allow lungs to empty.
7. **Listen** for snoring and gurglings, signs of throat obstruction.
8. **Repeat mouth to mouth breathings** 10-20 times a minute.

Continue rescue breathing until he breathes for himself.




SLT
ASLT
SLD
MST

- MST, a new technology.
- Greater packaging density

Monolithic system technology (MST) is IBM's newest method of designing and manufacturing products. This technology provides a greater packaging density. The basic building block for the technology is the monolithic chip. The chip is mounted on modules; the modules are mounted on logic cards to be inserted into the boards. The boards make up gates which are grouped as frames. The boards, gates and frames are interconnected by cables.

The technology of MST consists of three types: MST-1, MST-2, and MST-4. Each type differs in circuit speed, circuit voltage, card and board size, and number of boards in a frame.

MONOLITHIC CHIP

The monolithic chips used in MST have all the circuit elements necessary to perform the basic logic functions needed for current IBM products. The chip illustrated in Figure 1-1 is typical of the monolithic chips used in MST-1, MST-2, and MST-4.

The MST chip has approximately the same number of circuits as a single-socket SLT card (about five circuits).

MODULE

The MST module (Figure 1-2) is a ceramic wafer approximately 1/2-inch square. The modules are packaged in a manner similar to a 16-pin SLT module. A module can have from one to four monolithic chips which can contain all the circuit elements needed for several complete logic elements.

MST module pin nomenclature (Figure 1-2) uses a letter and number combination. The module number 1 pin of an SLT module corresponds to pin A01 of the MST module.

CARDS

- Cards have internal voltage and ground planes.
- Cards may have discrete wiring.
- Cards are 1-wide, 2-wide, and 4-wide for MST-1 and MST-2.
- Cards are 2-wide and 4-wide for MST-4.
- Cards are 2-high for MST-1 and MST-2; 3-high for MST-4.

The components normally found on an MST card are modules, R-Pacs and decoupling capacitors. An R-Pac is a molded component with multiple resistors. The decoupling capacitor is a molded component with single or multiple capacitors.

The cards used in MST appear similar to the cards used in SLT. However, MST cards, like both SLT and MST boards, use internal voltage and ground planes for voltage distribution to the components, while SLT cards use surface (printed circuit) wiring for voltage distribution. In contrast, the voltage connections to the R-Pacs are made by surface (printed circuit) wiring from the closest voltage via hole. The MST card thickness, therefore, is comparable to the thickness of the SLT board.

Pins and vias are the connections between signal planes, or voltage planes and card wiring. Pins may be either a pin the thickness of the card or a pin of a component, such as a module. A via is a hole, absense of a pin, that is plated to provide an electrical connection from one outer surface of the card to the other outer surface of the card.

MST-1 and MST-2 cards are available in 1-, 2-, and 4-socket widths. All the MST-1 and MST-2 cards are 2-high, MST-4 cards are available in 2-socket and 4-socket widths. All MST-4 cards are 3-high. The terminology used to describe MST-4 cards is 2-high and 4-wide, all 3-high. To differentiate between a 2-wide MST-2 and a 2-wide MST-4 card, the MST-2 card is described as a 2-wide, 2-high card, and the MST-4 card is described as a 2-wide, 3-high card.

The contact assignments for each socket are shown in Figure 1-3 (Parts 1 and 2). A comparison of MST card characteristics is shown in Figure 1-4. Figure 1-5 shows a comparison of the internal voltage planes for various MST cards.

The different sizes of MST cards are shown in Figure 1-6.

MST-1 Card

The MST-1 card is a 2-high card (21 land patterns high) that is available in 1-, 2-, and 4-socket widths (Figure 1-6). Each socket width of the card has 24 contact tabs. All card widths have two internal voltage planes as shown in Figure 1-5.

One internal plane is subdivided for two voltages (-4V and reference voltage); the second plane serves as a ground. Voltage distribution is not required on the card surface as in SLT because the two internal planes are provided. The reference voltage is supplied by an on-card reference voltage module.

The bottom two columns of holes (A and B), parallel to the contact tabs, are reserved for common connections to all contact tabs. Voltage tabs are connected to the associated internal planes through common via within columns A and B.

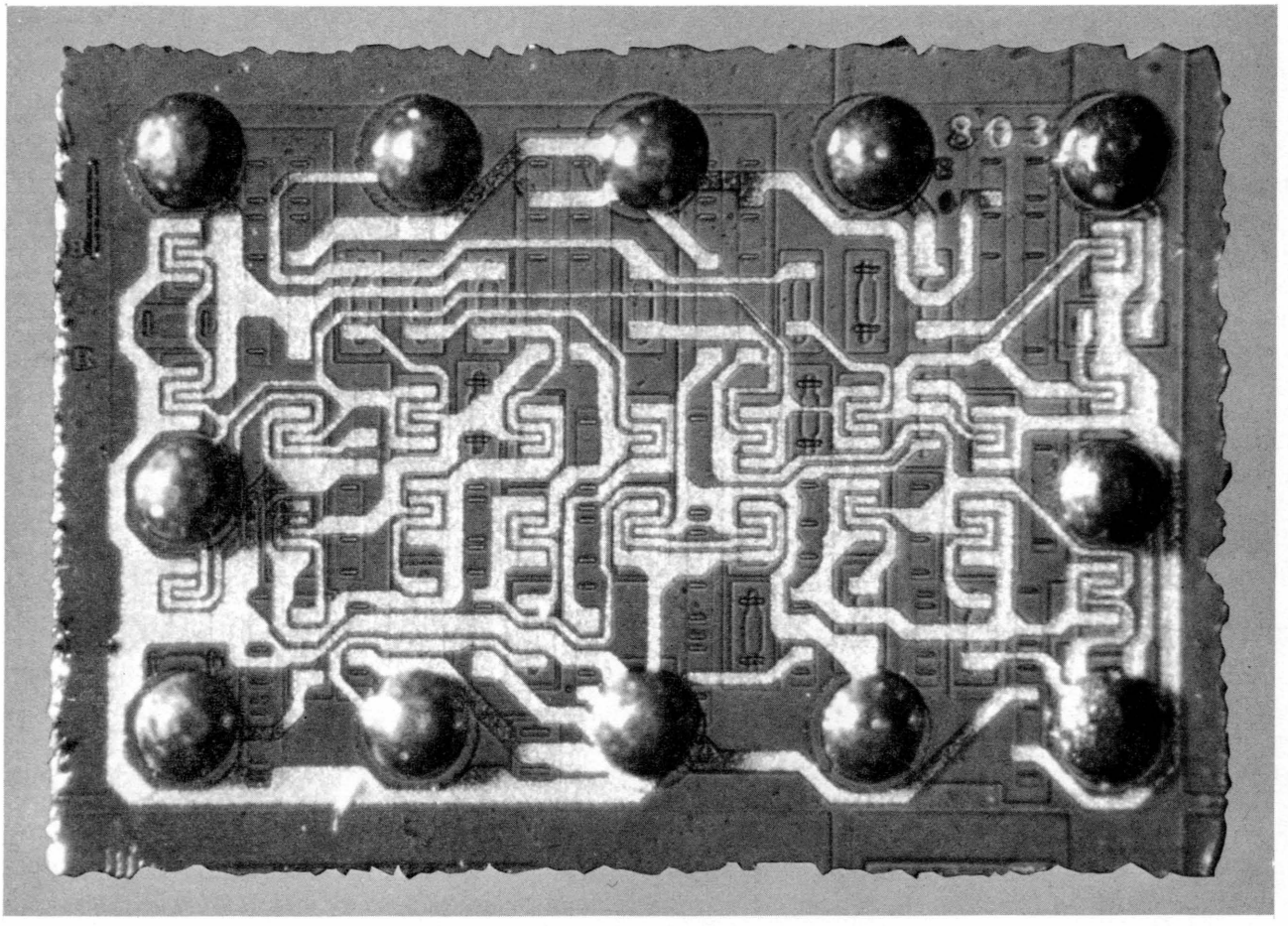


Figure 1-1. Monolithic Chip

The standard voltages assigned to MST-1 card contact tabs and the module pins for all available card widths are:

Voltage	*Card (Contact Tab)*	*MST Module (Pin)*
-4	B06, G06, M06, and S06	B02
Ground	D08, J08, P08, and U08	B03
Reference	B08	C02

Note: Horizontal wiring is routed on the probe side (parallel to the contact tab edge); vertical wiring is routed on the module side.

MST-2 Card

The MST-2 card is a 2-high card (21 land patterns high) that is available in 1-, 2-, and 4-socket widths (Figure 1-6). Each socket width of the card has 24 contact tabs. All card widths have two internal voltage planes as shown in Figure 1-5.

One internal plane is subdivided for two voltages (-3V and ground); the second plane has a voltage of +1.2V. Voltage distribution is not required on the card surface as in SLT because the two internal planes are provided.

The bottom two columns of holes (A and B), parallel to the contact tabs, are reserved for common connections to all contact tabs. Voltage tabs are connected to the associated internal planes through common vias within columns A and B.

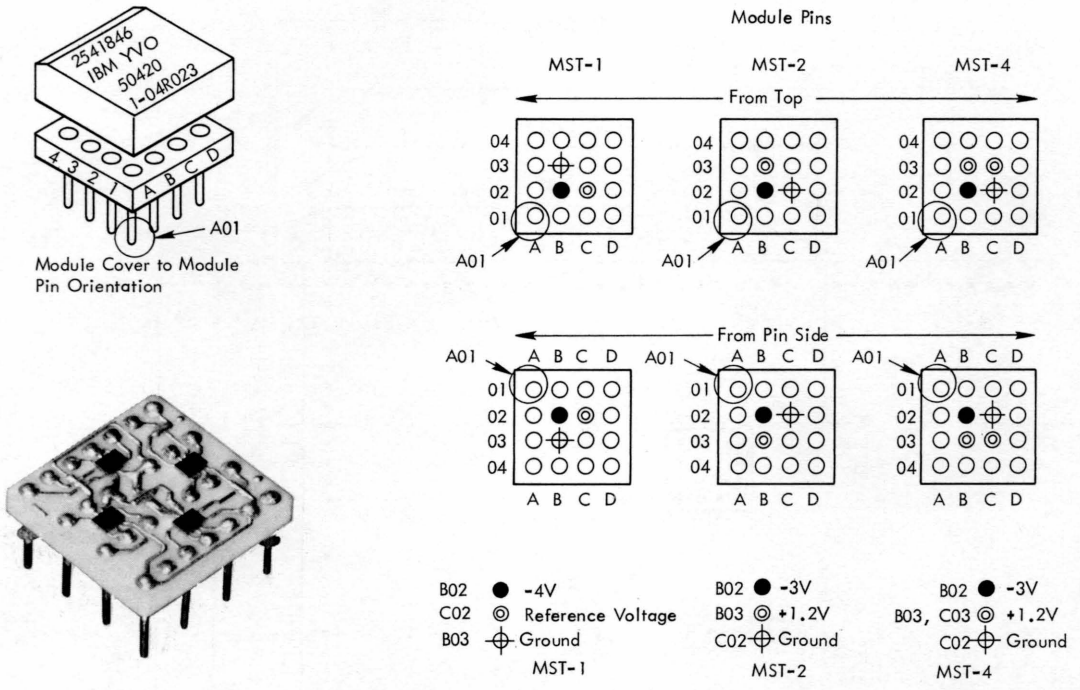
The standard voltages assigned to MST-2 card contact tabs and the module pins for all available card widths are:

Voltage	*Card (Contact Tab)*	*MST Module (Pin)*
-3	B06, G06, M06, and S06	B02
+1.2	D03, B11, J03, G11, P03, M11, U03, and S11	B03
Ground	D08, J08, P08, and U08	C02

Note: Horizontal wiring is routed on the probe side (parallel to the contact tab edge); vertical wiring is routed on the module side.

MST-4 Card

The MST-4 card is a 3-high card (33 land patterns high) that is available in 2- and 4-socket widths (Figure 1-6). Each socket width of the card has 26 contact tabs; 52 contact tabs for each 2-wide card and 104 contact tabs for each 4-wide card. The extra contacts are gained by removing the notch between socket positions 1 and 2 of the 2-wide card;



●Figure 1-2. MST Module

and between socket positions 3 and 4 of the 4-wide card. Both card widths have three internal voltage planes as shown in Figure 1-5.

Each internal plane has one voltage potential (-3V, +1.2V, or ground). Voltage distribution is not required on the card surface because the three internal planes are provided.

The bottom two columns of holes (A and B), parallel to the contact tabs, are reserved for common connections to all contact tabs. Voltage tabs are connected to the associated internal planes through common vias within columns A and B.

The standard voltages assigned to MST-4 card contact tabs and the module pins for all available card widths are:

Voltage	*Card (Contact Tab)*	*MST Module (Pin)*
-3	B05, G06, M05, and S06	B02
+1.2	D04, D09, J05, J10, P04, P09, U05, and U10	C03 and B03
Ground	B10, D14, G01, G11, M10, P14, S01, and S11	C02

Note: Horizontal wiring is routed on the probe side (parallel to the contact tab edge); vertical wiring is routed on the module side.

CARD RETENTION AND CARD GUIDANCE SYSTEM

- Cards are placed in plastic card holders.
- Card holders, in effect, change MST cards into 4-wide cards.
- MST-2 card holders are for 2-high cards.
- MST-4 card holders are for 3-high cards.

Both the MST-2 and MST-4 card guidance systems were designed to reduce the incidence of loose cards. The plastic card holders change all cards into 4-wide cards which are less susceptible to being loosened by vibration or during EC rework.

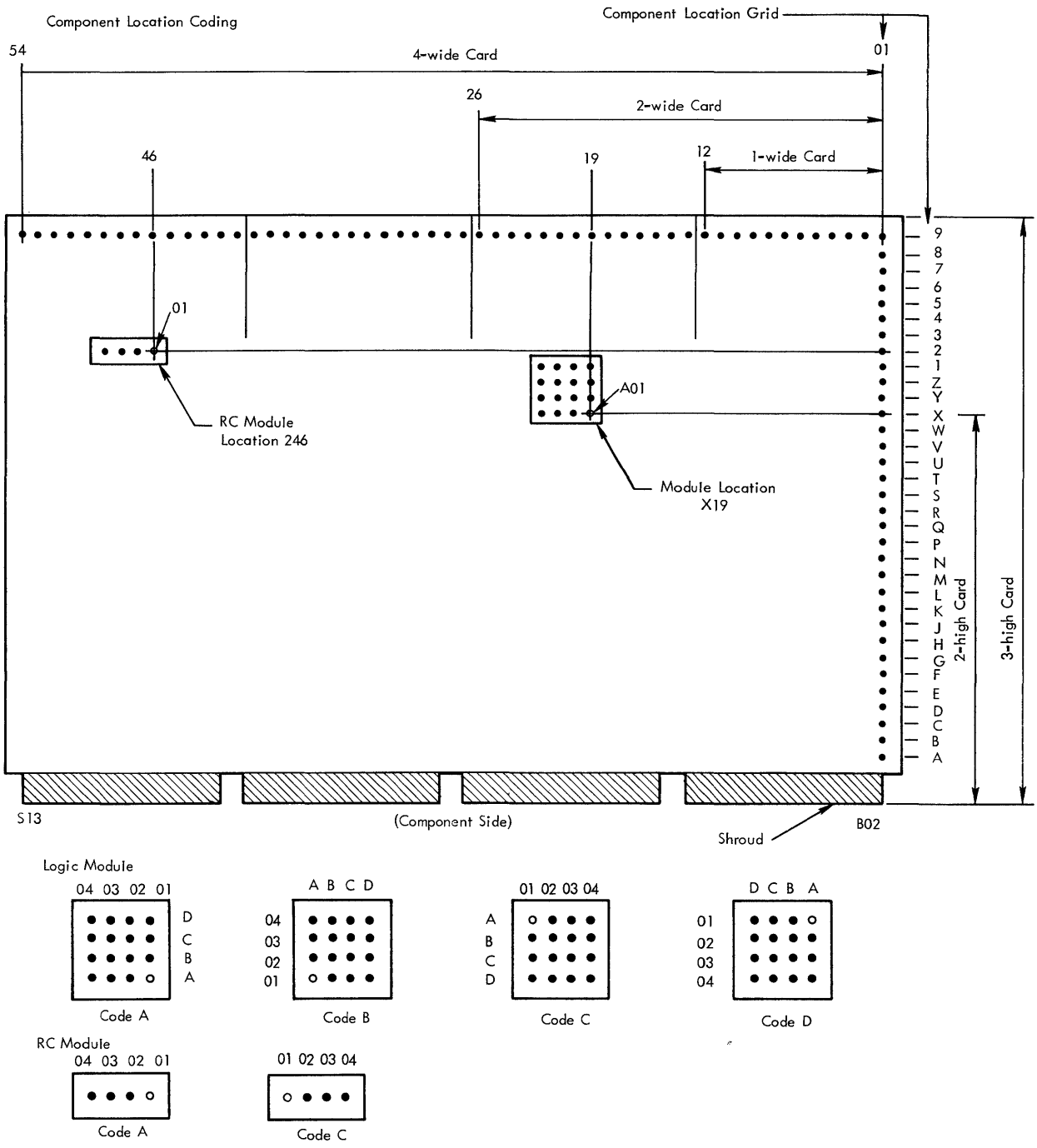
The MST Card Holder

The MST card holder (Figures 1-7 and 1-12) is a plastic frame that fits around the card on three sides, not the socket (shroud) side or edge, and holds the card edges in a groove. The card holder and card(s) are firmly held together by the side legs snapping over the boss (a small rectangular protrusion on the end of the shroud) of the shroud, and the inner legs hooking over the shroud between socket positions (Figures 1-10 through 1-15).

MST-2

The 1-, 2-, and 4-wide, 2-high MST-2 cards use a card guidance system to support the cards and to provide a card extraction capability (Figures 1-7 through 1-11). The cards are carried in plastic holders that accept four 1-wide, two 2-wide, or one 4-wide MST-2 cards, or any combination of cards that yields a 4-socket width.

The card holder is guided into the card socket by an aluminum die-cast guide that is mounted on the MST-2 board. Extraction levers are molded into the card holder; the plastic web of the lever is used as a hinge.

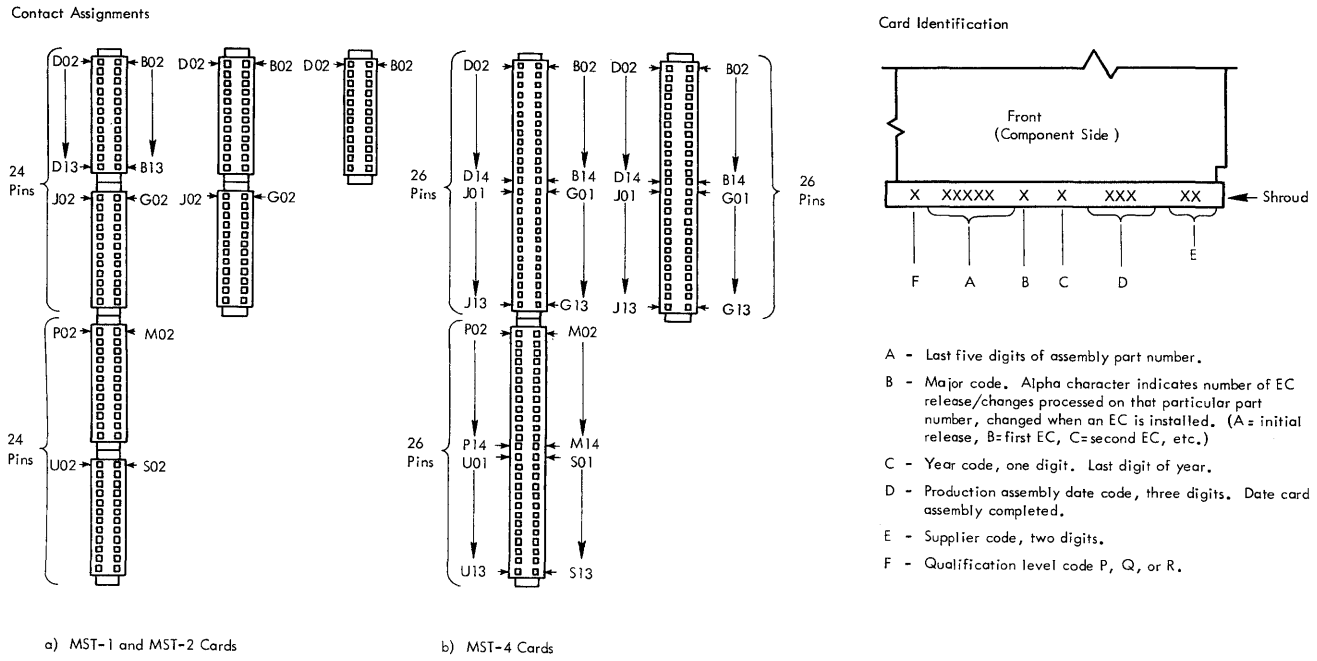


● Figure 1-3. MST Card Component Location and Contact Assignments (Part 1 of 2)

MST-4

The 2- and 4-wide, 3-high MST-4 cards use a card guidance system to support the cards and to provide a card extraction capability (Figures 1-12 through 1-15). The cards are carried in a plastic card holder that accepts one 4-wide card or a card holder that accepts two 2-wide cards.

The card holder assembly is guided into the socket by plastic card guides mounted on aluminum beams that are attached to the board stiffener. Polarization is provided by the relationship of the keys on the card holder to the slots on the card guides. Extraction levers are molded into the card holder; the plastic web of the lever is used as a hinge.



● Figure 1-3. MST Card Component Location and Contact Assignments (Part 2 of 2)

Card Holder Removal and Installation

To remove the card holder:

1. Hold the card with the component side up and the tab pin shroud to the right. Push the small locking finger, between the tab pin shroud, forward (toward the shroud) and down with a sweeping motion. Turn the card over and pick up the locking finger with the thumb and forefinger until it is clear of the shrouds and release it gently. The locking finger continues to exert force on the wiring side of the card.
2. Lift the card locking guides on the edges of the card, one at a time, over the small square protrusions on the ends of the shrouds. Pull the card forward relative to the card holder, so that the guides do not lock over the protrusions as the guides are released. Do not pull the card too far—just enough to ensure that the guides will not lock again.

CAUTION

Discrete wiring may be on the card; the locking fingers will tear the wiring if care is not used.

Technology	Supply Voltage	Card Internal Planes	Card and Maximum Module Capacity	Circuit Transition Delay Time (ns)
MST-1	-4V Reference Ground	2	1-wide, 2-high 12 Modules 2-wide, 2-high 24 Modules 4-wide, 2-high 44 Modules	8-20
MST-2	-3V +1.2V Ground	2	1-wide, 2-high 9 Modules 2-wide, 2-high 18 Modules 4-wide, 2-high 36 Modules	6-8
MST-4	-3V +1.2V Ground	3	2-wide, 3-high 20 Modules 4-wide, 3-high 60 Modules	4

Figure 1-4. MST Card Characteristics

3. Lift the locking fingers so that they are clear of the exposed wiring and carefully slide the card out of the holder.

To install the card holder:

1. Hold the locking fingers up so that they are out of the way and place the card in the two grooves of the card holder. The module side of the card should be down, and the reinforcing ribs of the holder should be up.
2. Continue to hold the locking fingers up and slide the card into the holder until a gentle push causes the sides

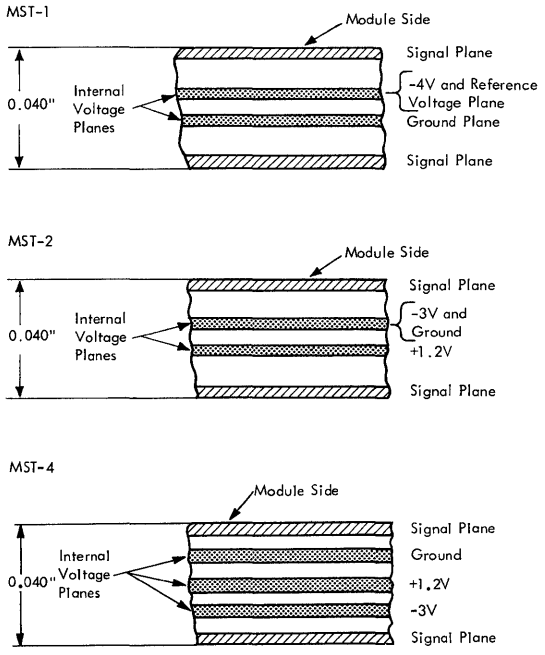
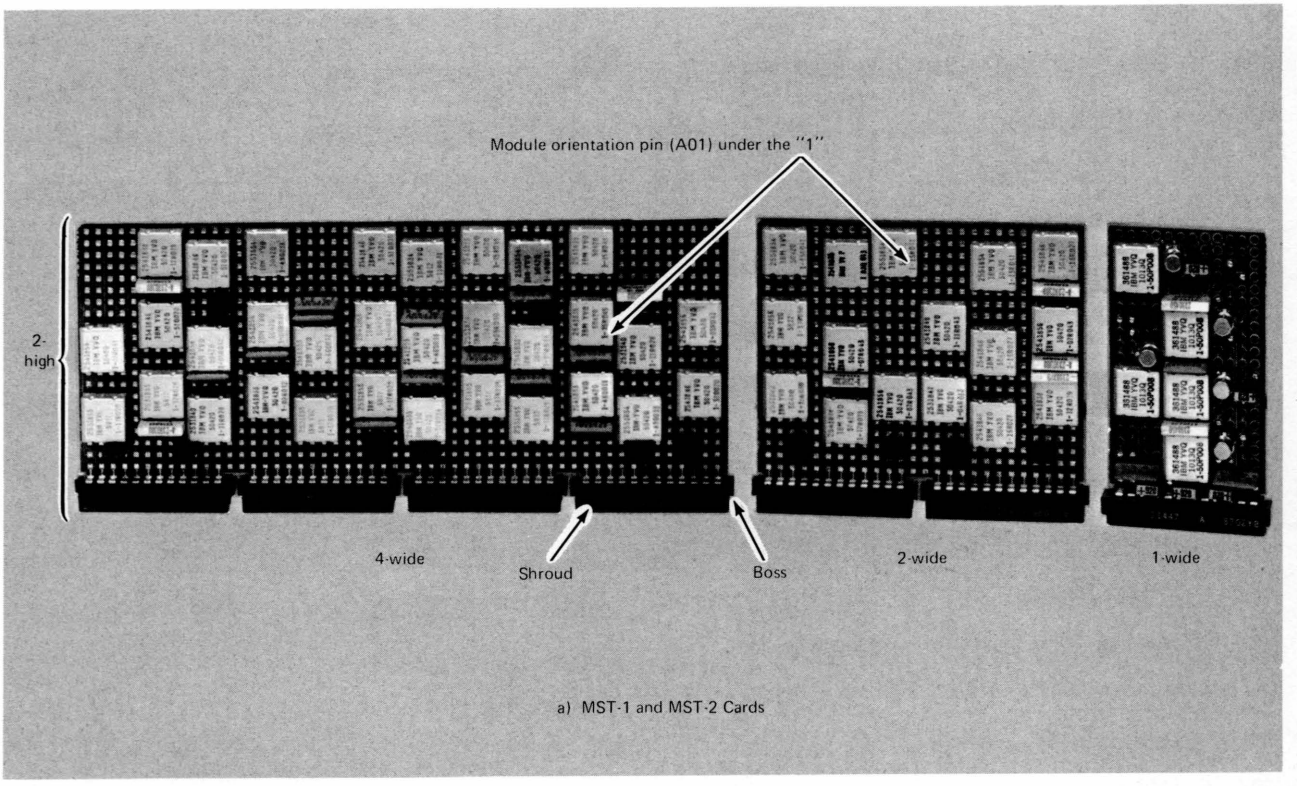
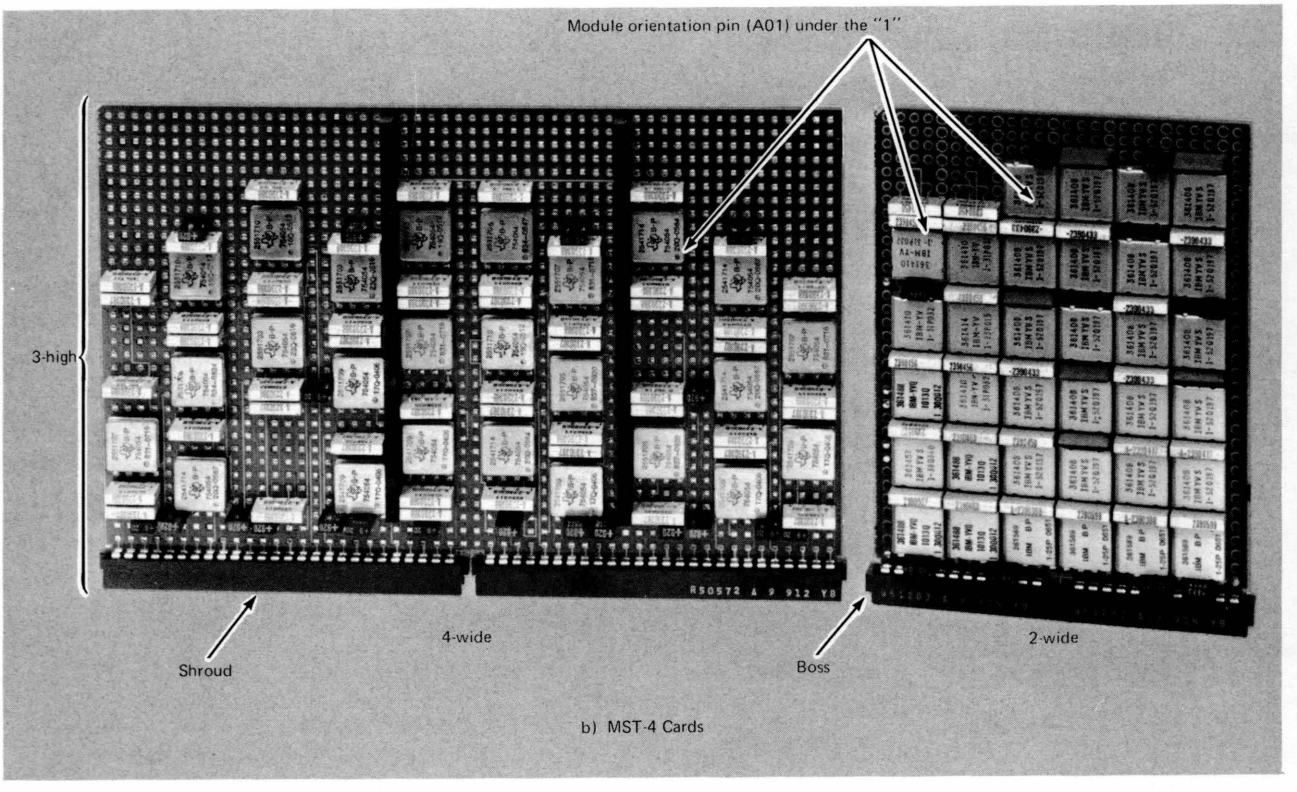


Figure 1-5. MST Card Cross Section

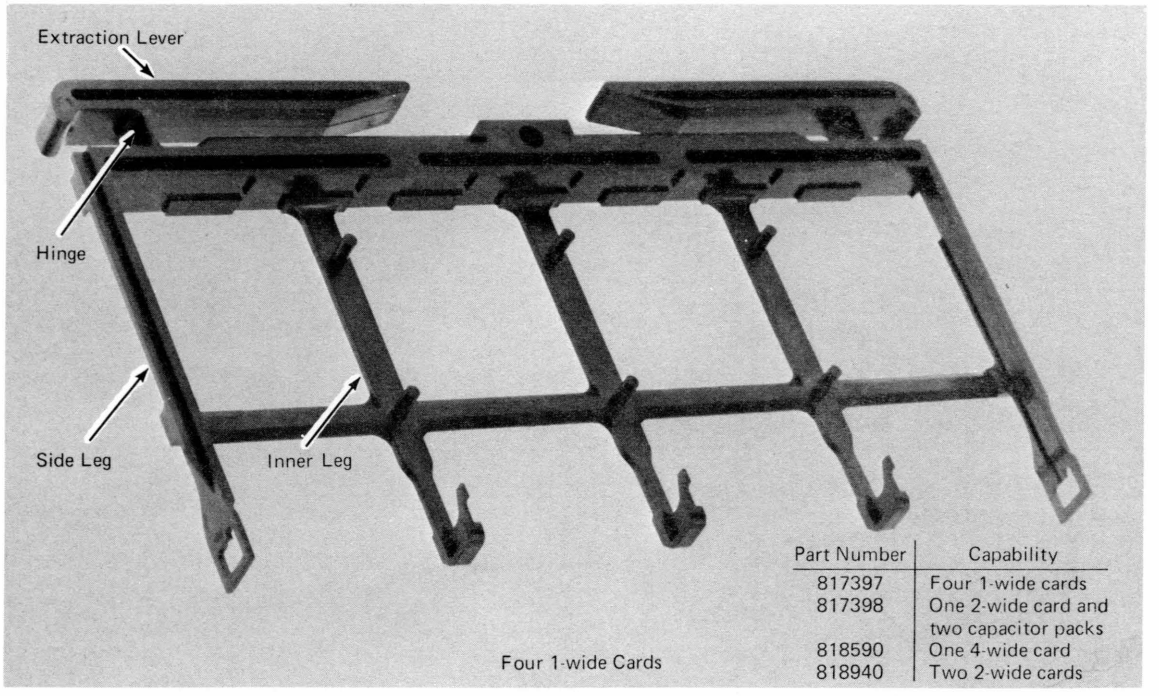


a) MST-1 and MST-2 Cards



b) MST-4 Cards

Figure 1-6. MST Cards



Part Number	Capability
817397	Four 1-wide cards
817398	One 2-wide card and two capacitor packs
818590	One 4-wide card
818940	Two 2-wide cards

Figure 1-7. Example of MST-2 Card Holder

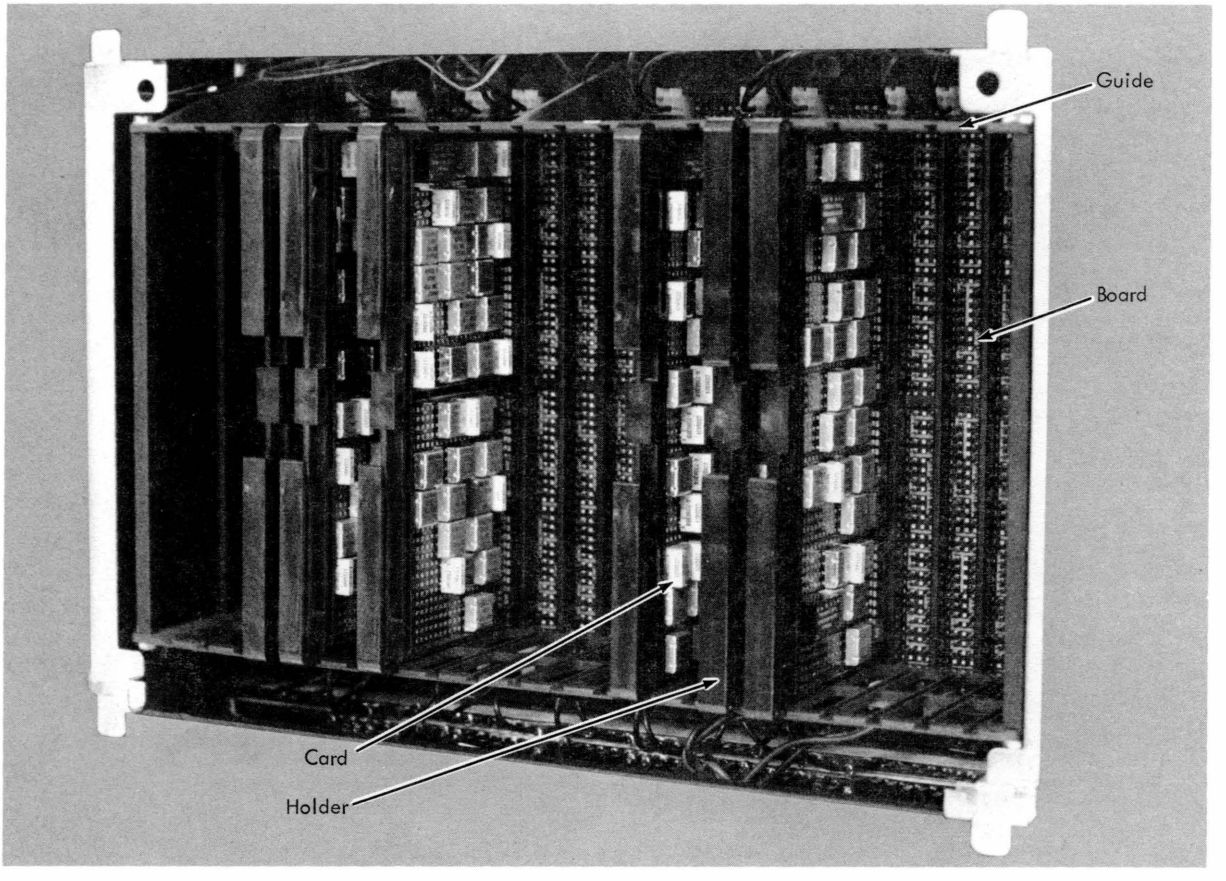


Figure 1-8. MST-2 Card Guidance System with Cards in Place

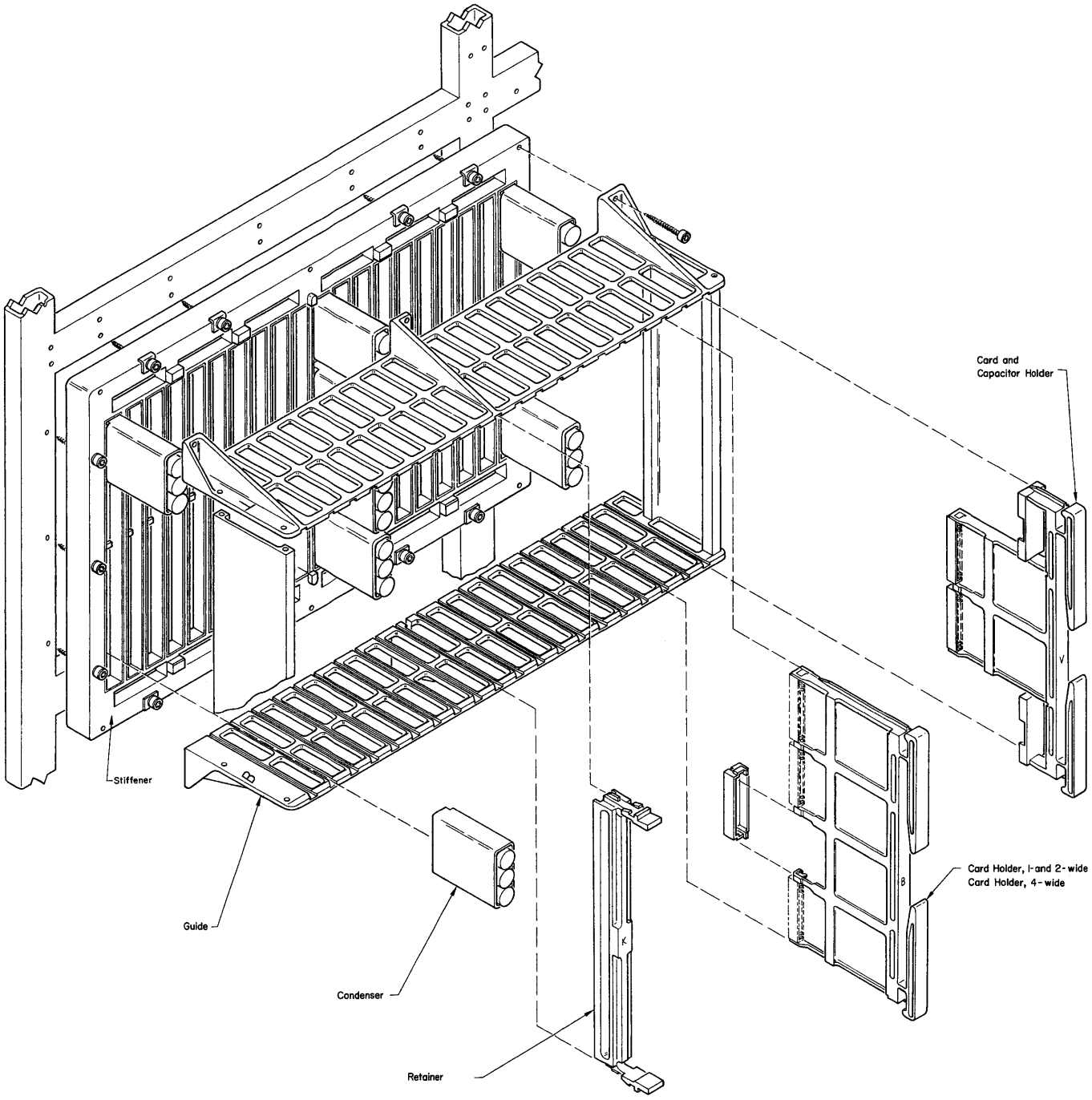


Figure 1-9. MST-2 Card Guidance System

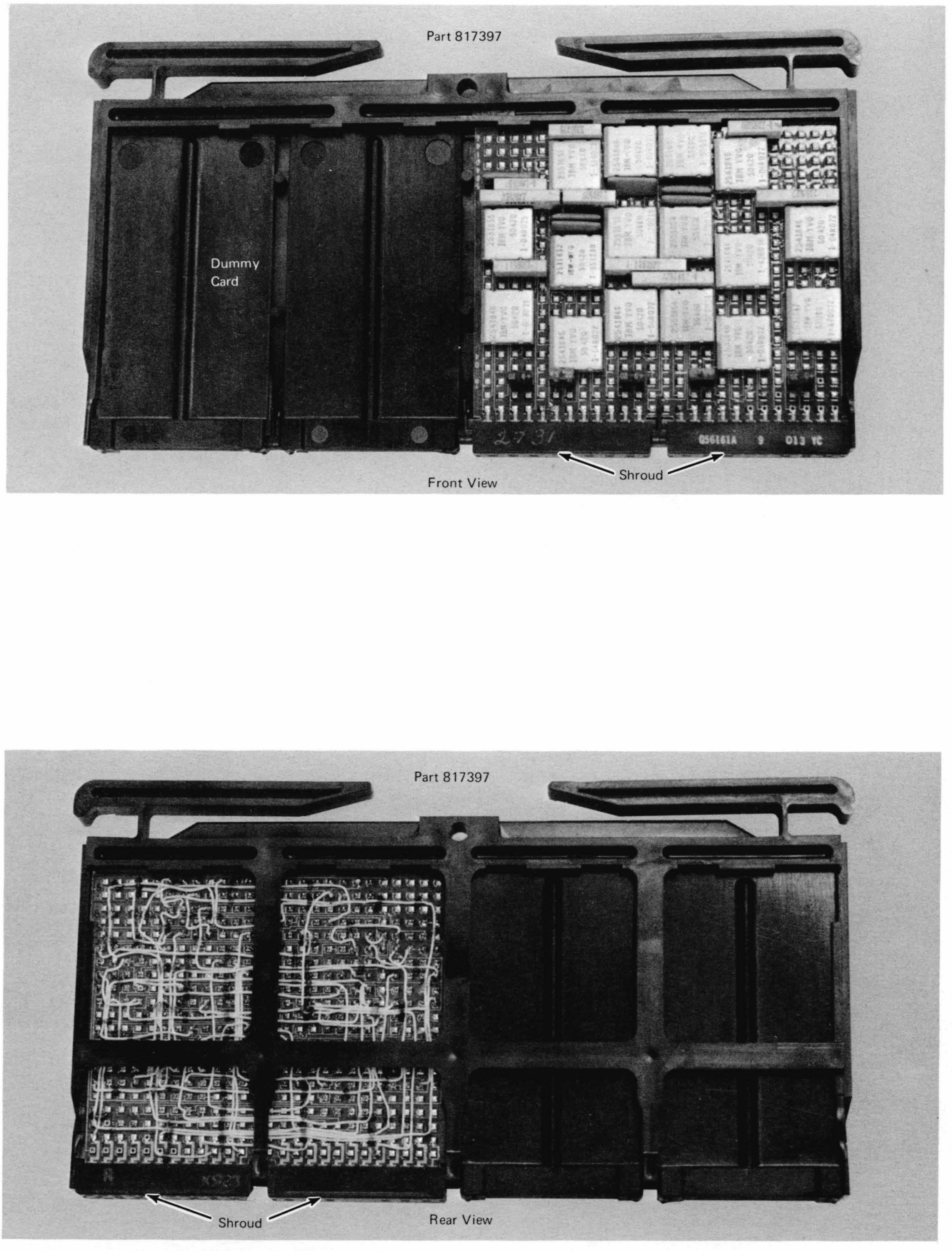


Figure 1-10. MST-2 Cards in Card Holder

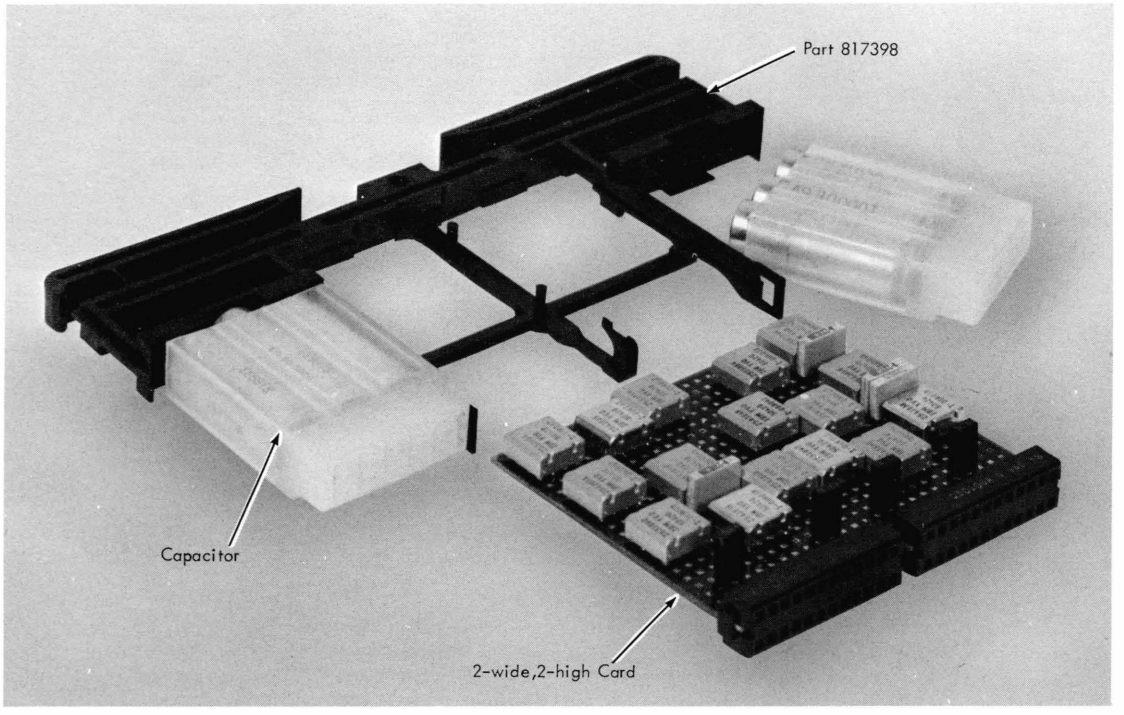


Figure 1-11. MST-2 Card Holder for Card and Capacitors

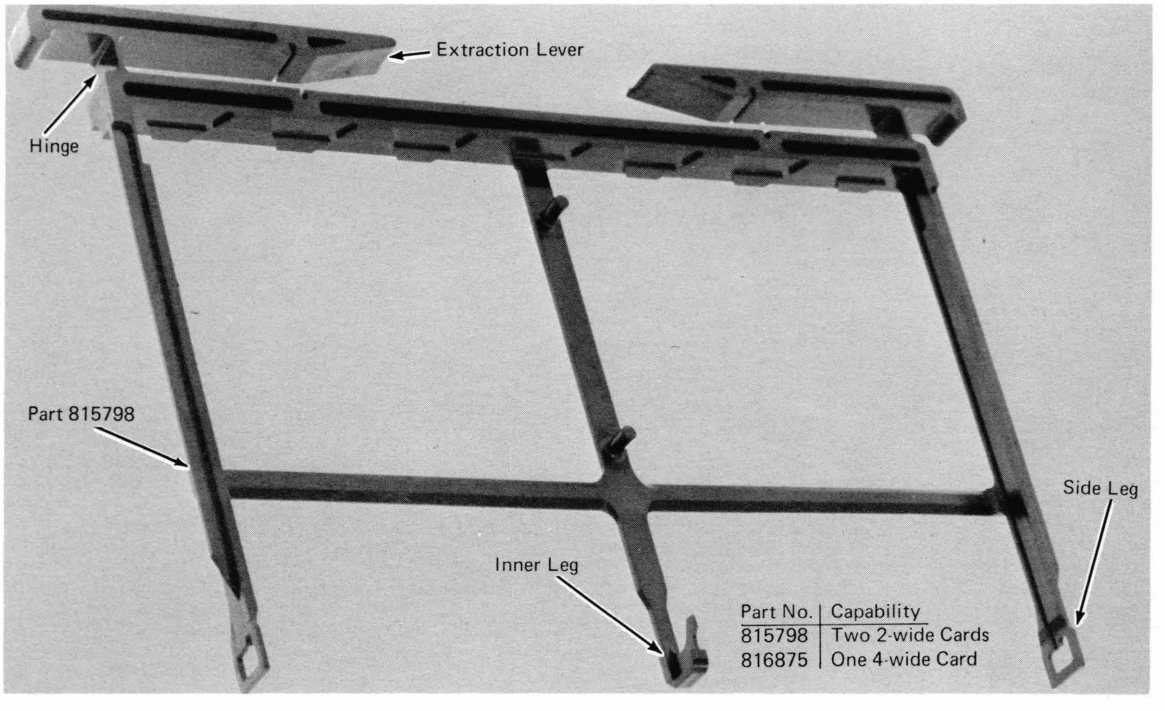


Figure 1-12. MST-4 Card Holder

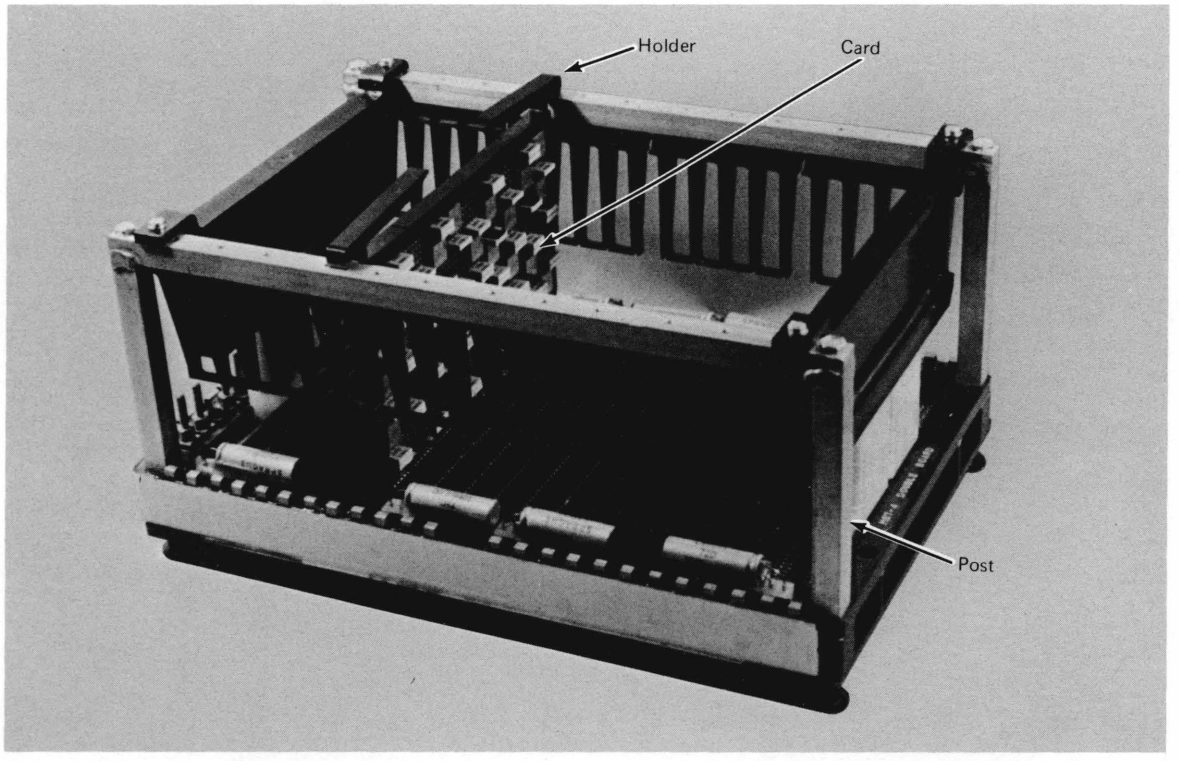


Figure 1-13. MST-4 Card Guidance System with Cards in Place

of the holder to snap over the small protrusions on the ends of the shrouds.

3. Ensure that there is no wiring between the locking fingers and the shroud. If there is, lift the locking finger and gently push the wiring up the card until the locking finger is ahead of the wiring when the locking fingers are released. Push down upon the center of the holder and apply pressure about 1/4-inch from the end of the locking finger, so that the locking finger tip moves forward and down over the card stock. There will be several "clicks" as the fingers lock, but the finger is not fully locked until the back of the locking finger is flush with the side of the shroud.
4. Install the card holder in the machine.

BOARDS

- Single boards have only internal voltage planes.
- Double boards have internal signal and voltage planes.
- MST-1 uses single boards.
- MST-2 uses single and double boards.
- MST-4 uses double boards.
- MST-2 and MST-4 boards use ground rails.
- Ground rails allow use of special wires, a ground wire and a signal wire.

The board used in MST-1 is similar to the board used in SLT, except that the board for MST-1 is mounted with the long dimension parallel to the floor. The boards used in MST-2 and MST-4 differ from the SLT boards and the MST-1 board both physically and electrically. Because of the circuit speeds in MST-2 and MST-4, the MST-2 and MST-4 double boards are wired with tri-lead cables. MST-2 single boards use tri-lead cables for intraboard wiring and yellow wire for interboard wiring. Some MST-4 boards are wired with twisted pair and coaxial cables. These special wires consist of a ground wire and a signal wire; therefore, the MST-2 and MST-4 boards require a system of ground rails along the side of each signal pin. The wires are attached to a signal pin and ground rail by a connector. Pins and vias are the connections between signal planes, or voltage planes and board wiring. Pins may be either a pin the thickness of the board, or may be a pin that protrudes from each side of the board. The protruding pins on the card side make connections with the card socket; the protruding pins on the probe side are used for scoping and for discrete wire connections such as Wire-Wrap* connections, housing connections, or I/O cable connections. A via is a hole, absence of a pin, that is plated to provide an electrical connection from one outer surface of the board to the other outer surface of the board.

Physically, the MST-2 and MST-4 boards differ from the SLT and MST-1 boards by use of the ground rail system (Figures 1-16, 1-42, 1-43, and 1-44).

* Trademark of Gardner-Denver Company

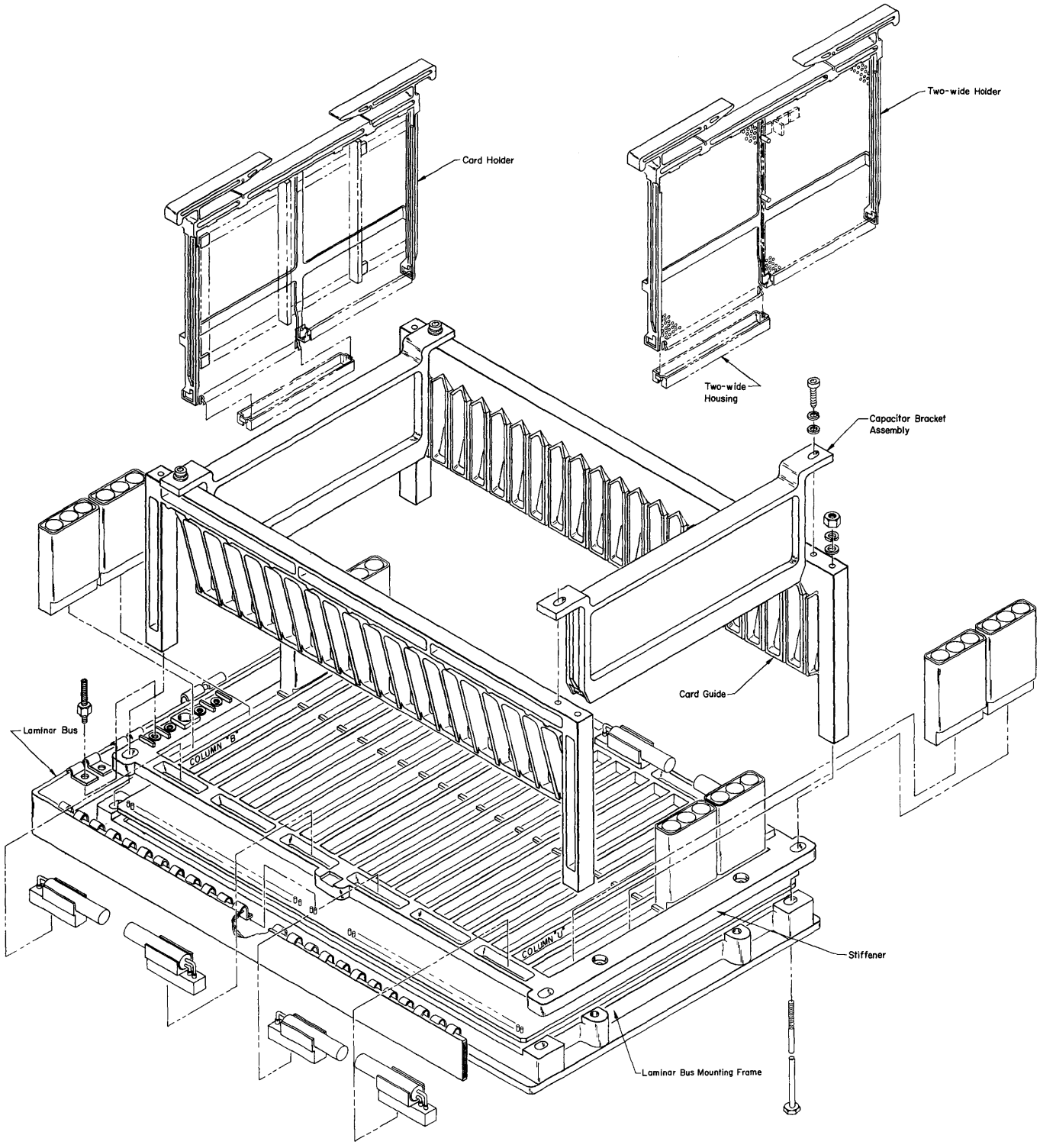
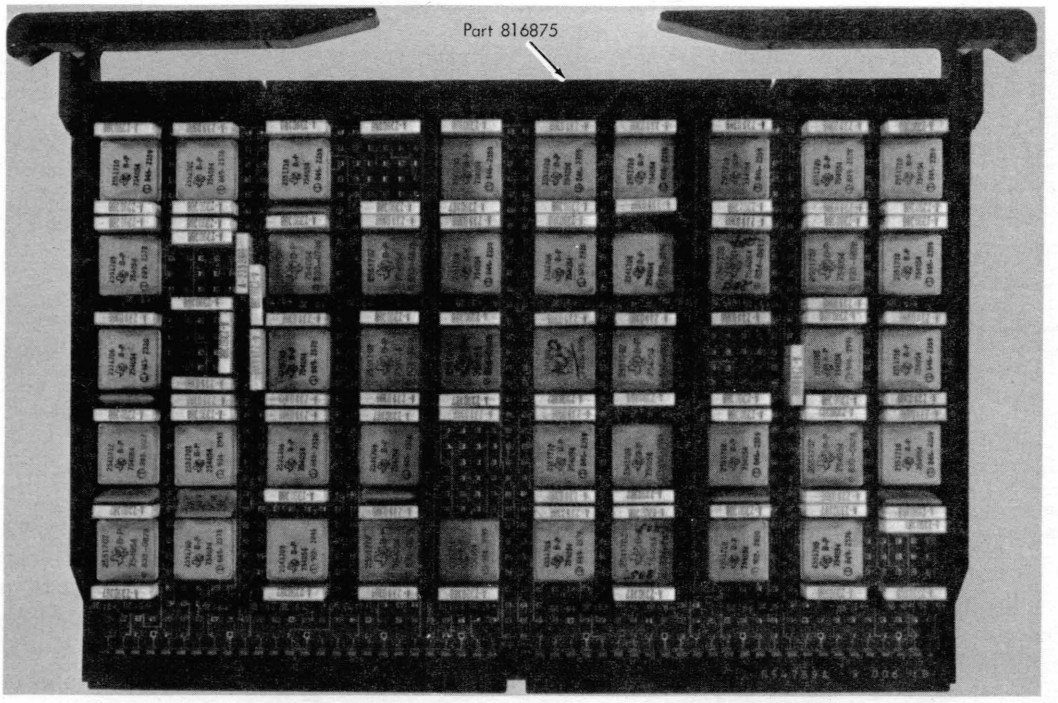
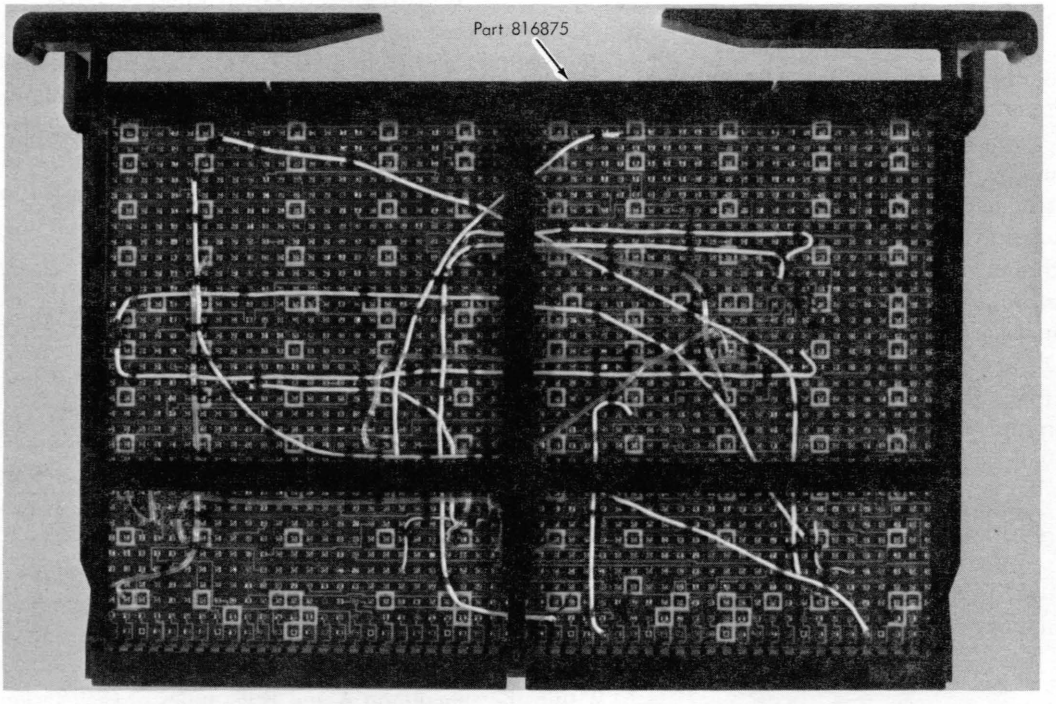


Figure 1-14. MST-4 Card Guidance System



MST Card in Holder (Front View)



MST-4 Card in Holder (Rear View)

Figure 1-15. MST-4 Cards in Card Holder

The MST-2 and MST-4 boards also differ in thickness (Figure 1-17). Some MST-2 and all MST-4 boards with the exception of special boards are double-layer boards. Also, MST-2 single boards are provided. MST-2 uses:

1. An MST-2 double board, with ground rails fully utilized.
2. An MST-2 single board, with ground rails used only in the I/O area of the board; other variations exist.

The pin pattern and voltage pin designations for MST-1, MST-2, and MST-4 boards are shown in Figures 1-18 through 1-21.

MST-1 Board

The MST-1 board (Figure 1-22) is a composite structure that has two internal and two surface planes with a space between each plane as shown in Figure 1-17a. This construction provides one internal voltage plane (-4V) and one ground plane within the board assembly. Voltage distribution is not required on the board surface when using these two internal planes, except within rows 2-5 of card columns B, C, T, and U where logic or cable card plugging is optional.

The socket configuration of the board is illustrated in Figure 1-18. Flat cables and logic cards are plugged on the card side of the board; discrete wiring, yellow #30 AWG, is used on the opposite or probe side of the board. The 20 perimeter socket positions (card rows 1 and 6, and card rows 2-5 of card columns A and V) are reserved for cable cards; each position uses 18 signal pins and 6 ground pins. Card rows 2-5 of card columns B, C, T, and U, as previously mentioned, may have either cable or logic cards. All other socket positions (card rows 2-5 of card columns D-S) are used for logic cards.

Horizontal wiring is routed on the probe side of the board (parallel to the long dimension of the board); vertical wiring is routed on the card side of the board.

Board voltage is distributed by laminar buses and crossover connectors that are terminated at the board voltage and ground via holes. Each crossover connector position has access to two voltage and ground vias. Crossover connector positions are provided on all four sides of the board. Five positions are available for each horizontal side (long dimension of the board) and three positions are available for each vertical side. Therefore, laminar bus location is optional. Special voltages are distributed on the board by a minibus or by using specially designed boards.

MST-2 Board

The MST-2 board (Figure 1-23) has three configurations: two types of single boards and one double board.

MST-2 Single Board

The MST-2 single board (Figure 1-17b) is a composite structure that has three internal and two surface planes.

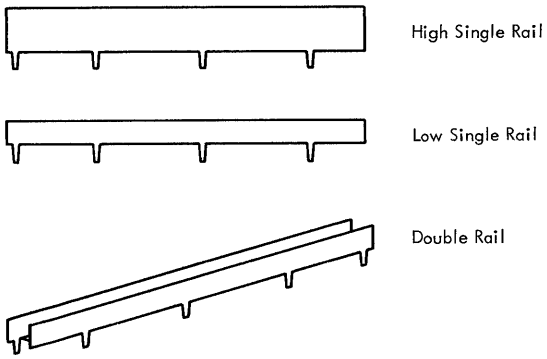


Figure 1-16. Ground Rails

Within the single-board assembly, each internal plane has one voltage potential (-3V, +1.2V, or ground). Voltage distribution is not required on the board surface, except within rows of card columns A, B, U, and V where logic card and I/O cable plugging is optional.

The socket configuration of each board assembly is shown in Figure 1-19. Logic cards and decoupling packs are terminated on the card side of each board assembly; therefore, cabling (tri-lead) is restricted to the opposite or probe side of the board. Four socket positions, A2, A5, V2, and V5 (or K2, K3, K4, and K5), are used for voltage decoupling.

Horizontal wiring is routed on the probe side of the board (parallel to the long dimension of the board); vertical wiring is routed on the card side of the board.

Board voltage is distributed by laminar buses and discrete wire crossover connectors that are terminated individually at board voltage and ground vias on the card side. Twenty positions are available on the card side of the board for crossover connectors: ten in card row 1 and ten in card row 6. The connector plug has six pins, two vertical rows of three pins (2 x 3). A crossover connector can be plugged to either a -3V or a +1.2V pin and to a ground pin. Twenty connectors can be plugged onto the board (Figure 1-19).

1. Sixteen connectors: In the center four socket positions of card rows 1 and 6, the connectors are plugged flush left and flush right in each socket position.
2. Two connectors: In the leftmost socket position of card rows 1 and 6, the connectors are plugged flush right.
3. Two connectors: In the rightmost socket position of card rows 1 and 6, the connectors are plugged flush left.

Special voltages are distributed on the board by special jumpers or by using specially designed boards.

Interboard cables are tri-lead connector-terminated cables. The connectors are plugged onto the socket pins and ground rails. Ground rails are placed on the probe side of the board. Vertically, they are placed:

1. Within the subcolumn A and E via holes of each socket position in card rows 2-5 of card columns A, B, U, and V.

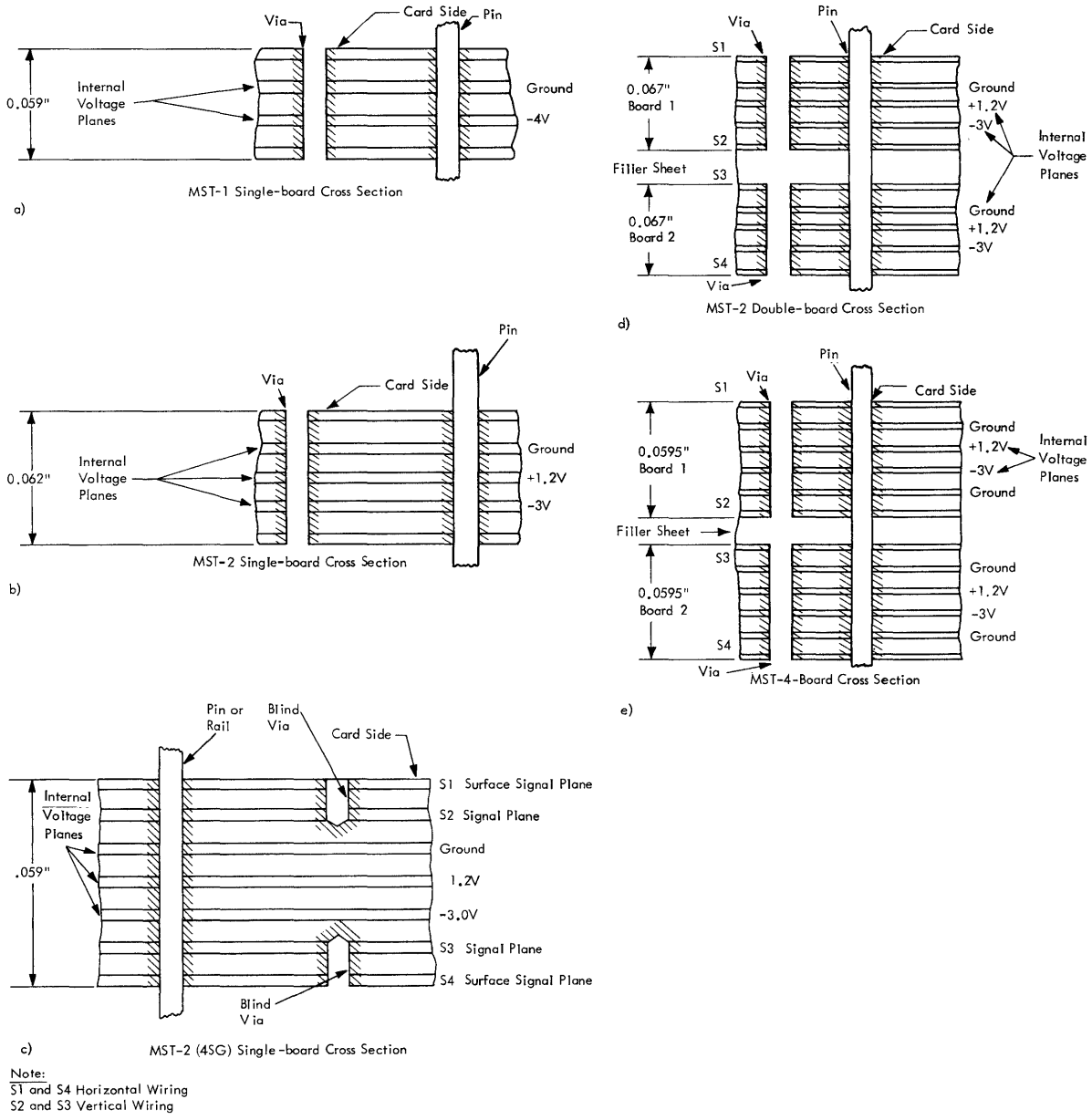


Figure 1-17. Cross Sections of MST Boards

2. Within the subcolumn A via holes in card rows 2-5 of card column C.
3. Within the subcolumn E via holes in card rows 2-5 of card column T. (Variations in the number and positions of ground rails may exist.)

Horizontally, they are placed:

1. Within the six socket positions of card row 1 in subrows 10 and 14.
2. Within the six socket positions of card row 6 in subrows 1 and 5.

One Wire-Wrap connection is allowed under each I/O connector. Board overflow wires are wrapped with # 30 AWG wire.

Pins are re-formed on the card side of the board and are squared on the probe side of the board.

MST-2 (4SG) Single Board

The MST-2 (4SG) single board (Figure 1-17c) is a composite structure that has 3 internal voltage places, 2 internal signal planes, and 2 surface signal planes. Within the single-board assembly each internal voltage plane has one

voltage potential (-3V, +1.2V, or ground). The socket configuration, pin and high rail locations, yellow wire overflows, I/O cabling, power distribution and decoupling requirements of the (4SG) board are identical to those of the two-signal plane MST-2 single-board assembly with high rails. Logic cards and decoupling packs are terminated on the card side with I/O cabling restricted to the probe side. Voltage distribution is not required on the board surface, except within card rows 2-5 of card columns A, B, U, and V where logic card and I/O cable plugging is optional.

Connections between S1 and S2 and between S3 and S4 are made through plated-blind-holes (blind vias). *These blind vias extend only from the surface plane to the internal signal plane immediately below it.* Regular plated via holes are used in all pin and rail positions. The S1 and S4 surface planes have horizontal wiring (parallel to the long dimension of the board). The S2 and S3 internal signal planes have vertical wiring. The horizontal ground rails are placed in a manner identical to the MST-2 single board. Vertical ground rails are placed within the sub-column A and E via holes of each socket position in card rows 2-5 of card columns A, B, C, D, and S, T, U, V. Variations in the number and positions of ground rails may exist.

MST-2 Double Board

The MST-2 double-board assembly consists of two boards. Each board subassembly has three internal and two surface planes, each separated by a dielectric material. Each subassembly or board is aligned and assembled parallel to the other planes, maintaining a prescribed spacing. A cross-sectional view of the double-board construction is shown in Figure 1-17d.

This construction provides two internal voltage planes (-3V and +1.2V) and one internal ground plane for voltage and ground distribution within each board. The double-board assembly, as a unit, has four internal voltage planes, two internal ground planes, two internal signal planes, and two surface signal planes. Voltage distribution is not required on the board surface, except within card rows 2-5 of card columns A, B, U, and V where logic card and cable plugging is optional.

The socket configuration of this board assembly is identical to the MST-2 single-board assembly. Logic cards and decoupling packs are terminated on the card side. Cabling is restricted to the opposite or probe side of the board assembly.

Four socket positions, A2, A5, V2, and V5 (or K2, K3, K4, and K5), are used for voltage decoupling. Card rows 2-5 of card columns A, B, U, and V, other than decoupling positions, are used for either logic cards and/or cables (as many as 23 signal pins). All other socket positions (card rows 2-5 of card columns C-T) are used for logic cards.

Horizontal surface wiring (parallel to the long dimension of the board) is routed on the card side of board 1 and the probe side of board 2; vertical wiring is routed on the probe side of board 1 and the card side of board 2.

Voltage for the board assembly is distributed by laminar buses and discrete crossover connectors that are terminated individually at board voltage and ground vias along each horizontal edge of boards 1 and 2. Twenty positions are available on the card side of the board for crossover connectors: ten in card row 1 and ten in card row 6. The connector plug has six pins, two vertical rows of three pins (2 x 3). A crossover connector can be plugged to either a -3V or a +1.2V pin and to a ground pin. Twenty connectors can be plugged onto the board (Figure 1-20).

1. Sixteen connectors: In the center four socket positions of card rows 1 and 6, the connectors are plugged flush left and flush right in each socket position.
2. Two connectors: In the leftmost socket position of card rows 1 and 6, the connectors are plugged flush right.
3. Two connectors: In the rightmost socket position of card rows 1 and 6, the connectors are plugged flush left.

Special voltages are distributed on the board by special jumpers or by using specially designed boards.

Both interboard and overflow cables are connector-terminated cables. The connectors are plugged onto the socket pins and ground rails. Low-profile ground rails are installed in card columns A and E of all socket positions—single ground rails in the perimeter positions and double ground rails throughout the remainder of the board. Wire-Wrap termination under the cable connectors is not allowed.

Pins are re-formed on the card side of the board and are squared on the probe side of the board.

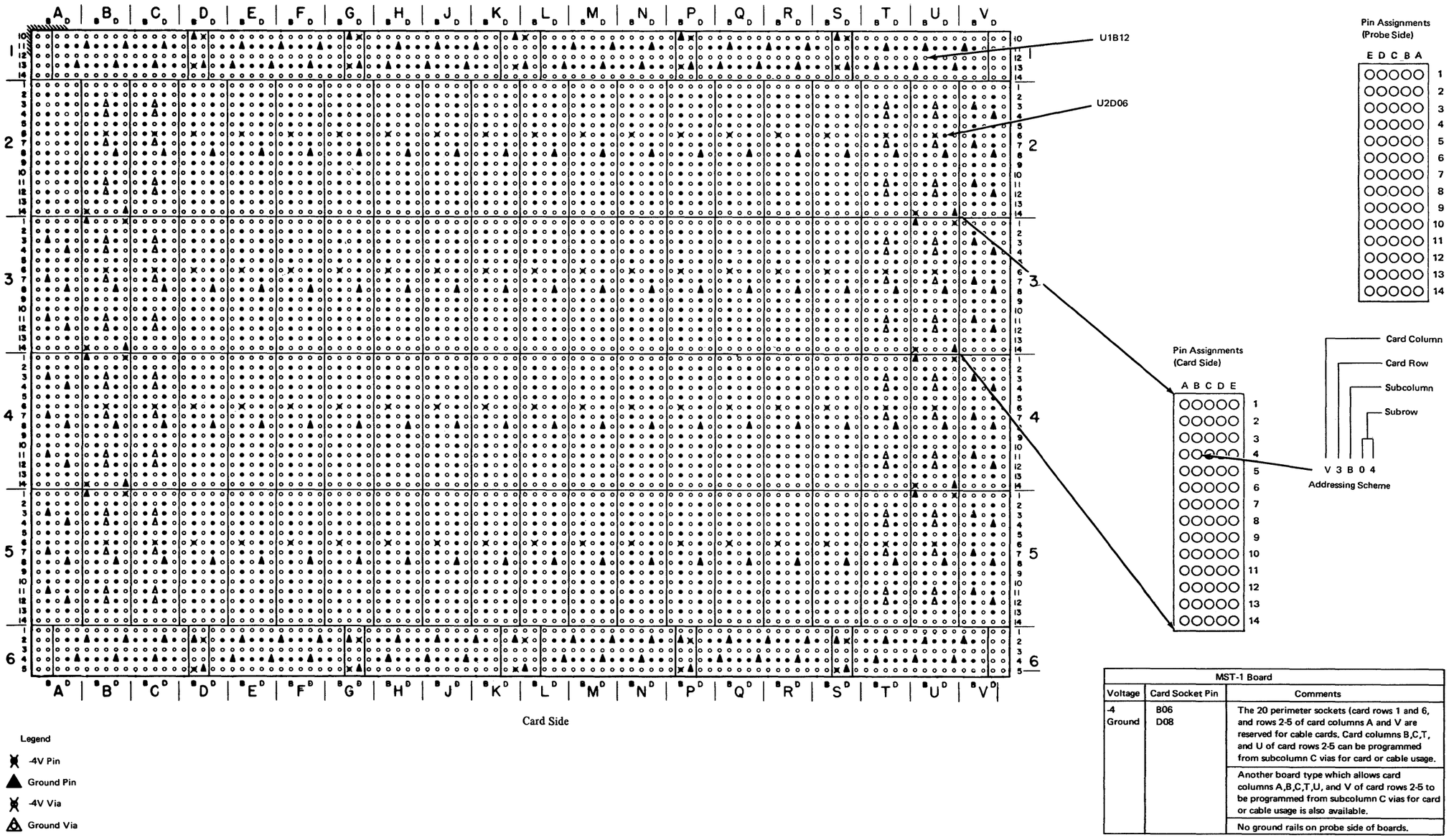
MST-4 Board

MST-4 Double Board

The MST-4 board assembly (Figure 1-24) is a double-board construction. Each board has four internal and two surface planes, each separated by a dielectric material. A cross-sectional view of the double-board construction is shown in Figure 1-17e.

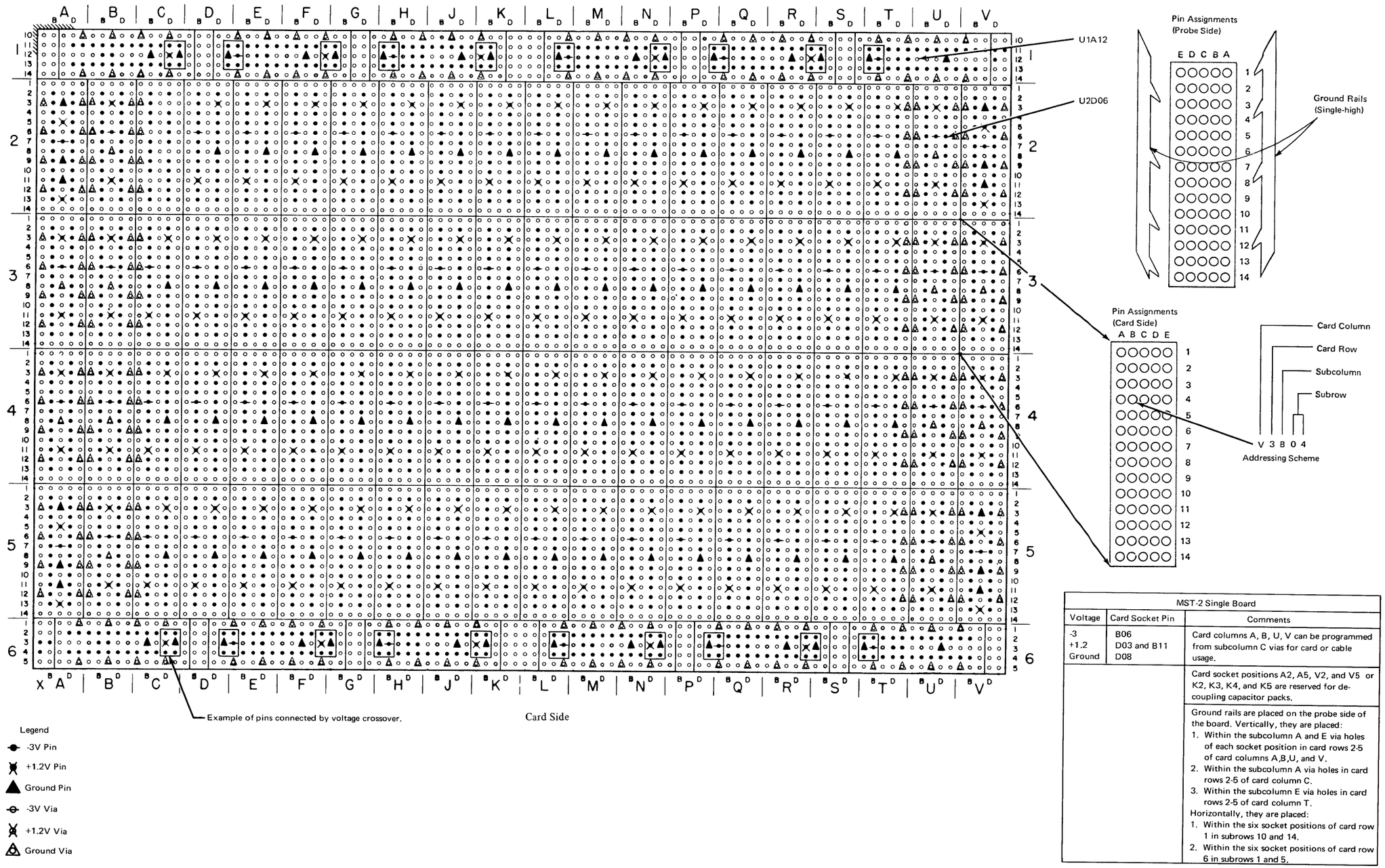
This construction provides two internal voltage planes (-3V and +1.2V) and two internal ground planes for voltage and ground distribution within each board. The double-board assembly, as a unit, has four internal voltage places, four internal ground planes, two internal signal planes, and two surface signal planes. Voltage distribution is not required on the board surface.

Logic cards and decoupling packs are terminated on the card side and coaxial or tri-lead cabling is restricted to the opposite or probe side of the board. Voltage decoupling for the +1.2V plane is done in card rows 2-5 of card columns A and V. Voltage decoupling for a -3.0V plane is done in the four socket positions in rows 1 and 6 (A1, T1, A6, and T6). All other socket positions (card rows 2-5) of card columns B-U) are used for logic cards.



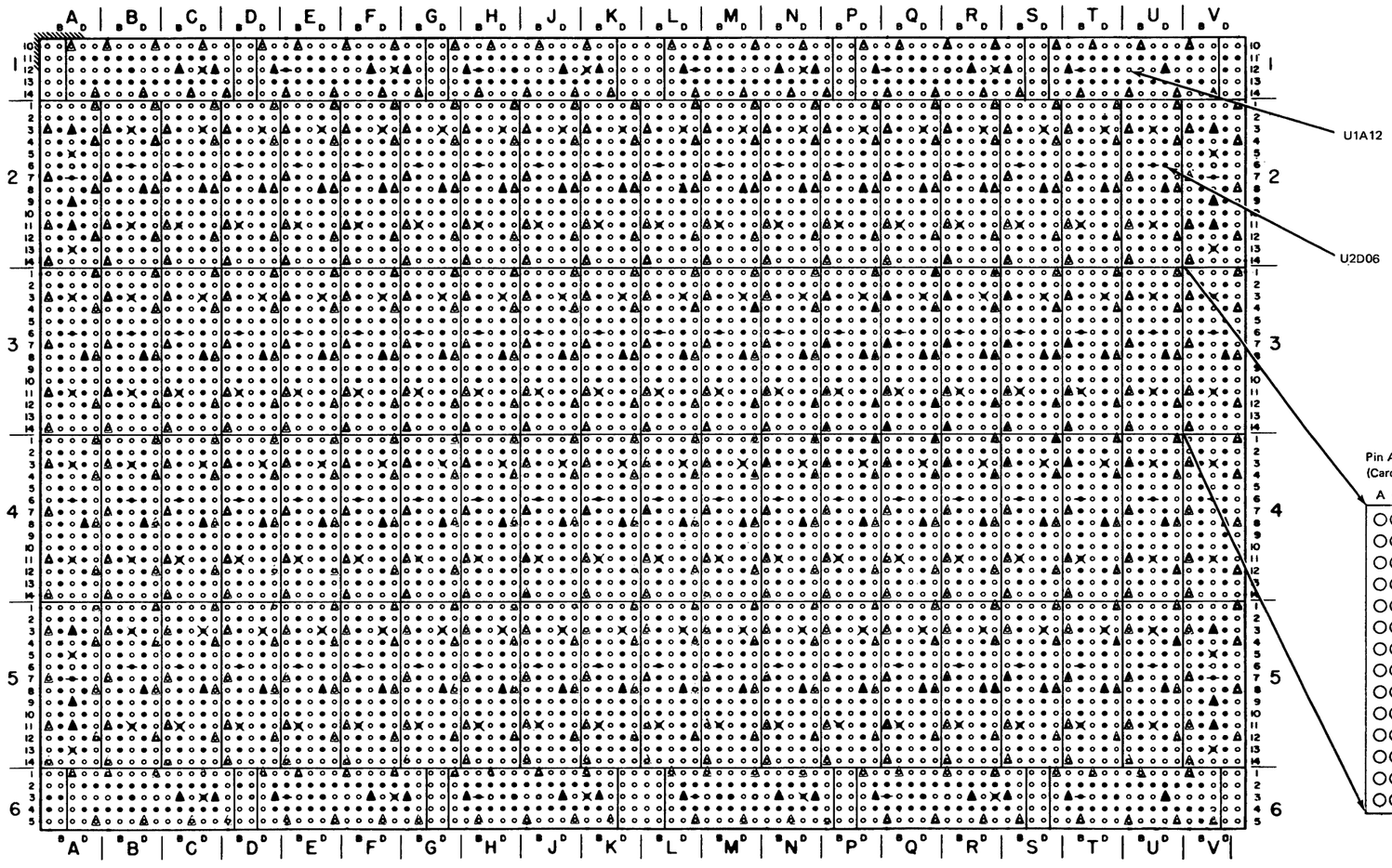
MST-1 Board		
Voltage	Card Socket Pin	Comments
-4 Ground	B06 D08	The 20 perimeter sockets (card rows 1 and 6, and rows 2-5 of card columns A and V are reserved for cable cards. Card columns B,C,T, and U of card rows 2-5 can be programmed from subcolumn C vias for card or cable usage.
		Another board type which allows card columns A,B,C,T,U, and V of card rows 2-5 to be programmed from subcolumn C vias for card or cable usage is also available.
		No ground rails on probe side of boards.

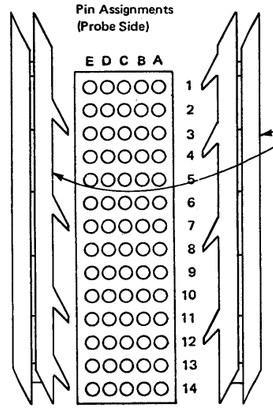
Figure 1-18. MST-1 Board Pin Layout

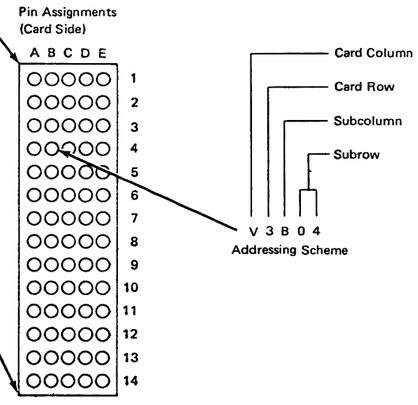


MST-2 Single Board		
Voltage	Card Socket Pin	Comments
-3 +1.2 Ground	B06 D03 and B11 D08	Card columns A, B, U, V can be programmed from subcolumn C vias for card or cable usage.
		Card socket positions A2, A5, V2, and V5 or K2, K3, K4, and K5 are reserved for de-coupling capacitor packs.
		Ground rails are placed on the probe side of the board. Vertically, they are placed: 1. Within the subcolumn A and E via holes of each socket position in card rows 2-5 of card columns A,B,U, and V. 2. Within the subcolumn A via holes in card rows 2-5 of card column C. 3. Within the subcolumn E via holes in card rows 2-5 of card column T. Horizontally, they are placed: 1. Within the six socket positions of card row 1 in subrows 10 and 14. 2. Within the six socket positions of card row 6 in subrows 1 and 5.

Figure 1-19. MST-2 Single-board Pin Layout





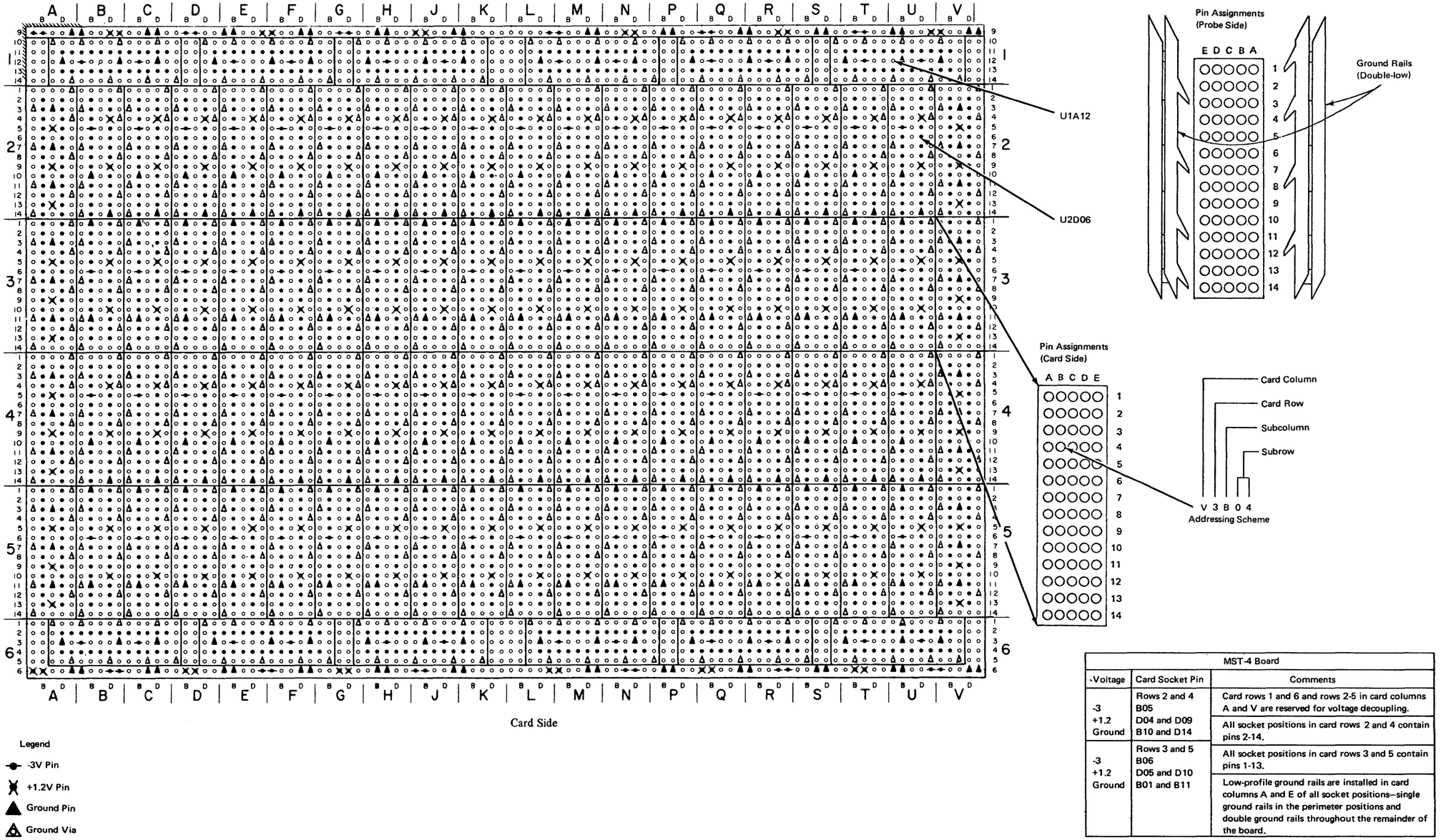


Legend

- -3V Pin
- +1.2V Pin
- Ground Pin
- -3V Via
- +1.2V Via
- Ground Via

MST-2 Double Board		
Voltage	Card Socket Pin	Comments
-3 +1.2 Ground	B06 D03 and B11 D08	Card columns A,B,U, and V can be programmed from subcolumn C vias for card or cable usage.
		Card socket positions A2, A5, V2, and V5, or K2, K3, K4, and K5 are reserved for decoupling capacitor packs.
		Low-profile ground rails are installed in card columns A and E of all socket positions—single ground rails in the perimeter positions and double ground rails throughout the remainder of the board.

Figure 1-20. MST-2 Double-board Pin Layout



MST-4 Board		
Voltage	Card Socket Pin	Comments
-3 +1.2 Ground	Rows 2 and 4 B05 D04 and D09 B10 and D14	Card rows 1 and 6 and rows 2-5 in card columns A and V are reserved for voltage decoupling.
		All socket positions in card rows 2 and 4 contain pins 2-14.
-3 +1.2 Ground	Rows 3 and 5 B06 D05 and D10 B01 and B11	All socket positions in card rows 3 and 5 contain pins 1-13.
		Low-profile ground rails are installed in card columns A and E of all socket positions—single ground rails in the perimeter positions and double ground rails throughout the remainder of the board.

Figure 1-21. MST-4 Board Pin Layout

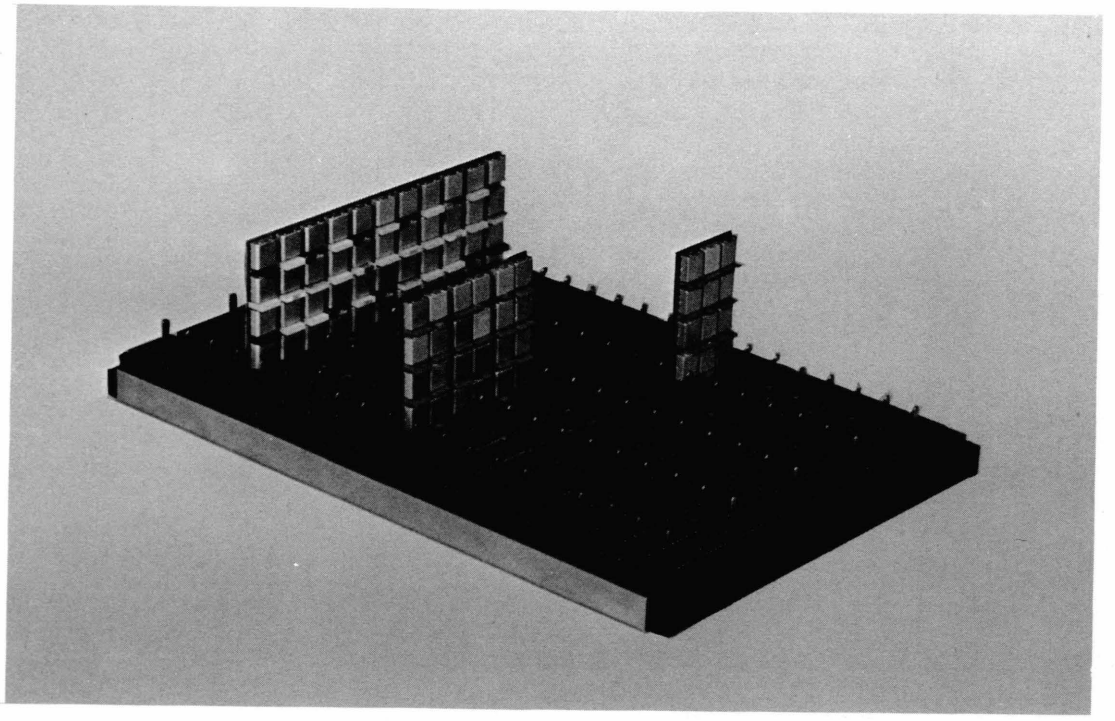


Figure 1-22. MST-1 Board (Card Side)

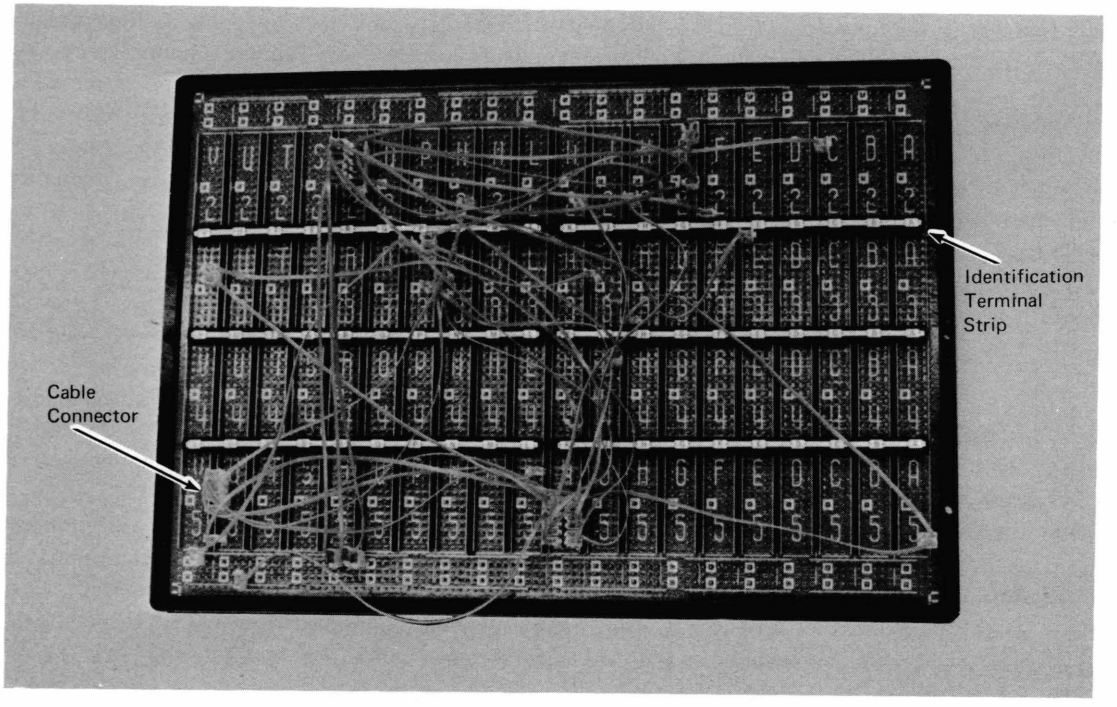
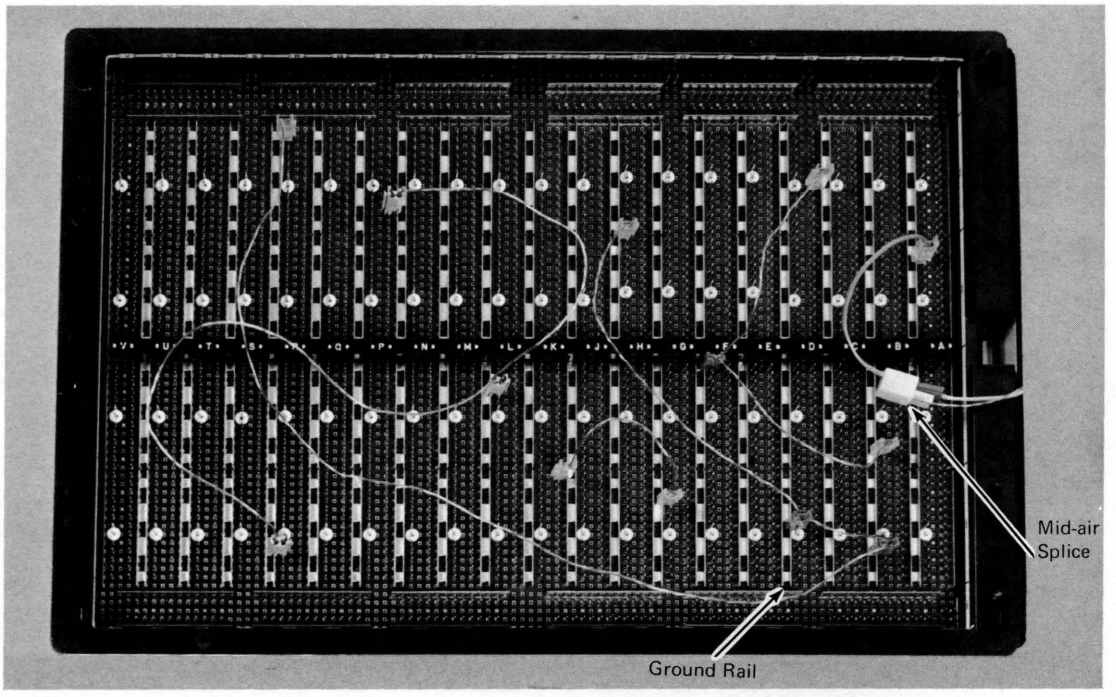


Figure 1-23. MST-2 Board (Probe Side)



●Figure 1-24. MST-4 Board (Probe Side)

Low-profile ground rails are installed in card columns A and E of all socket positions–single ground rails in the perimeter positions and double ground rails throughout the remainder of the board.

Horizontal surface wiring (parallel to the long dimension of the board) is used on the card side of board 1 and the probe side of board 2.

Voltage for the board assembly is distributed by a laminar bus that is terminated to voltage and ground vias along each horizontal edge (long dimension of the board) of boards 1 and 2. Special voltages are distributed on the board by a minibus or by using specially designed boards.

Pins are re-formed on the card side of the board and are squared on the probe side of the board.

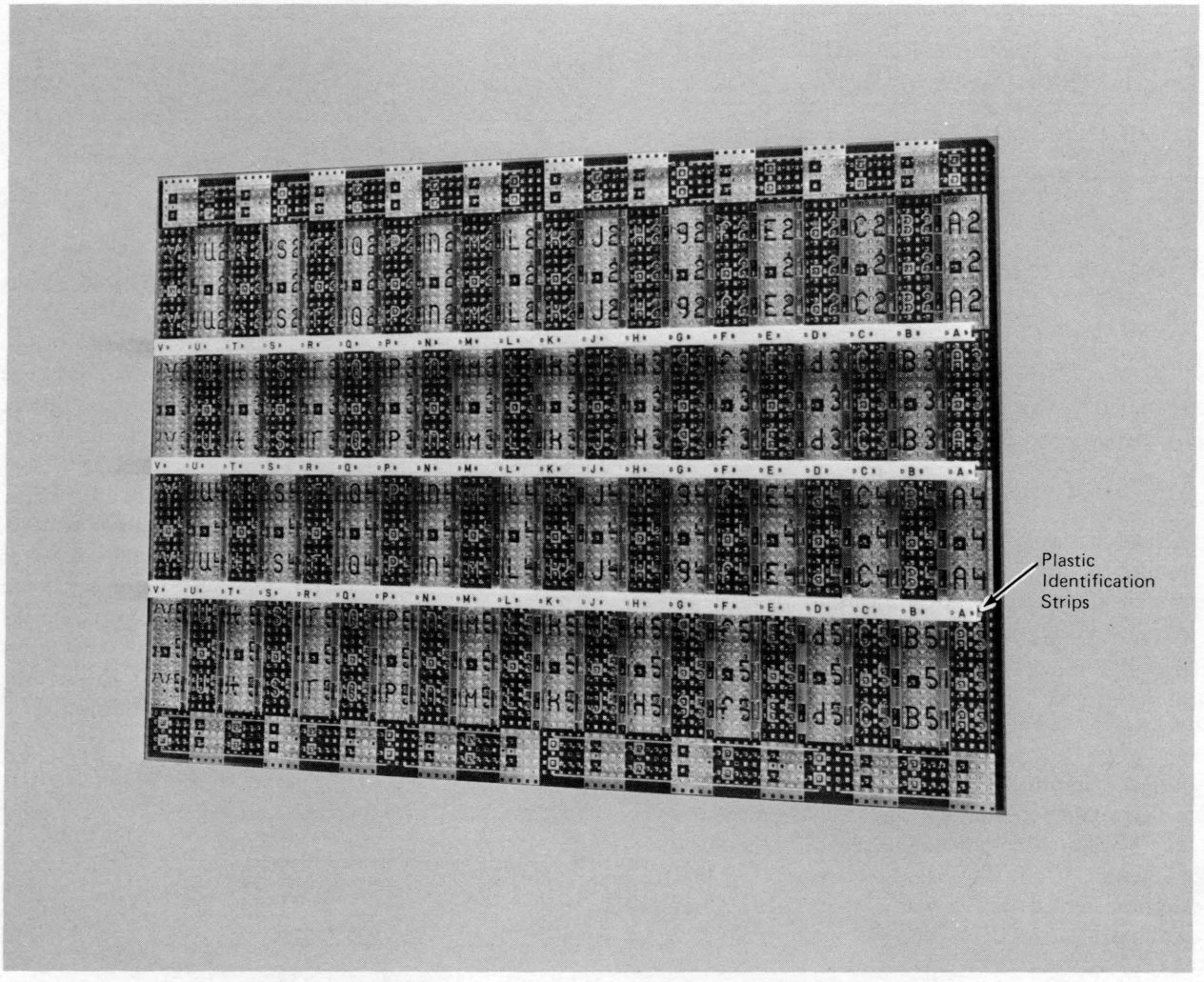
Board Identification

MST-1, -2, and -4 boards have a white checker board identification pattern with a combination of numeric and alphabetic (upper and lower case) characters. Each vertical card socket position is identified with its corresponding alphameric location. The alphabetic and numeric characters are repeated within each socket position such that there are 2 alphabetic and 3 numeric characters per socket on the probe side of the board (Figure 1-25) and 3 alphabetic and 2 numeric characters per socket on the card side of the board. Each D08 pin in every vertical socket position is identified by a square. Each "D" pin location in each horizontal socket position is also identified by a square. Marking the D08 pins and the "D" pins in their socket positions aids in locating pins for pin reference purposes only. The D08 pin should not always be considered as a ground pin because variations within the MST technology prevent usage of the D08 pin as a ground in all cases. To ensure proper ground or voltage pin locations, reference should be made to the board layouts (Figures 1-15, 1-16, 1-17, and 1-18). Caution should be used in those areas of the board which have optional card or cable usage because ground or voltage may be programmed from C row vias.

Plastic strips are an additional identification aid used on boards that contain a full complement of ground rails.

On MST-2 boards there are three such strips plugged horizontally between rows 2 and 3, 3 and 4, 4 and 5. On MST-4 boards there is one strip plugged horizontally between rows 3 and 4.

The checker board pattern for MST boards was not used during the early phases of MST board production and as a result some boards lack the checker board pattern; however, the plastic identification strips will be on those boards to aid in pin location.



● Figure 1-25. Example of Board Identification (Probe Side)

CABLES

- MST cables are SLT-type flat cables or discrete cables.
- All signal cables have a ground wire.
- Cables may be SLT-type flat, twisted pair, coaxial, tri-lead, or twin-lead.
- Most MST cables are terminated with a tuning fork connector.
- Tuning forks are placed in a housing for ease of plugging.
- Single boards use Wire-Wrap terminations for overflow wires.
- Double boards use slip-on connectors for overflow wires.
- Wire-Wrap termination is used only on single boards.

Figure 1-26 shows the cable characteristics for some of the various types of MST.

MST-1 Cables

The MST-1 boards are interconnected with SLT flame-retardent polyethylene cables, 92-ohm impedance, terminated with cable cards that provide 18 signals for each assembly. The cable card has 24 SLT contacts (18 signal and 6 ground). See Figure 1-27.

Cable/Board Connection

Cable assemblies are inserted into the card side of the boards, as in SLT, at 20 perimeter socket positions which are reserved for cable cards. Additional cable positions are available in card columns B, C, T, and U. Programming the voltages from the vias in card column C to the pins in subcolumns B and D converts card columns B, C, T, and U from the cable socket positions to card socket positions. If these lines are not programmed, the socket positions are used for cables.

Technology	Type	Connector Type	Plug into Board	Color
MST-1	SLT Flat Cable (90 ohms)	Cable Card	Card Side	Not Applicable
MST-2	90-ohm Twin-lead 90-ohm Tri-lead	Tuning Fork	Probe Side	Clear Orange
MST-4	50-ohm Tri-lead 50-ohm Coaxial	Tuning Fork	Probe Side	Purple White

Figure 1-26. MST Cable Characteristics

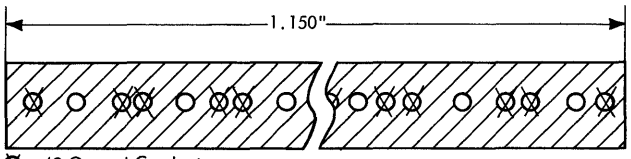
Cable Routing

Cables are routed between the boards in the card side raceways or interlattice raceways, as required.

MST-2 Cables

The MST-2 board is interconnected with discrete tri-lead cable transmission lines. This cable consists of three conductors that are positioned in a dielectric material to provide a characteristic impedance of 90 ohms (Figure 1-28). The connector consists of one tuning fork contact for the signal conductor, one tuning fork contact for the two ground conductors, and a housing. Orange insulation is used.

An additional transmission line, twin-lead cable, consists of two parallel conductors that are enclosed in a dielectric material to provide a characteristic impedance of 90 ohms. This cable is terminated by plugging slip-on connectors that have been preassembled to the wire (Figure 1-19). Clear insulation is used.

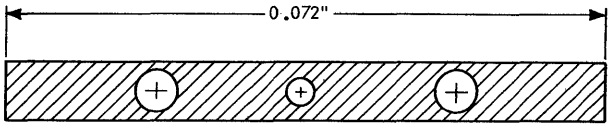


⊗ 40 Ground Conductors.
○ 20 Signal Conductors.
(In MST applications, 2 of the signal conductors are grounded, leaving 18 signals.)
All wires are #33 AWG.

Figure 1-27. 60-conductor Flat Cable

Cable/Board Connection

Single Board: Single-board interconnections are made on the probe side. High-profile single ground rails are assembled on the probe side of the board in subcolumns A and E of the 20 perimeter socket positions. Also, they are placed in subcolumns A and E of the four-position sockets in card columns B and U, in subcolumn A of the four-position socket in card column C, and in subcolumn E of the four-position socket in card column T. Other variations may exist.

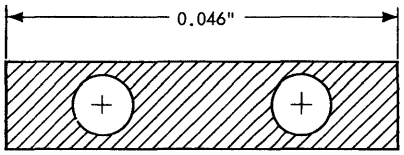


Center wire is #33 AWG.
Outer conductors are #30 AWG.

Figure 1-28. 90-ohm Tri-lead Cable

The discrete 90-ohm tri-lead cables are fastened to the probe side of the board by inserting the terminated ends onto a signal pin and ground rail of the required position. The connector housing prevents inadvertent grounding of the signal contact.

The high ground rail permits the placement of a single first level Wire-Wrap termination on a signal pin under a discrete tri-lead connector. The slot depth in the connector housing limits the travel of the connector onto the ground rail and signal pin. This allows sufficient height from the board surface to the bottom of the cable connector housing for the Wire-Wrap termination. (Figure 1-30). Engineering change cables are 90-ohm tri-lead . Board overflow and EC wires are #30 AWG.



Both conductors are #30 AWG.

Figure 1-29. 90-ohm Twin Lead Cable

Double Board: Board interconnections for the double-board assembly are made on the probe side, using 90-ohm tri-lead cable (Figure 1-31). Low-profile ground rails are installed in card columns A and E of all socket positions—single ground rails in the perimeter positions and double ground rails throughout the remainder of the board.

The discrete tri-lead cables are fastened to the probe side of the board by inserting the terminated ends onto a signal pin and ground rail of the designated I/O cable positions. The low-profile ground rail permits the placement of the connector housing on the board surface. Accidential grounding of a signal contact is prevented by the connector housing.

Overflow and engineering change wires are tri-lead cables that are terminated with slip-on connectors. This slip-on connector is designed so that up to two tri-lead cables can be joined at one signal position with one connector housing.

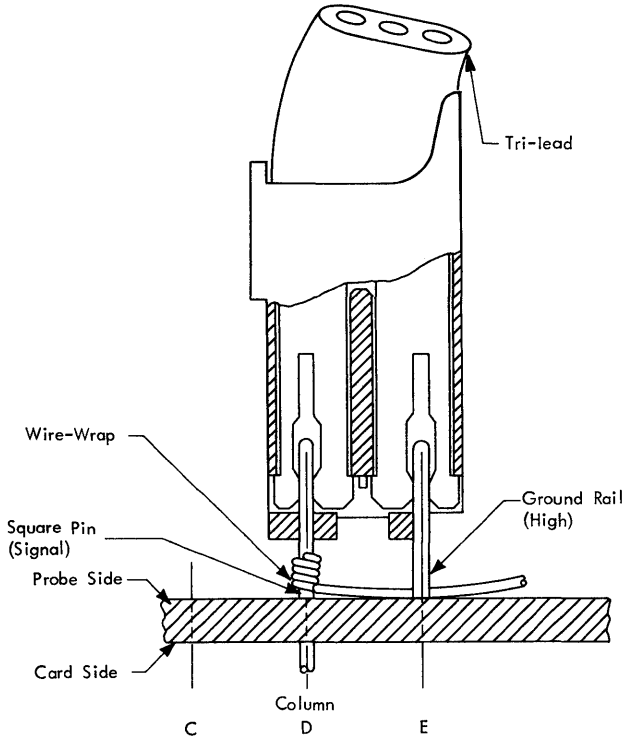


Figure 1-30. MST-2 Cable/Single-board Connection

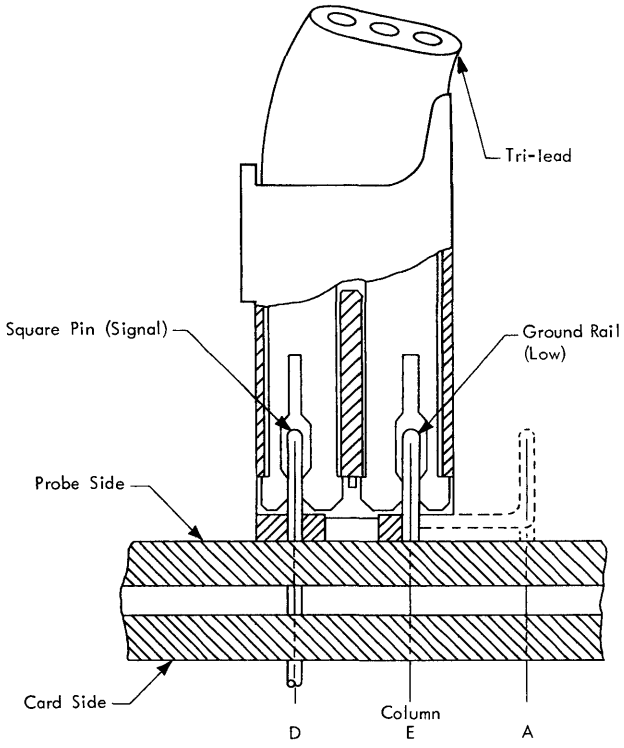


Figure 1-31. MST-2 and MST-4 Cable/Double-board Connection

Cable Routing

All I/O tri-lead cables are routed through the probe side cable raceways on the gate.

MST-4 Cables

The MST-4 coaxial cables consist of a single conductor surrounded by a braided shield wire with a characteristic impedance of 50 ohms. The connector consists of one tuning fork for the center signal connector and one tuning fork for the braided shield wire. Both tuning forks are placed in a housing (Figure 1-32).

Only one coaxial cable may be installed in a housing because of the diameter size of the coaxial cable. A connection to a pin which has a printed wire connection is made by plugging the housing containing the coaxial cable directly onto the pin. If the connection is to a pin which has a discrete wire connection (tri-lead or twisted pair), a conductive or nonconductive mid-air splice (Figure 3-21) is used, depending on whether the pin is only I/O, or logic and I/O. The coaxial cable housing and the discrete wire housing are inserted into the mid-air splice which commons the two housings electrically. An insulated tether (for nonconductive mid-air splice) attaches a dummy housing to the mid-air splice. The dummy housing is placed on the I/O pin which normally would have the coaxial cable. This is done to maintain the pin identification of the two wires in the mid-air splice.

An additional type of cable used for MST-4 is 50-ohm tri-lead. This cable consists of three conductors that are positioned in a dielectric material to provide a characteristic impedance of 50 ohms (Figure 1-33). The connector consists of one tuning fork contact for the signal conductor and one tuning fork contact for each of the two ground conductors and a housing. Purple insulation is used.

Cable/Board Connection

All tri-lead or twisted pair and coaxial cables are fastened to the probe side of the boards by plugging the connectors onto a signal pin and ground rail of the designated I/O socket positions. Low-profile ground rails are installed in card columns A and E of all socket positions–single ground rails throughout the remainder of the board.

The slip-on connector, when used with tri-lead or twisted pair cable is designed to allow the addition of another tri-lead or twisted pair cable that is terminated with tuning fork connectors. Therefore, two tri-lead or twisted pair cables may be joined at one signal pin for engineering changes, if required.

Overflow and engineering change wires are 50-ohm twisted pair or 50-ohm tri-lead (Figure 1-33). that are terminated with tuning fork connectors.

Cable Routing

All I/O tri-lead and coaxial cables are routed through the probe side cable raceways on the gate.

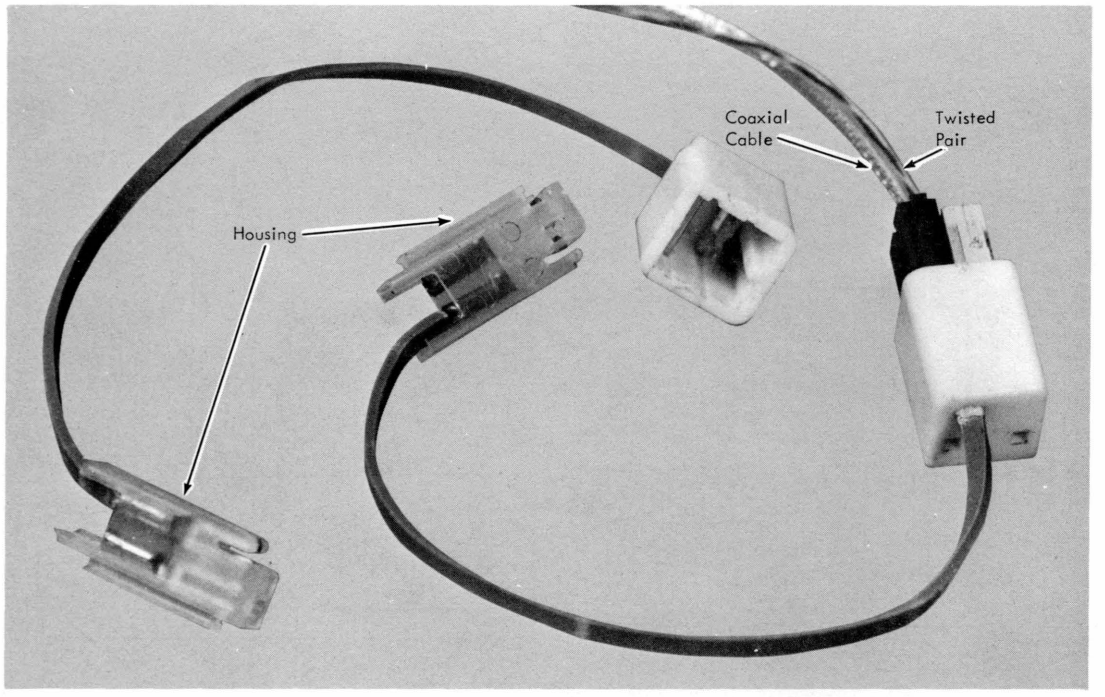
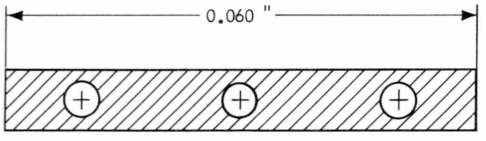


Figure 1-32. Coaxial Cable in Mid-air Splice

Cables and Connectors

Housings

There are many types of housings used in MST. Figure 1-34 shows the main characteristics of many of the MST housings.



Center wire is #30 AWG.
Outer conductors are #30 AWG.

Figure 1-33. 50-ohm Tri-Lead Cable

- *Plug-on Terminating Resistor*

The plug-on terminating resistor is a discrete component plugged on the wiring side of MST-2 and MST-4 boards. It allows termination to a net and is relocated by engineering changes with no need to change a card as would be the case if the terminator were a fixed component within a card.

The current plug-on terminator is the miniature type which is a screened resistor on a ceramic substrate soldered to the tuning fork connectors.

Both 50-ohm and 91-ohm miniature terminators are in blue housings. The resistance value is stamped on the housing for easy identification. There is currently available a 50-ohm miniature terminator (part 815685) for use on 50-ohm impedance systems and a 91-ohm miniature terminator (part 817123) for use on the 90-ohm impedance systems. Only one type terminator (50-ohm or 91-ohm), will be found on a given board. No combination is allowed.

The miniature terminator is assembled into a housing and cannot be removed from the housing. A rule has been established that if a miniature resistor is deleted from a pin or if a wire is deleted from a pin which contains a miniature resistor, the resistor must be discarded. This prevents reuse of a housing which may have damaged contact latching surfaces.

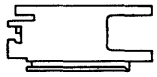
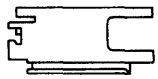
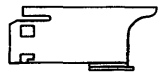
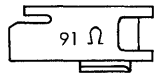
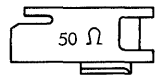
A different type of terminating resistor is the encapsulated terminating resistor. This resistor can be removed from a housing and reused. It can be easily identified by its larger size. It protrudes out of the housing by approximately 3/4"; the miniature terminating resistor does not extend beyond the housing. The 90-ohm impedance systems use a white encapsulated terminating resistor and the 50-ohm impedance systems use a green encapsulated terminating resistor. The part numbers of the encapsulated and the miniature terminating resistors are the same and can be used interchangeably.

The rules for adding a wire to a plug-on terminator are as follows:

1. For encapsulated terminating resistors, add wire to the flat side of the terminating resistor (Figure 1-35).

2. For miniature terminating resistors, add wire to the flat (colored side) of the terminating resistor (Figure 1-35).

These rules are required to prevent tuning fork connector "pop-out" and to allow for scope probe entry clearance between the terminating resistor and the tuning fork connectors.

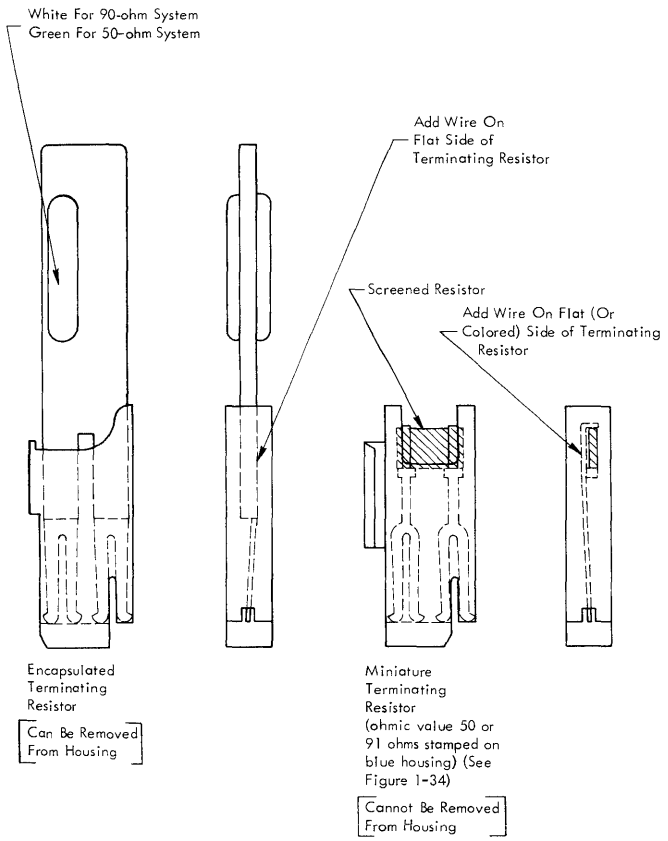
Type	Part Number	Housing Color	Usage
	816862	Clear	For single wire only; either unencapsulated coax, unencapsulated twisted pair, or encapsulated tri-lead.
	815630	Red	For two unencapsulated twisted pair wires.
	815568	Clear (Yellow)	Universal housing; accepts only encapsulated tri-lead; either one or two wires. (Yellow housing is an early development.) Only clear housings will be used for a dummy housing in the board replacement procedures.
	817123	Blue	90-ohm terminating resistor assembly. The value in ohms (91) of the assembly is stamped on the housing. Can accept one wire, either encapsulated tri-lead or an unencapsulated twisted pair wire.
	815685	Blue	50-ohm terminating resistor assembly. The value in ohms (50) of the assembly is stamped on the housing. Can accept one wire, either encapsulated tri-lead or an unencapsulated twisted pair wire.

● Figure 1-34. Housing Identification

● *Six-pack Retainer*

The six-pack retainer provides for simultaneous plugging or unplugging of up to six connector assemblies. This retainer also holds together as many as six connector assemblies, after they have been disconnected from the board.

The current six-pack retainer is molded polypropylene plastic available in two colors, white (part 818686) and black (part 818268). An earlier type of six-pack is made of Nomex*. (The Nomex six-pack is similar to the white plastic six-pack but is stamped and not molded.) The Nomex six-pack has the same part number (part 818686) as the white molded plastic retainer. All the retainers, are interchangeable. An area of the six-pack retainer, above the slots, is reserved for identification purposes.



● Figure 1-35. Terminating Resistors

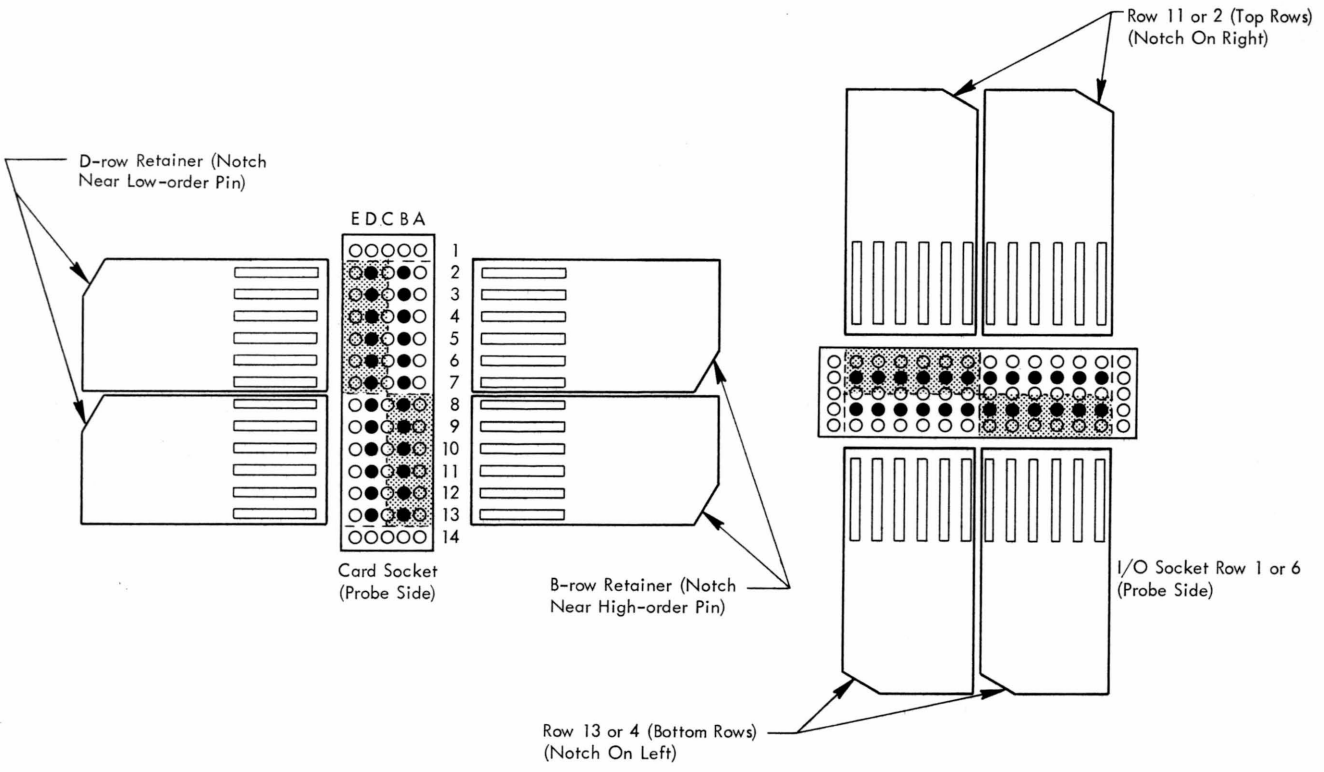
When plugging a six-pack retainer in the D row of a card socket position, the low-order pin number will be near the notch on the retainer; when plugging the B row, the high-order pin number will be near the notch. See Figure 1-36 for row 1 and row 6.

The six-pack retainer has four fixed plugging positions in each card socket position. These four positions are referred to as quadrants. Each quadrant contains six pins (Figure 1-36).

CAUTION

Plugging a six-pack retainer outside of its quadrant boundary is incorrect and will cause machine malfunctions.

*Trademark of E.I. duPont deNemours & Co. (Inc.)



● Figure 1-36. Six-pack Retainer Nomenclature

Examples

Other types of cables and connectors that are used in MST are shown in Figures 1-37 through 1-44.

POWER DISTRIBUTION

- Power is distributed by a laminar bus.
- The laminar bus may receive power from the gate or from the regulator mounted on the board.
- MST-4 uses the laminar bus and it is an integral part of the board.
- MST-4 has voltage regulators mounted on each board.

The theory information for the MST power supplies is in Field Engineering Theory of Operation, *Power Supplies–SLT, SLD, ASLT, MST,* SY22-2799.

MST-1 Power Distribution

Laminar Bus Assembly

The laminar bus supplies power from the edge of the gate to the edge of the boards. All bus assemblies have the equivalent of 12 layers, each layer is 0.020-inch thick and 0.75-inch wide.

A wire bus assembly instead of a laminar bus assembly may be used for small machines.

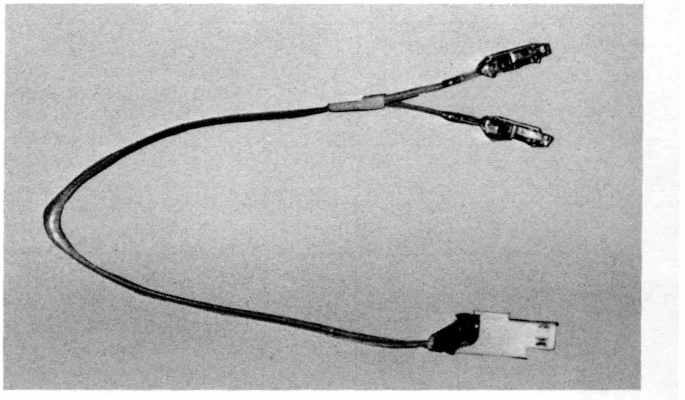


Figure 1-37. Slip-on to Serpentine Cable

Cards

All MST-1 cards have two internal planes to distribute the standard voltages: one for ground and the other is divided to distribute -4V and -1.2V.

Power to the internal planes (-4V and ground) is distributed by the voltage tabs through vias in card columns A and B. The ground tab is connected to board socket pin D08 and the -4V tab is connected to pin B06. The reference voltage (-1.2V) is supplied by a special module. Generally, it is generated on each card and is not distributed from card to card. In some special cases, reference voltage can be distributed from card to card.

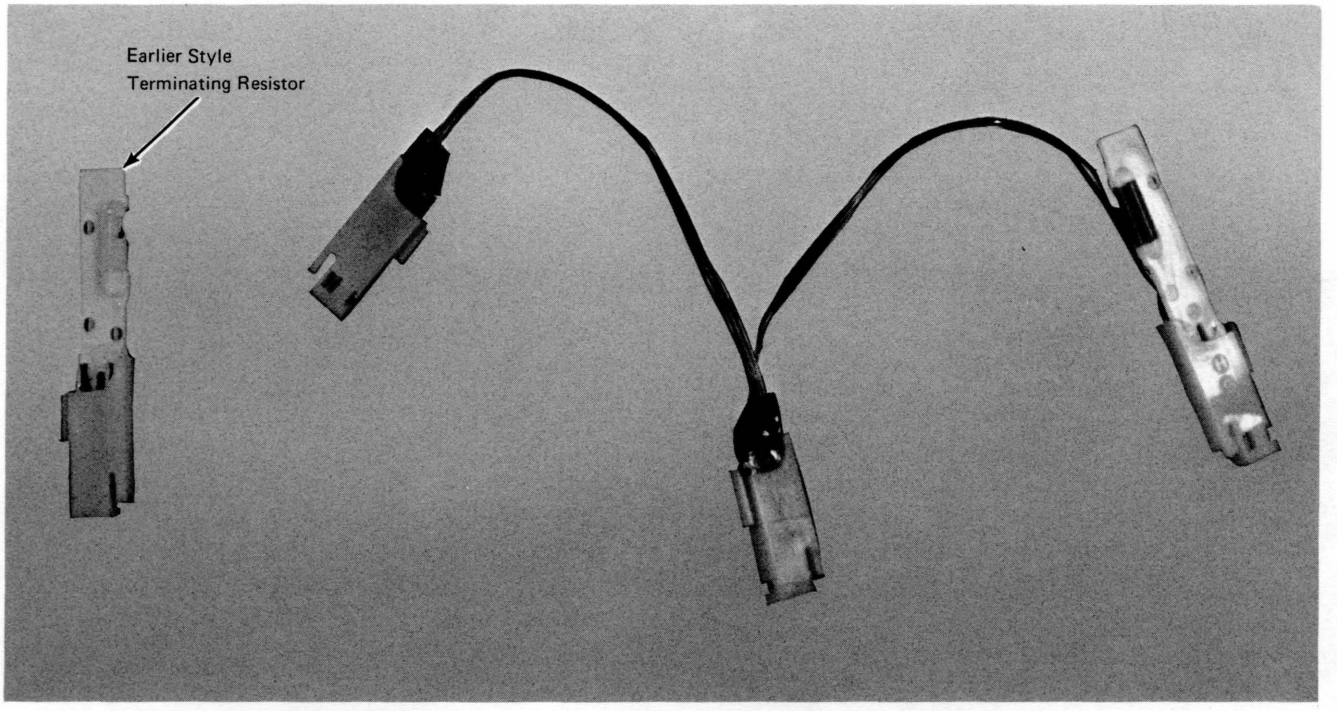


Figure 1-38. Terminating Resistor and Cable Assembly

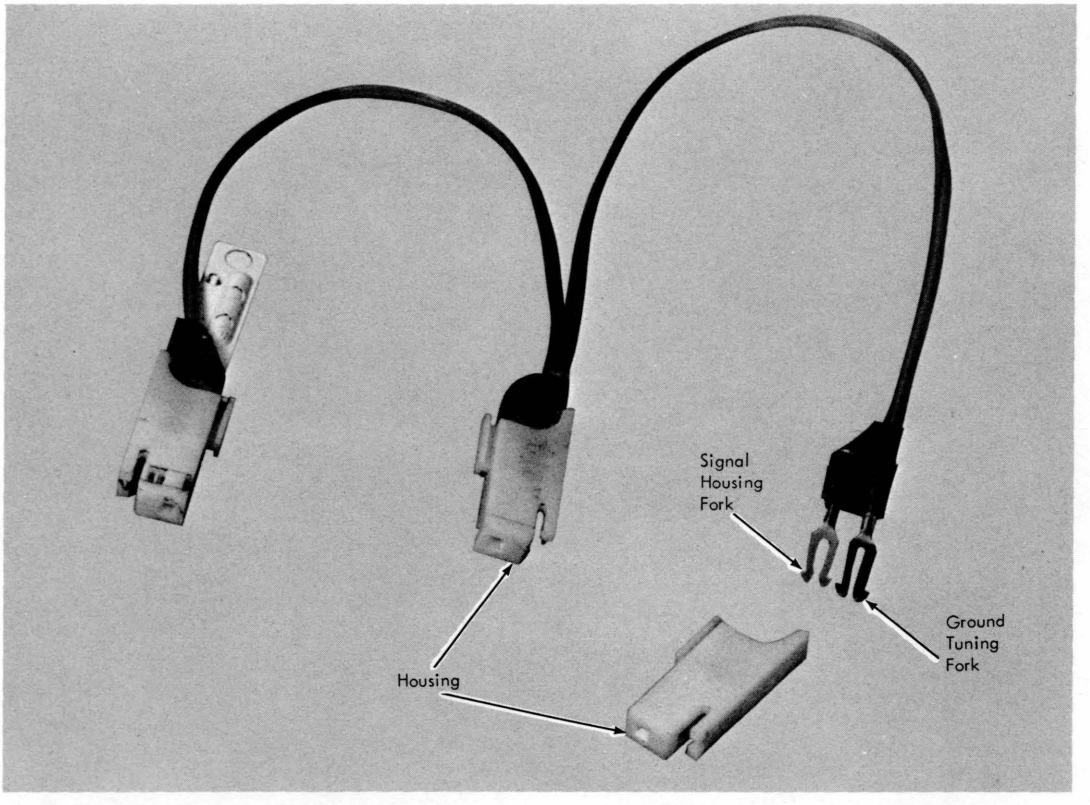
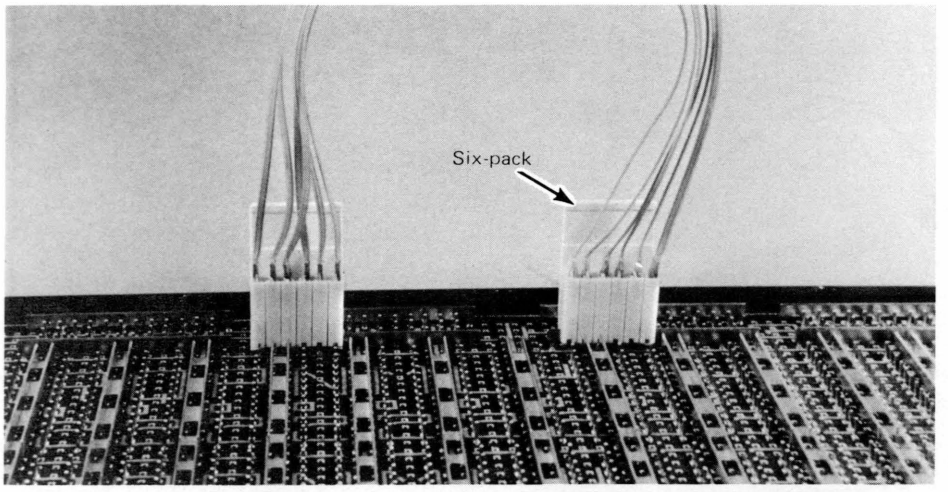
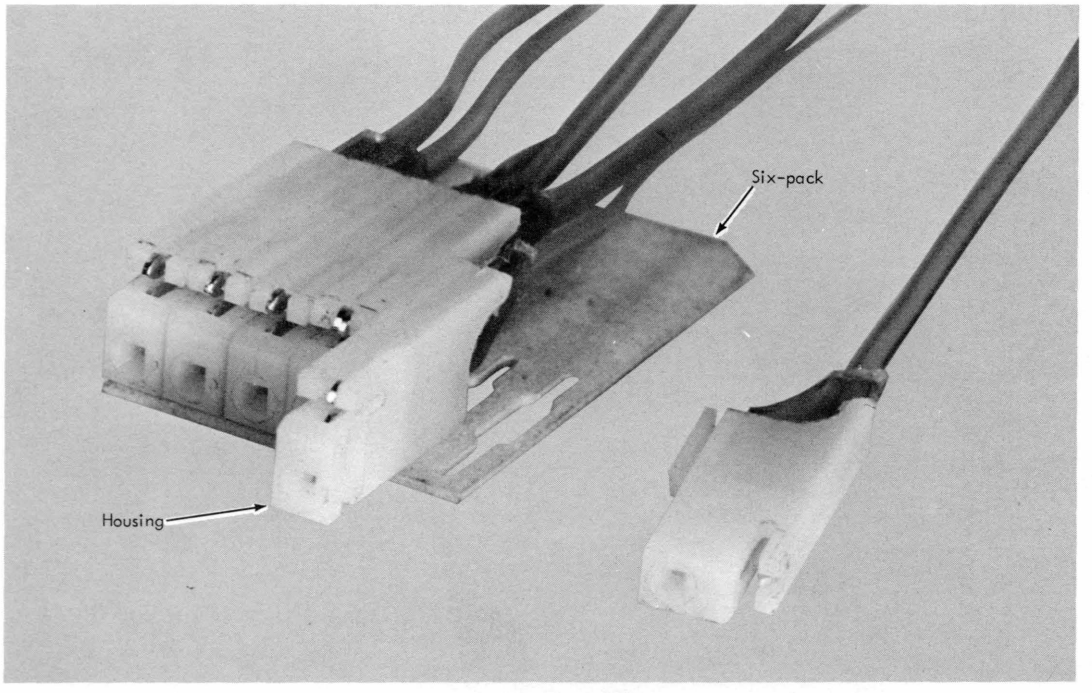


Figure 1-39. Cable Assembly with One Housing Removed to Show Tuning Forks



a. Six-pack Cable in place on board



b. Assembly of Six-pack Cable

Figure 1-40. Six-pack Cable

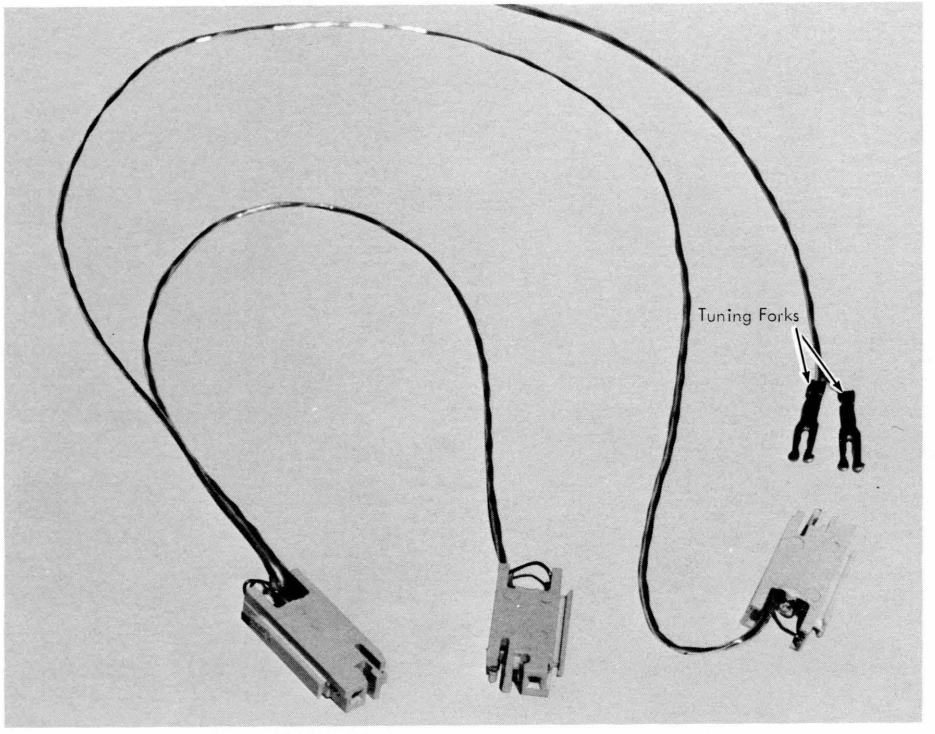


Figure 1-41. Twisted Pair Cable Assembly

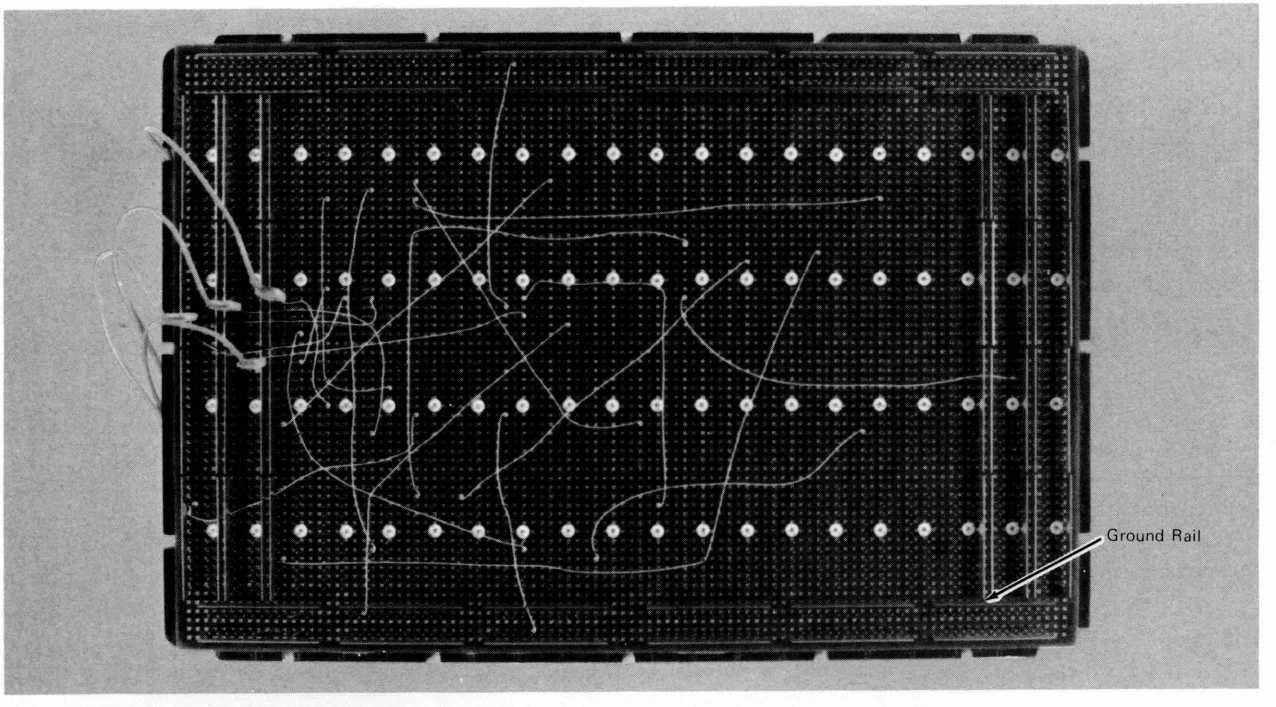


Figure 1-42. Single-board Connections

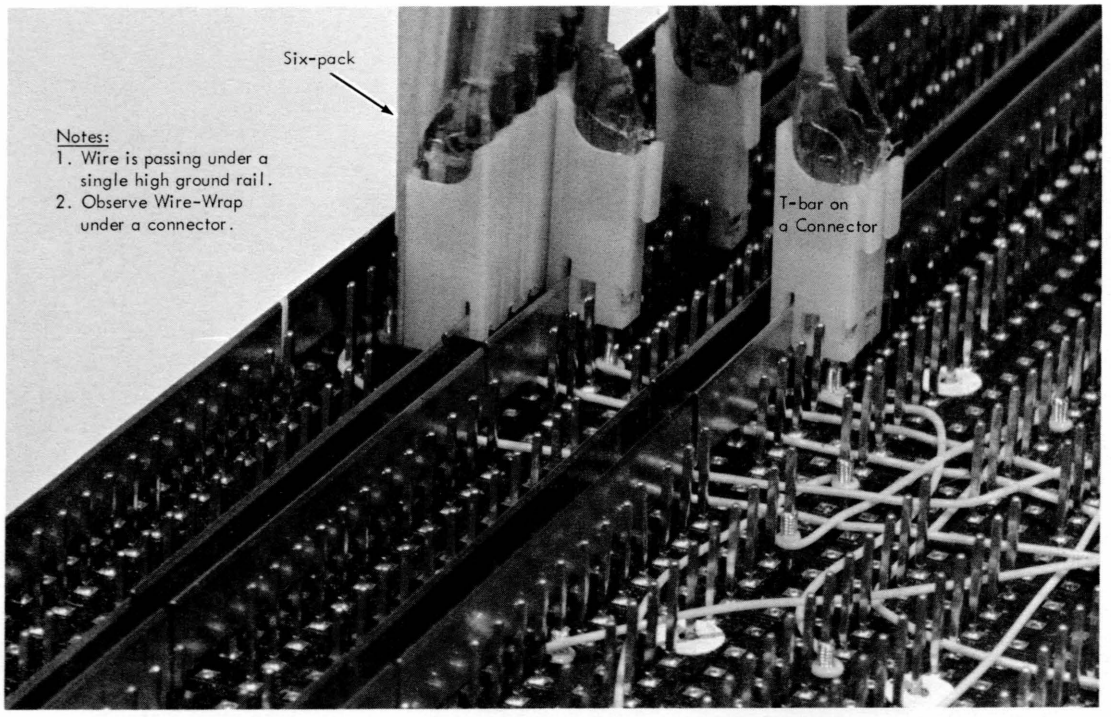


Figure 1-43. Single-board Ground Rail and Cable Connections

Boards

The MST-1 board is a single board with two internal voltage planes: one for ground and the other for -4V.

Power to the board can be supplied from all four sides. Depending on the application, the board can receive power along its long edge with a maximum of five crossovers for each side, or along its short edge with a maximum of three crossovers for each side.

MST-2 Power Distribution

Laminar Bus Assembly

The laminar buses for MST-1 and MST-2 are similar except for the copper thickness of the conductors. Power is supplied to each long edge of the board by discrete wire voltage crossovers, a total of 20.

The two types of bus assemblies are:

1. A 3-wide, 10-layer assembly. Layers 1, 7, 8, 9, and 10 of this bus are not assigned voltages. Layers 2 and 5 are for +1.2V, 3 and 6 are for ground, and 4 is for -3V. If more layers are required for the preceding standard voltages, the layers not assigned are used.
2. A 2-wide, 6-layer assembly. Layers 3 and 6 are for ground, layer 4 is for +1.2V, and layer 5 is for -3V. If more than one layer is required for +1.2V, layers 2 and 5 are used for +1.2V and layer 4 is used for -3V.

A connector equalizes the power for the +1.2V bus layers at each crossover position.

Cards

The MST-2 cards have two internal voltage planes: one to distribute +1.2V and the other is divided to distribute -3V and ground. Power to the internal planes is distributed by the voltage tabs through specified vias in card columns A and B. The +1.2V tabs are connected to board socket pins D03 and B11, the ground tab is connected to pin D08, and the -3V tab is connected to pin B06.

Boards

The MST-2 boards have two configurations: a single board with three internal planes to distribute the standard voltages and a double board with six internal planes. Power for both boards is supplied along the long edges with 10 crossovers for each.

MST-4 Power Distribution

Laminar Bus Assembly

A U-type, 1-wide laminar bus is used and it is an integral part of the board (Figure 1-45). The bus has three conductors to distribute the standard voltages. Each conductor is 0.024-inch thick and 1-inch wide. Power from the bus is supplied to the board along each of its long edges by voltage tabs. These tabs are soldered to the pins.

Cards

All cards have three internal planes: one plane for each standard voltage. Power to the internal planes is supplied by voltage tabs through specified vias in card columns A and B.

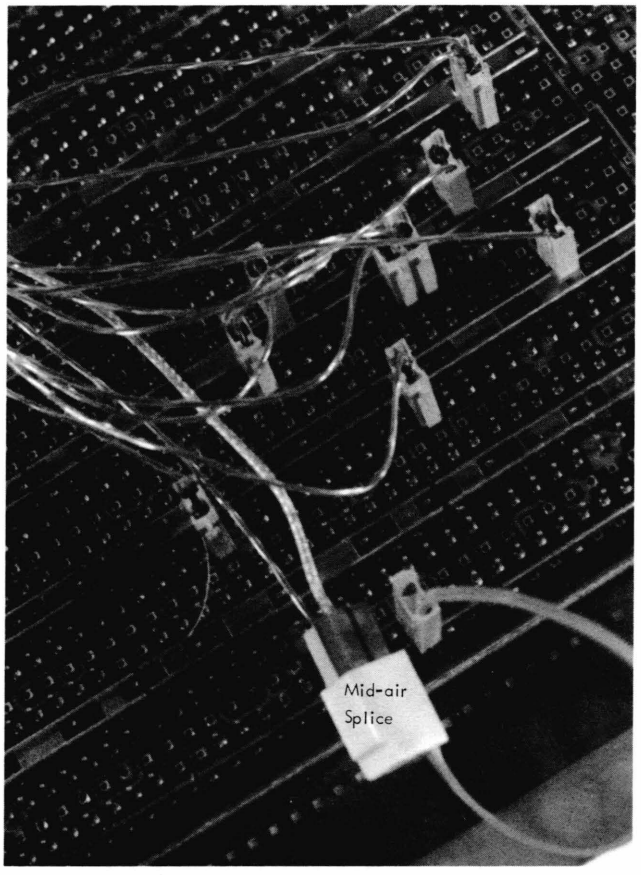


Figure 1-44. Double-board Ground Rail and Cable Connections

The voltage tabs are connected to the board socket pins as follows:

	Card	
Voltage	*2-Wide*	*4-Wide*
+1.2	D04, D09, J05, and J10	P04, P09, U05, and U10
-3	B05 and G06	M05 and S06
Ground	D14, B10, G01, and G11	P14, M10, S01, and S11

Boards

The MST-4 board is a double board with eight internal voltage planes: two planes for +1.2V, two for -3V, and four for ground. Power to the board is supplied along both of its long edges. The voltage crossovers are part of the laminar bus assemblies.

The laminar power bus is U-shaped and is permanently bonded to the board stiffener and laminar bus mounting frame assembly. Twenty-four tabs extend from the bus and are soldered directly to the pins along each long axis of the board. Four tabs from the bus mate with inserts in the stiffener. These four tabs provide unregulated power input to the power regulator and voltage distribution from the regulator to the bus. The two tabs in the lower section mate with the two #6 AWG wires that provide unregulated power to each board.

The MST-4 board, including the card retention system that is filled with cards, is assembled, as a unit, on the gate from the card side. Each board is fastened to the gate by four screws and two clamps.

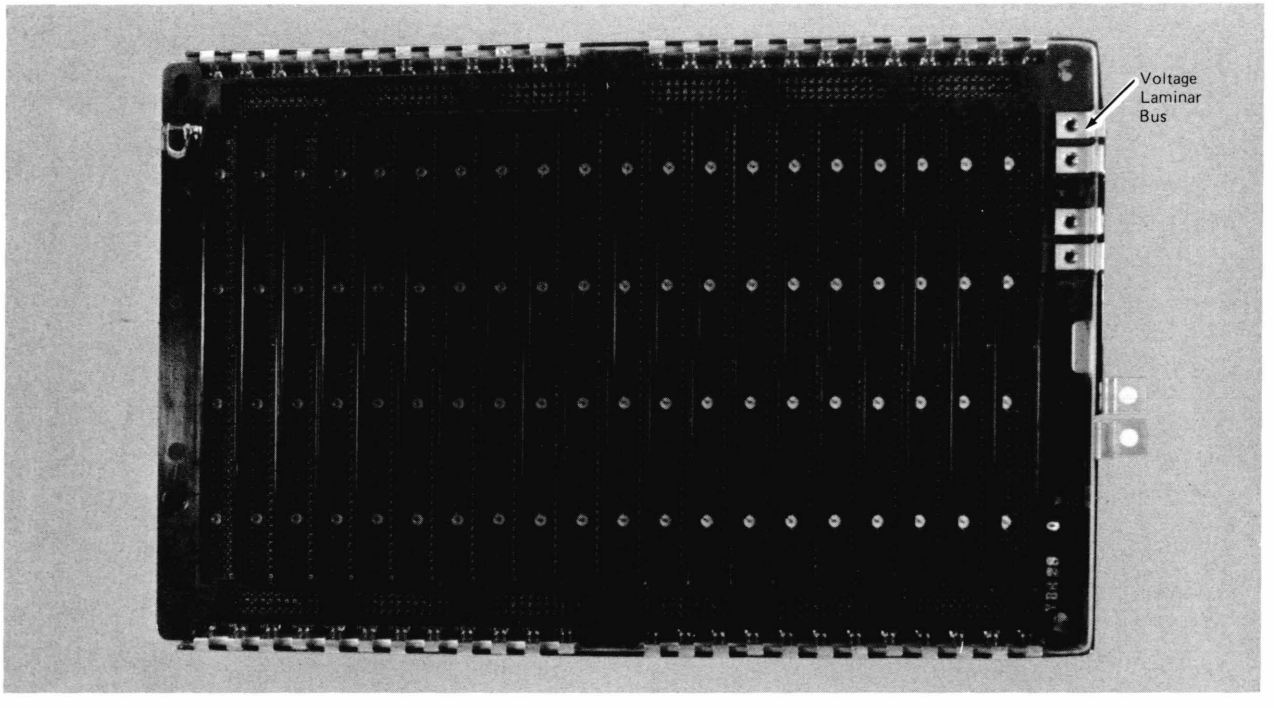


Figure 1-45. MST-4 Laminar Bus Connections

• GATES

- Boards are mounted on gates.
- Gates are a part of a frame.
- Cable channels surround each board on the probe side.
- Heat exchangers may be positioned between each row of boards.
- Blowers may be mounted on top and bottom of each frame.
- Board numbering is left to right, top to bottom, as viewed from card side.

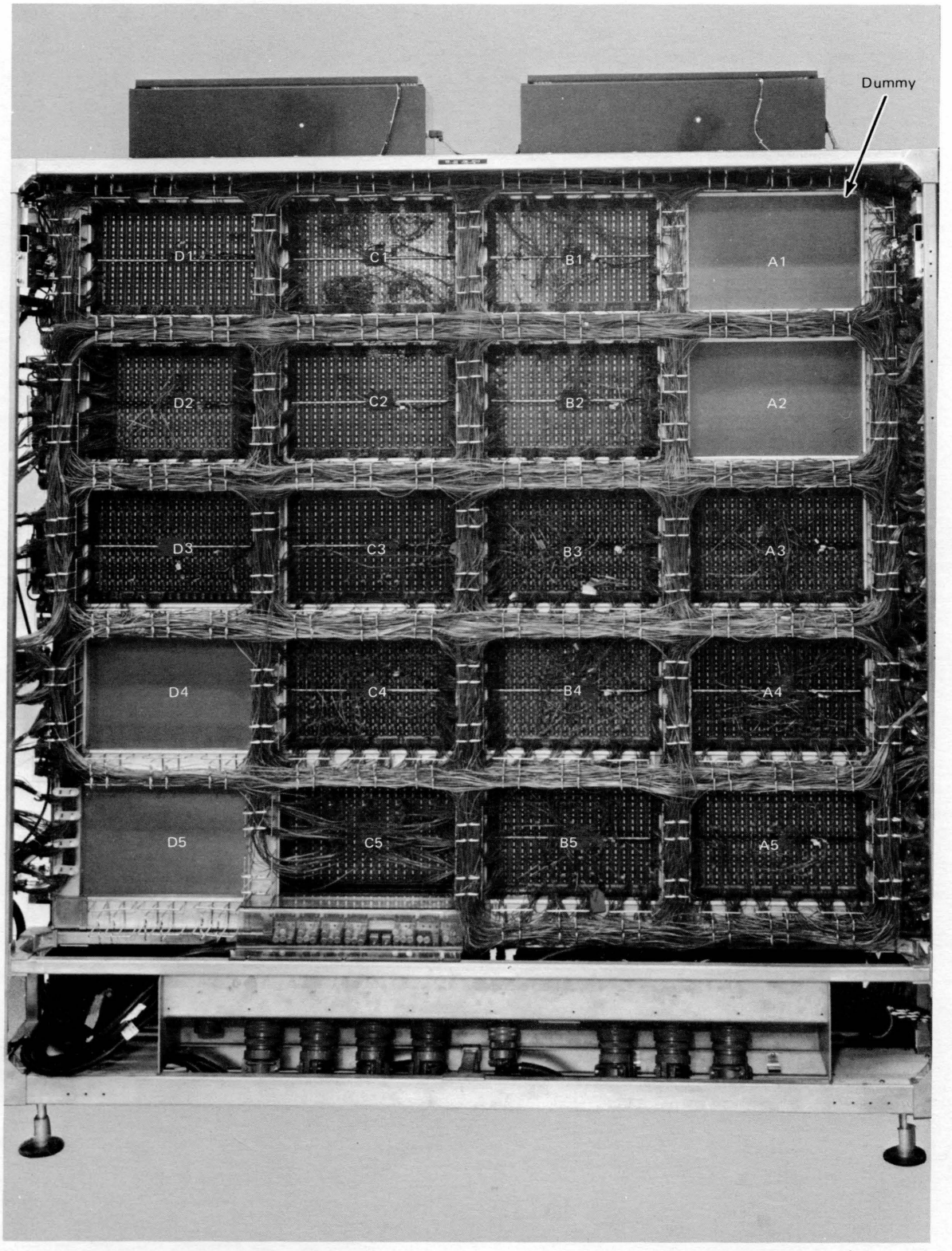
The board retention assembly, mounted on a gate which is part of a frame, has a rectangular opening for each board. Cable channels that house interconnecting wiring are mounted on the probe side of a gate, above, below, and on each side of every board (Figure 1-46).

Four blower assemblies, each containing two blowers, can be mounted on a frame. Two assemblies can be below the gate and force air upwards and through the rows of boards. Two assemblies can be above the gate and pull air upwards and out of the frame (Figure 1-46).

Heat exchangers can be positioned between each row of boards so that the air that has been heated when passing through the cards can be recooled before entering the next row of boards.

Board locations within a gate are identified alphabetically by column and numerically by row. The numbering sequence is left-to-right, and top-to-bottom when looking at the card side of a gate (Figures 1-46 and 1-47).

• Figure 1-46. An Example of a Frame (Card Side)



● Figure 1-47. An Example of a Frame [Pin (Probe) Side]

Many tools are used in MST; some are identical or similar to those used with SLT or SLD.

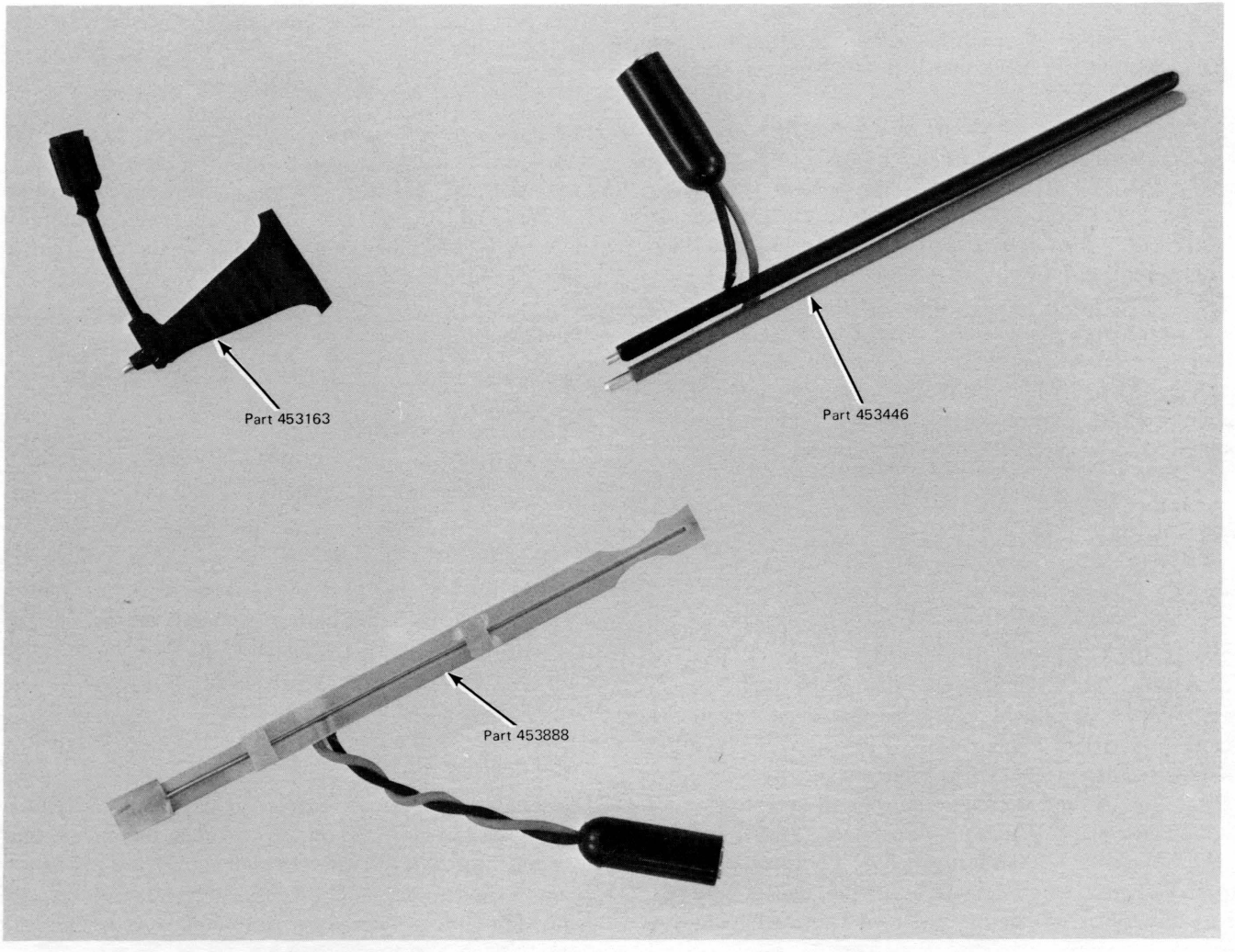
OSCILLOSCOPE PROBE TIPS

- Probe tip for MST-1 (part 453163).
- Probe tip for all MST-2 boards and MST-4 double boards with encapsulated wire (part 453888).
- Probe tip for MST-4 double board with unencapsulated wire (part 453446).

MST-1 Board

A probe tip (Figure 2-1) part 453163, is available for use with an oscilloscope and probe assembly for probing the pins on MST-1 single boards.

To attach the probe, grasp it at the portion of the body nearest the tip and press the tip straight onto the pin. Remove it by grasping the probe body in the same fashion and pulling so that the tip is withdrawn parallel to the pin.



● Figure 2-1. MST Oscilloscope Probe Tips

CAUTION
When probing a pin that has solderless terminations, be careful not to disturb the terminations by pressing too hard on the tip.

MST-2 and MST-4 Double Boards (Encapsulated Wire)

This probe, part 453888 (Figure 2-1), is used for probing all boards that have pluggable discrete wires with encapsulated terminals.

To probe pins and rails, push the button on the back of the probe toward the body of the probe as far as possible. This will move the guide block forward so that it encloses the contact blades on the front of the probe. Hold the button on this position while placing the probe on the desired pin and ground rail.

To probe a pin which has an encapsulated wire housing on it, push the button on the back of probe toward the body of the probe as far as possible. Orient the probe to the housing so that the ground blade is aligned with the end of the housing where the tri-lead cable exits. Hold the button on the probe in the forward position while seating the guide block on the tri-lead housing. If there are two tri-lead cables in the housing, the guide block must be placed *between* them.

Insert the blades far enough into the housing to make good electrical contact by applying forward pressure only to the body of the probe. The blades will be held in position by friction. When probing a housing containing only one cable, the blades must be inserted into the housing until they contact the pin and ground rail.

To remove probe from a housing, grip the recessed areas of the probe body between the index and second fingers. While holding the probe button in its present position by applying pressure with your thumb, retract the body of the probe from the housing. This method will prevent the housing from being pulled from the pin while removing the probe.

MST-4 Double Board (Unencapsulated Wire)

Note: MST-4 usage only.

Connect the scope probe (Figure 2-1), part 453446, to the scope lead. Place the ground side of the probe (black insulation) on a ground rail. Place the signal side of the scope probe (red insulation) on the signal side of the housing so that the slot in the probe tip goes into the T-bar of the housing and the bullet-nose of the probe tip goes into the housing.

To probe an area that does not have a housing, place the ground side of the probe (black insulation) on a ground rail. Place the signal side of the probe (red insulation) on the desired signal pin.

• CONTINUITY CHECKER

- Used alone as a hand-held tool or used with power delete handle.

Continuity checker, part 453587 (Figure 2-2), consists of a plastic housng with a clear plastic lens, and contains an indicator bulb. A #6-32 threaded rod extends from one end and a flexible lead with a #6-32 threaded stud extends from the other end.

An adapter can be used to adapt various probe tips to the continuity checker. The extension rod can be used when the probe lead will not reach a pin or connector.

Note: The adapter, part 453954, and the bracket, part 453588, are not included with the continuity checker.

Operations

Hand-held Operation

Assemble the necessary probe tip to the continuity checker. Connect the probe tip on the flexible lead to a convenient checkpoint and probe with the threaded rod (with probe tip) protruding from the other end on the continuity check.

Operation with Power Delete Handle

Insert the continuity checker into its adapter plate on the power delete handle assembly with the clear plastic lens facing forward. Assemble the appropriate probe tip to the flexible lead. Check the operation of the continuity indicator by touching the probe tip to delete ferrule cutter shaft. The indicator must light.

Maintenance

Maintenance consists of replacing the following parts when necessary:

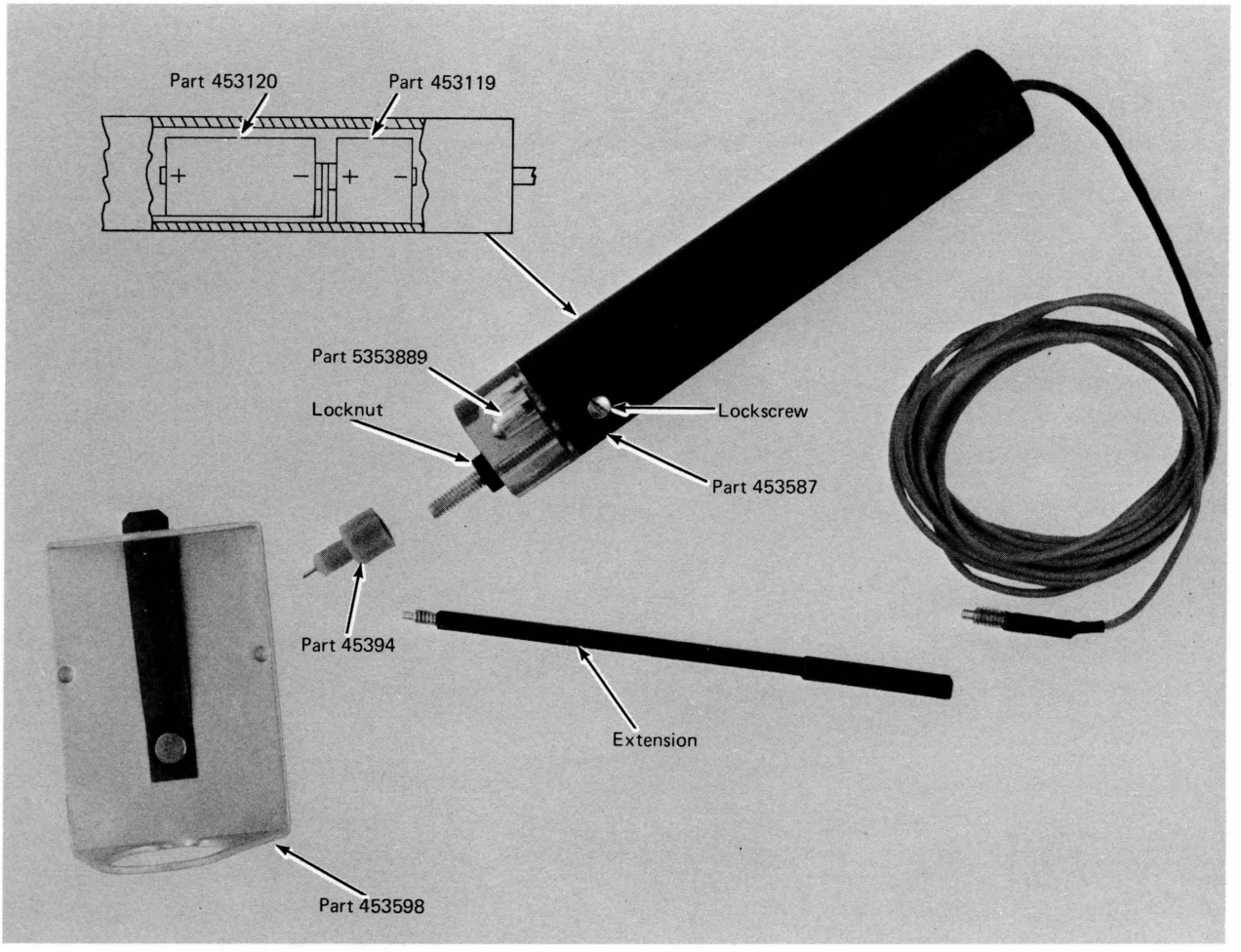
1.35V battery – part 453119
2.8V battery – part 453120
Indicator lamp – part 5353889

Battery Replacement

Remove the lock screw near the front of the continuity checker. Hold the barrel portion, and pull the clear plastic end until the two parts are separated. Replace the defective batteries (observe correct polarity) as shown in Figure 2-2. Reassemble checker in reverse order.

Lamp Replacement

Disassemble tool as in battery replacement procedure. Loosen locking nut (Figure 2-2), remove the circuit card assembly from the plastic lens and unplug the bad lamp. Remove the lens cap from the new lamp and insert the new lamp into the circuit card assembly. Reassemble the continuity checker in reverse order.



● Figure 2-2. Continuity Checker

EXTENDERS AND OFFSETS

Probing Card Extender

- Probing extender for MST-1 (parts 2360067 and 2360068).
- Probing extender for MST-2 (parts 2360069 and 2360070).
- Probing extender for MST-4 (part 453454).
- Extender offsets (parts 452530 and 5853341).

The extender consists of a plug and receptacle assembly that has a one-for-one electrical connection from the receptacle to the plug. Each circuit in the extender is completed, from the receptacle to the plug, through a wire clip. Therefore, any circuit or circuits may be interrupted during probing or other circuit analysis.

Before using the extender (Figure 2-3), ensure that all the clips are in place to provide a one-for-one circuit completion from the receptacle to the plug.

Remove the card holder containing the card that is to be used on the extender. Remove the card(s) from the card holder. (See "Card Holder Removal and Installation" in the first chapter of this manual.) Insert the card extender into the board socket(s) of the card to be used on the extender. Insert the card to be probed into the receptable of the extender. Insert the remaining cards, if any, directly onto the board in their respective socket(s).

After using the extender, replace the cards in the card holder and plug the card holder with cards into the board. Use a 2-wide extender to probe a 2-socket card; use the 2-wide and two 1-wide extenders to probe a 4-wide card.

The offset is used with the extender to probe the card, except when conflict exists with the machine frame.

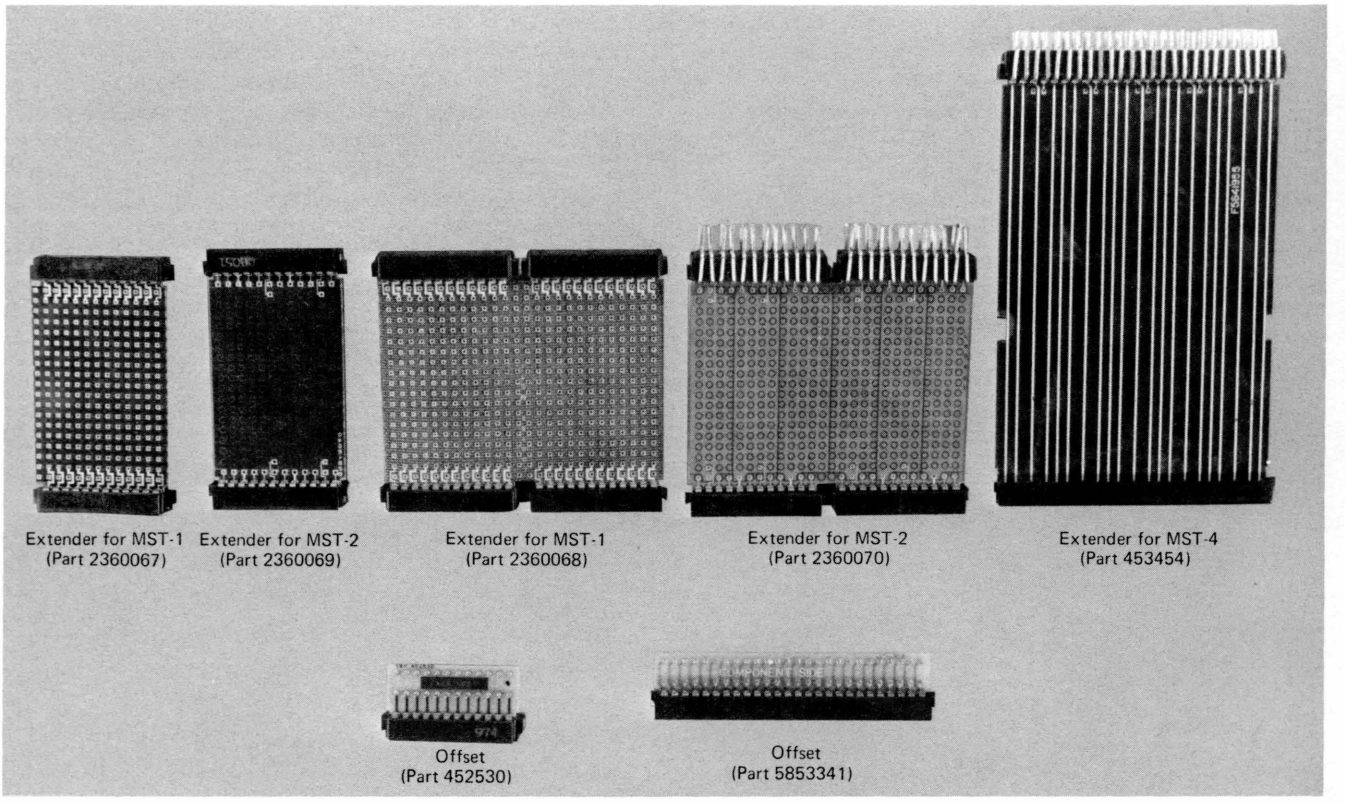


Figure 2-3. Extenders and Offsets

The card offset consists of a plug and receptacle assembly that provides a 90-degree change in orientation of the card. As in the extender, the offset circuits are completed from the receptacle to the plug on a one-for-one basis. A circuit interruption feature is not provided in the offset assemblies. To use the offset, plug it into the receptacle end of the extender and plug the card into the receptacle end of the offset (Figure 2-3).

Card Extender for MST-4

The extender used with MST-4 boards and cards is 5.2 inches long and covers two socket positions. The extender (part 453454) has housings (receptacles) at both ends of the card that have a one-for-one electrical connection (Figure 2-3).

Each circuit in the extender is completed from one housing to the other by a spring contact at one end of the extender; therefore, any circuit or circuits may be interrupted during probing or other circuit analysis.

Note: Make certain that all contact springs are in place to ensure a circuit completion between the card extender and the card being probed.

To probe a card:

1. Open and remove the door.
2. Determine which card is to be probed and remove it from the card holder assembly.
3. Plug the card extender and offset into the board column just vacated.
4. Plug the card into the offset making certain the card is oriented in the same manner as it was in the board.

Note: A contact may be removed from the extender housing to isolate a signal contact.

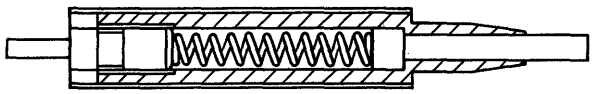
The offset (Figure 2-3, part 5853341) is used with the extender to probe the card, except when conflict exists with the machine frame.

The card offset consists of a plug and receptacle assembly that provides a 90-degree change in orientation of the card. As in the extender, the offset circuits are completed from the receptacle to the plug on a one-for-one basis. A circuit interruption feature is not provided in the offset assemblies. To use the offset, plug it into the receptacle end of the extender and plug the card into the receptacle end of the offset.

• Card Probing Masks and Tips

Card probing masks and tips are available to assist in locating points on a card and to provide retention for one or more probe tips simultaneously.

Any of the various size cards used in MST can be scoped using a probe tip adapter, part 2360333, (Figure 2-4) and one of the card probing masks listed in Figure 2-5.



Part 2360333

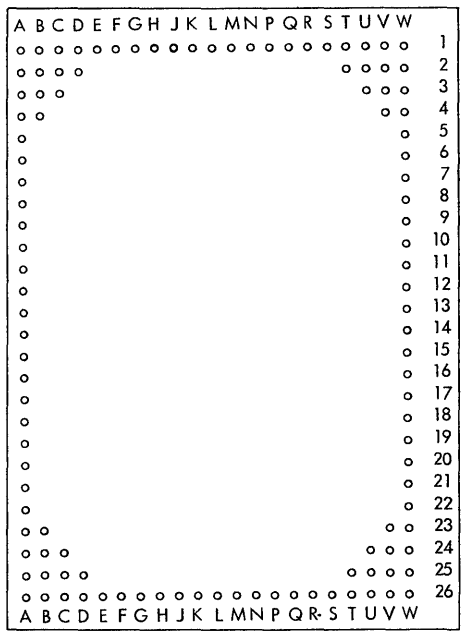
● Figure 2-4. Probe Tip Adapter

Prior to placing the card to be scoped on the extender:

1. Remove card from holder. (See "Card Holder Removal and Installation.")
2. Determine a ground pin of a module mounted on a card. (See following heading "Procedure for Determining a Ground Pin of a Module Mounted on a Card.")
3. Slide the appropriate mask over the card. Ensure that the outboard end of the card is fully seated in the retention groove on 3 sides.

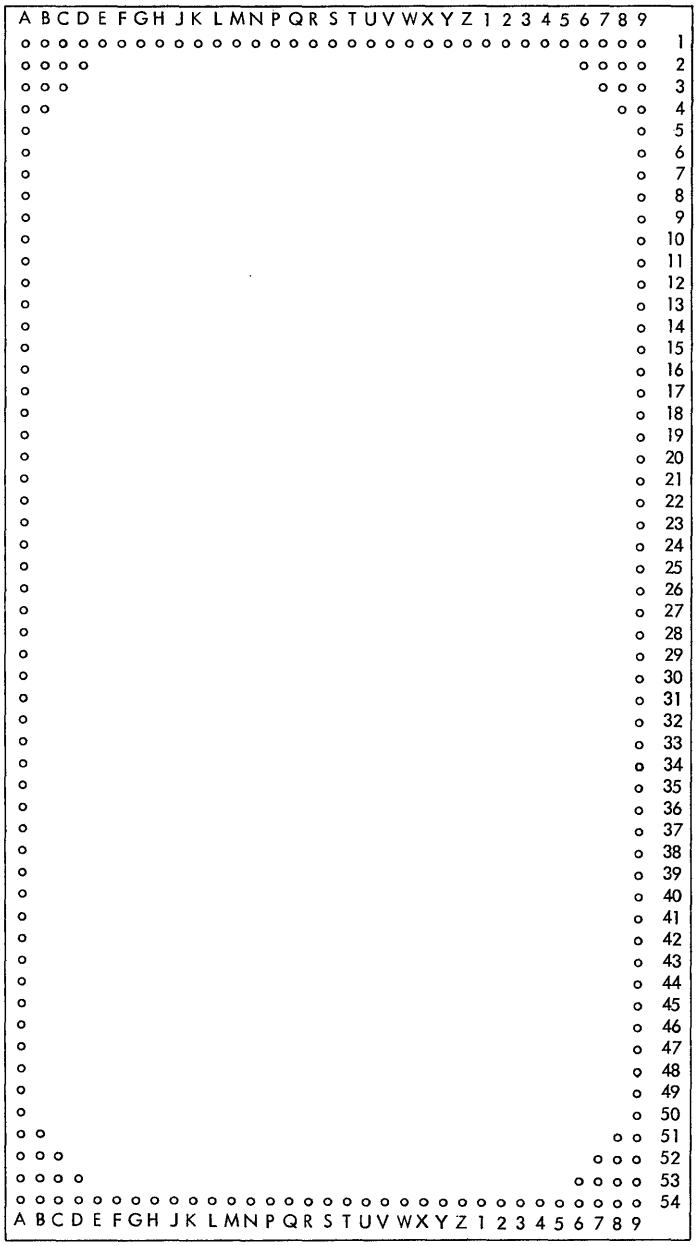
Part Number	Card Size
2360328	1-wide, 2-high
2360329	2-wide, 2-high
2360330	4-wide, 2-high
2360331	2-wide, 3-high
2360332	4-wide, 3-high

Top



Part 2360329
2-wide, 2-high Extender

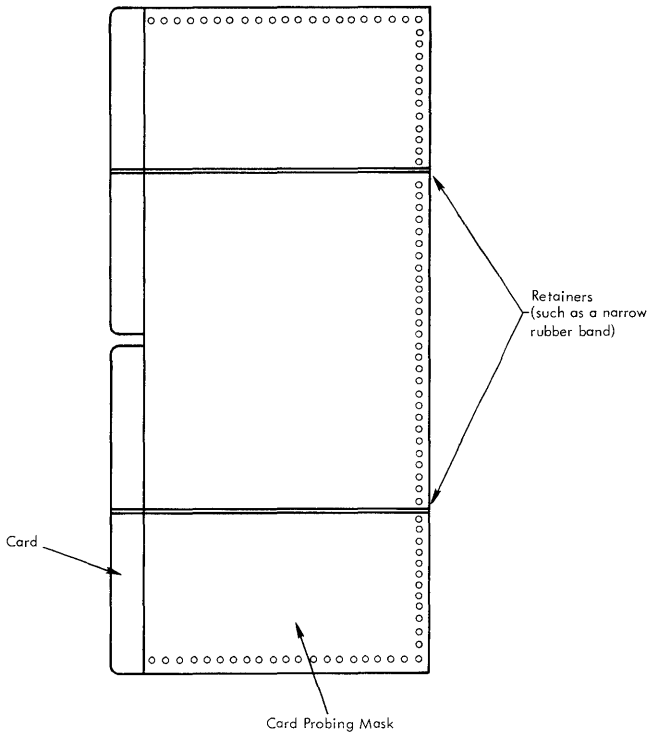
Top



Part 2360332
4-wide, 3-high Extender

● Figure 2-5. Card Probing Masks

4. Place one or more retainers, such as narrow rubber bands that may be obtained from the local Branch Office, around card and mask as shown in Figure 2-6. This prevents the overlay from shifting and forces a warped card to conform to the mask.
5. Plug card and mask onto extender guiding the rubber bands so that they pass between extender pins.
6. Physically locate the ground pin determined in step 2. Insert a probe tip adapter into the tapered hole at the point just located. Use a twisting motion so that the adapter is firmly held into the probing mask. This probe tip adapter can now be used as the ground when scoping.
7. Locate the point to be scoped on the card. Insert a probe tip adapter into the tapered hole at the point just located. Use a twisting motion so that the adapter is firmly held into the probing mask. The exposed portion of the probe tip adapter can now be scoped using probe tip, part 453163.
8. Use a twisting motion to remove a probe tip adapter from a card scoping mask.



*Note: Fit retainer between pins of card

● Figure 2-6. Use of Card Probing Mask

Procedure for Determining a Ground Pin of a Module Mounted on a Card

1. Determine the type of modules on the card, MST-1, MST-2, or MST-4.
2. Locate a module that is close to the edge of the card.
3. Locate the A01 pin location from the component side of the card (see Figure 1-3).
4. Determine the ground pin of the module:
   B03 for MST-1
   C02 for MST-2
   C02 for MST-4
5. Determine the card mask grid coordinate for the ground pin of the module by orienting the A01 pin to the ground pin and using the card coordinate layout as shown in Figure 1-3.

Note: An alternate method is to physically locate the ground pin of the module on the card, then count the pin positions that the ground pin is from the top and a side edge of the card. When the card is turned over this point may be located on the pin side of the card after the card mask is mounted.

6. After the ground pin is located, insert probe tip adapter into card mask.
7. Place scope lead on probe tip adapter of the located ground pin to determine if ground potential does exist on the pin selected. If correct pin (ground potential) has been verified proceed with scoping, if not, repeat steps 1 through 5.

PRINTED CIRCUIT DELETION

- Electrical isolation of board pins from printed circuits.
- Deep deletion on probe side of double board.
- Shallow deletion on card side of double board.
- Shallow deletion on both sides of single boards.

Normal system maintenance and engineering change installation require the electrical isolation of board pins from printed circuits (printed circuit deletion) by using a power delete tool (Figure 2-7), associated ferrules (Figure 2-8), and the hand delete tool and vacuum pump (Figure 2-9).

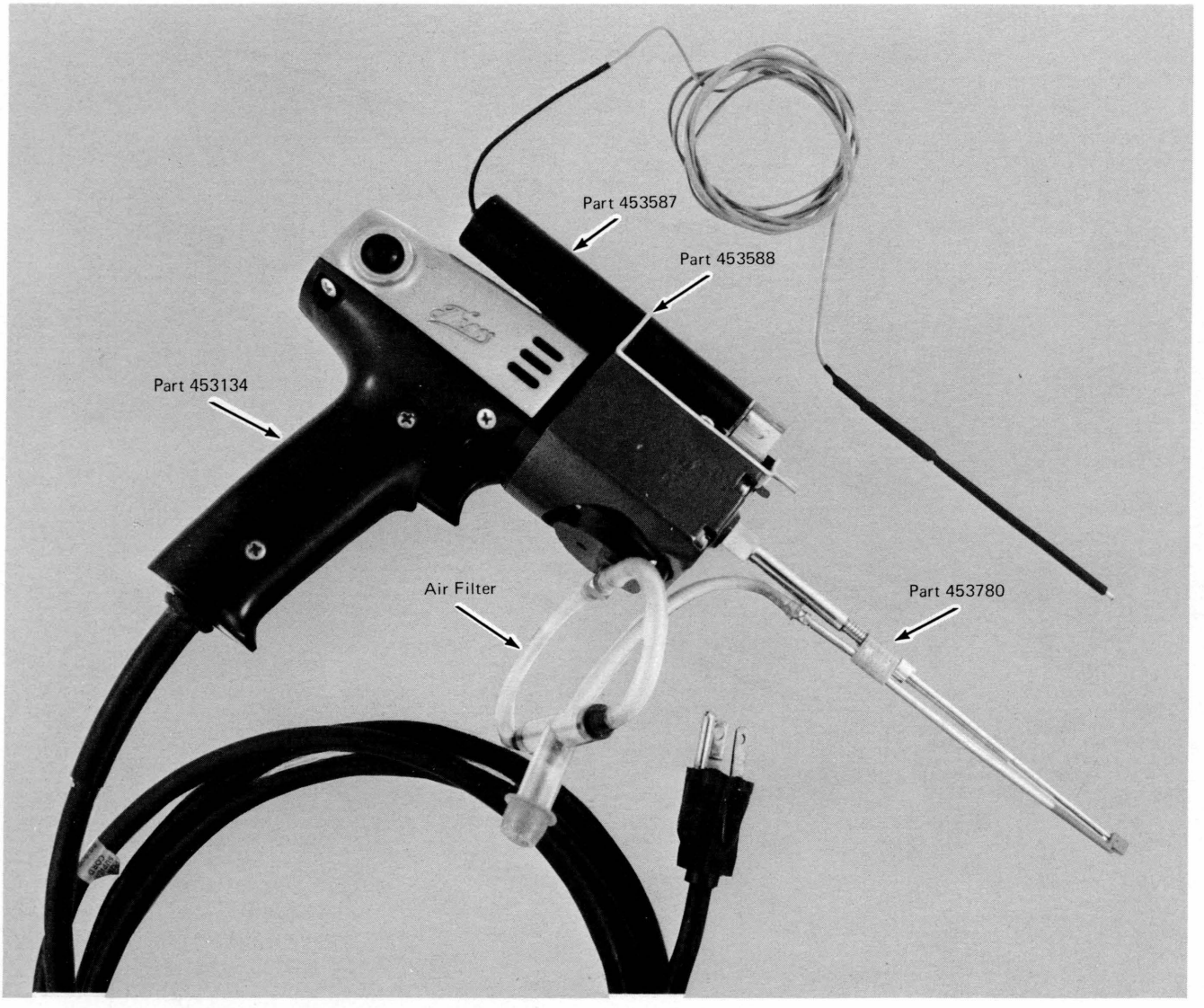
Power Delete Tool

Power Delete Handle Assembly

The power delete handle assembly (part 453134) includes the motor, vacuum pump, filter, and continuity checker adapter plate.

Replaceable parts for the power delete handle assembly (part 453134) and their corresponding part numbers are:

Name	*Part Number*
Screw, Adapter Plate	251970
Pump Assembly, Vacuum	453063
Assembly, Filter	453064
Filter Ring	453066
Filter Sponge	453067
Assembly, Motor	453084
Assembly, Reducing Gear Shaft	453085
Adapter Plate, Continuity Checker	453588
Rectifier	453766
Switch	2176205



● Figure 2-7. Power Delete Tool

Ferrule Assemblies

Two types of deletions are made with the power delete tool: shallow deletions on single boards or the card side of double boards, and deep deletions on the probe side of double boards only.

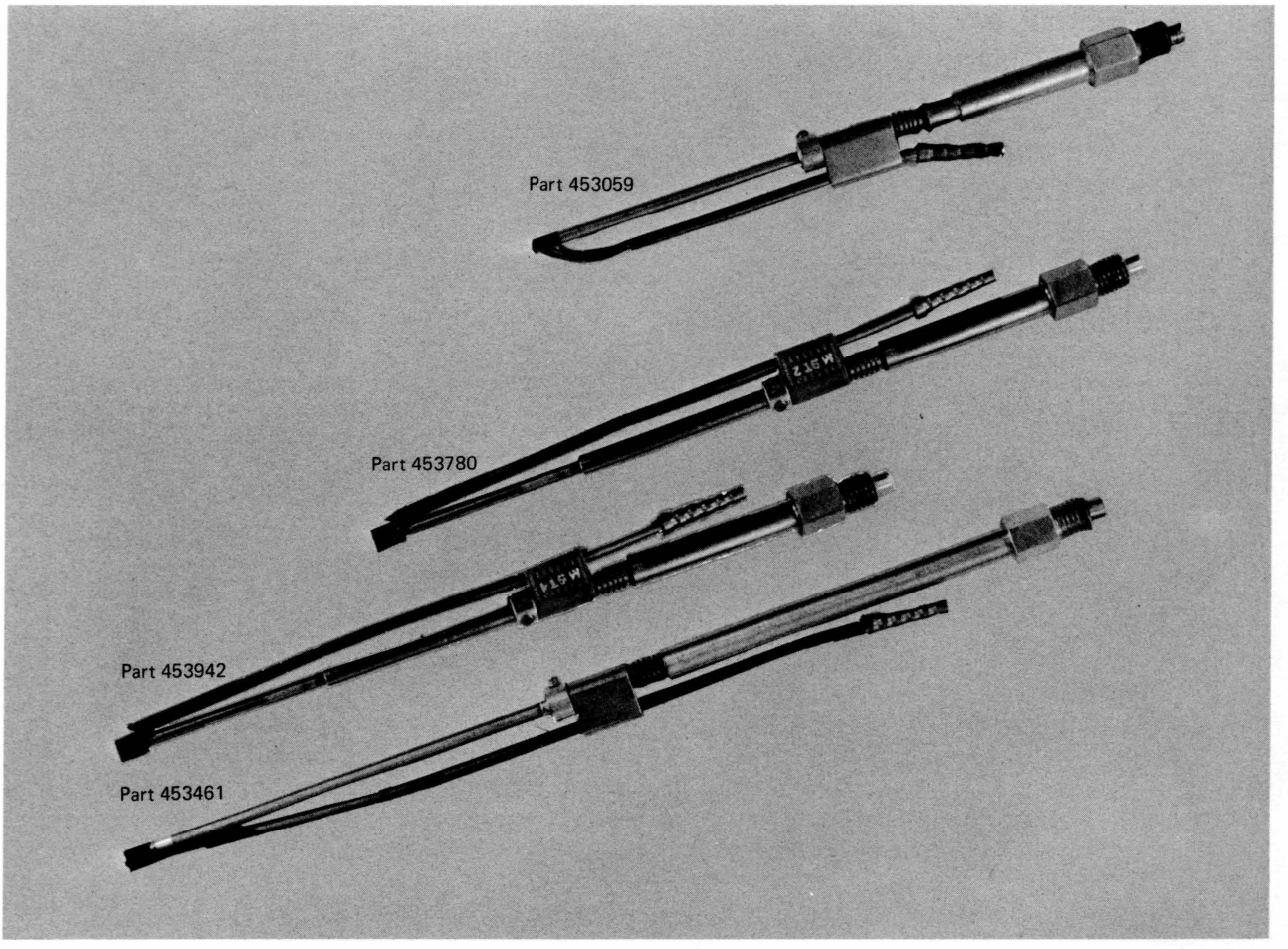
Four ferrules (Figure 2-8) are provided:

1. Part 453059 is the standard SLT ferrule assembly and is only usable on MST-1 boards.
2. Part 453461 is a longer shallow delete ferrule assembly with a more compact control tip. On MST-2 and MST-4 boards, the necessary ferrule length must be provided to reach the board on the card side and to avoid interference with the housings on the probe side of MST-2 single boards.
3. Part 453780 is the deep delete assembly for use only on the probe side of MST-2 double-board assemblies.
4. Part 453942 is the deep delete ferrule assembly for use only on the probe side of MST-4 double-board assemblies.

Figure 2-10 shows cutaway drawings of the various MST board assemblies with deletions. The dimensions relevant to deletion depth are also shown.

Replaceable parts for the ferrule assemblies and their corresponding part numbers are:

Name	*Part Number*
Set Screw	74530
Cutter Tip (Shallow)	452572
Cutter Tip (Deep)	453808
Ring	453944



● Figure 2-8. Ferrules

Using the Power Delete Tool

Printed Circuit Deletion

The following precautions must be observed when using delete tools:

1. The delete tool assemblies, which include the cutter, cutter shaft, control tip, and vacuum line can be easily damaged due to the weight of the pump housing and the drive unit on which they are mounted. Avoid striking any part of the tool against a solid object. The ferrule assembly should always be detached from the drive unit when the assembly is not in use.
2. Do not use the deletion tool if the vacuum-operated chip collection system is inoperative.
3. *A deep deletion is made only from the probe side of a double-board assembly.*

Assembly and Preparation of the Delete Tool:

1. Attach the ferrule assembly to the pump housing by engaging the shaft connector to the tongue on the pump crank shaft, screwing the tool sleeve into the housing, and tightening the sleeve with a 3/8-inch wrench. Attach the continuity checker, part 453587, to the plate on top of power delete tool.
2. Check the operation of the spring and set ring and be sure the control tip slides freely on the cutter. When the spring is released, there should be a gap between the shoulder on the cutter and the back end of the control tip. Pull the guide block back and check to see that the cutter shoulder and control tip make positive contact, resulting in a 0.015-inch protrusion of the cutter from the front of the tip on the shallow delete tool and approximately 0.090-inch protrusion for the deep delete tool. *Note:* A gap between the shoulder on the cutter and the back of the control tip on the *shallow* ferrule assembly must be 0.035 to 0.045 inch. This gap should be set using a feeler gage. *Note:* A gap between the shoulder on the cutter and the back of the control tip in the *deep delete* assembly must be 0.100 to 0.110 inches. This gap should be set using a feeler gage.

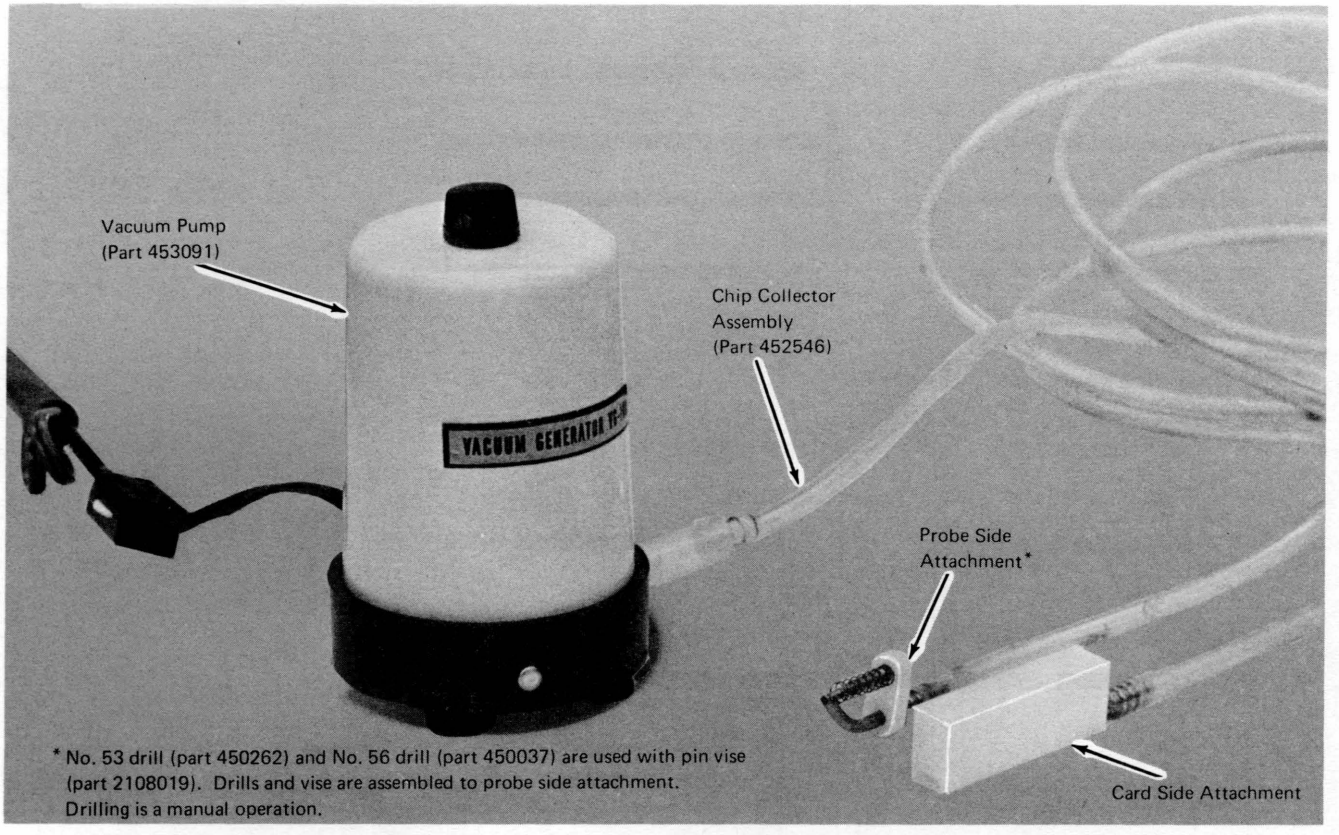


Figure 2-9. Hand Delete Tool and Vacuum Pump

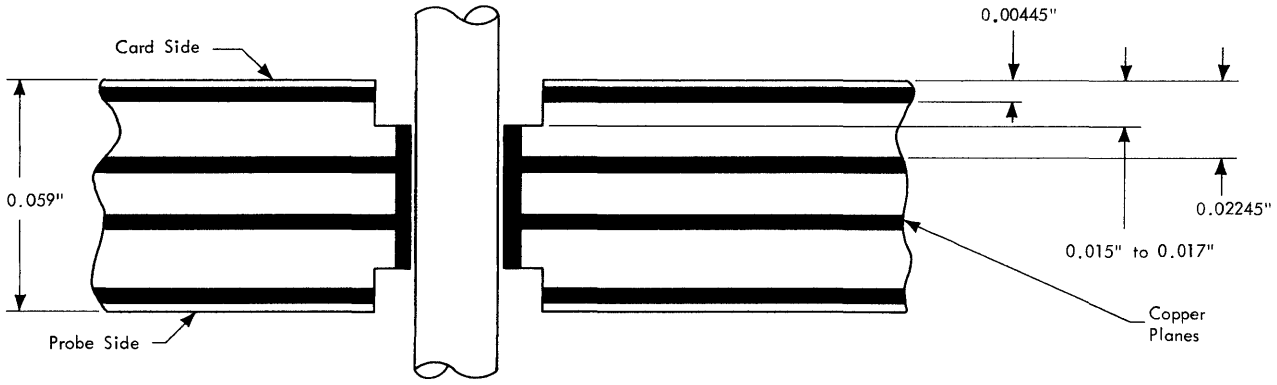
3. Connect the tool to a 115V ac power source. Turn on the tool and check its operation. While the tool is running, touch the end of the flexible line from the top of the filter to the cheek or lip to check the operation of the vacuum pump.
4. If the tool is received without the filter attached, connect the lines from the ends of the horizontal leg of the tee to the brass tee in the pump valve block, keeping the trap (the vertical leg) in the downward position. It is not necessary to remove the filter assembly, except for service or replacement.
5. Attach the remaining filter line to the fitting on the ferrule assembly and recheck the operation of the control tip.
6. Check the operation of the continuity indicator by touching the probe tip to the cutter shaft. If the lamp fails to light, check the bulb and batteries. Battery orientation (polarity) is indicated in Figure 2-2 and by a label on contact strap inside the continuity checker.
7. Visually examine the cutter for extreme wear or damage, and replace it if necessary. Approximately 400 deletions should be considered maximum life for shallow delete cutter and approximately 160 deletions for a deep delete cutter.

Deletion Procedure:

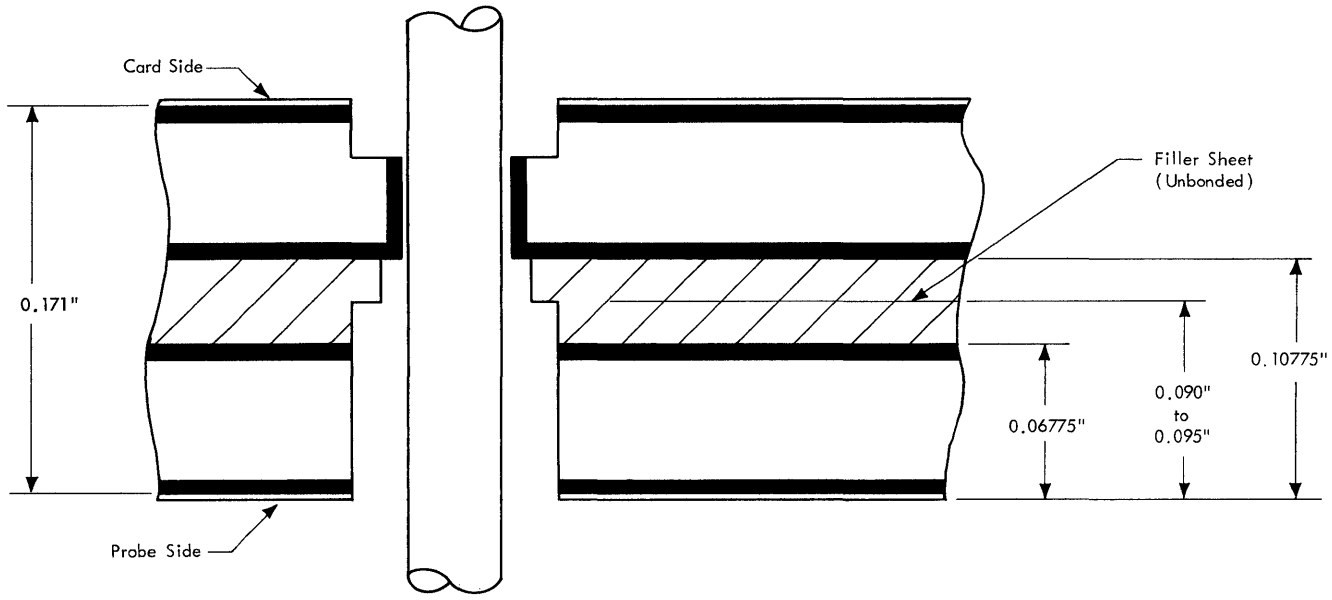
1. Turn off machine power.
2. Test the circuit tracer by touching the probe to the shaft of the deletion tool. The continuity lamp should light.
3. Locate a "check pin" in the particular net concerned. Place the circuit tracer lead on the "check pin." If a slip-on connector is in the location where the circuit tracer probe is to be used, an adapter (part 453954) and appropriate scope probe tip (Figure 2-1) should be inserted into the end of the probe lead to allow probing the slip-on connector.
4. Place the delete tool on the pin where the circuit is to be deleted. The lamp should glow. If the lamp does not glow, recheck the pin and EC deletion list.
5. With the control tip in contact with the board, turn the tool on and allow it to reach its maximum speed of rotation. The deletion is complete when the shoulder on the cutter contacts the control tip.

CAUTION

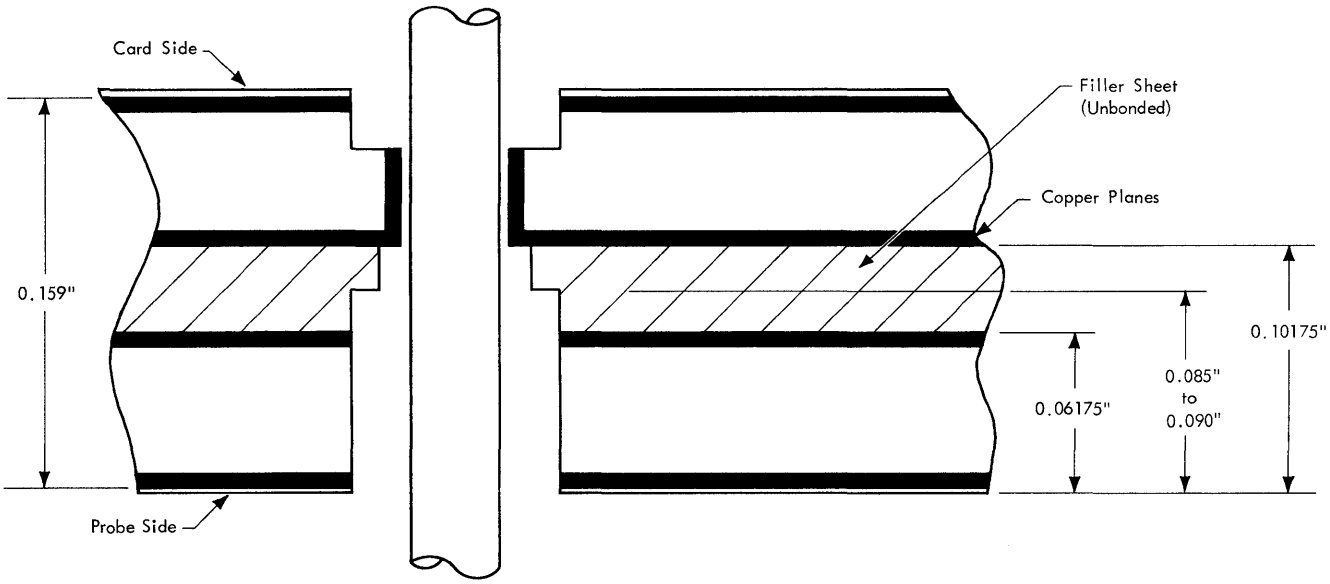
Before applying power, be sure the cutter is centered over the pin and the tool is held perpendicular to the board within 5 degrees; otherwise, the cutter can cause serious pin damage and improper deletion. The



a. Shallow Deletions, Single-board (MST-1 and MST-2)



b. Deep and Shallow Deletions, Double-board (MST-2)



c. Deep and Shallow Deletions, Double-board (MST-4)

Figure 2-10. Deep and Shallow Deletions

vacuum line portion of the ferrule assembly must be held to prevent rotation of the tool when the cutter contacts the control tip. Failure to prevent this rotation may result in bending an adjacent pin.

6. A cutter should be worked in and out of the delete cavity several times to ensure complete removal of chips. When the deletion has been completed, retract the tool slightly and turn off power to allow the tool to stop rotating before removing it from the pin.
7. With the cutter out of the deletion cavity, but still in contact with the pin, the indicator lamp should be off. If the lamp is not off, repeat the deletion operation to be sure the full depth of cut was made. Do not remove the tool from the pin while the tool is rotating.

   CAUTION
   When removing the tool, be sure to pull it straight back. Pulling the tool off at an angle may damage the pin. Disconnect the probe lead and proceed to the next change operation.

Power Delete Tool Maintenance

To replace the cutting tip, disconnect the flexible vacuum line from the steel tube. Remove the ferrule assembly from the power handle. Remove the cutter drive shaft from the ferrule assembly. Remove the cutter from the drive shaft by using needle-nose pliers to grasp the cutter and rotate it counterclockwise. Discard the used cutter; do not attempt to sharpen it. The new cutter does not have to be tightened with a pair of pliers; normal use will position it.

Make a periodic check for lubricant on the cutter drive shaft especially during any extensive engineering change activity. Always check for lubricant before a new change activity. The deep delete cutter drive shaft should be lightly lubricated at each of the support areas of the shaft.

Filter Service

The filter has a trap to catch a major portion of the chips before they reach the foam elements. This trap should be emptied after every 20 to 50 shallow deletions, after every 12 to 24 deep deletions, and before packing the tool for return to storage. To empty the trap, remove the plug at the bottom of the trap and tap the filter until the chips stop dropping. Replace the plug; ensure that plug is in place before starting any delete procedure.

When chips work into the cylindrical foam elements in the horizontal leg of the tee, the elements must be removed and cleaned or replaced. Never wash the filter elements.

SOLDERLESS-WRAPPED TERMINATIONS

Generally, the circuits on or within the boards are produced automatically at the factory. All circuit changes, additions, and repairs to machines in the field are done manually. These circuits are installed on the probe side of the boards, using solderless-wrapped terminations and #30 AWG solid copper wire. The part numbers for the available colors of #30 AWG solid copper wire (bulk) are:

Color	*Part Number*	*Use*
Yellow	811425	Controlled wiring
Blue	811747	ECR
Blue with white tracer	811748	Repair or uncontrolled wiring
Black and yellow twisted pair	5347623	Temporary cable repair

Figure 2-11 shows the tools required to install the solderless-wrapped terminations:

Tool	*Part Number*
Wrapping tool	452527
Wire stripper pliers for #30 AWG wire	452528
Wire gripper	452529
Sleeving (not shown)	452614

These pieces of sleeving help to locate pins when making wire additions.

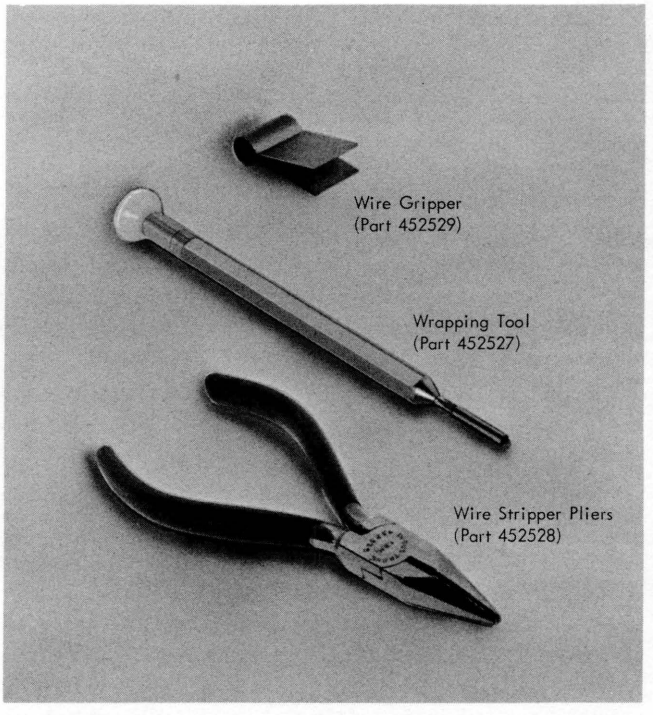


Figure 2-11. Tools for Installing Solderless-wrapped Terminations

Wire Stripping

1. Wire strippers (part 452528) are made especially for #30 AWG wire. Because of the diameter of the wire, the cutting edges of the stripper are precise and delicate. The stripper must be used with care.

   CAUTION
   Do not strip #30 AWG wire with other strippers because the wire may be nicked or scratched, weakening the termination.

2. Wire gripper (part 452529) enables you to hold the wire without damaging the insulation during the stripping operation (Figure 2-12).

Wire Routing

1. For reference, locate the two pins to be connected and place short lengths of sleeving over them.
2. Measure the length of wire required to connect the two pins, using the most convenient route.

   CAUTION
   Do not route the wires under a minibus or a voltage crossover.

3. Using the cutting jaws of the wire stripper, cut a piece of wire 3½ inches longer than the length determined in step 2.
4. Using the wire stripper as shown in Figure 2-12, strip 1 inch of insulation from each end of the wire.

Wire-Wrapping

The hand wire-wrapping tool, part 452527 (Figure 2-13), is designed especially for use with #30 AWG wire. The wrapping bit is spring-loaded within the handle which permits the sleeve to cut the wire to the exact length and to provide a gage for measuring the pressure applied to the tool during the wrapping operation. Ideally, the optimum pressure is applied to the tool when the cutting edge at the bottom of the handle is halfway between its normal position and the cutting edge on the wrapping bit. With a little practice, this can be easily achieved. *Note:* A "first level wire-wrap" is the first wire-wrap on a pin; i.e., wire near the board (Figure 2-19). A "second level wire-wrap" is a wire-wrap that is added to a pin after one has already been made on the pin (Figure 2-20).

First Level Wire-Wrapping

1. Insert one end of the wire into the "V" opening at the end of the wrapping tool so that all the bare wire is inside the tool (Figure 2-13). Pull gently on the end of the bare wire which projects from the other end of the sleeve to be certain the insulation is into the tool as far as possible.
2. Hold the tool with one hand (Figure 2-14). With the thumb and forefinger of the other hand, press the end of the tool containing the wire until it is positioned and the wire is cut. (A slight twisting motion will ease the cutting operation.) The tool cuts the bare wire to the exact length to produce five turns of wire on the pin.
3. Remove the wire cut in step 2 and discard it.

   CAUTION
   Do not cut the wire by pressing the tool against the machine or any other hard surface. This may damage the insulation.

4. Remove the sleeving and place the tool over one of the two pins so that the pin enters the round hole at the end of the wrapping tool (Figure 2-15). The pin should enter the hole freely. If it does not, a gentle rocking of the tool will bring the tool and the pin into alignment. If trouble persists, inspect the tool and pin for any obstruction.
5. Holding the wire close to the board with the wire gripper (part 452529) and without applying pressure, rotate the wrapping tool one turn clockwise. Then apply pressure to the tool until the cutting edge on the handle is halfway between its normal position and the cutting edge on the sleeve.

   CAUTION
   Do not bottom the tool because excessive pressure may damage a termination.

6. Rotate the tool clockwise (viewed from the spinner end), being careful to maintain the pressure described in step 5.
7. Make a minimum of nine clockwise revolutions of the wrapping tool.
8. Remove the wrapping tool from the pin and inspect the termination carefully for defects. Defective terminations, described under "Inspection," are shown in Figure 2-21. If a defective termination is found, the entire wire must be replaced. See "Wire Removal."
9. Route the wire as planned to the other pin. Make the second wrapped termination by repeating steps 1-8.

   CAUTION
   Do not pull the wire too tightly around the pins because continued pressure on the insulation may cause cold flow and an electrical short may occur.

The wrapping tool is designed to provide a minimum of one-half turn to a maximum of one and one-half turns of insulation around the pin. When routing the wire from one pin to the other, always lay the wire in a manner which will add more insulation around both pins.

Second Level Wire-Wrapping

When a pin already has one termination, the second termination may be added as follows:

1. Repeat steps 1-4 under "First Level Wire-Wrapping."

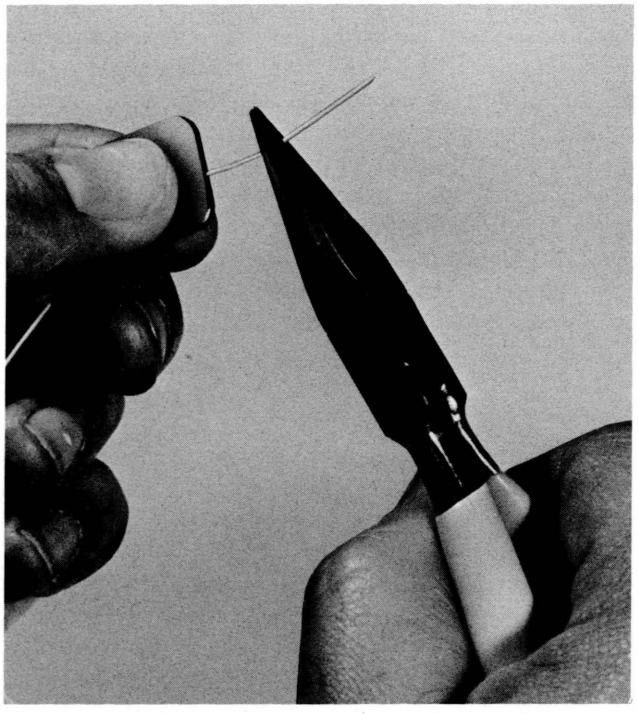


Figure 2-12. Stripping Insulations from #30 AWG Wire

Figure 2-14. Cutting the Excess Bare Wire

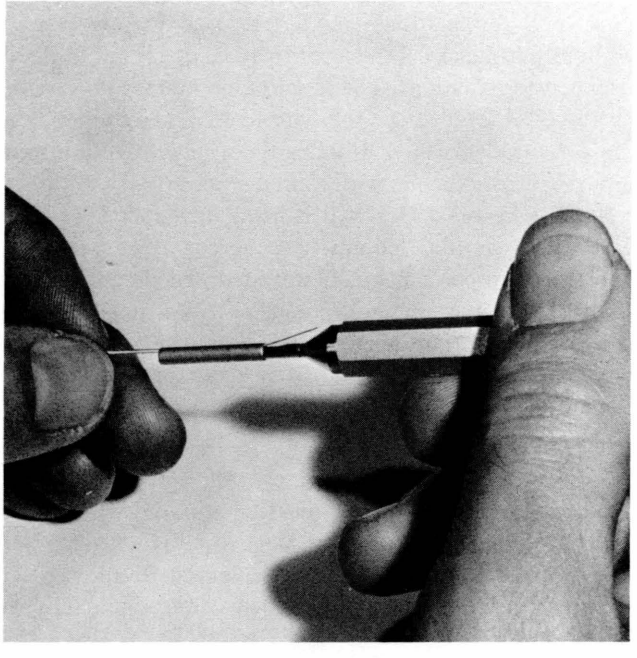


Figure 2-13. Preparing to Cut the Excess Bare Wire

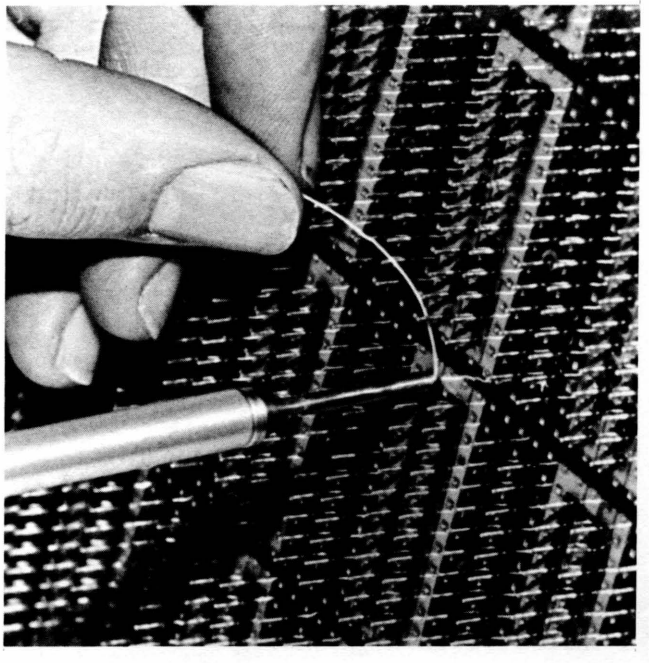


Figure 2-15. Placing the Wrapping Tool on the Pin

2. Before applying pressure to the wrapping tool, rotate the tool one to one and one-half turns, allowing the insulation to wrap around the lower termination.
3. Grip the wire with the wire gripper or your fingers to prevent any more insulation from wrapping around the pin.
4. Apply pressure to the tool until the cutting edge on the handle is halfway between its normal position and the cutting edge on the sleeve.
5. Repeat steps 6-9 under "First Level Wire-Wrapping."

Power-operated Wire-Wrapping Tool

The power-operated wire-wrapping tools used with SMS and SLT can also be used for MST by installing a new bit and sleeve assembly that permits wrapping #30 AWG wire onto SLT and MST pins. Bit, part 9263122, and sleeve, part 9328353, (Figure 2-16) are used with the power-driven tool, part 453512.

When wire-wrapping around the periphery of MST-1 single boards, wire-wrap bit extension, part 2360355, (Figure 2-17), may be needed to gain access to the pins. To use the wire-wrap bit extension, part 2360355, assemble the tool as follows:

1. Remove the bit and sleeve, parts 9263122 and 9328353, from the chuck.
2. Loosen and remove the chuck from the power wire-wrap tool, part 453512.
3. Screw the wire-wrap bit extension, part 2360355, into the power tool.
4. Place the chuck on the end of the wire-wrap bit extension.
5. Assemble the bit and sleeve to the chuck on the end of the wire-wrap bit extension. Ensure that the wire slot in the wire-wrap bit, part 9263122, is properly aligned to the window in the sleeve, part 9328353.
6. Ensure that the tool assembly is completely free of binds before attempting to apply a wire-wrap.

Refer to Figure 2-18 and proceed as follows:

1. Insert one end of the wire into the top of the "V" opening at the end of the wrapping tool so that all the bare wire is inside the tool.
2. Pull gently on the end of the bare wire which projects from the opening on the top of the sleeve to be certain the insulation is into the tool as far as possible.
3. Bend the bare wire 90 degrees to the right and wrap it around the sleeve. Do not wrap the wire too tight.
4. Bend the insulated portion of the wire which projects from the front of the sleeve back toward the chuck, inserting it into the groove provided.
5. Bend the wire 90 degrees to the right.
6. Wrap the wire around the sleeve as shown.

Note: Steps 5 and 6 may be omitted when wrapping the second end of a short length of wire.

Place the tool over the pin so that the pin enters the round hole at the end of the tool. The tool should go over the pin freely. If it does not, a gentle rocking of the tool will bring the tool and the pin into alignment. If trouble persists, inspect the tool and pin for any obstruction. Turn the tool on, at the same time allowing it to be lifted away from the board by the wrapping motion. When the wrapping operation is completed, remove the tool from the pin. The bit must continue revolving when the tool is removed from the pin because the built-in detenting mechanism unwraps the last turn of wire.

Wire-Wrapping Tool Maintenance

The only maintenance required may be cleaning or removal of a broken wire from the wire slot. This can usually be done by feeding a stripped piece of wire through the slot in the reverse direction.

The sleeve on the hand wire-wrapping tool can be removed, if necessary, by gripping the portion of the wrapping bit between the cutting edges with needle-nose pliers. Holding the pliers closed lightly so that the bit can slide through the jaws, pull on the handle of the tool to remove the sleeve.

To replace the sleeve, grip the wrapping bit securely with the pliers and press the sleeve against a hard surface.

CAUTION

Special equipment is required to adjust the spring tension; therefore, do not attempt to adjust the spring.

Wire Removal

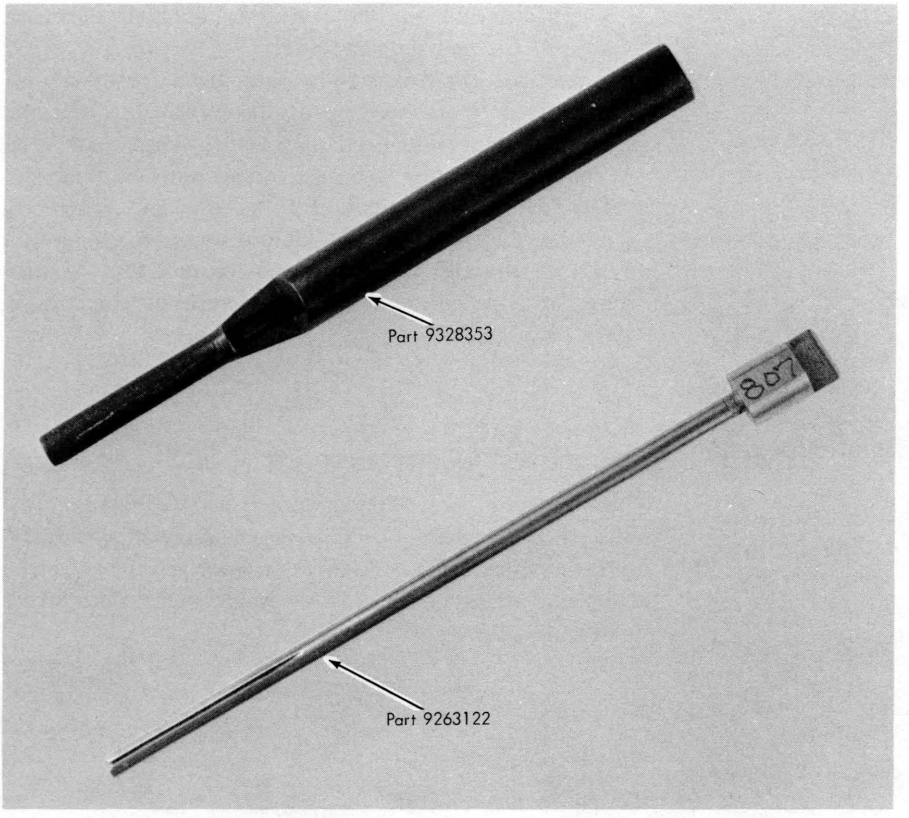
First Level Wire Removal

First level terminations can be removed in several ways without particular care, except to avoid disturbing adjacent wrapped terminations. The simplest method is to locate the pin to be deleted, trace the wire to its other end, and cut the wire near its center. Holding the wire with your fingers, unwrap it from the pin with a circular motion.

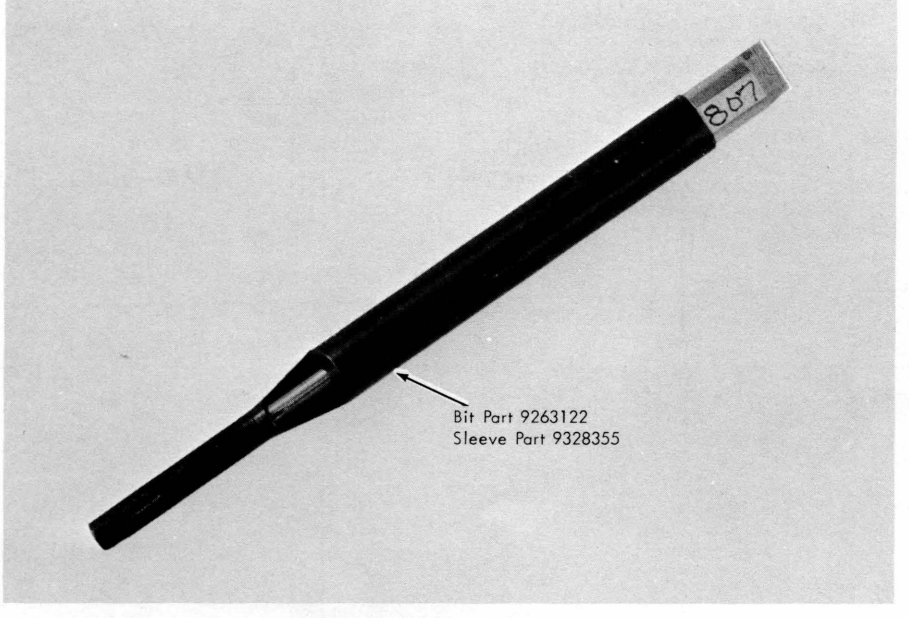
If the wire breaks while it is being unwrapped, or if the wire is too short to permit it to be cut at its center and unwrapped, use the manually operated wrapping tool. Place the tool over the pin, apply pressure to bottom the spring, and rotate the tool in a direction opposite to that of the wrap. After the wire has been unwrapped, it can be removed from the board with needle-nose pliers.

Second Level Wire Removal

A second level termination must be removed with care so that the wrapped termination beneath it is not disturbed. Cut the wire near its center and unwrap it. If a lower level wrapped termination is disturbed, the wire must be removed and replaced.

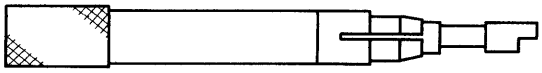


a. Wire-Wrap bit and sleeve



b. Assembled

● Figure 2-16. Wire-Wrap Bit and Sleeve



Part 2360355

● Figure 2-17. Wire-Wrap Bit Extension

Wire-Wrap Inspection

A poorly wrapped solderless termination is easily recognized and must be replaced. Figures 2-19 through 2-21 show examples of good and bad terminations:

1. Figure 2-19 shows one correctly wrapped termination. Figure 2-20 shows two correctly wrapped terminations. In both cases, at least one-half turn of insulated wire is wrapped around the pin.
2. Figure 2-21 (Part 1) shows a termination that has an open helix. "Open helix" is a termination that has more than 0.001-inch space between adjacent turns. This type of bad termination is usually caused by applying insufficient pressure on the tool during the wrapping operation.
3. Figure 2-21 (Part 2) shows a termination that has less than the minimum five turns of insulated wire. This easily recognized condition is usually caused by a break in the bare wire.
4. Figure 2-21 (Part 3) shows a termination with piled up turns instead of a tight helix around the pin. A piled-up wrapped termination is caused by applying excessive pressure on the wrapping tool.
5. Figure 2-21 (Part 4) shows a pin with two terminations. The first termination is wrapped correctly; however, the second termination overlaps the first termination. The second termination is defective and must be removed. This defective termination is usually caused by permitting the conductor to slide out of the wrapping tool before rotating it. A maximum of one turn of wire overlap is permitted as long as five turns of wire contact the pin.

CONNECTOR INSERT/EXTRACT TOOL

The connector insert/extract tool (part 453904) has two spring steel members, one stationary and one movable. The stationary member is slotted to fit over the T-bar on the signal side of the housing. The movable member is hooked. See Figure 2-22.

Connector Removal

To remove a connector:

1. Tap working end of tool against a surface to bring hook to end of slot.

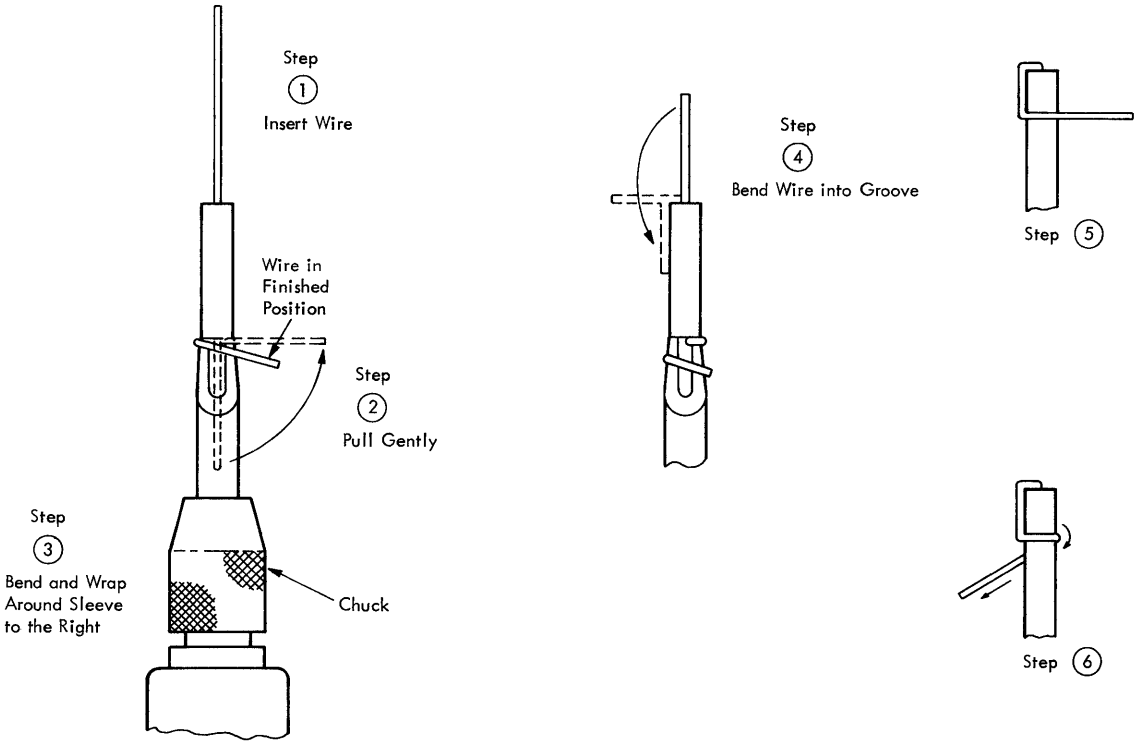


Figure 2-18. Preparing Power-driven Wire-Wrapping Tool

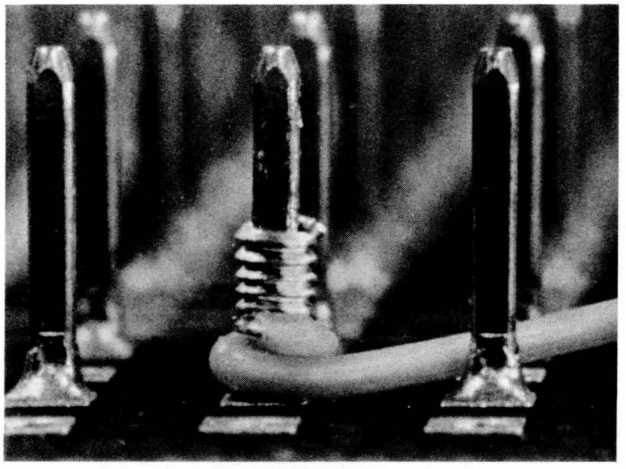


Figure 2-19. One Acceptable Termination

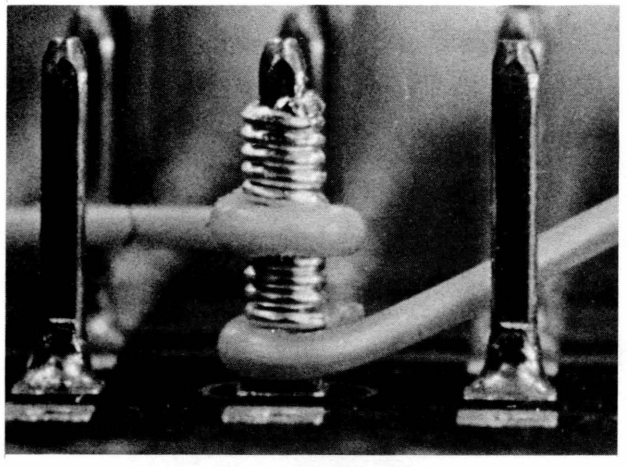


Figure 2-20. Two Acceptable Terminations

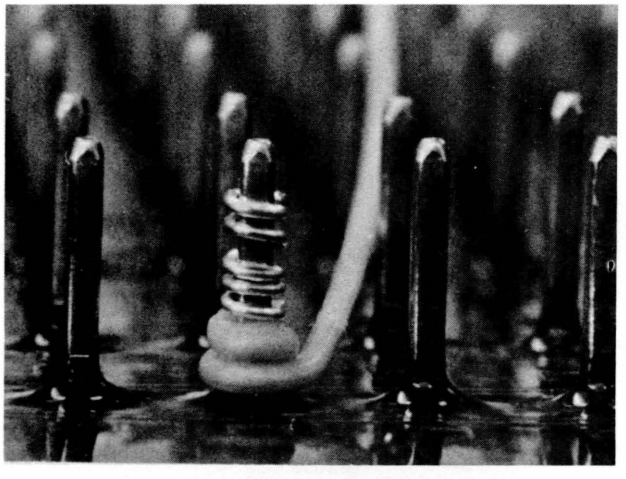


Figure 2-21. Unacceptable Termination (Open Helix) (Part 1 of 4)

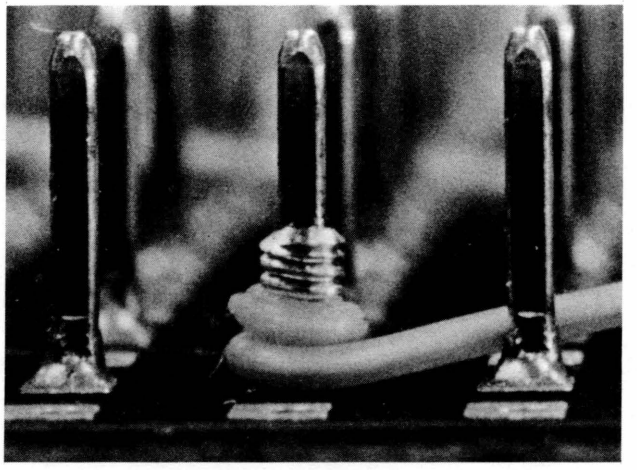


Figure 2-21. Unacceptable Termination (Insufficient Turns) (Part 2 of 4)

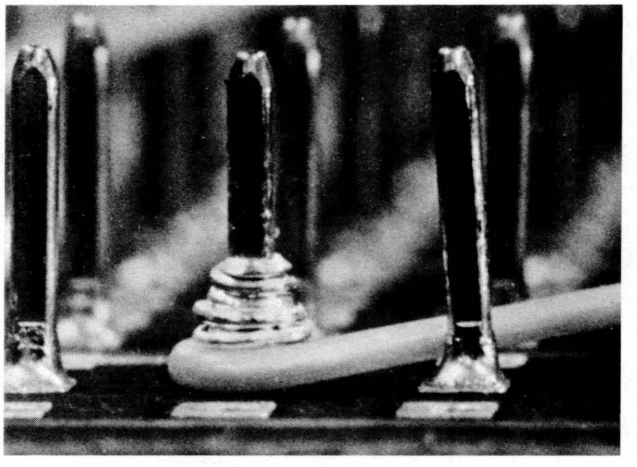


Figure 2-21. Unacceptable Termination (Piled-up Turns) (Part 3 of 4)

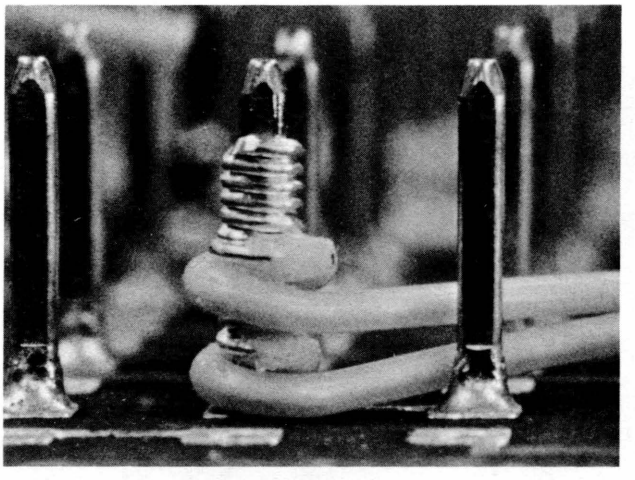


Figure 2-21. Unacceptable Termination (Second Overlaps the First) (Part 4 of 4)

2. Slide slotted member over T-bar and push down till seated. Using the rubber bushing pull back on hooked member until housing is removed.
3. To remove the housing from tool tap working end of tool against a surface. Otherwise, housing will remain locked in tool.

Connector Insertion

To insert a connector:

1. Tap working end of tool against a surface to bring hook to end of slot. Insert T-bar of housing into slot.
2. Place housing over required pin location on the board and push housing onto pin and ground rail.
3. Remove tool from housing.

Note: Unencapsulated tuning forks may rise slightly when the housing is replaced on the board. Insert tool, part 453889, (Figure 2-22) should be used when replacing these housings.

MID-AIR SPLICE INSERT/EXTRACT TOOL

To extract a housing from a mid-air connector, hold the connector in one hand and push the cylindrical end of the mid-air splice insert/extract tool, part 453470, (Figure 2-22) into the hole at the base of the connector beneath the desired housing.

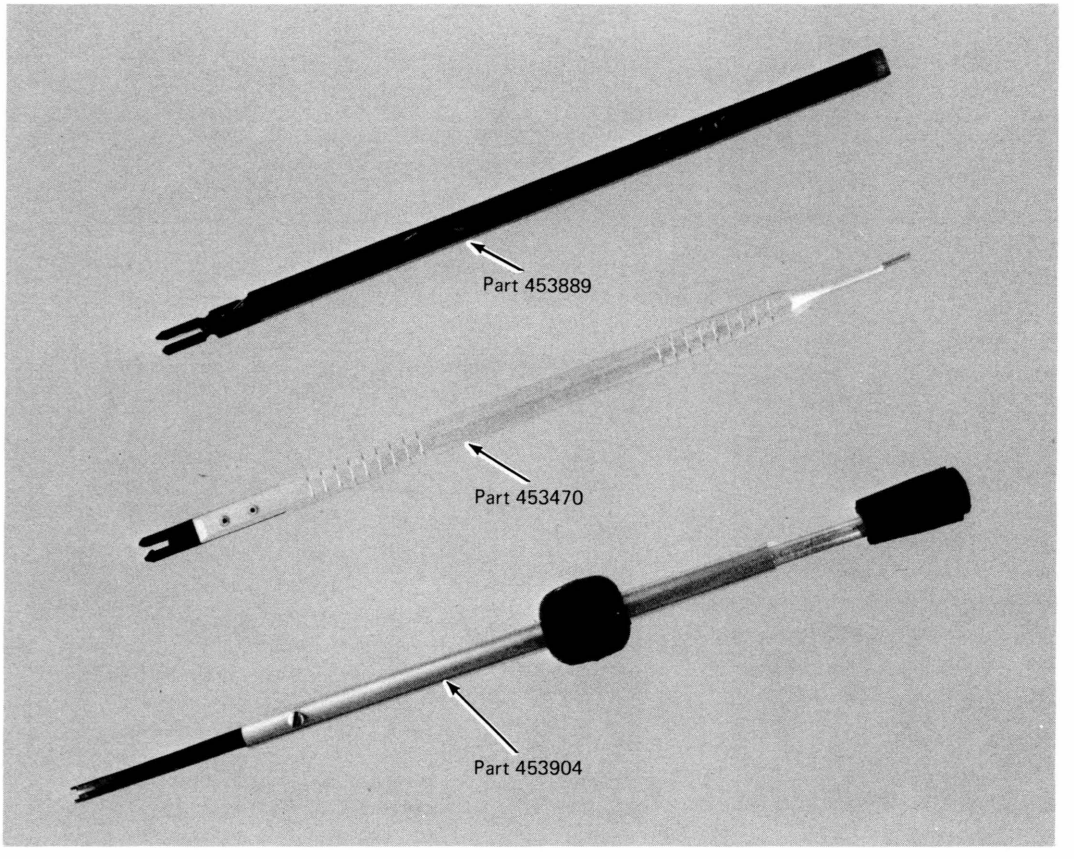
To insert a housing into the mid-air connector, attach the housing to the forked end of the tool by pushing the T-bar of the housing between the tuning forks. With the housing wires protruding toward the tool and holding the connector in one hand, insert the housing and observe the orientation. Remove the tool from the housing.

WIRE CADDIES

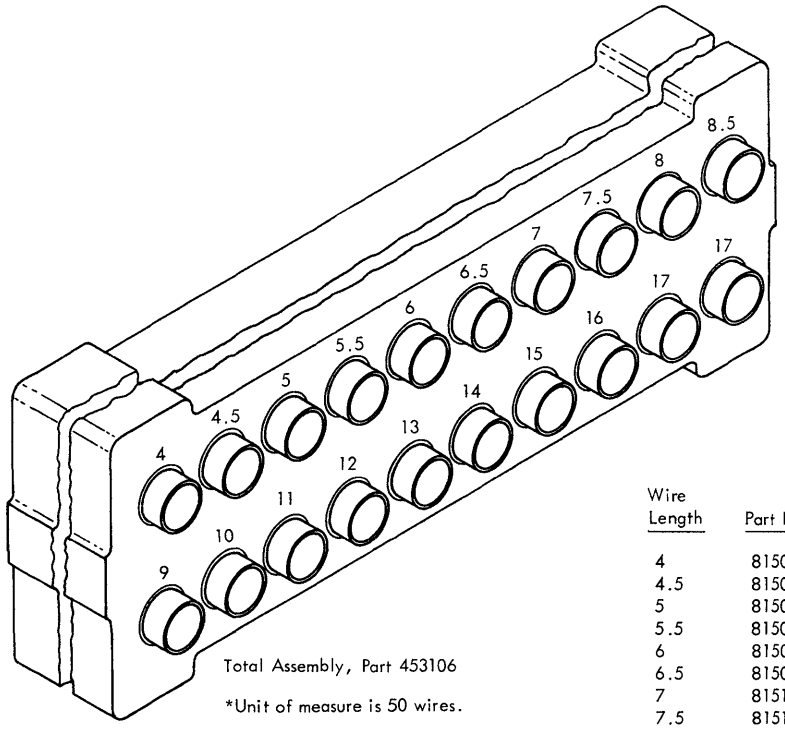
SLT Wire Caddy

Twenty vials of precut and prestripped wire are held in the SLT wire caddy (Figure 2-23). The wires vary in length from 4 to 17 inches and the individual throw-away vials of 50 wires may be ordered as required. The second 17-inch space is for the blue/white wire for SLT use only.

Note: MST uses yellow wire for all discrete wiring.



● Figure 2-22. Insert/Extract Tools



Wire Length	Part No.*	Wire Length	Part No.*	Reel Assembly	Part No.
4	815094	9	815104	Yellow wire	815905
4.5	815095	10	815105		
5	815096	11	815106		
5.5	815097	12	815107		
6	815098	13	815108		
6.5	815099	14	815109		
7	815100	15	815110		
7.5	815101	16	815111		
8	815102	17	815112		
8.5	815103	17 B/W**	815113		

Figure 2-23. SLT Wire Caddy

Tri-lead Wire Caddies

Two types of wire caddies are available: 50 ohm and 90 ohm. Each caddy (Figure 2-24) has tri-lead cables with housings on each end of the wire in lengths from 2.5 to 6 inches in ½-inch increments and from 7 to 20 inches in 1-inch increments. For 2.5 to 16 inches, however, 8 pieces of each wire length are in half-sheet containers; and for 17 to 20 inches, 12 pieces of each wire length are in full-sheet containers. Each caddy, 50-ohm (part 453900 and 90-ohm) (part 453903), also has an envelope (part 453917) that contains 50 spare housings, and an envelope (part 236070) containing four mid-air splice adapters. An envelope, part 453737, containing 10 terminating resistors is included in the 50-ohm wire caddy. An envelope, part 453738, containing 20 terminating resistors, is included in the 90-ohm wire caddy. Replacement sheets of tri-lead cables are listed in Figure 2-24.

A vial containing ten 90-ohm terminating resistors is available, part 2360358. This vial is designed to fit into the position normally used for the 17 inch blue/white wire vial of the SLT wire caddy, part 453106.

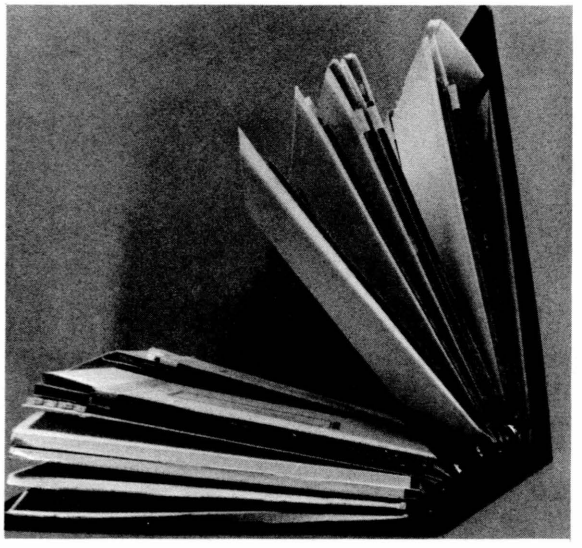
TUNING FORKS

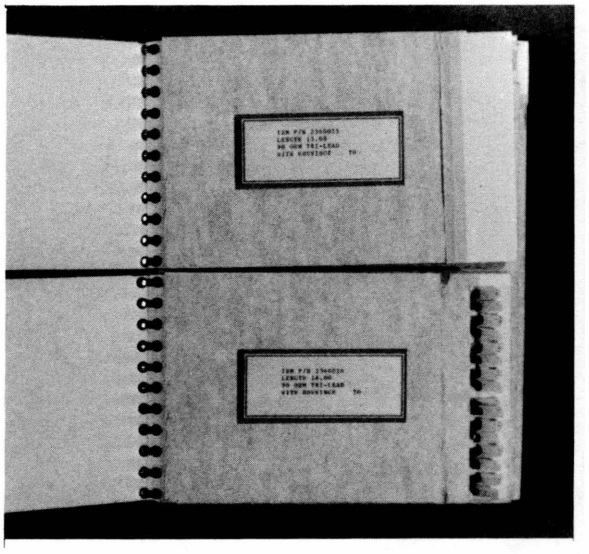
Encapsulated Wire Insertion

The procedure for inserting encapsulated tuning fork connectors into housings is quite different from inserting unencapsulated connectors:

1. Each end of the wire is enclosed in a capton* film. When mating two wire ends into a common connector housing, insert the tuning fork connectors into the housing by using duckbill pliers.
2. Grasp the encapsulation with the duckbill pliers and insert the tuning forks into the housing. Be certain to orient the tuning forks so that the edge of the encapsulation from which the wire exits is toward the ground rail side of the connector housing (away from the T-bar edge).
3. Push the tuning forks into the connector housing as far as possible.
4. Visually examine the connector to check placement of the tuning fork connectors; openings in the housing are provided for this examination.

*Trademark of E. I. duPont deNemours & Co. (Inc.)





Wire Cable Caddy
50-ohm (Part 453900)
90-ohm (Part 453903)

CADDY FULL SHEET ASSEMBLY CHART			
OHM	JUMPER INCH	LENGTH (MM)	FULL SHEET PART NUMBER
50	17.00	(431,8)	453935
50	18.00	(457,2)	453936
50	19.00	(482,6)	453937
50	20.00	(508)	453938
90	17.00	(431,8)	2360017
90	18.00	(457,2)	2360018
90	19.00	(482,6)	2360019
90	20.00	(508)	2360020

October, 1970

Envelopes		Caddy Where Found
Contents	Part No.	
50 Spare Housing	453917	50 and 90 Ohm
4 Mid-air Splice Adapter	2360370	50 and 90 Ohm
10 Terminating Resistors	453737	50 Ohm
20 Terminating Resistors	453738	90 Ohm
10 Terminating Resistors	2360358	90 Ohm (SLT)

October, 1970

CADDY HALF SHEET ASSEMBLY CHART			
OHM	JUMPER INCH	LENGTH (MM)	HALF SHEET PART NUMBER
50	2.50	(63,5)	1360089
50	3.00	(76,2)	453918
50	3.50	(88,9)	453919
50	4.00	(101,6)	453920
50	4.50	(114,3)	453921
50	5.00	(127)	453922
50	5.50	(139,7)	453923
50	6.00	(152,4)	453924
50	7.00	(177,8)	453925
50	8.00	(203,2)	453926
50	9.00	(228,6)	453927
50	10.00	(254)	453928
50	11.00	(279,4)	453929
50	12.00	(304,8)	453930
50	13.00	(330,2)	453931
50	14.00	(355,6)	453932
50	15.00	(381)	453933
50	16.00	(406,4)	453934

October, 1970

CADDY HALF SHEET ASSEMBLY CHART			
OHM	JUMPER INCH	LENGTH (MM)	HALF SHEET PART NUMBER
90	2.50	(63,5)	2360078
90	3.00	(76,2)	2360000
90	3.50	(88,9)	2360001
90	4.00	(101,6)	2360002
90	4.50	(114,3)	2360003
90	5.00	(127)	2360004
90	5.50	(139,7)	2360005
90	6.00	(152,4)	2360006
90	7.00	(177,8)	2360007
90	8.00	(203,2)	2360008
90	9.00	(228,6)	2360009
90	10.00	(254)	2360010
90	11.00	(279,4)	2360011
90	12.00	(304,8)	2360012
90	13.00	(330,2)	2360013
90	14.00	(355,6)	2360014
90	15.00	(381)	2360015
90	16.00	(406,4)	2360016

October, 1970

● Figure 2-24. Tri-lead Wire Caddies

Encapsulated Wire Extraction

To extract an encapsulated wire:

1. Remove the connector housing from the board.
2. Determine which wire in the housing is to be removed.
3. Grasp the connector housing with duckbill pliers.
4. Grasp the encapsulation of the wire to be removed with needle-nose pliers.
5. Pull the wire from the connector housing.

Unencapsulated Tuning Fork Insertion

Insertion of unencapsulated tuning forks into a housing is a more difficult operation than extraction and it requires much care. Because insertion of four tuning forks in one housing is more frequent than insertion of two and because the methods are similar, the more difficult operation of inserting four tuning forks is described in this section.

Precautions:

1. Be sure the tuning forks are joined: signal-to-signal, ground-to-ground, and flat surface-to-flat surface on the crimp.
2. Be very careful not to pull on the wires, bend the wire at the crimp, or crush the insulation with the tools, etc.
3. Be certain tuning forks are inserted into the housing—signals on T-bar side.

A tuning fork is flat on one side and is rounded on the other side in the crimp area. To fit four tuning forks into the same side of a housing, they must be placed back-to-back; that is, with their flat sides together.

In most cases, it is necessary to move the signal fork over to the other side of the ground fork to combine them back-to-back with the forks on the other wire. This operation must be done with extreme care.

After the forks have been oriented, grip the crimp area of the combined pairs with duckbill pliers. Holding the end of the fork, align the crimp portions so that they can be easily gripped with the pliers. Note closely the position of the signal forks, whether toward or away from you, before gripping them with the pliers. Hold the forks as far back on the crimp as possible, on the smaller insulation crimp portion, and insert the forks into the housing as far as possible. *Be sure* that the signal forks are in the T-bar side of the housing.

Note: When inserting tuning forks into a housing, a strain is placed on the signal wire if either a signal or ground tuning fork is pushed too far. Use the insert tool, part 453889, (Figure 2-22) to fully position the tuning forks in the housing.

Unencapsulated Tuning Fork Extraction

To remove tuning forks from a housing, place the connector housing in the tool, part 453452, (Figure 2-25) as follows:

1. With the top end (wire end) of the housing pointed away from the tool and the T-bar side (signal side) down, place the housing into the cavity at the front of the tool so that the T-bar is in the recess provided for it. The housing will then be lying on edge and closely confined with the pin and rail end exposed to the ejector mechanism.
2. Hold the connector down with the thumb and squeeze the handle, advancing the ejector forks which unlocks the tuning forks as the spring pressure increases.
3. Continue squeezing the handle until the tuning forks have been released from the housing retention.

Use care in removing the tuning forks the rest of the way out of the housing.

CAUTION

The housing must be discarded. Do not allow it to become mixed with the unused housings.

TEMPORARY GANG BRACKETS AND HOLDERS

Two types of temporary gang brackets are provided (Figure 2-26). Part 453447 is used on MST-4 boards, where a combination of long and short T-bar connector housings may be used. Part 453879 is used on MST-2 boards, where all short T-bar connectors are used. To position the gang bracket:

1. Grip the gang bracket with the fingers.
2. Position the teeth of the gang bracket so that they straddle the T-bars of the connectors to be removed.
3. Spring the gang bracket so that this hooked member clears the T-bars of the connector to be removed. This is to be done as the gang bracket is moving forward.

When the gang bracket is positioned, pull straight back on the gang bracket to free the connectors from the board.

Gang Bracket Holder Installation

To install the gang bracket holder:

1. Remove the gang bracket from the board.
2. Take the populated gang bracket and snap it into the gang bracket holder. Part 453842 (9 positions) is used for vertical I/O housings and part 453844 (12 positions) is used for horizontal I/O housings. See Figure 2-27.
3. When the gang bracket holder is populated, swing the holder to the opposite side of the cable raceway and hook the populated holder onto the cable raceway projections.
4. After the new board is in place, reverse the preceding procedure to replace the I/O housings.

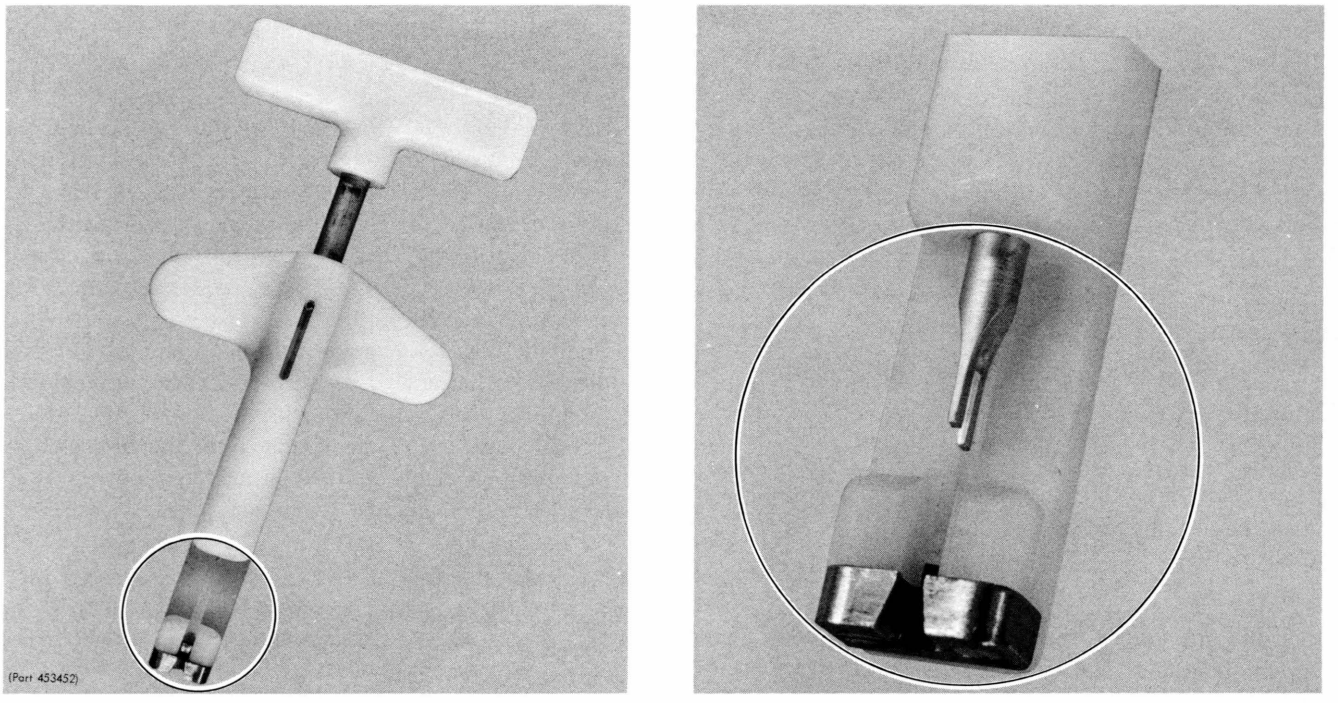


Figure 2-25. Tuning Fork Extract Tool

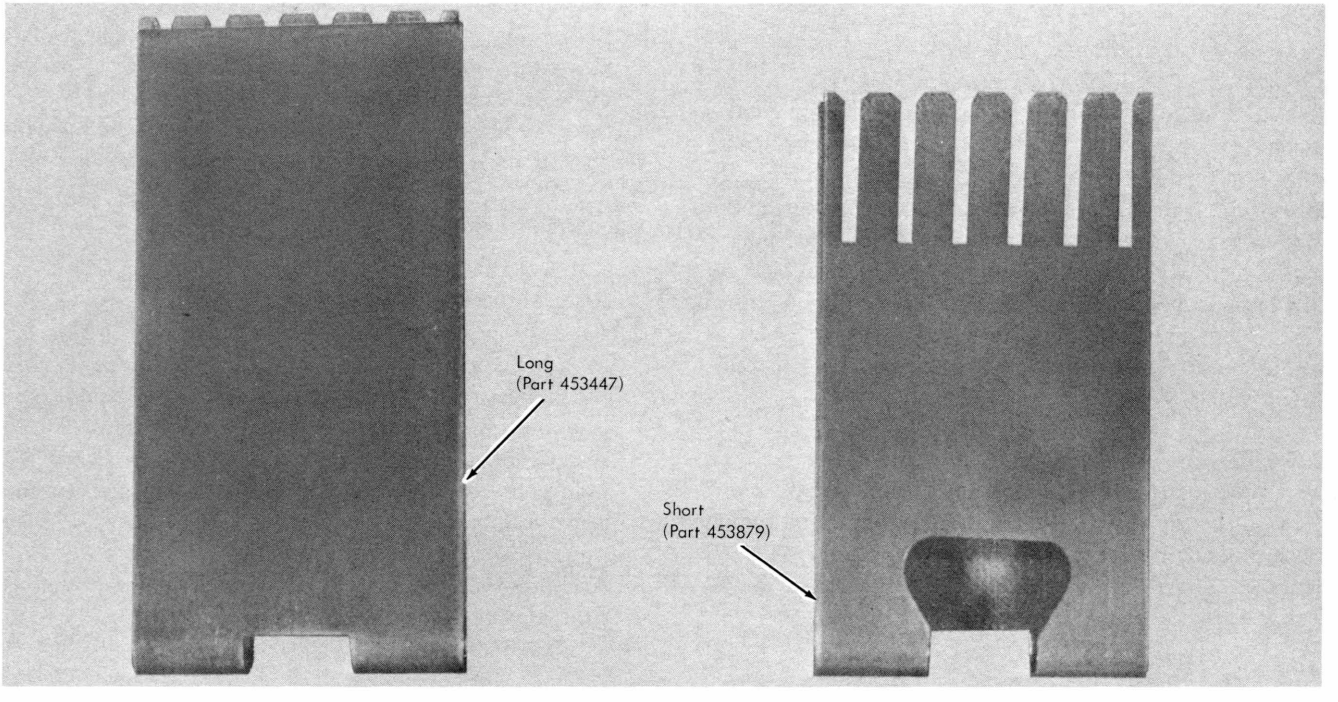


Figure 2-26. Gang Brackets

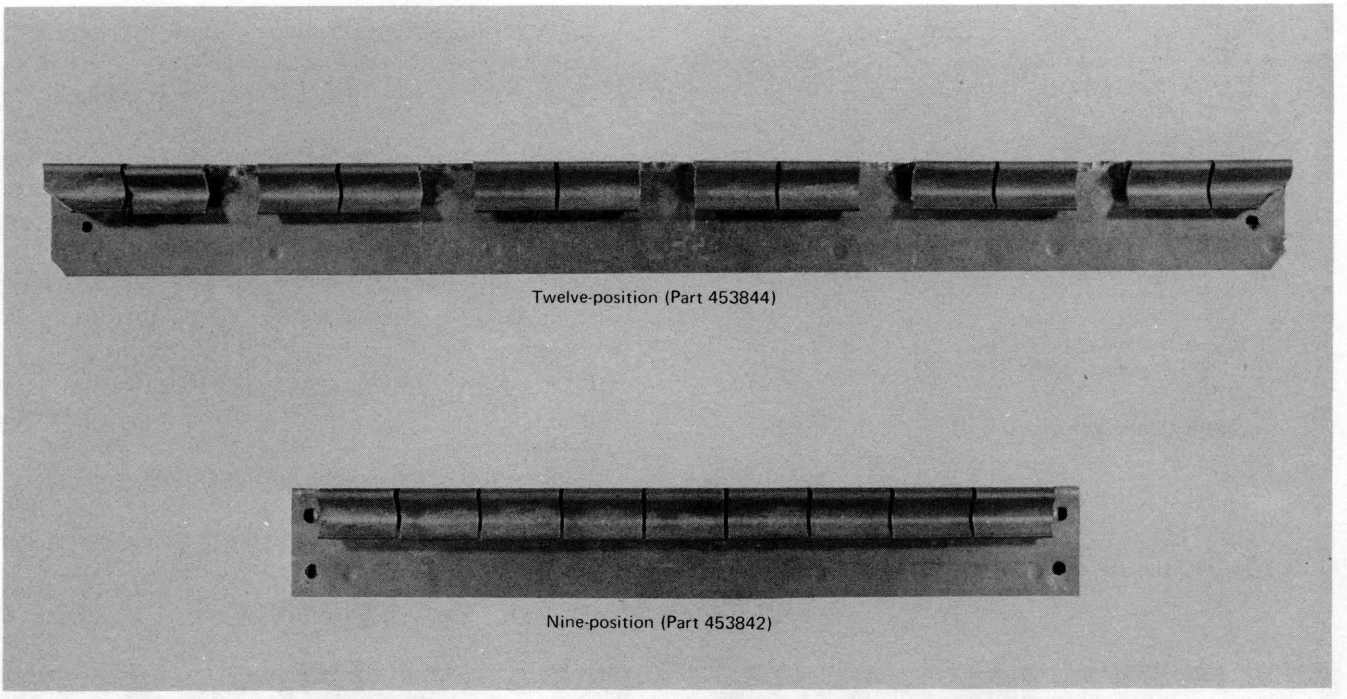


Figure 2-27. Gang Bracket Holders

MST-4 CARD GUIDANCE SYSTEM REMOVAL/INSTALLATION

Removal

To remove the MST-4 card guidance system (see Figure 1-14):

1. Remove all the cards.
2. Remove the nut, lock washer, and washer from each corner of the guideposts.
3. Slide the guideposts off the studs.

Installation

To install the MST-4 card guidance system (see Figure 1-14):

1. Determine which of the guideposts is top and bottom by orienting the guidepost with the legs toward the board in such a manner that the "X" and the letter "A," etched on the guidepost, are on the same edge of the board as the terminal block.
2. Slide the legs of the guidepost over the studs until the guidepost rests on the stiffener.
3. Install the washer, lock washer, and nut. Do not fully tighten the nut.
4. Install the second guidepost; see steps 2 and 3.
5. Install the cards that are to be plugged in columns B and U.
6. Fully tighten the nuts on the guideposts until there is a slight drag on the cards.
7. Install the remaining cards.

PIN ALIGNMENT

- Pins must be straight for card or cable installation.
- Card side pin aligner (part 453868).
- Probe side pin aligner (part 452535).
- Pencil probe (part 453101).
- Ground rail aligner (part 453777).

Occasionally, pins will be bent so that cards or cables cannot be installed. Bent pins must be straightened so that row and column alignment is satisfactory for card and cable installation. The tools provided for pin alignment are shown in Figure 2-28.

If a pin is bent excessively, straighten it first with the pencil probe; otherwise, the aligner tools will not function.

Card Side Pin Alignment

To align a pin on the card side of a board:

1. Place the card side pin aligner (part 453868) over the signal pin so that the board pins enter the cone-shaped holes in the face of the tool. The long portion of the tool handle should be at a right angle to the board surface (Figure 2-29).
2. Apply firm pressure on the tool until it is positioned against the board.
3. Remove the tool by pulling it straight out while rocking it slightly.
4. Repeat this procedure two or three times to overcome springiness of the pins.

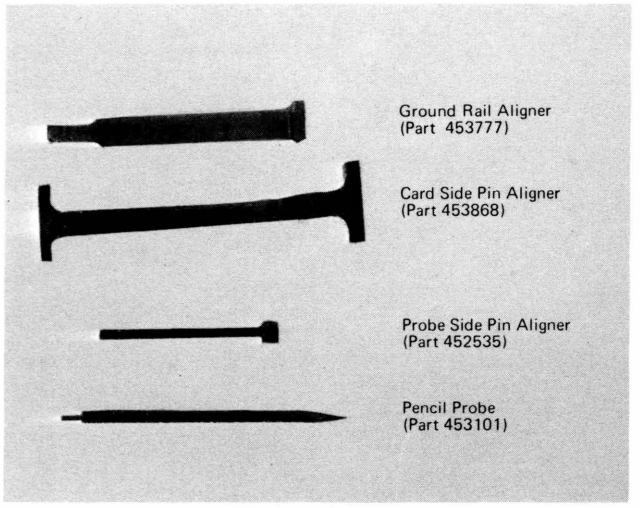


Figure 2-28. Pin Alignment Tools

2. Apply firm pressure on the tool until it is positioned against the board.
3. Remove the tool by pulling it straight out while rocking it slightly.
4. Repeat this procedure two or three times to overcome springiness of the pins.

Probe side pin aligner (part 453777) is used to align two signal pins or six signal pins to an adjacent ground rail.

Before using the tool, clear wires away from the area where pins are to be straightened. Do not disturb the terminations.

1. Press the tool onto the pins to be straightened with the slot in the tool over the ground rail until the tool is positioned.
2. Remove the tool by pulling it straight out while rocking it slightly.
3. Repeat this procedure two or three times to overcome springiness of the pins.

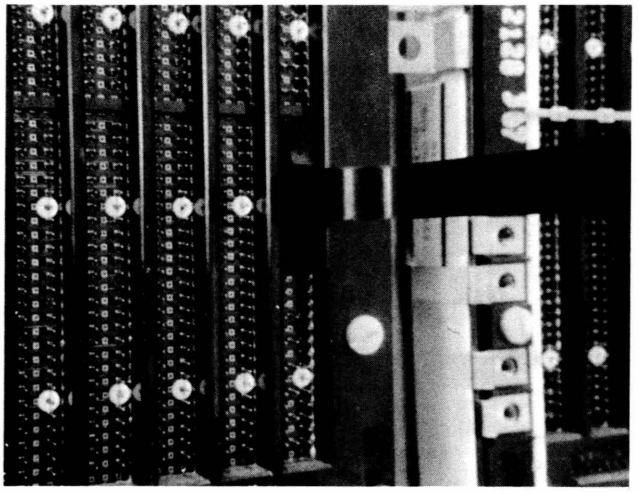


Figure 2-29. Card Side Pin Alignment

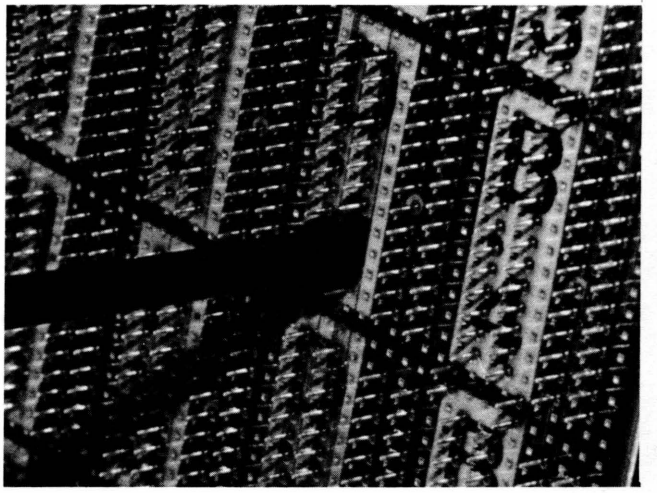


Figure 2-30. Probe Side Pin Alignment

One end of the aligner is offset for insertion into card positions at the edge of the board where the card gate circuits prevent the use of the straight end of the tool. Cards adjacent to the socket position where pins are being straightened may have to be removed so that the tool can be inserted straight onto the pins.

Probe Side Pin Alignment

Probe side pin aligner (part 452535) is used to align pins adjacent to each other and pins opposite to each other.

Before using the tool, clear wires away from the area where pins are to be straightened. Do not disturb the terminations.

1. Place the tool over the pins to be straightened (Figure 2-30).

PIN REPLACEMENT

Pins may be damaged or broken on either side of a board, or the same pin may be damaged or broken on both sides of a board. These possibilities require slightly different procedures for pin removal and replacement. Regardless of which procedure is used, pin replacement is a delicate operation and the use of the correct tool at the appropriate time is essential for a successful repair operation.

Figure 2-31 (part 1) is a flowchart for use as a flexible procedure and guide for the repair of all combinations of broken pins, regardless of the situation. The flowchart includes solutions to problems that may be encountered in the procedures. Figure 2-31 (parts 2 and 3) also illustrate cross sections of damaged pins and show the tools used for pin removal and replacement.

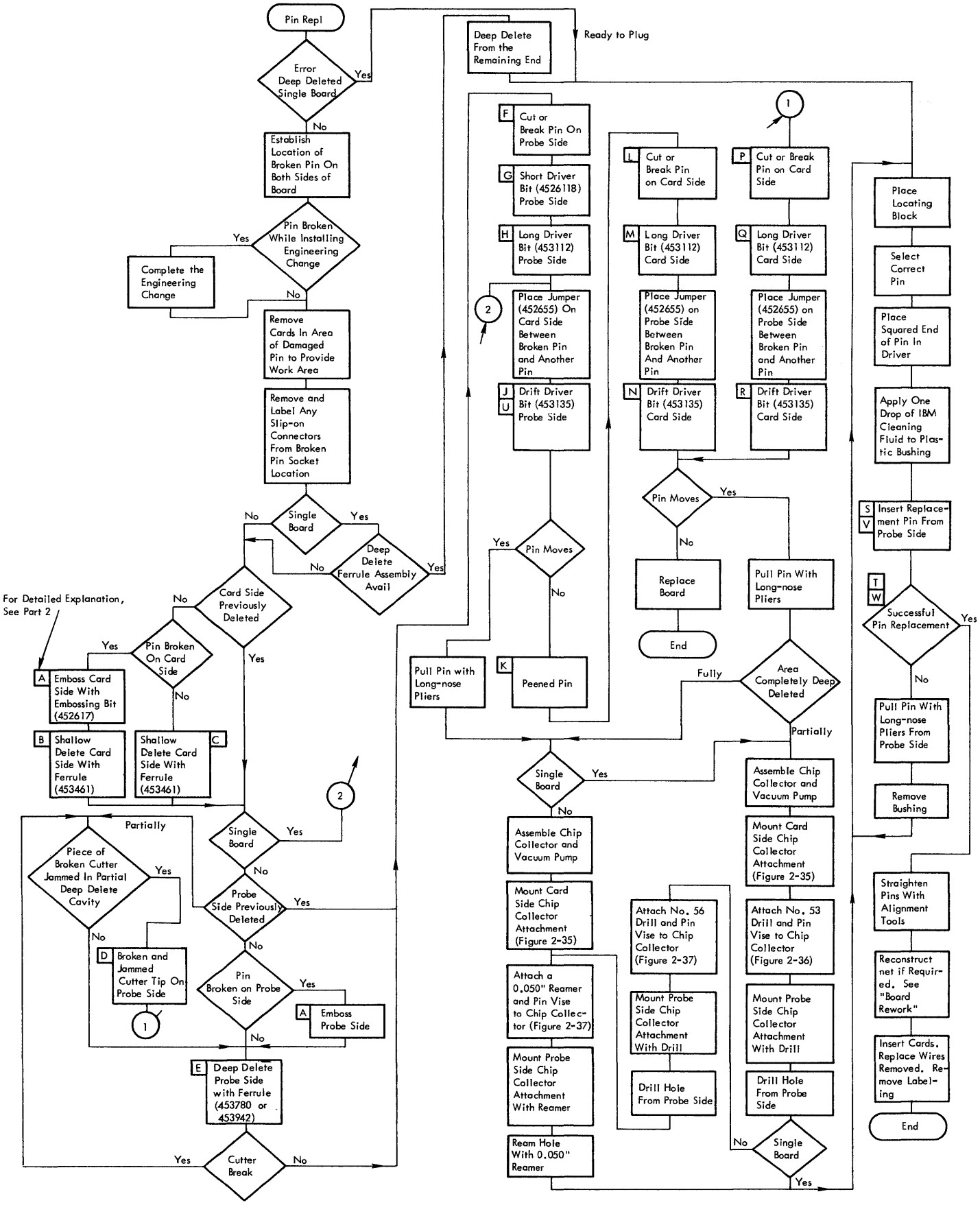
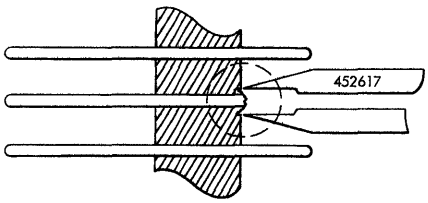
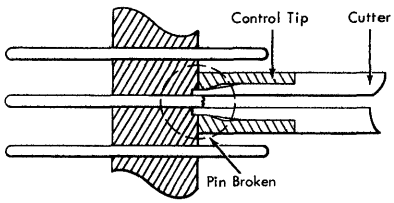


Figure 2-31. MST Pin Replacement (Part 1 of 3)



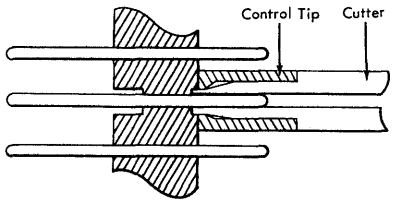
- Embossing provides guide for power delete tool cutter. Otherwise, a complete pin is used as a guide for cutter, as shown in "C".
- Clean embossing bit periodically.
- Impact board up to four times to provide sufficient cut in board.

[A] Embossing, Card Side



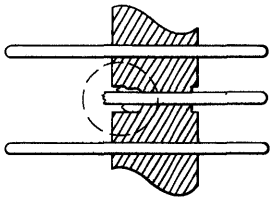
- Place tool solidly against board. Do not allow cutter to move across board surface.
- Use embossed area as a guide for cutter tip.

[B] Shallow Deletion After Emboss



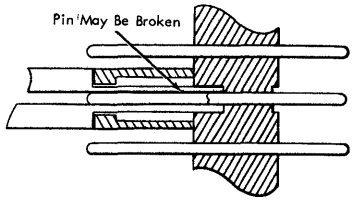
- Use pin as guide for cutter tip.

[C] Shallow Deletion With Pin



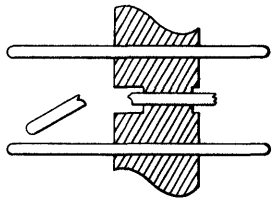
- A pin with a broken and jammed cutter tip in partial deep delete cavity must be impacted from the card side.
- Pin removal for broken and jammed cutter tip is the same as for peened pin removal.

[D] Broken and Jammed Cutter Tip



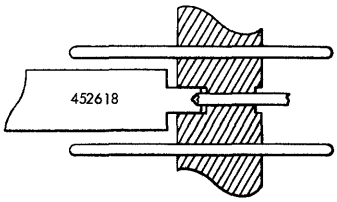
- Place tool solidly against board. Do not allow cutter to move across board surface.
- Use embossed surface, or pin if present, as a guide for cutter tip.

[E] Deep Deletion



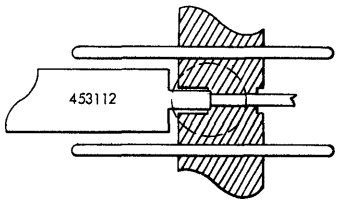
- Break pin on probe side with long-nose pliers flush or below board surface, if required.

[F] Breaking Pin, Probe Side



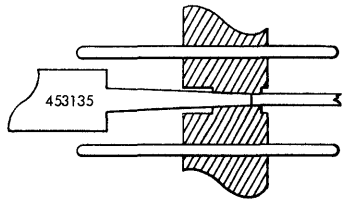
- Short driver bit holds pin centered in deep delete cavity while driving pin nearly flush with bottom of deep delete cavity.
- Shoulder of bit should never contact board surface.

[G] Removal With Short Driver Bit, Probe Side



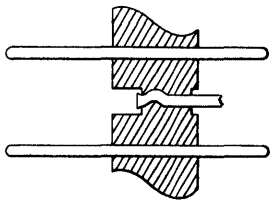
- Long driver bit is used to drive pin stub slightly below bottom of deep delete cavity.
- Shoulder of bit should never contact board surface.

[H] Removal With Long Driver Bit, Probe Side



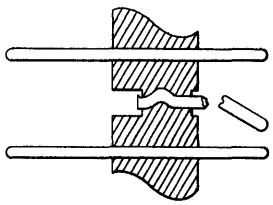
- Drift driver bit is used to push pin from board far enough so that pin can be pulled with pliers.
- Remove tool from board after each impact to check pin position and to prevent bit from jamming.
- Drift driver bit is tapered to reduce bit breakage and to prevent shoulder of bit from contacting board surface.

[J] Removal With Drift Driver Bit, Probe Side



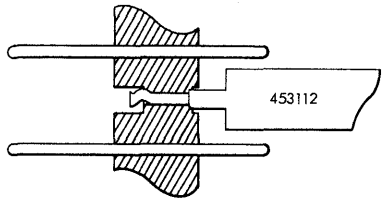
- Peened pin must be impacted from card side.

[K] Peened Pin, Probe Side



- Break pin on card side with long-nose pliers flush or below board surface.

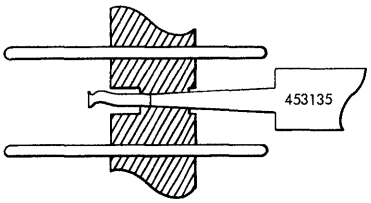
[L] Breaking Pin, Card Side



- Long driver bit is used to drive pin stub slightly below bottom of shallow delete cavity.
- Shoulder of bit should never contact board surface.

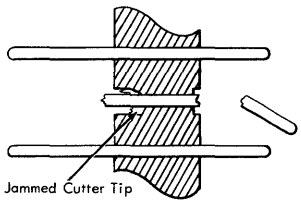
[M] Removal With Long Driver Bit, Card Side

Figure 2-31. MST Pin Replacement (Part 2 of 3)



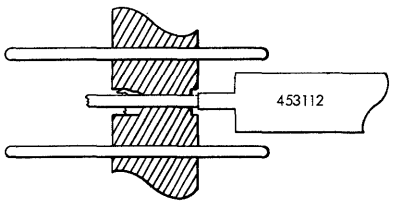
- Drift driver bit is used to push pin from board far enough so that pin can be pulled with pliers.
- Remove tool from board after each impact to check pin position and to prevent bit from jamming.
- Drift driver bit is tapered to reduce bit breakage and to prevent shoulder of bit from coming in contact with board surface.

N Removal With Drift Driver Bit, Card Side



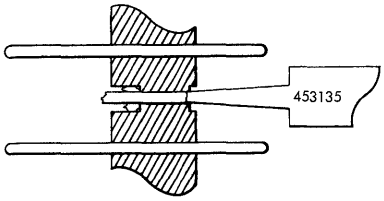
- Break pin on card side with long-nose pliers flush or below board surface.

P Breaking Pin, Card Side



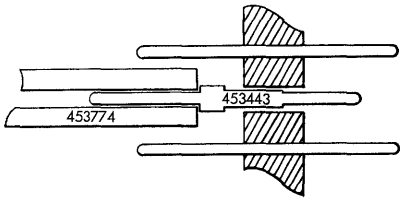
- Long driver bit is used to drive pin stub slightly below bottom of shallow delete cavity.
- Shoulder of bit should never contact board surface.

Q Removal With Long Driver Bit, Card Side



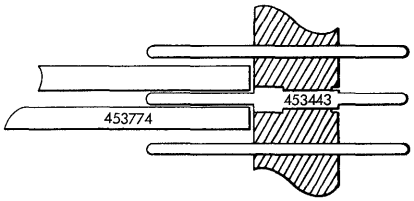
- Drift driver bit is used to push pin from board far enough so that pin can be pulled with pliers.
- Remove tool from board after each impact to check pin position and to prevent bit from jamming.
- Drift driver bit is tapered to reduce bit breakage and to prevent shoulder of bit from contacting board surface.

R Removal With Drift Driver Bit, Card Side



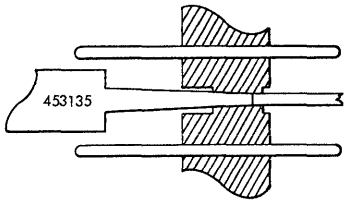
- Replace pins from probe side of board only. Insert pin driver bit into impact tool, then insert replacement pin into pin driver bit.
- Place locating block, part 453778, over pin. Place a drop of IBM Cleaning Fluid on plastic bushing of replacement pin.
- Be sure larger pin diameter is against driver head.
- Drive pin into board until driver head is flush with board surface.

S Inserting Replacement Pin Into Double-board Assemblies With Pin Driver Bit



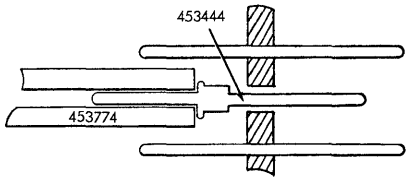
- Check pin height. It should be about the same as adjacent pins. Plastic bushing should not be mushroomed.

T Replacement Pin Fully Seated



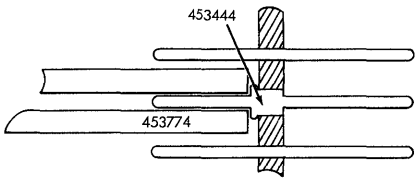
- Drift driver bit is used to push pin from board far enough so that pin can be pulled with pliers.
- Remove tool from board after each impact to check pin position and to prevent bit from jamming.
- Drift driver bit is tapered to reduce bit breakage and to prevent shoulder of bit from coming in contact with board surface.

U Removal With Drift Driver Bit, Probe Side



- Replace pins from probe side of board only. Match length of pin on probe side. Use either 453444 or 453442.
- Insert pin driver bit into impact tool, then insert replacement pin into pin driver bit.
- Be sure larger pin diameter is against driver head.
- Drive pin into board until driver head is flush with board surface.

V Inserting Replacement Pin Into Single-board Assemblies With Pin Driver Bit



- Check pin height. It should be about the same as adjacent pins. Plastic bushing should not be mushroomed.

W Replacement Pin Fully Seated

Note: In all illustrations, probe side of board is on left side; card side is on right.

Figure 2-31. MST Pin Replacement (Part 3 of 3)

Note: The details of many steps of the flow chart, "MST Pin Replacement," (Figure 2-31, part 1 of 3) may be found under the appropriate letter in parts 2 of 3 and 3 of 3 in Figure 2-31.

PIN REPLACEMENT PROCEDURES

When a pin is broken on either side of a board or on both sides of a board, always perform the deletions on both sides of the board before attempting to remove the broken pin, unless a deep delete cutter bit is broken and jammed on the probe side of a board.

Perform deep deletion on only the probe side of a board and shallow deletion on only the card side of a board.

The following steps must be done and the precautions must be observed prior to removing a broken pin from a board:

1. Identify the pin to be removed.
2. Remove the card in the area of the pin to be removed and remove any adjacent cards to provide a sufficient work area.
3. Remove any slip-on connectors from the damaged or broken pin. Always hold pin removal and replacement tools perpendicular to the board before performing any operation.
4. Be certain that the impact tool adjustment head is secured on the barrel of the tool before impacting a pin.
5. Do not impact a pin excessively with the driver bit because the shoulder on the bit could easily damage the printed circuits on the surface of the board.
6. Before impacting a pin stub, be sure that the pin is in the center of the hole to prevent it from being peened over in hole.

Note: Place one end of a 4-inch jumper wire, part 452655, (Figure 2-32) onto the pin (card side) being removed and place the other end of the jumper on a conveniently located pin to prevent the pin being removed from falling into the machine.

Tools Required

Tools required for pin replacement on a double board are:

Tool	*Part No.*
1. Pin Replacement Kit for SLT/MST	453428
No. 56 Drill, 0.046"	450037
No. 53 Drill, 0.059"	450262
Plastic Box	451148
Impact Tool	452616
Embossing Bit	452617
Short Driver Bit	452618
Long Driver Bit	453112
Drift Driver Bit	453135
Extension	453390
Vial of Replacement Pins, 0.515" Double Bd	453443
Vial of Replacement Pins, 0.515" Single Bd	453444
Reamer, 0.050"	453773
Driver, Replacement Pin	453774
Locating Block	453778
Pin Vise	2108019
2. Chip Collector Assembly	452546
3. Vacuum Pump	453091
4. Power Delete Tool	453134
Deep Delete Ferrule Assembly (MST-2D)	453780
Deep Delete Ferrule Assembly (MST-4)	453942
Shallow Delete Ferrule Assembly	453059 and 453461
5. Card Side Pin Aligner	452868
6. Probe Side Pin Aligner	452535
7. Long-Nose Pliers	450494
8. Four-Inch Jumper Wire	452655
9. Ground Rail Aligner	453777
10. Lubricant	453391
11. IBM Cleaning Fluid	450608

CAUTION

When doing a pin replacement operation, be certain that you know which type of board you are working on so that the correct set of procedures is used.

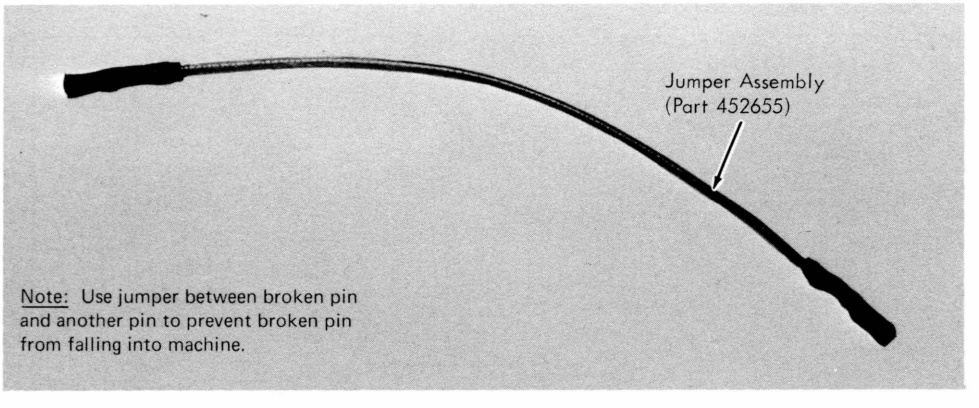
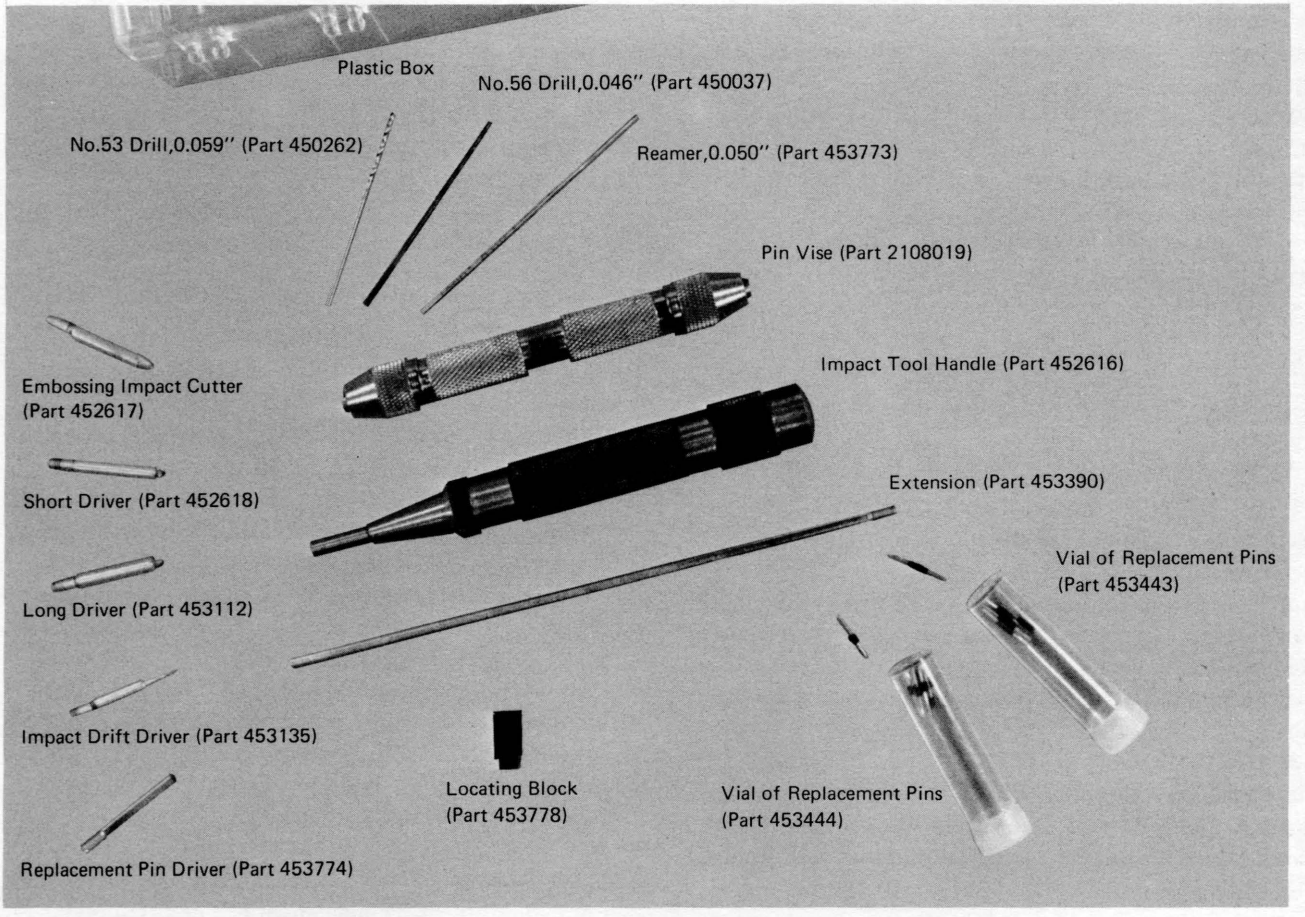


Figure 2-32. Broken Pin Jumper



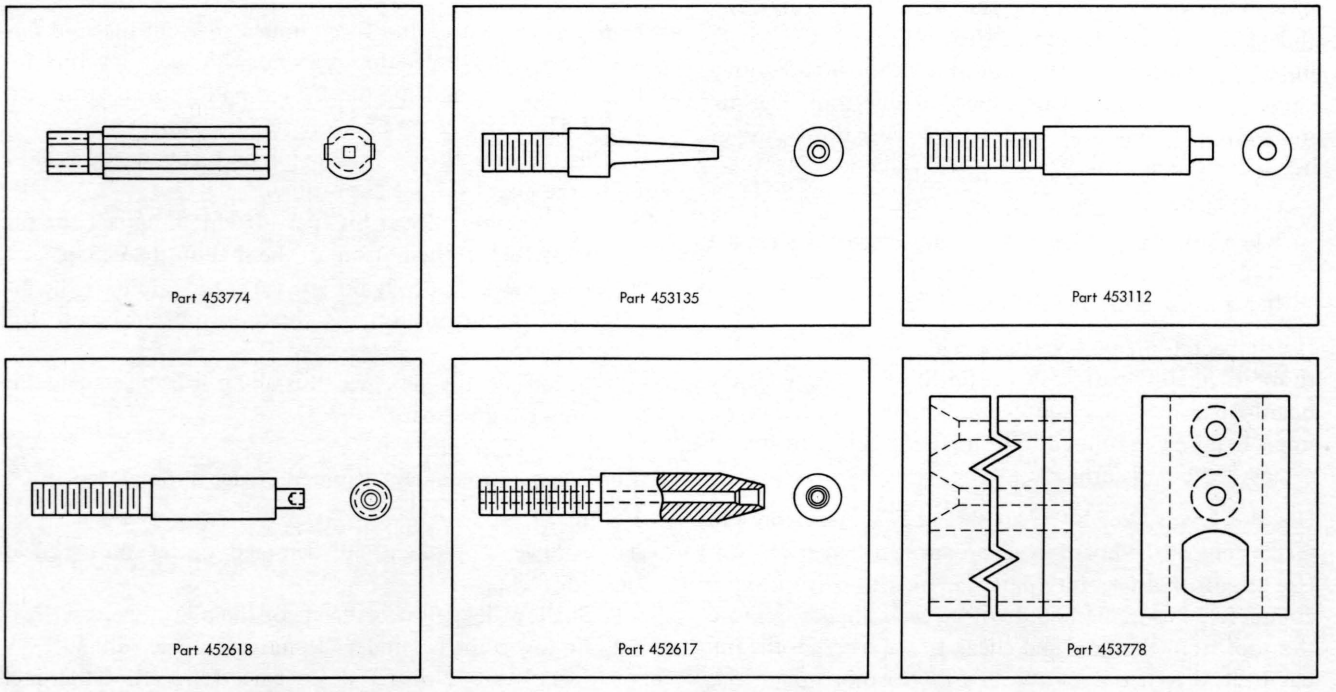


Figure 2-33. Impact Tool and Attachments

The impact tool (Figure 2-33) is spring-loaded and manually operated. A few precautions when using the tool are:

1. Hold the tool perpendicular to the board while performing the operations.
2. Be sure that the tool adjustment head is snug on the barrel before impacting a pin.
3. Do not impact a pin more than four times with any driver bit. The shoulder on the bit could easily damage the printed circuits on the surface of the board.
4. Before impacting a pin stub, be sure that the pin is in the center of the hole. This prevents the pin from being peened over in the hole.

Removing a Broken Pin on the Card Side of a Double Board

Note: If a pin is broken on the card side of a board, a jumper should be placed on the pin as soon as enough of the pin is protruding.

1. Install deep delete ferrule assembly, part 453780 or 453942, into the power delete tool, part 453134, (Figure 2-7), and deep delete the pin on the probe side of the board; see "Installing a Replacement Pin into a Double Board."
2. Use impact tool, part 452616, (Figure 2-33), with an embossing bit, part 452617, on the card side of the board to cut the area around the broken pin. *Note:* Clean the embossing bit periodically so that it functions efficiently.
3. Compress the impact tool at least three or four times to create sufficient depth to the cut, enabling the power delete cutter to be guided correctly.
4. Install shallow delete ferrule assembly, part 453461, into the power delete tool, part 453134, (Figure 2-7), and shallow delete the pin on the card side of the board.
5. Break the pin off on the probe side of the board with a pair of long-nose pliers or other suitable tool. The pin should be broken flush and square with the board or below the board surface.

   CAUTION
   When using any driver bit, do not trigger the impact tool if the pin moves. This prevents the bit from being wedged in the board.

6. Use impact tool, part 452616, (Figure 2-33), with the short driver bit, part 452618, on the probe side of the board to loosen the pin. Approximately one to two impacts may be required to bring the shoulder of the bit against the board surface.
7. Use the long driver bit (part 453112) to push the pin farther out of the board in accordance with step 3.
8. Use the drift driver bit (part 453135) to drive the pin completely from the board. After each impact, remove the tool from the hole and check to see whether the pin has been driven out of the board. No more than four impacts should be made on a pin with this bit from the probe side. If the pin is nearly out, use a pair of long-nose pliers to remove the pin; if it has not moved, or moved very little, refer to procedure under "Removing a Peened Pin."
9. To replace a pin, see "Installing a Replacement Pin into a Double Board."

Removing a Broken Pin on the Probe Side or Both Sides of a Double Board

To remove a broken pin on the probe side or both sides of a double board:

1. Use impact tool, part 452616, (Figure 2-33), with an embossing bit, part 452617, on the probe side of the board to cut the area around the broken pin. *Note:* Clean the embossing bit periodically so that it functions efficiently.
2. Compress the impact tool at least three or four times to create sufficient depth to the cut, enabling the power delete cutter to be guided correctly.
3. Deep delete the broken pin by placing the cutter into the circular cut surrounding the broken pin. Apply sufficient pressure to the delete tool so that it is placed solidly against the board, preventing the cutter tip from riding on the surface of the board.
4. Apply power and perform the deletion.
5. Refer to step 4 under "Removing a Broken Pin on the Card Side of a Double Board," and continue the procedure from there.

Removing a Peened Pin

Note: A peened pin has to be impacted from the card side because a shallow deletion does not provide a location for the impact bits and the pin is bent and peened within the board. Use extreme care in centering the impact bits.

1. Cut or break the protruding pin on the card side as close to the board surface as possible.
2. Using the long driver bit (part 453112), impact the pin slightly below the bottom of the shallow delete cut.
3. Using the drift driver bit (part 453135), impact the pin out of the board. Remove the tool from the board after each impact.
4. To replace the pin, see "Installing a Replacement Pin into a Double Board."

Removing a Broken and Jammed Cutter during Deep Deletion

To remove a broken and jammed cutter during deep deletion:

1. Shallow delete the card side of the pin.
2. Follow steps 1-3 under "Removing a Peened Pin."
3. Install the No. 53 drill (part 450262), 0.059-inch diameter, into the pin vise (part 2108019).

4. Assemble the chip collector (Figure 2-34) and the vacuum pump (Figure 2-9). Turn the vacuum pump on.
5. Install the card side chip collector (part 452546) into the appropriate card socket position (Figure 2-35). The slot in the chip collector must be centered over the pin hole.
6. Insert the No. 53 drill (part 540262) into the spring-loaded tubing of the probe side chip collector (part 452546). Hold the vacuum tube in one hand, and press the spring by pushing on the pin vise with the other hand until 0.090 to 0.095 inch of the drill is exposed (Figure 2-36).
7. Insert the point of the drill into the hole on the probe side of the board and slowly release the spring pressure until the housing rests against the board.

   CAUTION
   During the drilling operation, the drill must be kept perpendicular to the board.

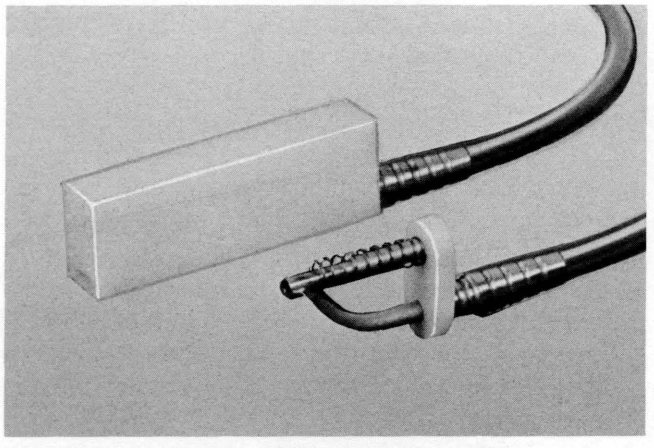


Figure 2-34. Chip Collector Assembly

Board Card Side

Note: Slot in chip collector must be over pin hole in card socket location.

Figure 2-35. Chip Collector (Card Side Attachment)

8. Drill the hole to 0.050-inch diameter and 0.090-inch to 0.095-inch depth.
9. Remove the drill from the hole and from the chip collector.
10. Proceed with steps under "Installing a Replacement Pin into a Double Board."

Installing a Replacement Pin into a Double Board

A replacement pin is installed on the probe side of the board, unless otherwise specified.

1. Install the No. 53 drill (part 450262) into the pin vise (part 2018019).
2. Assemble the chip collector (Figure 2-34) and the vacuum pump (Figure 2-9). Turn the vacuum pump on.
3. Install the card side chip collector (part 452546) into the appropriate card socket position (Figure 2-35). The slot in the chip collector must be centered over the pin hole.
4. Insert the drill into the spring-loaded tubing of the probe side chip collector (part 452546). Hold the vacuum tube in one hand, and press the spring by pushing on the pin vise with the other hand until 0.090 to 0.095 inch of the drill is exposed (Figure 2-36).
5. Insert the point of the drill into the hole that is to receive the replacement pin.
6. Slowly release the spring pressure until the housing rests against the board.

   CAUTION
   During the drilling operation, the drill must be kept perpendicular to the board (Figure 2-38).

7. Drill the pin hole to 0.090- to 0.095-inch depth.
8. Remove the drill from the hole and from the chip collector.
9. Install the No. 56 drill (part 450037) into the pin vise (part 2018019).
10. Insert the drill into the spring-loaded tubing of the probe side chip collector (part 452546). Hold the vacuum tube in one hand, and press the spring by pushing on the pin vise with the other hand until approximately 0.250 inch of the drill is exposed (Figure 2-37).
11. Insert the point of the drill into the hole that is to receive the replacement pin.
12. Slowly release the spring pressure until the housing rests against the board.

    CAUTION
    During the drilling operation, the drill must be kept perpendicular to the board (Figure 2-38).

13. Drill the pin hole to 0.0465-inch diameter completely through the board assembly.
14. Remove the drill from the hole and from the chip collector.
15. Install the reamer, 0.050-inch diameter, (part 453773) into the pin vise (part 2018019).
16. Insert the reamer into the spring-loaded tubing of the probe side chip collector (part 452546). Hold the vacuum tube in one hand, and press the spring by pushing on the pin vise with the other hand until approximately 0.250 inch of the reamer is exposed (Figure 2-37).
17. Insert the point of the reamer into the hole that is to receive the replacement pin.
18. Slowly release the spring pressure until the housing rests against the board.

    CAUTION
    During the reaming operation, the reamer must be kept perpendicular to the board.

19. Ream the pin hole to 0.050-inch diameter completely through the board assembly.
20. Remove the reamer from the hole and from the chip collector.
21. Turn off the vacuum pump, and remove the chip collector from the card side of the board.
22. Install the pin driver bit (part 453774) into the impact tool and then insert the replacement pin (Figure 2-39) into the driver bit with the squared end of the pin into the driver head.
23. Place the locating block (part 453778) in position so that the pin hole is aligned with the large hole of the locating block. Place the replacement pin in the square hole of the pin driver bit (part 453774), place a drop of IBM Cleaning Fluid on the plastic sleeve using a suitable tool, and insert the pin into the locating block.
24. Exert pressure on the impact tool and drive the pin into the board until the driver head is flush with the board.
25. After insertion of the pin, realign and lubricate the pins on the probe side of the board with ground rail aligner, part 453777.
26. Replace all components previously removed.
27. Check the pin height and plastic bushing on the probe side of the board. If the pin height is not approximately the same height as the adjacent pins, and the bushing is peened over the pin, replace the pin. *Note:* A maximum of two replacement pins are allowed for each 4-wide socket position. A maximum of ten replacement pins are allowed for each board.
28. To supply power to a replaced voltage pin, follow the procedure in Chapter 3, "Replacement of a Connection from a Voltage Pin to a Via."

Erroneous Deep Deletion on a Single-board Assembly

If a single-board assembly is erroneously deep deleted, a replacement pin (part 453444) may be installed from the probe side of the board.

1. Install the pin driver bit, part 453774, (Figure 2-32) into the impact tool and then insert the replacement pin, part 453444, into the driver bit with the larger diameter of the pin against the driver bit.
2. Place the locating block (part 453778) in position so that the pin hole is aligned with the large hole of the locating block.
3. Place the replacement pin in the square hole of the driver (part 453774), place a drop of IBM Cleaning Fluid on the plastic sleeve with a suitable tool, and insert the pin into the locating block.
4. Exert pressure on the impact tool and drive the pin into the board until the driver head is flush with the board.
5. After the insertion of the pin, realign and lubricate the pins on the card side of the board with aligner tool, part 453868, and on the probe side with ground rail aligner, part 453777.
6. Replace all components previously removed.
7. Check pin height and plastic bushing on the probe side of board. If the pin height is not approximately the same as that of the adjacent pins, and the bushing is peened over the pin, replace the pin.

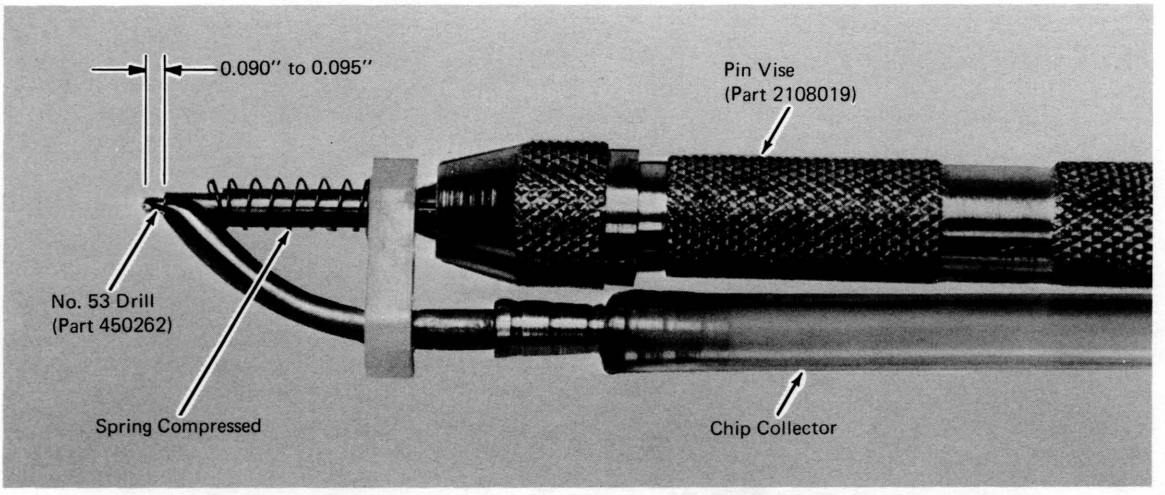


Figure 2-36. Chip Collector with No. 53 Drill

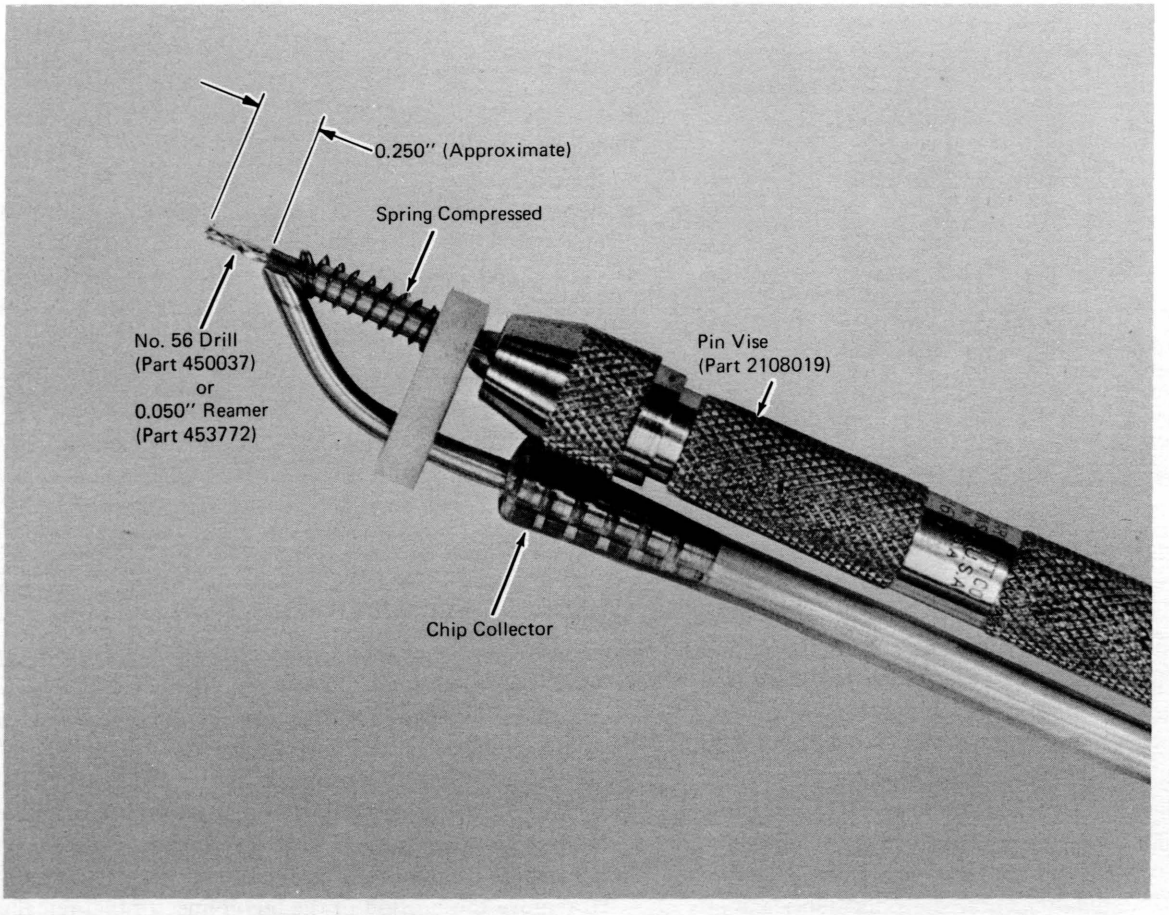


Figure 2-37. Chip Collector with No. 56 Drill or 0.050" Reamer

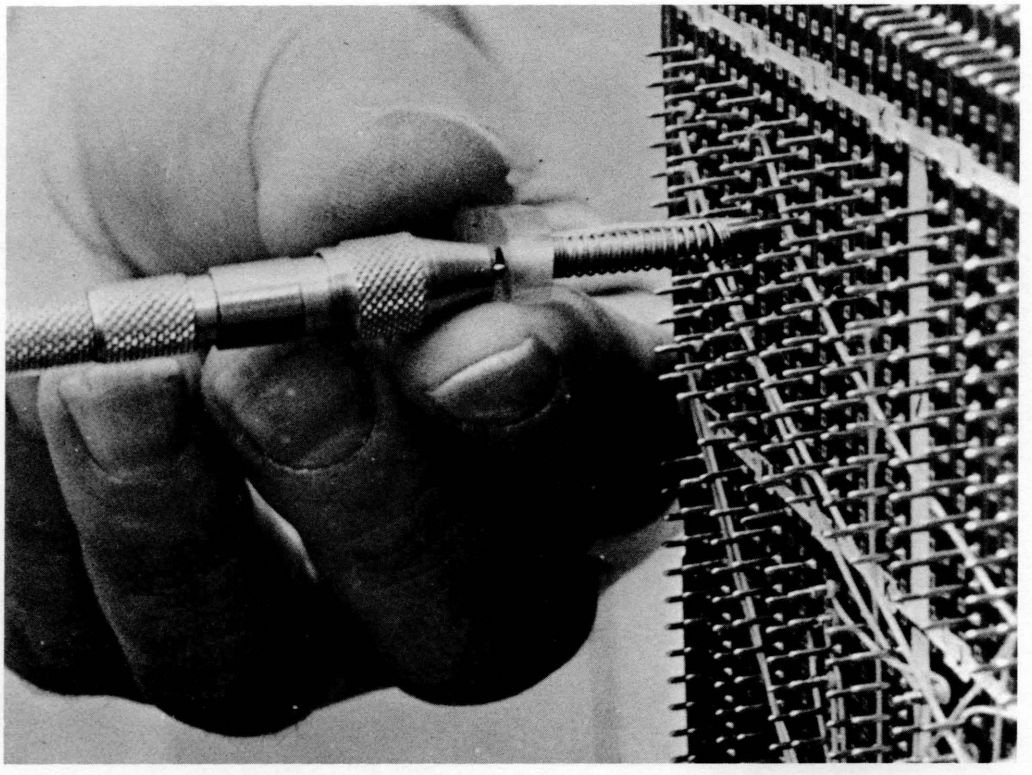


Figure 2-38. Drilling Hole for Replacement Pin

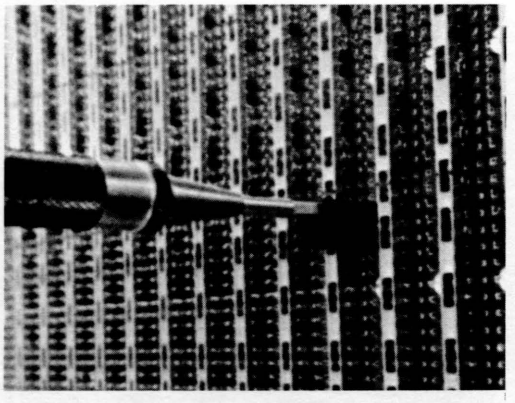


Figure 2-39. Inserting Replacement Pin

Pin Lubrication

The following procedure is to be used for only the pluggable indicator card positions:

1. If the pins to be lubricated are bent, follow procedure under "Pin Alignment."
2. Open the lubricant container (part 453391) and place the card side pin aligner (part 453868) into the lubricant, just touching the surface of the lubricant (Figure 2-40). Capillary action pulls the lubricant up into the aligner.
3. Holding the container firmly, remove the aligner from the lubricant and shake the excess lubricant from it into the container.
4. Wipe the bottom and sides of the aligner with a lint-free cloth.
5. Place the aligner on the socket position to be lubricated, being careful not to bottom the aligner on the board surface (Figure 2-40).
6. Repeat this procedure after a maximum of five positions have been lubricated.

Note: Check the container periodically for excessive lint and debris. When an excessive amount of lint and debris accumulates in the container, replace the container with a new assembly (part 453391).

LAMINAR BUS CONNECTOR REMOVAL

To remove a crimped bus connector from a tab on the laminar bus (Ⓐ, Figure 2-41), apply a load slowly as indicated in the figure with a pair of duckbill pliers. If difficulty is experienced, it may be necessary to reapply the load 30 degrees out of phase with the first trial. Apply the load until the connector is fractured as shown in Ⓑ, Figure 2-41. Be careful when removing the connector so that no metallic chips drop into the machine.

To remove the portion of the bus connector that remains attached to the lead, place the partial connector between

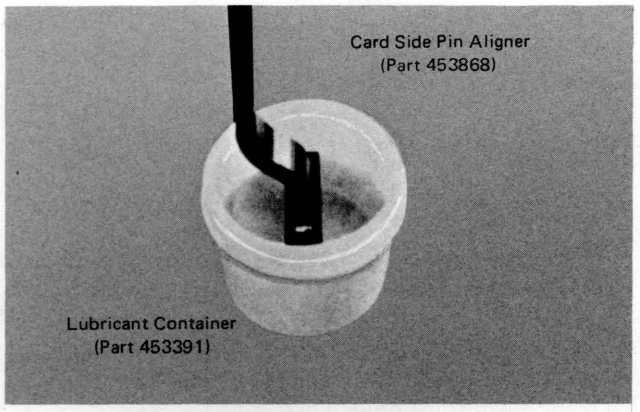


Figure 2-40. Applying Lubricant to Pin Aligner

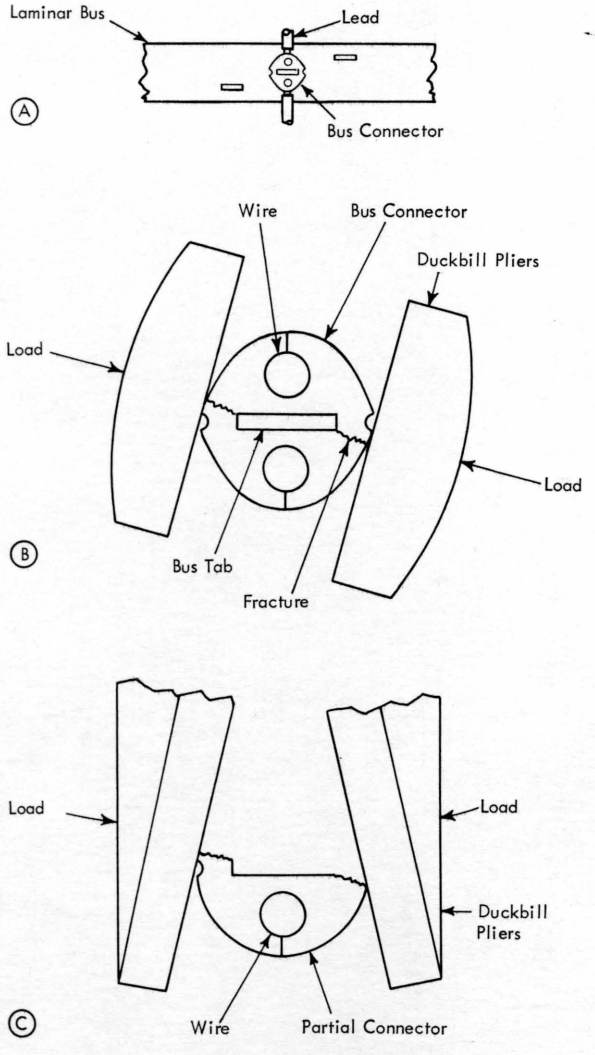


Figure 2-41. Laminar Bus Connector Removal

the jaws of the duckbill pliers as indicated in Ⓒ, Figure 2-41 and apply a load to open the crimp. While the load is being applied, pull the wire out of the connector perpendicular to the applied load.

Use a bus connector when replacing or adding leads to the laminar bus. Solder the connector to the tabs on the bus and to the leads simultaneously.

REMOVING A DECOUPLING CAPACITOR FROM A BOARD

To remove a decoupling capacitor from a board:

1. Remove about six cards from the area of the capacitor to be removed. This allows a sufficient working area.
2. Use a screwdriver that is 6 inches or less in length.
3. Grasp the screwdriver handle and carefully insert the tip of the screwdriver between the shoulder of the capacitor housing and the top edge of the stiffener and carefully rotate the screwdriver handle. The capacitor housing is disengaged from the board.

VOLTAGE CROSSOVER ASSEMBLY

The voltage crossover assembly electrically connects a laminar bus to a board. Each board is encompassed by a U-bus. Power is supplied to the board through the voltage connectors on both sides of the board.

The voltage crossover assembly is made up of four stranded, insulated wires. A tuning fork connector is attached to one end of the wire; the other end has a connector that is soldered to the laminar bus tab.

The voltage crossover assembly is oriented by the two locating holes that are on the toe or shoulder of the housing; these locating holes are always positioned on the board in the I/O area, facing toward the center of the board.

Removal

To remove a voltage crossover assembly, grasp the top portion of the plastic housing with a pair of duckbill pliers and pull upward, releasing the assembly from its position.

CAUTION

Do not try to remove the housing by pulling on the wires that protrude from the back of the housing. When the housing breaks free of the board, be sure to stop pulling on the housing. The other end of the wire is soldered to the laminar bus and the connection may be broken.

Replacement

Before replacing the voltage crossover assembly, ensure that the pins are straightened and aligned to within acceptable limits by using the pin aligner (part 453868).

To replace the assembly, grasp the crossover housing at the top and insert the housing into the designated area. The locating holes of the toe or shoulder of the housing should face the center of the board.

BOARD REPAIR

Open Printed Net Repair

A break in a printed net on a board can be caused by:

1. An erroneous deletion where a pin has been disconnected from a net.
2. A broken pin in an undeleted net.
3. An open circuit in a printed net.

To repair a break in a printed net:

1. Locate all the pins in the affected net, using the board discrete wire equivalent lists (by pin and by net).
2. Delete all the pins in the net.
3. Use the appropriate wire caddy to reconstruct the affected net, using the wire lengths specified in the board discrete wire equivalent list.

Shorted Printed Net Repair

Shorts that can exist are:

1. Net-to-net.
2. Net-to-voltage or ground plane.
3. Pin-to-voltage or ground plane.

Because it is difficult to determine the extent of the defect causing the short, replace the board as soon as possible.

To repair a short in a printed net:

1. Locate all the pins in the affected net, using the board discrete wire equivalent lists (by pin and by net).
2. Delete all the pins in the affected net.
3. Perform a continuity check between all the affected pins. Those pins that are still shorted must be replaced; see "Pin Replacement Procedures."
4. Use the appropriate wire caddy to reconstruct the affected net, using the lengths specified in the board discrete equivalent list.

Wiring change procedures define the methods used in performing board and cable rework. The engineering change procedures for boards are based on a single rework instruction philosophy. One set of rework instructions is sufficient to rework a board from one level to the next level, regardless of the level at which a board was manufactured and regardless of the number of engineering changes that may have been previously installed. The engineering change procedures have been made to fit the requirements of the MST-1, MST-2, and MST-4 families.

- **MST Wiring Rule Restrictions**

1. No stubs allowed. This requirement states that every subnet, which is deleted, (or 2 pin net) must be disconnected at both ends. This requirement is necessary to prevent circuit reflections.
2. Only defined wire types must be used. This requirement is necessary to prevent mismatching the impedance requirements of the technology.
3. Only defined wire lengths must be used. This requirement is due to the critical circuit speeds at which MST operates. Incorrect wire lengths change circuit timings and can affect machine operation.
4. A maximum of two connections per pin. This requirement is due to the fact that all printed connections must be capable of being duplicated in discrete wiring. The physical restrictions of discrete wiring are such that only two wires may be placed on a single pin.

The procedures must be followed exactly, as any deviation from the procedures and their sequence may result in *additional work* and *unnecessary machine downtime.*

- **Hardware Restrictions**

1. A housing is not reusable. When a housing containing one or two wires has a wire removed, a new wire (or the same wire) may not be plugged back into the housing. The reason for this restriction is that the plastic housing is internally damaged by the tuning forks when the wire is removed. This may cause the connectors to back off the pins. All additions of wire (using the tuning fork connective system) to an existing wire are performed by removing the existing wire from its housing and plugging the removed wire into the housing of the added wire. All wires to be added during an engineering change or error recovery contain housings on both ends. There are spare housings in the tri-lead wire caddies.
2. Miniature plug-on terminating resistors *cannot* be removed from their housings due to the method by which the part is manufactured and assembled. Attempts to remove the resistor from the housing will cause damage to the resistor. All deleted terminating resistors must be discarded. Added terminating resistors will be included in the engineering change. There are spare terminating resistors in the tri-lead wire caddies.

Note: A tri-lead wire removal from a housing that contains a miniature plug-on terminating resistor will result in both the wire and the terminator being removed as a unit. If the terminator is not called out to be removed, it must be treated similar to secondary wire removal. The rework instructions must be marked to indicate that the terminator is to be added back during the add operations.

TERMINOLOGY USED IN REWORK

Logic Pin

Board pin used for communication to the logic circuits on a card.

I/O Pin (Dedicated)

Board pin used for communication off the board by a cable. I/O pins are identified in the rework documentation with a "■" next to the pin coordinate.

I/O Logic Pin

Board pin used for both communication to card logic circuits and communication off the board by a cable. I/O logic pins are identified in the rework documentation with an "*" next to the pin coordinate. I/O logic pins not connected to other board pins are called "one-pin nets." I/O logic pins are used on MST boards where there is discrete cabling on the probe side of the board.

Net

Wiring on the MST board is made up of nets. A net is two or more board pins connected electrically; it has one or more subnets. A wiring change is an alteration to the connections in existing nets or the creation of new nets by the removal or additon of subnets. A net image is shown in Figure 3-1.

Stub

A stub is a printed or discrete wire disconnected at one end. Deletion of subnets can create stubs when one end of a subnet is deleted, leaving the other end connected to a pin.

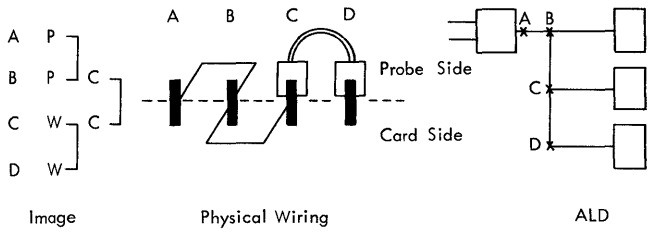
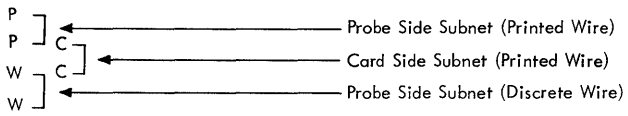


Figure 3-1. Board Net

MST cannot tolerate stubs left on pins after rework is completed because of the generation of reflections that can cause intermittent errors in machine function. Care should be used when deleting board wiring to ensure that no stubs are left on the board.

Subnet

A subnet is the electrical connection between two board pins and it can be either a printed or discrete wire connection. In a net image as shown on the add-delete rework instructions, a subnet appears as shown in Figure 3-2.



• Figure 3-2. Subnets

Discrete Wire

Discrete wires are used on new boards because it is not always possible to make the necessary connections with printed wires. Discrete wires also appear on a board as a result of engineering change activity because discrete wire is the only way a customer engineer can interconnect pins. Different types and lengths of wire are used in rework, depending on the circuit speed and circuit impedance and only the type and length of wire as specified in the rework documentation must be used.

In the rework documentation, the types of discrete wires specified have the following abbreviations:

Abbreviation	*Definition*
CX	Coaxial wire
FTR	50-ohm tri-lead
FTW	50-ohm twin-lead
NTR	90-ohm tri-lead
NTW	90-ohm twin-lead
TW	Twisted pair
Yel	Yellow wire, #30 AWG

Printed Wire

Most wiring from pin to pin on the MST board is printed wiring that is distributed between the signal planes on the board. Two types of boards are available: a single-layer board and a double-layer board. Card side printed connections on both board types are deleted by using a shallow delete tool. Probe side printed connections, depending on the board, are deleted by using a deep or shallow delete tool as specified on the EC instructions.

CAUTION

The tool to be used on the probe side of a board is specified on the rework documentation, and only the type of tool specified must be used to avoid damage to the boards.

Deep Delete

MST double boards contain printed signal lines on the surface of the board and also in the interior of the board at a depth which requires a deep delete. On a double board, the interior signal line closest to the probe side of the board can be connected to a pin. The interior signal line closest to the card side of the board is never connected to a pin. Therefore, deletes on the probe side of double boards are always deep deletes to ensure severing both the surface and the interior signal connection; deletes on the card side are always shallow deletes which sever only the surface printed connection.

The depth of cut of a deep delete is 0.090"-0.095" for a MST-2 double board and 0.085"-0.090" for a MST-4 double board. The MST-2 and MST-4 ferrules use the same cutter, with the depth of cut being governed by the shoulder of the ferrule. Caution and care must be used when selecting the proper delete ferrule prior to performing board deletes.

If a deep delete is performed on a single-layer board, the pin will be cut out of the board. If a deep delete is performed on both sides of a pin on a double board, the pin will be cut out of the board. Care should be used when operating the deep delete tool to *ensure that full depth of penetration* has been made.

Shallow Delete

Most MST single boards contain printed signal lines only on the surface of the probe side and card side of the board. There is one type of single board that contains not only the surface signal lines but also *shallow* buried printed signal lines on the probe side and card side of the boards which are severed by using the shallow delete cutter. All deletes on single-layer boards are performed with the shallow delete cutter. In addition, card side deletes on all double-layer boards are performed with the shallow delete cutter.

The depth of cut when using the shallow delete cutter is 0.015"-0.017"; the depth of cut is governed by the shoulder of the ferrule. Care should be used when operating the shallow delete tool to *ensure that full depth of penetration* has been made.

BOARD REWORK

- Rework is directed by engineering change instructions.
- Rework is done by removing (printed or discrete) subnets and adding (discrete) subnets.
- All board deletions are done first and wire additions are done last.
- Instructions include a list of all pins in the affected net.
- New jumper assemblies and/or wires for rework for tri-lead or twisted pair are included in the bill of material (B/M).
- Yellow (#30 AWG) wire for rework and net reconstruction is in the wire caddy.

Board rework includes the deletion of printed circuitry and the reconstruction of the net affected by the engineering change. Board deletions are done first, followed by the wire additions for net reconstruction.

Board Add-Delete Rework Instructions

The add-delete rework format is designed to provide the information required by the customer engineer to make changes to the board wiring. The instructions show:

1. Total board net prior to rework.
2. Total net as it must appear after rework.
3. Pins and subnets being deleted.
4. Pins and subnets being added.
5. Subnets being relocated to other nets.
6. Add wire type and length.
7. Terminating resistors being removed.
8. Terminating resistors being added.
9. I/O pin identification.
10. Pins to be checked as removed after rework.
11. Net sequence number.

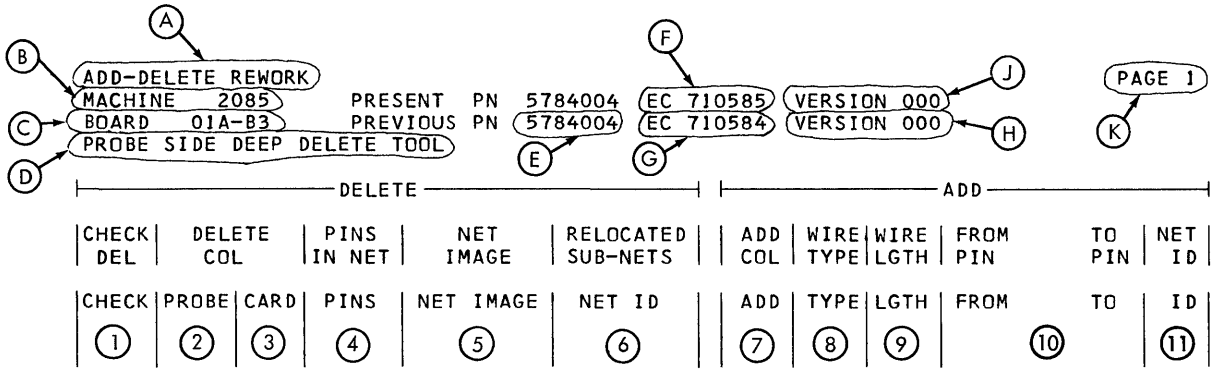
Format

The format for the board add-delete rework instruction is shown in Figure 3-3. The upper half of Figure 3-3 (A through K) shows the following general information headings:

A. Document title.
B. Machine type affected.
C. Location of the board affected.
D. Delete tool to be used for probe side deletions (shallow or deep).
E. Part number of the board affected.
F. EC level of the board after rework.
G. EC level of the board before rework.
H. Previous board version number.
J. New board version number.
K. Number of rework instruction pages in numeric sequence.

The lower portion of Figure 3-3 (1 through 11) is divided into two parts: delete and add. A description of each column is:

1. *Check Del:* This column is for checking purposes and shows the *pins which do not appear* in the net after rework is completed. Pins deleted from a net are checked when rework is completed.
2. *Delete Col (Probe):* This column shows the number of probe side connections to be deleted from a pin. A "0*" in this column shows that there are no probe side connections to the pin, but the pin must be inspected for the presence of a discrete wire that can be substituted for a card side printed connection that is specified to be deleted. A "T" in this column indicates removal of a terminating resistor.
3. *Delete Col (Card):* This column shows the number of printed card side connections to be deleted from a pin.



Note: Also see Figure 3-6.

Figure 3-3. Rework Instruction Format

4. *Pins in Net:* This column lists all the pins in the net before rework. Each pin is shown using the pin location coordinate. I/O pins are identified by one of two special characters next to the pin coordinate (■ or *): either case denotes the presence of a cable. The presence of a terminating resistor is identified by a "T" next to the pin coordinate.
5. *Net Image:* This column shows the net number and image of the net which allows the customer engineer to select the correct check pins when deleting printed connections in a net. The net is shown as it appears in printed or discrete wire connections in the latest image. In the image, a "P" indicates a probe side printed connection and a "C" indicates a card side printed connection. Any of the connections may be in discrete wire as a result of repairs or previous changes to the net. A "W" indicates a connection in wire.
6. *Relocated Subnets (Net ID):* This column shows the subnets being deleted from the original net and relocated in another net. The number shown in this column, adjacent to the subnet being relocated, identifies the net in which the subnet is reused; this allows the customer engineer to transfer add information concerning a relocated subnet to the add portion of the net in which the subnet is reused. It is only necessary to transfer add information concerning a relocatable subnet if the subnet, for any reason, cannot be salvaged.
7. *Add Col:* This column specifies the connections to be added in discrete wire. Terminating resistors to be added are also specified in this column. An "XXX" entry in this column denotes that a wire or terminating resistor is to be added to the corresponding subnet or pin.
8. *Wire Type:* This column shows the type of wire or terminator to be used for any connection in the resultant net. Terminating resistors are specified as "T" following the value of the resistor (in ohms); for example, 50T.
9. *Wire Lgth:* This column specifies the length of wire to be used for any connection in the resultant net. The length is specified in inches and tenths of an inch.
10. *From-to-Pin:* This column lists the "From Pin" and "To Pin" for wire additions and shows the total net as it must appear after rework; the "From" portion of this column shows all the pins in the net. I/O pins are identified by one of two special characters (■ and *) next to the pin coordinates. The presence of a terminating resistor is shown by a "T" next to the pin coordinate.
11. *Net ID:* This column shows the number attached to the nets in numeric sequence for identification purposes. The number in this column is the number referred to in the relocated subnets column.

The statement "End of Rework for Board XXX-XX" appears following the last net to be reworked on that board.

Methods of Rework

The wiring on an MST board is comprised of printed and discrete wire subnets. The subnets are used as building elements in the construction of various net configurations. Board wiring is changed by the removal and addition of subnets. The physical construction of a net can appear in discrete wire, printed wire, or as a mixture of discrete and printed wires.

The maximum number of connections to a pin is two. To allow all nets to be reconstructed in discrete wire, all subnets are wired pin to pin.

All combinations of nets and wire types are handled by one set of rework instructions which, in conjunction with the error recovery documentation, make it possible to change and repair board wiring at the installation.

Deletion

Printed wiring on the MST boards is distributed on the card and probe sides of the board; discrete wiring appears only on the probe side. Single-layer boards, require the use of the shallow delete tool on both sides of the board. The double-board assemblies have printed wire connections to pins on three of the four signal planes; two are on the outside surfaces and one is internal. Probe side deletions on this board require the use of the deep delete tool. This ensures the deletion of the probe side surface printed wiring and the buried surface printed wiring. To perform a deletion on the card side of the double-board assembly, use the shallow delete tool. The type of probe side delete tool, deep or shallow, to be used in the rework of a given board is specified in the heading on the rework instruction.

CAUTION

Card side deletions must always be performed by using the shallow delete tool.

The delete columns in the rework instructions specify the number of connections to be removed from a pin and the chain of entries shows the subnets to be deleted on the probe and card sides of the board. A card side connection can, however, appear as discrete wire on the probe side and "0*" indicates that the customer engineer must check for the presence of a wire that can be substituted for a card side printed connection.

Because of the "no stubs allowed" rule dictated by the technology, deletions are often propagated because of the physical construction of a net, and the rework instructions specify the connections which must be deleted to ensure that no stubs are left on the board.

Secondary Wire

When yellow wire is used for discrete wiring on the board, there will be occasions when deletions terminated at a pin require the removal of a wire not specified in the instructions. This occurs when a wire is removed under a second wrap or when a wire must be unwrapped to delete a probe side printed connection. In these cases, where the customer engineer must remove wire other than that specified in the rework instructions (secondary wire), the customer engineer must manually insert "XXX" in the add column of the appropriate add subnet entry. This may be either in the same net or in another net. If the subnet does not appear in the add portion of the same net, the identification in the relocated subnets column specifies the net where this subnet can be found. When encapsulated tri-lead wire is used for discrete wiring on the board there may be instances when deletions terminated at a pin require the removal of a wire which shares a housing with a wire which does need deletion. In this case, the wire to be deleted is extracted from the housing containing both wires. The housing and remaining wire are replugged onto the board pin from which they had been removed.

For deleting a miniature plug-on terminating resistor which shares a housing with an encapsulated tri-lead wire, the *wire* is removed from the housing. The housing containing the terminator is discarded, a spare housing is obtained from the tri-lead wire caddy and is assembled to the removed wire and replugged on the same board pin.

Relocateable Subnets and Salvageable Subnets

The relocated subnets column in the rework instructions specifies the *salvageable subnets* that are reused in another net. A subnet is salvageable if the subnet in the net image is intact after deletions to the net are completed. Therefore, no add information is specified for a salvageable subnet in the add portion of the net where this subnet is relocated. Action should be taken only when a relocateable subnet is removed during the deletion as a result of a secondary operation or error deletion; it is then necessary to specify the subnet as a connection to be added in the net where the subnet is relocated.

Additions

The only way to interconnect board pins at the installation is by the use of discrete wires. The rework instructions specify the wire type and length for each appropriate subnet in the resultant net, and only the wires specified must be used for wire additions because of the critical timing and noise conditions that exist. Connections that must be made as a result of previous deletions to the net or additions or new subnets in the net are specified by "XXX" in the add column of the appropriate add subnet entry. If a connection is removed erroneously or as a result of a secondary involvement during the delete rework, the customer engineer must manually enter "XXX" in the add column of the appropriate add subnet.

General Sequence of Rework

For MST-1 the sequence for performing engineering change rework is the same as used in SLT. For MST-2 and MST-4 the sequence for performing engineering change rework is as follows:

1. Remove all cards (if card side deletes are required) and place in card caddy, part 453769.
2. Perform all cable deletes.
3. Perform all probe side deletes (including wire removals).
4. Perform visual check procedure on all last pins of a net of the probe side deletes.
5. Perform all card side deletes.
6. Perform visual check procedure on all last pins of a net of the card side deletes.
7. Perform all wire adds.
8. Perform all cable adds.
9. Perform net check of board rework.
10. Perform check of all cable rework.
11. Perform all card deletes and adds (while the cards are in the card caddy).
12. Replug all cards.

Board Rework Procedures

In the type of MST that uses probe side cabling, board add-delete rework is iniated on completion of the cable removals (if any) and no cable additions should be done until the board add-delete rework is completed. This sequence is established to ensure a minimum number of physical operations and to reduce the EC installation time.

Board rework requires all probe side printed and discrete wire deletions to be reworked first, followed by card side printed deletions. When the deletions are completed, relocateable subnet information is transferred to the add portion and then the wire additions are done. No wire additions must be done until all deletions have been completed. This is required because a wire may be added to a pin which is specified to be deleted later in the rework instructions, and this results in incorrect rework.

The procedures for board rework are shown in a detailed flowchart in Figure 3-23. The flowchart can be used for all MST environments, but the physical operations required to obtain the operations specified in the flowchart vary according to the environment. A description of these physical operations is given in the following sections. This information should be used as a supplement to the procedure flowchart.

Physical Operations

The physical operations to be performed in MST board rework vary because of the different boards, wires, and cables used in MST-1, MST-2, and MST-4. The list under "Printed Wire Deletion" shows the physical operations for each technology. This list describes the actions that must be taken, depending on the actual physical configuration of the board net being reworked. (Figure 3-4 shows the technology groups and their associated environments.) Only operations that vary by technology are listed.

Printed Wire Deletion

When performing deep or shallow deletes, it is important that the delete tool be used as described in the tool section of this manual. Emphasis should be placed on that portion of the delete operation which deals with the completed operation. The cutter, deep or shallow, should always penetrate to its maximum depth to prevent leaving a printed circuit connection to a pin in the interior of the board. Leaving this connection would result in a stub on the pin which may cause machine malfunctions. The continuity light on the delete tool is used to locate the proper pins and to check if the connection has been severed in those cases where applicable. In no case should the delete operation be ended as soon as the light goes out.

Technology	*Physical Operation*	*Action*
MST-1 MST-2 MST-4	Check Pin Available	1. Locate the check pin and attach one end of the continuity checker. 2. Locate the delete pin. 3. Perform the deletion. 4. Mark the instructions.
MST-1 MST-2 MST-4	No Check Pin Available	1. Locate the delete pin. 2. Perform the deletion. 3. Check the deletion visually. 4. Mark the instructions.
MST-1 MST-2 (Single Board)	Yellow Wire Removal	1. Locate the pin. 2. Unwrap the wire. 3. Locate the other end of the wire. 4. Unwrap the other end of the wire. 5. Mark the instructions.
MST-1 MST-2 (Single Board)	Yellow Wire Addition	1. Locate the "From" pin. 2. Wrap the wire. 3. Locate the "To" pin. 4. Wrap the wire. 5. Mark the instructions.
MST-2 MST-4	Printed Wire Deletion under a housing (Ⓐ, Figure 3-5)	1. Locate the check pin (if available). 2. Locate the delete pin. 3. Remove the housing (J). 4. Perform the deletion. 5. Replug the housing (J on pin A). 6. Mark the instructions.
MST-2	Printed Wire Deletion under a Yellow Wire	1. Locate the check pin (if available). 2. Locate the delete pin. 3. Unwrap and remove the wire end. 4. Locate other end of wire. 5. Unwrap the other end of wire. 6. Mark add side of rework instructions to re-add the wire. 7 Relocate the delete pin. 8. Perform the deletion. 9. Mark the instructions.
MST-2 (Single Board)	Yellow Wire Removal under a Housing (Ⓑ, Figure 3-5)	1. Locate the pin. 2. Remove the housing (J). 3. Unwrap end of wire. 4. Replace the housing (J) on pin A). 5. Locate the other end of the wire. 6. Unwrap the other end of the wire and remove. 7. Mark the instructions.
MST-2 MST-4	Tri-lead Wire Removal from a Housing (Encapsulated Wire) (Ⓒ Figure 3-5)	1. Locate the pin. 2. Remove the housing (J). 3. Remove the wire to be removed from the housing (J). 4. Replug the housing (J on pin A). 5. Locate the other end of wire. 6. Remove the other end of the wire (housing K from pin B). 7. Mark the instructions.

Note: Removal of encapsulated tri-lead wire must always be done using pliers as described in the tool section. Removals of encapsulated tri-lead wire must never be done by pulling on the wire itself since the force necessary to pull the encapsulated wire from the housing exceeds the force at which elongation and possible breakage of the wire occurs.

Technology	*Physical Operation*	*Action*
MST-2 (Single Board)	Yellow Wire Addition under a Housing	1. Locate the pin. 2. Remove the housing. 3. Route the wire under or around the ground rail. 4. Wrap the wire. 5. Inspect the wrap. 6. Replace the housing. 7. Locate the "To" pin. 8. Wrap the wire. 9. Mark the instructions.
MST-2 MST-4	Single Tri-lead Wire Addition	1. Locate the correct wire. 2. Locate the "From" pin. 3. Plug the housing. 4. Locate the "To" pin. 5. Plug the housing. 6. Mark the instructions.

Technology	*Physical Operation*	*Action*
MST-2 MST-4	Tri-lead Wire Addition to an Existing Housing (Encapsulated Wire)	1. Locate the correct wire. 2. Locate the pin. 3. Remove the housing from pin. 4. Disconnect the housing from the board wire. Discard housing. 5. Insert the board wire into the add wire housing. 6. Replug the housing. 7. Locate the "To" pin. 8. Plug the housing. 9. Mark the instructions.

Note: When adding encapsulated wire into a connector housing, be sure that the signal and ground tuning forks are oriented in the housing. The triangular portion of the encapsulation should always slope toward the signal side or T-bar side of the housing. This can be used as a quick visual check for tuning fork and housing orientation and is especially useful during debugging of a grounded net after installing board engineering changes.

Technology	*Physical Operation*	*Action*
MST-2 MST-4	Addition of a Terminating Resistor to a Bare Pin (Encapsulated and Miniature Terminator)	1. Locate the pin. 2. Plug terminating resistor housing onto the pin. 3. Mark the instructions
MST-2 MST-4	Removal of a Terminating Resistor from a Bare Pin (Encapsulated and Miniature Terminator)	1. Locate the pin. 2. Remove terminating resistor housing from pin. 3. Mark the instructions.
MST-2 MST-4	Addition of a Terminating Resistor to an Existing Housing (Encapsulated and Miniature Terminator)	1. Locate the pin. 2. Remove the housing from pin. 3. Disconnect the housing from the board wire. 4. Discard housing. 5. For encapsulated resistor, obtain new housing and assemble to resistor. 6. Insert board wire into the terminating resistor housing. (See Note.) 7. Plug the terminating resistor housing onto pin. 8. Mark the instructions.

Note: For encapsulated terminating resistors, add wire to the flat side of the terminating resistor. For miniature terminating resistors, add wire to the flat side (colored) side of the terminating resistor.

Technology	*Physical Operation*	*Action*
MST-2 MST-4	Removal of a Terminating Resistor from an Existing Housing (Miniature Terminator)	1. Locate the pin. 2. Remove the housing from pin. 3. Disconnect the board wire from the housing. 4. Discard housing containing terminator. 5. Obtain new housing from wire caddy or stock. 6. Insert board wire into new housing. 7. Replug housing on pin. 8. Mark the instructions.
MST-2 MST-4	Removal of a Terminating Resistor from an Existing Housing (Encapsulated Terminator)	1. Locate the pin. 2. Remove the housing from pin. 3. Remove only the terminator from the housing. 4. Replug housing on pin. 5. Mark the instructions.
MST-2 MST-4	Removal of a Wire from an Existing Housing Containing a Terminator Resistor (Miniature Terminator)	1. Locate the pin. 2. Remove the housing from pin (contains both wire and miniature terminating resistor). 3. Locate the other end of wire. 4. Remove the other end of wire from pin. 5. Discard wire (contains miniature terminating resistor). 6. Mark instructions to indicate a terminator must be added during add operations. 7. Mark the instructions (for wire delete).
MST-2 MST-4	Removal of a Wire from an Existing Housing Containing a Terminating Resistor (Encapsulated)	1. Locate the pin. 2. Remove the housing from pin (contains both wire and encapsulated terminating resistor). 3. Remove the wire from the housing (leave terminator in housing). 4. Replug housing (containing terminator) on pin. 5. Remove the other end of wire from pin. 6. Mark the instructions (for wire delete).

Technology	*Physical Operation*	*Action*
MST-4	Twisted-pair Wire Removal from a Housing (Unencapsulated Wire)	1. Locate the pin. 2. Remove the housing. 3. Cut the signal and ground wire of the wire to be removed as close as possible to the tuning forks. 4. Inspect to ensure that no short circuit exists. 5. Replace the housing. 6. Locate the other end of the wire. 7. Remove the housing. 8. Mark the instructions.
MST-4	Addition of a Twisted-pair Wire to a Housing (Unencapsulated Wire)	1. Locate the "From" pin. 2. Remove the housing. 3. Remove the tuning forks from the housing, using the tuning fork extract tool. 4. Place the tuning forks of the add wire and the tuning forks of the existing wire with the two signal and the two ground tuning forks back-to-back with the flat side of the crimped connectors. Hold with pliers. 5. Use the housing that accepts four tuning forks and insert the two pair of tuning forks into the housing, maintaining ground and signal relationship. 6. Replug the housing. 7. Locate the "To" pin. 8. Insert the housing. 9. Mark the instructions.
MST-4	Twisted-pair Wire Removal from a Conductive Mid-air Splice (Ⓓ, Figure 3-5)	1. Locate the pin (*), pin A. 2. Trace the pigtail to the mid-air splice (housings M and L). 3. Dissassemble the mid-air splice. 4. Remove the housing (J) with the pigtail from pin A. 5. Insert the cable housing (M) onto pin A. 6. Locate the other end of the board wire. 7. Remove the other end of the wire (housing K from pin B). 8. Mark the instructions.
MST-4	Twisted-pair Wire Removal from Nonconductive Mid-air Splice (Ⓔ, Figure 3-5)	1. Locate the pin (■), pin A. 2. Trace the nonconductive lead to the mid-air splice (J to connectors M and L). 3. Remove the wire housing (L) from the mid-air splice. 4. Locate the other end of the wire (housing K). 5. Remove the other end of the wire (housing K from pin B). 6. Mark the instructions.
MST-4	Twisted-pair Wire Addition to a Cable	1. Locate the pin (*). 2. Remove the cable connector. 3. Insert the cable into a conductive mid-air splice. 4. Insert the pigtail connector into the mid-air splice. 5. Insert the connector containing the pigtail and board wire onto the pin. 6. Locate the "To" end of the wire. 7. Insert the housing. 8. Mark the instructions.
MST-4	Twisted-pair Wire Addition to a Cable	1. Locate the pin (■). 2. Remove the cable connector. 3. Insert the cable connector into a nonconductive mid-air splice. 4. Insert the board wire connector into the mid-air splice. 5. Insert the nonconductive lead connector onto the pin (■). 6. Locate the "To" pin. 7. Insert the board wire connector. 8. Mark the instructions.

Note: For MST-4 using twisted-pair board wires, the engineering change wires are supplied with the B/M as jumper assemblies that match the net configurations specified in the add columns of the rework instructions. An identifier (a mark or label) will be on the housing which is to be inserted on the first pin in the add "From" column. Subsequent housings in the assembly are plugged in sequence according to the pins listed in the add "From-To" columns. For MST-2 and MST-4 using encapsulated tri-lead board wires, the engineering change wires will be included in the B/M as individual wires containing housings on both ends. For MST-1 and MST-2 using yellow board wires, the engineering change wires will be obtained from the yellow wire caddy.

Technology	Board Type	Board Wire	Ground Rails	Cable Type	Delete Tool
MST-1	Single Layer	Yellow Wire	None	Flat Card Side Cables	Shallow Both Sides
MST-2	Single Layer	Yellow Wire	Periphery Sockets	Tri-lead Cables	Shallow Both Sides
	Double Layer	Tri-lead Wire	All Sockets	Tri-lead Cables	Deep Probe Side
					Shallow Card Side
MST-4	Double Layer	Twisted-pair or Tri-lead Wire	All Sockets	Coxial or Tri-lead Cables	Deep Probe Side
					Shallow Card Side

Figure 3-4. Technologies and Physical Characteristics

Six-pack Operations

For machines using permanent six-packs the following procedures should be used:

Removal:

1. Grasp the center edge of six-pack with duckbill pliers or fingers.
2. Use a rocking motion and pull the six-pack from the board. Care should be used when pulling to prevent wire breakage.

Replacement:

1. Be certain all housings are aligned in their most upward position in the retainer.
2. Grasp the center edge of six-pack with duckbill pliers or fingers.
3. Locate the proper six pin card quadrant.
4. Push the six-pack, while using a rocking motion, onto the board pins until fully seated.
5. Visually check the six-pack housings to ensure housings are on proper pins (no housings plugged between pins and that the six-pack is not plugged one pin off).

Removal of a Housing from a Six-pack:

1. Locate the six-pack containing the housing to be removed.
2. Remove the six-pack.
3. Locate the housing to be removed within the six-pack.
4. Slide housing towards bottom of retainer approximately 1/8".
5. Grasp the protruding end of the housing and cam housing away from and out of the slot in the retainer.
6. Perform the required operation with the removed housing.
7. Replace housing in retainer by performing steps 4 and 5 in reverse.

General Housekeeping Procedures

Proper marking of the instructions is essential to the successful installation of an engineering change on a board. The following housekeeping procedures must be followed:

1. When a deletion is done by removing a wire or wires, cross out the appropriate subnet in the net image column using a single diagonal stroke.

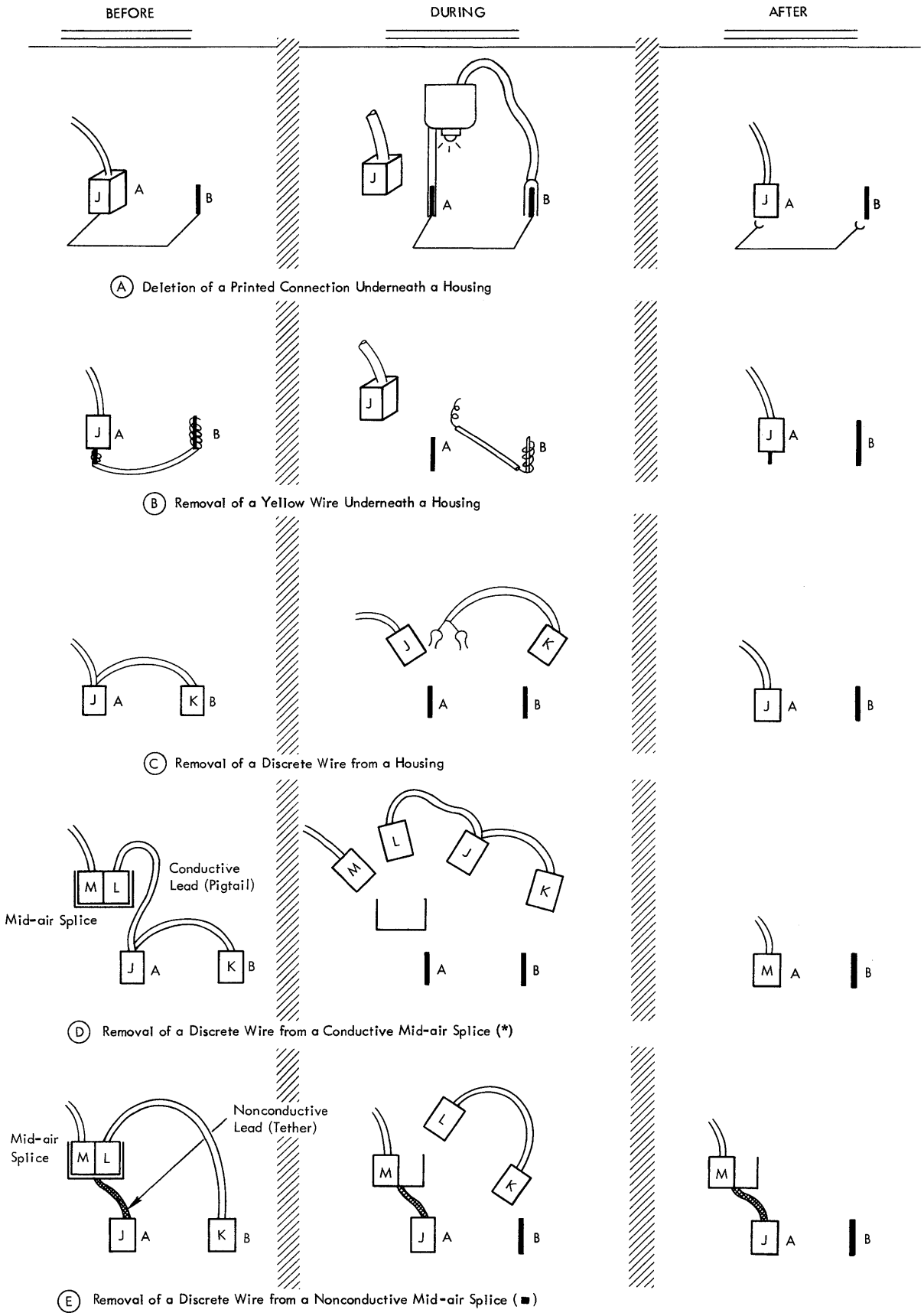


Figure 3-5. Examples of Pin Deletion

2. When a deletion is done using the delete tool, cross out the letters "P" and "C" in the net image column. When both ends of a subnet are deleted, cross out the appropriate subnet in the net image column using a single diagonal stroke.
3. When an appropriate addition is completed, cross out the "XXX" entry in the add column.
4. When forced to remove a secondary wire, and the subnet has an identification number in relocated subnets column, circle the identification number. If the subnet appears in the add portion of the net, enter "XXX" in the add column to indicate that this wire should be re-added when performing wire additions.
5. When a terminating resistor is removed, cross out the "T" in the probe delete column.
6. When a terminating resistor is removed due to secondary involvement, enter "XXX" in the add column to indicate that this terminator should be re-added when performing wire additions.

CABLE AND BOARD REWORK CHECKING PROCEDURE

On completion of cable and board rework, some checking system is required to ensure that rework was done as specified in the rework instructions. The following checking procedure should be followed.

Cable rework is checked on the probe side of the board for machines with discrete cables. The cable removals are checked at the "From" and "To" locations as specified in the cable removal instructions. A cable may, however, have been added at the same location. Refer to the cable add instructions when a cable is found at a cable removal location to determine whether the correct cable was removed.

Cable additions are checked according to the cable add rework instructions:

1. Locate the "From" end of the cable.
2. Attach one end of the continuity checker to the signal connector on the cable.
3. Touch the probe of the continuity checker to a ground pin or ground rail. If continuity exists, appropriate debugging action must be taken.
4. Locate the "To" end of the cable and touch the signal connector with the probe tip of the continuity checker. If continuity cannot be established, appropriate debugging action must be taken.

The board add-delete rework is checked on the probe side of an MST-1 board. The MST-2 and MST-4 boards are checked on the card side of the board with the cards removed. Board rework is checked as specified in the board rework instructions.

Any pin listed in the add "From" column should, according to the net, have continuity to all other pins in that net. When a multiconductor wire is used for board wiring, check to see that no continuity exists between the signal and ground pins. Continuity should not exist between a pin being deleted from a net and any pin in the resultant net. Pins deleted from a net are identified in the check delete columns with an "*."

The board rework checking operations are:

1. Read the rework instructions (add portion).
2. Locate the last pin listed in the wire add "From" column.
3. Attach one end of the continuity checker to the last pin listed in the wire add "From" column.
4. Touch the probe tip of the continuity checker to the ground pin in the same socket position with the last pin listed in the wire add "From" column. If continuity to ground is established, appropriate debugging action must be taken before proceeding to the following steps.
5. Touch the probe tip of the continuity checker to each of the pins listed in the "From pin" column for that net. If discontinuity exists, appropriate debugging action must be taken.
6. Continuity should not exist between the pin ("*" in check delete column) deleted from a net and any pin in the resultant net ("From Pin" column).
7. For a delete only net, the check column will contain an asterisk (*) for each pin. Checking for these nets is done using the delete side of the rework instructions. Attach one end of the continuity checker to the end pin of the net and check all pins for *discontinuity*. If continuity exists, scan the add side of the rework instructions to see if the deleted pins have been reused in another net. If not, appropriate debug action must be taken.

Note: To check a net on MST-4 boards using coaxial cable, continuity must be established to the I/O pins on the probe side of the board. This requirement is necessary because all wire additions to the I/O area are made through the mid-air splice; no electrical connection is made to the I/O pin involved.

Rework of a Single Board

Figure 3-6 shows an example of the add-delete rework instructions for MST-1 and MST-2 single-layer boards. Figure 3-11 shows an example of the add-delete rework instructions for the MST-2 and MST-4 double-layer boards. Figure 3-15 is an example of the card portion of any add-delete rework instruction. Nets are assumed to be wired in the machine as shown in the right margin of the figures. (This information is not included in the actual rework instructions.) PS and CS indicate pin side and card side. Assume the board is to be reworked in the machine. The machine, gate, and board locations are given in the general headings. The part number and EC level on the board must be the same as the part number and EC level in the headings of the instruction. The delete tool for probe side deletions must be available as specified in the heading. All probe side deletions are done first (wire or printed) for all nets, then all card side printed circuit deletions, and finally all wire additions.

The following procedure is used for reworking an MST-1 and MST-2 single-layer board (Figure 3-6)– shallow delete tool; probe side and card side.

Checking Procedures

When performing printed circuit deletes, select an end pin of a net for the check pin. In addition, choose the end pin that is not under an I/O or overflow wire housing (when applicable) to aid in checking the delete of the check pin.

By selecting an end pin for the check pin, location of all other pins to be deleted can be verified by the continuity light on the power delete tool. This will minimize pin location errors. However, by using this method, certain pins in the net which contain both probe and card side connections will not show discontinuity after the delete operation. This is another reason why a delete, either deep or shallow, must be performed properly with the cutter penetrating the board to its maximum depth.

The procedure to be followed is to circle the pin selected as the check pin on the rework instructions. After all probe side and card side printed deletes have been performed, and prior to wire adds, visually recheck those pins circled on the rework instructions to determine if the delete has actually been made. When a circled pin is found that has not been deleted, perform the required delete. If the rework instructions indicate the omitted pin was marked as deleted, an error has been made and debug action will be required.

If machine problems occur after an engineering change has been installed and all net checking has been performed, a follow up check on cables, both flat and discrete, should be made. For machines using tri-lead, check for housings which may have been pulled loose. Also check I/O cable plug locations on those I/O cables indicated on the add side of the rework instructions for proper plugging.

ADD - DELETE REWORK PAGE 1

MACHINE 20XX PRESENT PN 578001 EC 710002 VERSION 000

BOARD 01A-B3 PREVIOUS PN 578001 EC 710001 VERSION 000

PROBE SIDE SHALLOW DELETE TOOL

DELETE | ADD

CHECK DEL	DELETE COL	PINS IN NET	NET IMAGE	RELOCATED SUB-NETS	ADD COL	WIRE TYPE	WIRE LGTH	FROM PIN	TO PIN	NET ID

DEFINITION OF PRINT CHARACTERS USED ON THIS PACKAGE

* IN CHECK COLUMN INDICATES A PIN LOGICALLY DELETED FROM A NET

90T IN TYPE COLUMN IS THE REPRESENTATION FOR A TERMINATING RESISTOR

0* IN PROBE DELETE COL. DENOTES DISCRETE WIRE CONN. MAY EXIST ON PROBE SIDE

T IN THE PROBE SIDE DELETE COLUMN INDICATES A TERMINATING RESISTOR DELETE

T FOLLOWING THE PIN LOCATION INDICATES A TERMINATING RESISTOR

■ FOLLOWING THE PIN LOCATION INDICATES AN I/O PIN

* FOLLOWING THE PIN LOCATION INDICATES A PIN WITH ADDITIONAL CONNECTOR USAGE

THE DISCRETE WIRE MNEMONICS USED IN THE TYPE COLUMN ARE AS FOLLOWS

WIRE TYPE MNEMONICS

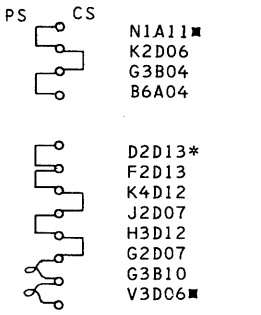
NTR

END OF DEFINITIONS FOR THIS PACKAGE

CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				PT071BM4							
			N1A11■	P			YEL	4.0	N1A11■	K2D06	1
			K2D06	P—C			YEL	6.0	K2D06	G3B04	
	1		G3B04	P—C					G3B04		
*	1		B6A04	P							
				PT081SA6							
	1		D2D13*	P		XXX	YEL	5.5	D2D13*	F2D13	2
	2		F2D13	P—P		XXX	YEL	4.0	F2D13	J2D07	
*	1	1	K4D12	C—P			YEL	3.0	J2D07	H3D12	
	0*	1	J2D07	C—P			YEL	4.0	H3D12	G2D07	
			H3D12	C—P		XXX	YEL	6.0	G2D07	C2B10	
	1		G2D07	C—P					C2B10		
*	1		G3B10	C—P							
*			V3D06■	C	6						
				PT081SA2							
*	1		U5B06	P		XXX	YEL	7.5	U5D06	L3D06	3
	2		U5D06	P—P		XXX	YEL	4.0	L3D06	K2B11	
	2		L3D06	P—P		XXX	YEL	5.0	K2B11	H3D04	
	1		K2B11	P					H3D04		
				PC141EN6							
			U2B08■	W			YEL	6.0	U2B08■	L2B08	4
	1		L2B08	W—W		XXX	YEL	6.0	L2B08	G4D02	
*	1		K2D10	W					G4D02		
				PC141ES6							
			F1E11■	P			YEL	5.5	F1E11■	K2B07	5
			K2B07	P—W			YEL	6.0	K2B07	G3D09	
	1		G3D09	P—W		XXX	YEL	4.0	G3D09	J2B02	
*	1	1	J4B08	P—C		XXX	YEL	8.0	J2B02	V4B08■	
	0*	1	V4B08■	C					V4B08■		
				PC131FW6							
						XXX	YEL	7.5	D2B05	G3B10	6
							YEL	10.0	G3B10	V3D06■	
									V3D06■		

AID IN UNDERSTANDING

DELETE PINS



*** END OF REWORK FOR BOARD 01A-B3 ***

*** END OF REWORK FOR BOARD 01A-B3***

Figure 3-6. MST-1 and MST-2 Single-layer Board Add-Delete Rework Instructions

Probe Side Deletions (Figure 3-7)

Net ID1 (Probe Side):

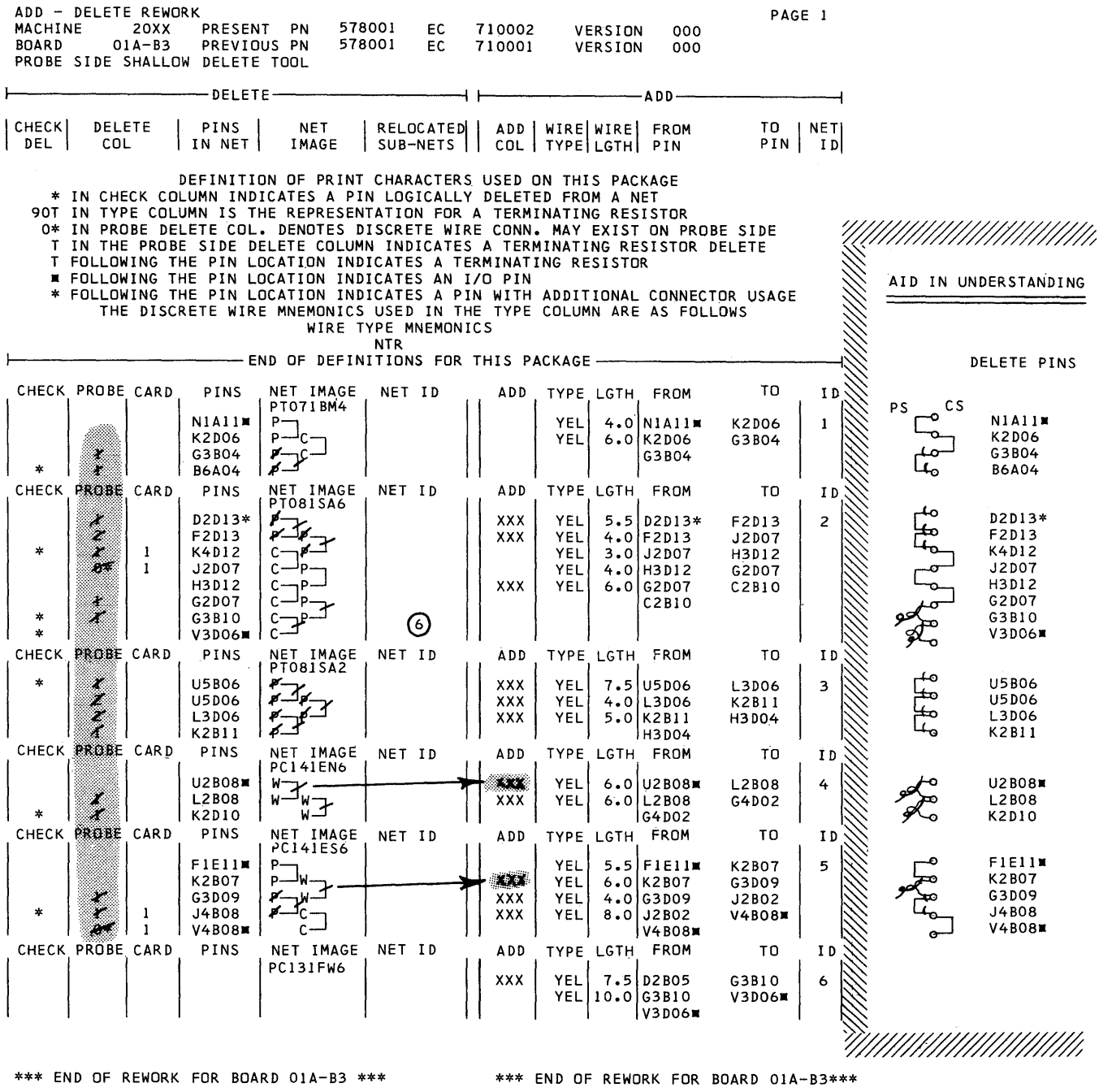
1. Locate pin B6A04. No wire is found on the pin and printed deletion of the subnet is required. Place the probe tip of the continuity checker on pin B6A04, which is used as a check pin for deleting G3B04. Printed connections are deleted with the shallow delete tool. To ensure that the correct pin is located, the delete tool has a continuity checker. A lamp indicates continuity. The probe lead is attached to a pin that will show continuity for the subnet or subnets to be deleted.
2. Locate pin B3B04 and delete the probe side printed connection.
3. Cross out the "1" in the probe delete column for pin G3B04.
4. Cross out the "P" in the net image column for pin G3B04.
5. Remove the probe tip of the continuity checker from pin B6A04 and perform the deletion. Check the pin visually to ensure that the probe deletion was done because no continuity check procedure is available for this pin.
6. Cross out the "1" in the probe delete column for pin B6A04.
7. Cross out the "P" in the net image column for pin B6A04, and using a diagonal stroke, cross out the subnet deleted.
8. Proceed to the probe side delete column for net ID2.

Net ID2 (Probe Side):

1. Pin K4D12 is selected as the check pin for this net.
2. Locate pin D2D13* and delete the probe side printed connection. Because this is an I/O pin, remove the cable connector (if any) and replace it after the deletion is completed.
3. Cross out the "1" in the probe delete column for pin D2D13*.
4. Cross out the "P" in the net image column for pin D2D13*.
5. Locate and delete pin F2D13.
6. Cross out the "2" in the probe delete column for pin F2D13.
7. Cross out the "P's" in the net image column for pin F2D13.
8. Using a diagonal stroke, cross out the deleted subnet in the net image column.
9. Delete the probe side connection for pin K4D12 and check the deletion visually.
10. Cross out the "1" in the probe delete column for pin K4D12.
11. Cross out the "P" in the net image column for pin K4D12.
12. Cross out the deleted subnet.
13. The next entry in the probe column is "0*." The "0*" indicates that there is no printed probe side connection to be removed from this pin, but that this pin must be examined for a wire that can be substituted for a printed card side connection. Because no wire was at pin location K4D12, the K4D12 to J2D07 subnet cannot be wired and the "0*" for pin J2D07 is crossed out.
14. Locate pin G2D07. A wire is found at this pin. To determine whether this wire is a substitute for the G2D07 to G3B10 subnet, trace the wire. The other end of the wire is on pin G3B10.
15. Unwrap the wire at pin G2D07.
16. Unwrap the other end of the wire at pin G3B10. Another wire is found at this pin location (wrapped on the top of the wire to be removed). Remove both wires from the pin.
17. Cross out the probe delete entries for pins G2D07 and G3B10.
18. Cross out the G2D07 to G3B10 subnet in the net image column, using a diagonal stroke.
19. Trace the wire that had to be removed from pin G3B10 (secondary wire) and remove the other end of the wire from pin V3D06■. If this pin has a discrete cable, remove the cable connector while the wire is being removed. After the wire has been removed, reinsert the cable onto the pin.
20. Using a diagonal stroke, cross out the deleted G3B10 to V3D06■. subnet in the net image column.
21. This subnet is specified in the net ID relocated subnets column as salvageable. Because of the wire removals, the G3B10 to V3D06■ subnet could not be saved; therefore, circle the "6" in the net ID relocated subnets column.
22. Proceed to the probe side delete column for net ID3.

Net ID3 (Probe Side):

1. Delete pin U5B06, using K2B11 as the check pin.
2. Cross out the "1" in the probe delete column for pin U5B06.
3. Cross out the "P" in the net image column for pin U5B06.
4. Delete pin U5D06.
5. Cross out the "2" in the probe delete column for pin U5D06.
6. Cross out the two "Ps" for pin U5D06 and the U5B06 to U5D06 subnet in the net image column.
7. Delete pin L3D06.
8. Cross out the "2" in the probe delete column for pin L3D06.
9. Cross out the two "P's" and the U5D06 to L3D06 subnet in the net image column.
10. Delete pin K2B11 and check the deletion visually.



For Instructional Use Only

Figure 3-7. MST-1 and MST-2 Single-layer Board Add-Delete Rework Instructions (Probe Side Deletions Completed)

11. Cross out the "1" in the probe delete column for pin K2B11.
12. Cross out the "P" and the L3D06 to K2B11 subnet in the net image column.
13. Proceed to the probe side delete column for net ID4.

Net ID4 (Probe Side):

1. Locate pin L2B08. Two wires are found as specified in the net image column. The wire from L2B08 to K2D10 is wrapped underneath the wire from L2B08 to U2B08■. Both wires must be removed at both ends. (At pin U2B08■, it may be necessary to remove and reinsert a cable.)
2. Cross out the two entries ("1's") in the probe delete column for pins L2B08 and K2D10.
3. Cross out the L2B08 to K2D10 subnet in the net image column.
4. Cross out the L2B08 to U2B08 subnet.
5. The L2B08 to U2B08■ subnet was removed as a result of secondary effect and must be re-added. To ensure this, "XXX" must be entered in the add column for the U2B08 to L2B08 connection. The wire addition is done during the add portion of the instructions.
6. Proceed to the probe side delete column for net ID5.

Net ID5 (Probe Side):

1. Locate pin G3D09. One wire is found. Looking at the net image, it can be seen that this wire must be removed before the printed connection at pin G3D09 can be deleted.
2. Remove the wire connection from pin K2B07 to pin G3D09.
3. Cross out the connection from pin K2B07 to pin G3D09 in the net image, using a diagonal stroke.
4. Enter "XXX" for this connection in the add column, to add this wire during add rework.
5. Delete pin G3D09, using J4D08 as the check pin.
6. Cross out the "1" in the probe delete column for pin G3D09.
7. Cross out the "P" in the net image column for pin G3D09.
8. Delete pin J4B08 and check the deletion visually.
9. Cross out the "1" in the probe delete column for pin J4B08.
10. Cross out the "P" and the G3D09 to J4B08 subnet in the net image column.
11. Next entry in the probe delete column is "0*" which indicates that no printed probe side connection is to be removed from this pin, but that this pin must be examined for a wire that can be substituted for the printed card side J4B08 to V4B08■ subnet. It can be assumed that the subnet is printed on the card side because no wire was found at pin J4B08; therefore, only cross out the "0*" in the probe delete column.
12. Proceed to the probe side delete column for net ID6.

Net ID6 (Probe Side): The net ID6 column does not contain any delete entries and the bottom line of the rework instructions shows that this is "End of Rework for Board 01A-B3." At this time, the rework instructions should appear as in Figure 3-7. Proceed to the first net with card side column delete entries (net ID2) and do card side deletions as indicated.

Card Side Deletions (Figure 3-8)

Note: For MST-2, remove cards prior to performing card side deletes. Place cards in card caddy.

For MST-1 remove only those cards or cables that are required to make the delete, replace upon completion of the delete.

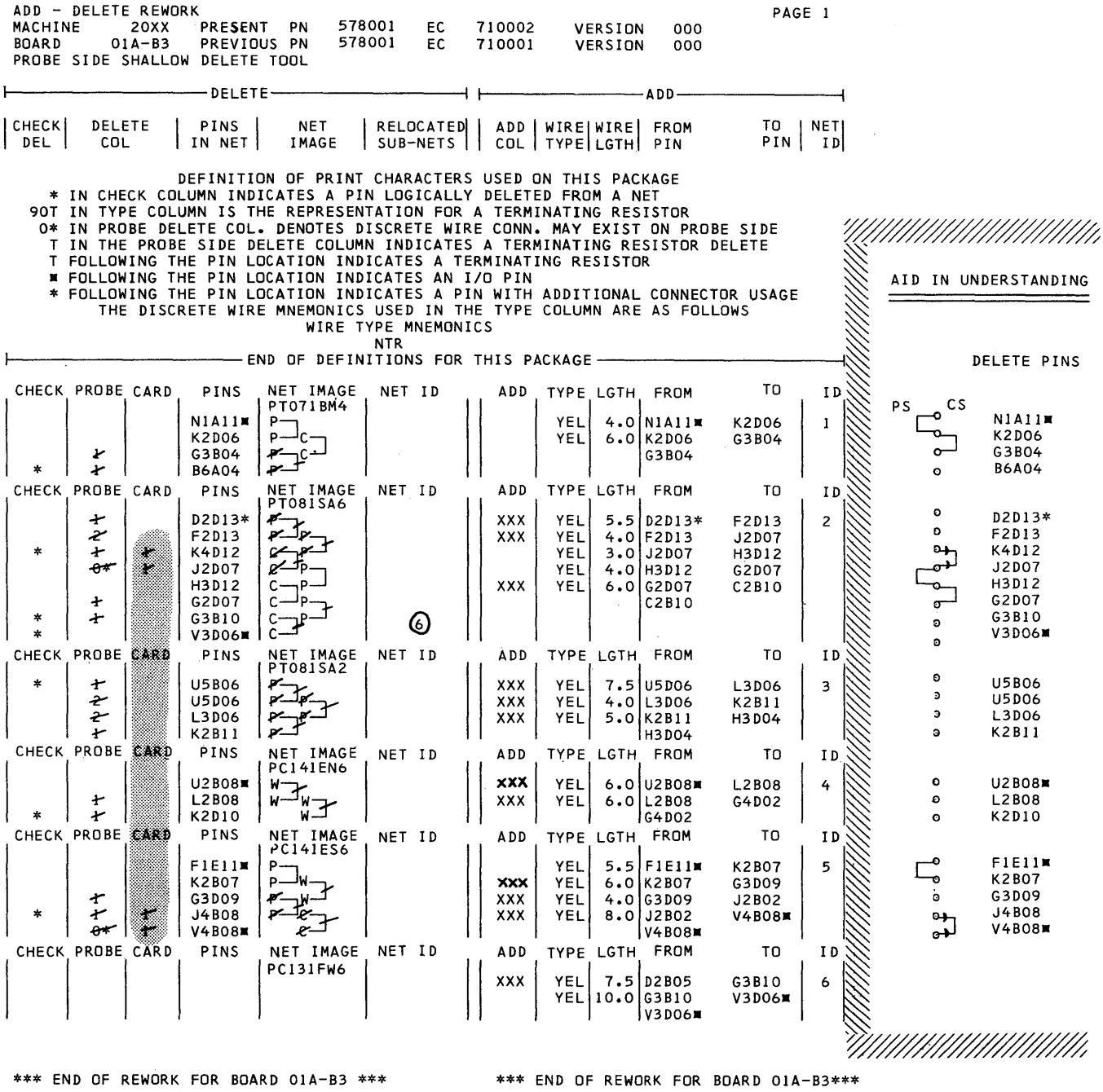
Net ID2 (Card Side):

1. Delete card side of pin K4D12, using J2D07 as the check pin.
2. Cross out the "1" in the card delete column and the "C" in the net image column for pin K4D12.
3. Delete card side of pin J2D07 and inspect the deletion visually.
4. Cross out the "1" in the card delete column and the "C" in the net image column for pin J2D07.
5. Cross out the K4D12 to J2D07 subnet in the net image column.
6. Proceed to the card side delete column for net ID5.

Net ID5 (Card Side):

1. Delete card side of pin V4B08, using J4B08■ as the check pin.
2. Cross out the "1" in the card delete column and the "C" in the net image column for pin V4B08.
3. Delete card side of pin J4B08■ and inspect the deletion visually.
4. Cross out the "1" in the card delete column for pin J4B08■.
5. Cross out the "C" for this pin and the J4B08 to V4B08■ subnet in the net image column.

This net is the last net that requires card side deletion and the last line on the page shows the statement "End of Rework for Board 01A-B3." The rework instructions should now appear as shown in Figure 3-8. Proceed to the first entry in the relocated subnets column.



For Instructional Use Only

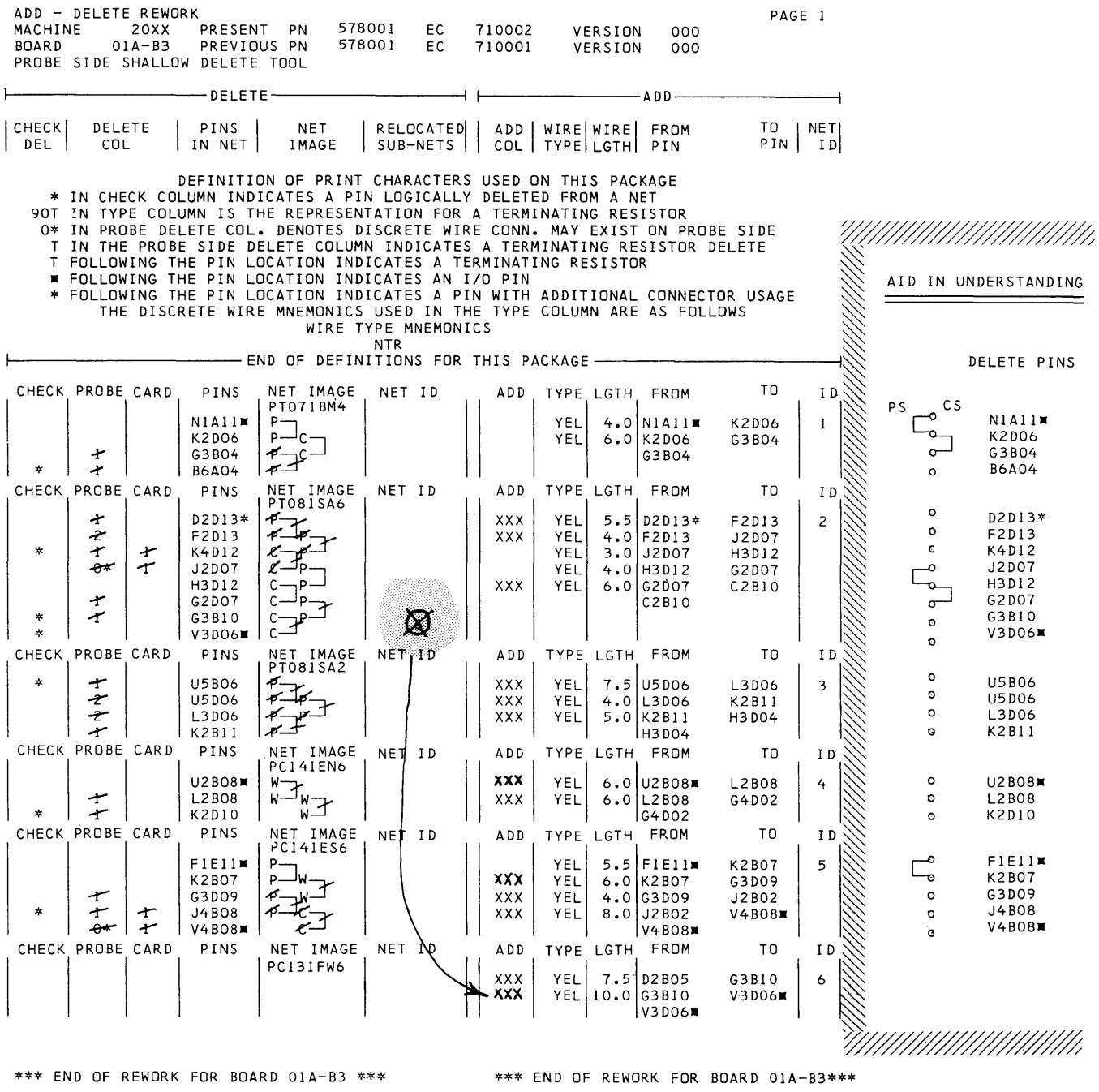
Figure 3-8. MST-1 and MST-2 Single-layer Board Add-Delete Rework Instructions (Card Side Deletions Completed)

Relocate Subnets (Figure 3-9)

Net ID2 (Relocated Subnet):

1. The ID number "6" is circled and this indicates that the corresponding subnet has to be re-added in the net for ID number 6.
2. Locate the net with a "6" in the net ID column.
3. Locate the G3B10 to V3D06■ subnet in the add "From-To" pin columns.
4. Write "XXX' for this subnet in the add column.
5. Cross out the circled "6" in the relocated subnets column.

The rework instructions should now appear as shown in Figure 3-9.



For Instructional Use Only

Figure 3-9. MST-1 and MST-2 Single-layer Board Add-Delete Rework Instructions (Relocated Subnets Completed)

Probe Side Additions (Figure 3-10)

The discrete wire additions are done according to the "XXX" entries in the add column. The wire type and length that must be used is specified in the type and length columns. The "From-To" columns provide the from and to pins needed for the additions.

Net ID2 (Probe Side):

1. Add the yellow wire, 5.5 inches, from pin D2D13* to pin F2D13. If probe side cabling is used, remove the cable connector from pin D2D13* while the wire is being added to this pin, and replace the connector when the addition is completed.
2. Cross out the "XXX' entry in the add column.
3. Add the yellow wire, 4.0 inches, from pin F2D13 to pin J2D07.
4. Cross out the "XXX" entry in the add column.
5. Add the yellow wire, 6.0 inches, from pin G2D07 to pin C2B10.
6. Cross out the "XXX" entry in the add column.
7. Proceed to the probe side add column for net ID3.

Net ID3 (Probe Side):

1. Add the yellow wire, 7.5 inches, from pin U5D06 to pin L3D06.
2. Cross out the "XXX" entry in the add column.
3. Add the yellow wire, 4.0 inches, from pin L3D06 to pin K2B11.
4. Cross out the "XXX" entry in the add column.
5. Add the yellow wire, 5.0 inches, from pin K2B11 to pin H3D04.
6. Cross out the "XXX" entry in the add column.
7. Proceed to the probe side add column for net ID4.

Net ID4 (Probe Side):

1. Add the yellow wire, 6.0 inches, from pin U2B08■ to pin L2B08. When probe side cabling is used, a cable connector must be removed and reinserted. This wire is added as a result of a manual entry written during deletions because of a secondary wire involvement.
2. Cross out the "XXX" entry in the add column.
3. Add the yellow wire, 6.0 inches, from pin L2B08 to pin G4D02.
4. Cross out the "XXX" entry in the add column.
5. Proceed to the probe side add column for net ID5.

Net ID5 (Probe Side):

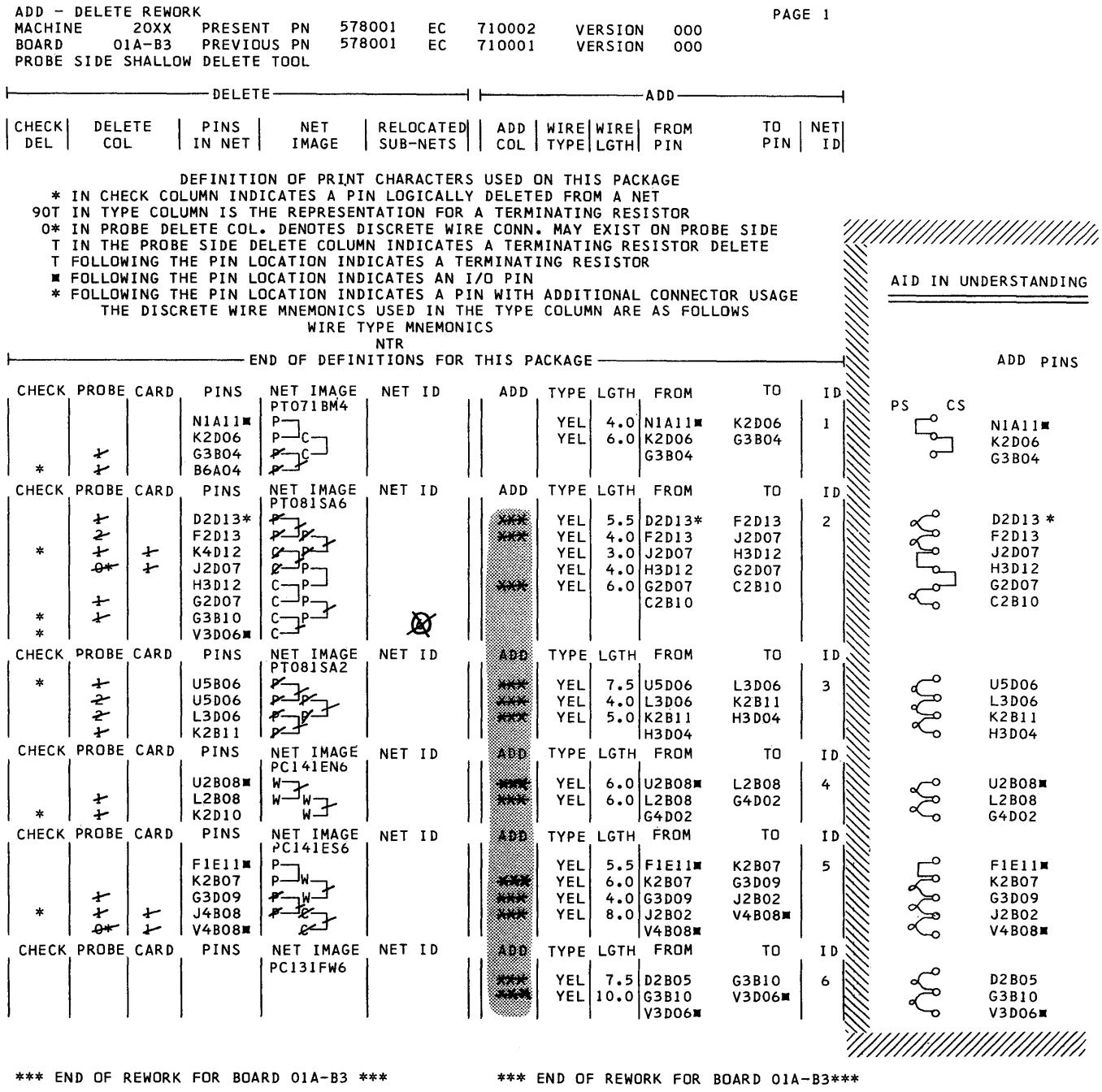
1. Add the yellow wire, 6.0 inches, from pin K2B07 to pin G3D09 (manual entry as a result of deletion).
2. Cross out the "XXX" entry in the add column.
3. Add the yellow wire, 4.0 inches, from pin G3D09 to pin J2B02.
4. Cross out the "XXX" entry in the add column.
5. Add the yellow wire, 8.0 inches, from pin J2B02 to pin V4B08■.
6. Cross out the "XXX" entry in the add column.
7. Proceed to the probe side add column for net ID6.

Net ID6 (Probe Side):

1. Add the yellow wire, 7.5 inches, from pin D2B05 to pin G3B10.
2. Cross out the "XXX" entry in the add column.
3. Add the yellow wire, 10.0 inches, from pin G3B10 to pin V3D06■ (manual entry from relocated subnets column).
4. Cross out the "XXX" entry in the add column.

The line at the bottom of the page "End of Rework for Board 01A-B3" indicates that rework for this board is completed. The rework instructions should now appear as shown in Figure 3-10.

At this point, rework is verified according to the checking procedure.



For Instructional Use Only

Figure 3-10. MST-1 and MST-2 Single-layer Board Add-Delete Rework Instructions (Probe Side Additions Completed)

Rework of a Double Board

The following procedure is used for reworking an MST-2 and MST-4 double-layer board (Figure 3-11)–deep delete tool (probe side); shallow delete tool (card side).

ADD - DELETE REWORK PAGE 1

MACHINE 20XX PRESENT PN 578001 EC 710002 VERSION 000
BOARD 01A-B3 PREVIOUS PN 578001 EC 710001 VERSION 000
PROBE SIDE DEEP DELETE TOOL

DELETE — ADD

CHECK DEL	DELETE COL	PINS IN NET	NET IMAGE	RELOCATED SUB-NETS	ADD COL	WIRE TYPE	WIRE LGTH	FROM PIN	TO PIN	NET ID

DEFINITION OF PRINT CHARACTERS USED ON THIS PACKAGE
* IN CHECK COLUMN INDICATES A PIN LOGICALLY DELETED FROM A NET
90T IN TYPE COLUMN IS THE REPRESENTATION FOR A TERMINATING RESISTOR
0* IN PROBE DELETE COL. DENOTES DISCRETE WIRE CONN. MAY EXIST ON PROBE SIDE
T IN THE PROBE SIDE DELETE COLUMN INDICATES A TERMINATING RESISTOR DELETE
T FOLLOWING THE PIN LOCATION INDICATES A TERMINATING RESISTOR
■ FOLLOWING THE PIN LOCATION INDICATES AN I/O PIN
* FOLLOWING THE PIN LOCATION INDICATES A PIN WITH ADDITIONAL CONNECTOR USAGE
THE DISCRETE WIRE MNEMONICS USED IN THE TYPE COLUMN ARE AS FOLLOWS
WIRE TYPE MNEMONICS
NTR

END OF DEFINITIONS FOR THIS PACKAGE

CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				AF121EJ6							
			N1A11■	P			NTR	6.0	N1A11■	K2D06	1
			K2D06	P—P			NTR	7.5	K2D06	G3B06	
			G3B06	C—P			NTR	5.5	G3B06	B6A04	
	T		B6A04 T	C					B6A04		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				AF121HB6							
			T2B02*	P			NTR	4.0	T2B02*	S5D05	2
			S5D05	P—C			NTR	6.0	S5D05	L3D10	
	1		L3D10	P—C					L3D10		
*	1		K2B11	P							
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				AF121GM6							
	1		U2B08■	P		XXX	NTR	8.0	U2B08■	N5B02	3
*	1		L2B08	P—C			NTR	9.5	N5B02	C2D11	
*			N4D03	C	5				C2D11		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD031DA6							
*	1		D2D13*	P		XXX	NTR	5.0	J6E04■	F2D13	4
	2		F2D13	P—P		XXX	NTR	10.0	F2D13	K3B03	
	2		K3B03	P—P		XXX	NTR	3.0	K3B03	J4D07	
	1		J4D07	P—W			NTR	3.0	J4D07	H5B11	
	0*	1	H5B11	C—W		XXX	NTR	4.5	H5B11	G3D09	
*	0*	2	H2B11	C—C		XXX	NTR	7.0	G3D09	M4D06 T	
	0*T	1	G3D09 T	C		XXX	90T		M4D06 T		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD111DA6							
	1		L3B02	P		XXX	NTR	5.0	L3B02	L2B08	5
*	1T		M4B12 T	P			NTR	5.0	L2B08	N4D03 T	
						XXX	90T		N4D03 T		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD111DC6							
						XXX	NTR	9.0	H4D02	E2D09 T	6
						XXX	90T		E2D09 T		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD111FA4							
						XXX	NTR	6.0	F3B10	G3B10	7
						XXX	NTR	10.0	G3B10	D2D11	
						XXX	NTR	4.5	D2D11	B2B04 T	
						XXX	90T		B2B04 T		

*** END OF REWORK FOR BOARD 01A-B3 *** *** END OF REWORK FOR BOARD 01A-B3 ***

AID IN UNDERSTANDING

DELETE PINS

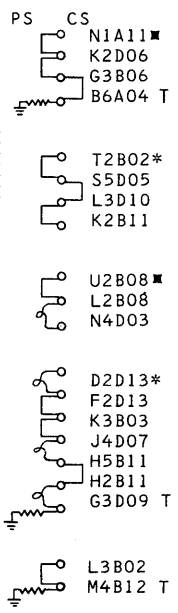


Figure 3-11. MST-2 and MST-4 Double-board Add-Delete Rework Instructions

Probe Side Deletions (Figure 3-12)

Net ID1 (Probe Side):

1. Locate pin B6A04 T and remove the terminating resistor.
2. Cross out the "T" in the probe delete column.
3. Proceed to the probe side delete column for net ID2.

Net ID2 (Probe Side):

1. Delete pin L3D10, using K2B11 as the check pin.
2. Cross out the "1" in the probe delete column for pin L3D10.
3. Cross out the "P" in the net image column for pin L3D10.
4. Delete pin K2B11 and check the deletion visually.
5. Cross out the "1" in the probe delete column for pin K2B11.
6. Cross out the "P" for pin K2B11 and the L3D10 to K2B11 subnet in the net image column.
7. Proceed to the probe side delete column for net ID3.

Net ID3 (Probe Side):

1. Delete pin U2B08, using L2B08 as the check pin. Because pin U2B08■ contains a cable, the cable connector must be removed before deletion and the connector must be replaced when the deletion is completed.
2. Cross out the "1" in the probe delete column and the "P" in the net image column for pin U2B08■.
3. Delete pin L2B08 and check the deletion visually. The wire connector found on pin L2B08 is removed during deletion and is replaced. The L2B08 to N4D03 subnet was not removed and no action is required with regard to the "5" entry in the relocated subnets column. If, for any reason, this subnet was removed, circle the number "5" in the relocated subnets column.
4. Cross out the "1" in the probe delete column for pin L2B08.
5. Cross out the "P" pin L2B08 and cross out the U2B08 to L2B08 subnet in the net image column.
6. Proceed to the probe side delete column for net ID4.

Net ID4 (Probe Side):

1. Pin D2D13* is located and contains a cable and a wire. If encapsulated tri-lead wire is used, remove the board wire from the connector housing and reposition the cable on pin D2D13*. If mid-air splice wire is used, it is the conductive type as indicated by the asterisk (*) and the following steps must be taken: the connector found on pin D2D13* is connected to the mid-air splice by a short piece of wire (pigtail). The cable connector and the pigtail connector are removed from the mid-air splice. Then remove the connector on pin D2D13* and plug the cable connector onto the same pin (D2D13*).
2. Trace the wire to locate the other end of pin F2D13 and remove the connector.
3. Cross out the "1" in the probe delete column for pin D2D13*.
4. Cross out the D2D13* to F2D13 subnet in the net image column.
5. Delete pin F2D13, using J4D07 as the check pin.
6. Cross out the "2" in the net image column for pin F2D13.
7. Cross out the rightmost "P" in the net image column for pin F2D13.
8. Delete pin K3B03, retaining J4D07 as the check pin.
9. Cross out the "2" in the probe delete column for pin K3B03.
10. Cross out the two "P's" in the net image column for pin K3B03.
11. Cross out the F2D13 to K3B03 subnet.
12. Delete pin J4D07 and check the deletion visually. The wire connector found on this pin is removed during deletion and is replaced on completion of the delete operation.
13. Cross out the "1" in the probe delete column for pin J4D07.
14. Cross out the "P" in the net image column for pin J4D07.
15. Cross out the K3B03 to J4D07 subnet.
16. Locate pin H2B11 and check for any wire, substituting the card side connections to this pin. One wire is found.
17. Remove the wire from pin H2B11.
18. Trace the other end of the wire to pin G3D09 T. For this pin, also remove the terminating resistor which is removed with the wire.
19. Cross out the "0*" in the probe delete column for pins H5B11, H2B11, and G3D09 T.
20. Cross out the "T" in the probe delete column and the "1" in the card delete column for pin G3D09 T. The wire is substituted for this connection. The "2" in the card delete column for pin H2B11 cannot be crossed out because one card side connection was made for the wire removal.
21. Cross out the "C" and H2B11 to G3D09 T subnet in the net image column for pin H2B11.
22. Proceed to the probe side delete column for net ID5.

Net ID5 (Probe Side):

1. Delete pin L3B02, using M4B12 T as the check pin.
2. Cross out the "1" in the probe delete column and the "P" in the net image column for pin L3B02.
3. Remove the terminating resistor from pin M4B12.
4. Cross out the "T" in the probe delete column.
5. Delete pin M4B12 and check the deletion visually.
6. Cross out the "1" in the probe delete column for pin M4B12.
7. Cross out the L3B02 to M4B12 subnet and the "P" for pin M4B12 in the net image column.

ADD - DELETE REWORK PAGE 1

MACHINE 20XX PRESENT PN 578001 EC 710002 VERSION 000
BOARD 01A-B3 PREVIOUS PN 578001 EC 710001 VERSION 000
PROBE SIDE DEEP DELETE TOOL

DELETE — ADD

CHECK DEL	DELETE COL	PINS IN NET	NET IMAGE	RELOCATED SUB-NETS	ADD COL	WIRE TYPE	WIRE LGTH	FROM PIN	TO PIN	NET ID

DEFINITION OF PRINT CHARACTERS USED ON THIS PACKAGE
* IN CHECK COLUMN INDICATES A PIN LOGICALLY DELETED FROM A NET
90T IN TYPE COLUMN IS THE REPRESENTATION FOR A TERMINATING RESISTOR
0* IN PROBE DELETE COL. DENOTES DISCRETE WIRE CONN. MAY EXIST ON PROBE SIDE
T IN THE PROBE SIDE DELETE COLUMN INDICATES A TERMINATING RESISTOR DELETE
T FOLLOWING THE PIN LOCATION INDICATES A TERMINATING RESISTOR
■ FOLLOWING THE PIN LOCATION INDICATES AN I/O PIN
* FOLLOWING THE PIN LOCATION INDICATES A PIN WITH ADDITIONAL CONNECTOR USAGE
THE DISCRETE WIRE MNEMONICS USED IN THE TYPE COLUMN ARE AS FOLLOWS
WIRE TYPE MNEMONICS
NTR

END OF DEFINITIONS FOR THIS PACKAGE

CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				AF121EJ6							
			N1A11■	P			NTR	6.0	N1A11■	K2D06	1
			K2D06	P—P			NTR	7.5	K2D06	G3B06	
			G3B06	C—P			NTR	5.5	G3B06	B6A04	
	T		B6A04 T	C					B6A04		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				AF121HB6							
			T2B02*	P			NTR	4.0	T2B02*	S5D05	2
			S5D05	P—C			NTR	6.0	S5D05	L3D10	
	T		L3D10	T—C					L3D10		
*	T		K2B11	T							
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				AF121GM6							
	T		U2B08■	T		XXX	NTR	8.0	U2B08■	N5B02	3
*	T		L2B08	T—C			NTR	9.5	N5B02	C2D11	
*			N4D03	C	5				C2D11		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD031DA6							
*	T		D2D13*	P—T		XXX	NTR	5.0	J6E04■	F2D13	4
	T		F2D13	P—T		XXX	NTR	10.0	F2D13	K3B03	
	T		K3B03	T—T		XXX	NTR	3.0	K3B03	J4D07	
	T		J4D07	T—W			NTR	3.0	J4D07	H5B11	
	0*T	1	H5B11	C—W		XXX	NTR	4.5	H5B11	G3D09	
*	0*T	2	H2B11	C—T		XXX	NTR	7.0	G3D09	M4D06 T	
	0*T	T	G3D09 T	C		XXX	90T		M4D06 T		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD111DA6							
	T		L3B02	T		XXX	NTR	5.0	L3B02	L2B08	5
*	TT		M4B12 T	T			NTR	5.0	L2B08	N4D03 T	
						XXX	90T		N4D03 T		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD111DC6							
						XXX	NTR	9.0	H4D02	E2D09 T	6
						XXX	90T		E2D09 T		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD111FA4							
						XXX	NTR	6.0	F3B10	G3B10	7
						XXX	NTR	10.0	G3B10	D2D11	
						XXX	NTR	4.5	D2D11	B2B04 T	
						XXX	90T		B2B04 T		

*** END OF REWORK FOR BOARD 01A-B3 ***

*** END OF REWORK FOR BOARD 01A-B3 ***

AID IN UNDERSTANDING

DELETE PINS

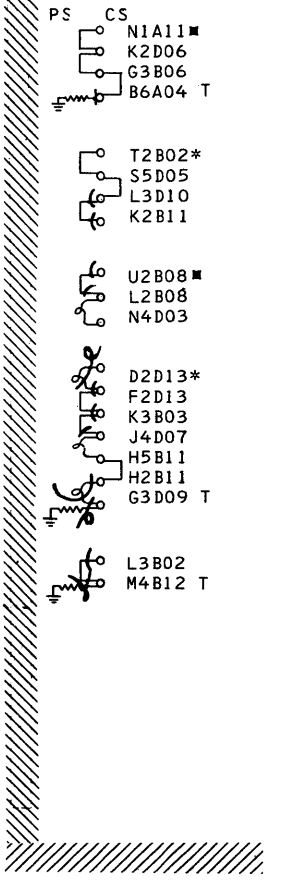


Figure 3-12. MST-2 and MST-4 Double-board Add-Delete Rework Instructions (Probe Side Deletions Completed)

No more probe side delete entries appear on this page and the statement at the bottom of the page indicates "End of Rework for Board 01A-B3." The card side deletions must be done next.

At this time, the rework instructions should appear as shown in Figure 3-12.

Card Side Deletions (Figure 3-13)

To provide access to delete pins, check pins, and net checking on completion of rework, the cards and in some cases the card retention system (MST-4) must be removed before card side deletions are initiated. Place cards in card caddy. Perform the card side deletions according to the delete entries in the card delete column. The first net showing card side delete entries is net ID4.

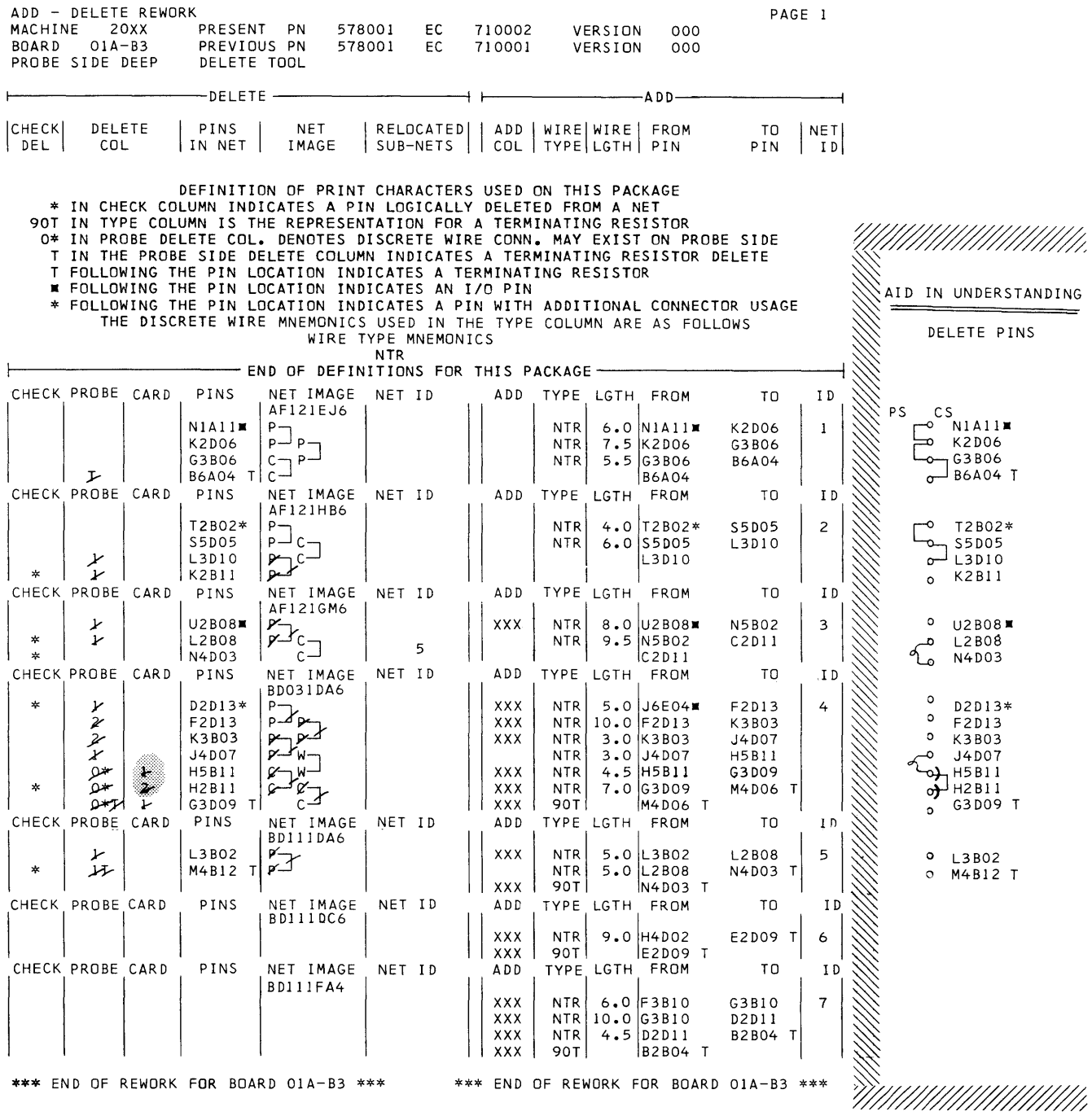
Note: MST-2 card retention hardware does not have to be removed for card side deletes. MST-4 card retention hardware should be removed only if there are card side deletes in rows 1 or 6.

Net ID4 (Card Side):

1. Delete pin H5B11, using H2B11 as the check pin.
2. Cross out the "1" in the card delete column and the "C" in the net image column for pin H5B11.
3. Delete pin H2B11 and check the deletion visually.
4. Cross out the "2" in the card delete column for pin H2B11.
5. Cross out the "C" for pin H2B11 and the H5B11 to H2B11 subnet in the net image column.

Scanning the relocated subnets column shows that no entires were marked during deletions and no action is required. The delete portion of the rework instructions is now complete, and the wire add rework procedure is initiated.

The rework instructions should appear as shown in Figure 3-13.



ADD - DELETE REWORK PAGE 1
MACHINE 20XX PRESENT PN 578001 EC 710002 VERSION 000
BOARD 01A-B3 PREVIOUS PN 578001 EC 710001 VERSION 000
PROBE SIDE DEEP DELETE TOOL

DELETE | ADD

CHECK DEL	DELETE COL	PINS IN NET	NET IMAGE	RELOCATED SUB-NETS	ADD COL	WIRE TYPE	WIRE LGTH	FROM PIN	TO PIN	NET ID

DEFINITION OF PRINT CHARACTERS USED ON THIS PACKAGE
* IN CHECK COLUMN INDICATES A PIN LOGICALLY DELETED FROM A NET
90T IN TYPE COLUMN IS THE REPRESENTATION FOR A TERMINATING RESISTOR
0* IN PROBE DELETE COL. DENOTES DISCRETE WIRE CONN. MAY EXIST ON PROBE SIDE
T IN THE PROBE SIDE DELETE COLUMN INDICATES A TERMINATING RESISTOR DELETE
T FOLLOWING THE PIN LOCATION INDICATES A TERMINATING RESISTOR
■ FOLLOWING THE PIN LOCATION INDICATES AN I/O PIN
* FOLLOWING THE PIN LOCATION INDICATES A PIN WITH ADDITIONAL CONNECTOR USAGE
THE DISCRETE WIRE MNEMONICS USED IN THE TYPE COLUMN ARE AS FOLLOWS
WIRE TYPE MNEMONICS
NTR

END OF DEFINITIONS FOR THIS PACKAGE

CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				AF121EJ6							
			N1A11■	P			NTR	6.0	N1A11■	K2D06	1
			K2D06	P P			NTR	7.5	K2D06	G3B06	
			G3B06	C P			NTR	5.5	G3B06	B6A04	
	T		B6A04 T	C					B6A04		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				AF121HB6							
			T2B02*	P			NTR	4.0	T2B02*	S5D05	2
			S5D05	P C			NTR	6.0	S5D05	L3D10	
	T		L3D10	P C					L3D10		
*	T		K2B11	P							
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				AF121GM6							
	T		U2B08■	P		XXX	NTR	8.0	U2B08■	N5B02	3
*	T		L2B08	P C			NTR	9.5	N5B02	C2D11	
*			N4D03	C	5				C2D11		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD031DA6							
*	T		D2D13*	P		XXX	NTR	5.0	J6E04■	F2D13	4
	T		F2D13	P P		XXX	NTR	10.0	F2D13	K3B03	
	T		K3B03	P P		XXX	NTR	3.0	K3B03	J4D07	
	T		J4D07	P W			NTR	3.0	J4D07	H5B11	
	0* T		H5B11	P W		XXX	NTR	4.5	H5B11	G3D09	
*	0* T		H2B11	P P		XXX	NTR	7.0	G3D09	M4D06 T	
	0* T	T	G3D09 T	C		XXX	90T		M4D06 T		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD111DA6							
	T		L3B02	P		XXX	NTR	5.0	L3B02	L2B08	5
*	T		M4B12 T	P			NTR	5.0	L2B08	N4D03 T	
						XXX	90T		N4D03 T		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD111DC6							
						XXX	NTR	9.0	H4D02	E2D09 T	6
						XXX	90T		E2D09 T		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD111FA4							
						XXX	NTR	6.0	F3B10	G3B10	7
						XXX	NTR	10.0	G3B10	D2D11	
						XXX	NTR	4.5	D2D11	B2B04 T	
						XXX	90T		B2B04 T		

*** END OF REWORK FOR BOARD 01A-B3 ***

*** END OF REWORK FOR BOARD 01A-B3 ***

AID IN UNDERSTANDING

DELETE PINS

PS CS
N1A11■
K2D06
G3B06
B6A04 T
T2B02*
S5D05
L3D10
K2B11
U2B08■
L2B08
N4D03
D2D13*
F2D13
K3B03
J4D07
H5B11
H2B11
G3D09 T
L3B02
M4B12 T

Figure 3-13. MST-2 and MST-4 Double-board Add-Delete Rework Instructions (Card Side Deletions Completed)

Probe Side Additions (Figure 3-14)

The discrete wire and terminating resistor additions are done according to the "XXX" entries in the add column. The wire type and length and the terminating resistor type are specified in the type and length columns for the associated subnets shown in the "From-To" columns. The "From-To" columns show the total net as it must appear after rework is completed.

Net ID3 (Probe Side):

1. Add 90-ohm tri-lead wire, 8.0 inches, from pin U2B08■ to pin N5B02. A cable is present on pin U2B08■. If encapsulated tri-lead wire is required, remove the cable, remove the connector housing from the cable, and insert the cable into the board wire connector housing. The cable and wire connector are inserted onto pin U2B08■ and the other end of the wire is plugged onto pin N5B02. If the mid-air splice wire is required, the wire assembly with an ID3 label is located. The cable is removed from the pin and inserted into a nonconductive mid-air splice. The wire connector with the ID3 label is then also inserted into the nonconductive mid-air splice. The connector on the nonconductive lead is plugged onto pin U2B08 and the other end of the wire is plugged onto pin N5B02.
2. Cross out the "XXX" entry in the add column.
3. Proceed to the wire add column for net ID4.

Net ID4 (Probe Side):

1. Add 90-ohm tri-lead wire, 5.0 inches, from pin J6E04■ to pin F2D13. (Use nonconductive mid-air splice, if required.)
2. Cross out the "XXX" entry in the add column.
3. Add 90-ohm tri-lead wire, 10.0 inches, from pin F2D13 to pin K3D03.
4. Cross out the "XXX" entry in the add column.
5. Add 90-ohm tri-lead wire, 3.0 inches, from pin K3B03 to pin J4D07.
6. Cross out the "XXX" entry in the add column.
7. Add 90-ohm tri-lead wire, 4.5 inches, from pin H5B11 to pin G3D09.
8. Cross out the "XXX" entry in the add column.
9. Add 90-ohm tri-lead wire, 7.0 inches, from pin G3D09 to pin M4D06 T.
10. Cross out the "XXX" entry in the add column.
11. Add 90-ohm terminating resistor to pin M4D06 T.
12. Cross out the "XXX" entry in the add column.
13. Proceed to the wire add column for net ID5.

Net ID5 (Probe Side):

1. Add 90-ohm tri-lead wire, 5.0 inches, from pin L3B02 to pin L2B08.
2. Cross out the "XXX" entry in the add column.
3. Add the terminating resistor, 90-ohm, to pin N4D03 T.
4. Cross out the "XXX" entry in the add column.
5. Proceed to the wire add column for net ID6.

Net ID6 (Probe Side):

1. Add 90-ohm tri-lead wire, 9.0 inches, from pin H4D02 to pin E2D09 T.
2. Cross out the "XXX" entry in the add column.
3. Add the terminating resistor, 90-ohm, to pin E2D09 T.
4. Cross out the "XXX" entry in the add column.
5. Proceed to the wire add column for net ID7.

Net ID7 (Probe Side):

1. Add 90-ohm tri-lead wire, 6.0 inches, from pin F3B10 to pin G3B10.
2. Cross out the "XXX" entry in the add column.
3. Add 90-ohm tri-lead wire, 10.0 inches, from pin G3B10 to pin D2D11.
4. Cross out the "XXX" entry in the add column.
5. Add 90-ohm tri-lead wire, 4.5 inches, from pin D2D11 to pin B2B04 T.
6. Cross out the "XXX" entry in the add column.
7. Add 90-ohm terminating resistor to pin B2B04 T.
8. Cross out the "XXX" entry in the add column.

The line at the bottom of the page "End of Rework for Board 01A-B3" indicates that rework for this board is complete. The rework instructions should now appear as shown in Figure 3-14.

At this point, rework is verified according to the checking procedure.

ADD - DELETE REWORK PAGE 1

MACHINE 20XX PRESENT PN 578001 EC 710002 VERSION 000
BOARD 01A-B3 PREVIOUS PN 578001 EC 710001 VERSION 000
PROBE SIDE DEEP DELETE TOOL

DELETE | ADD

CHECK DEL	DELETE COL	PINS IN NET	NET IMAGE	RELOCATED SUB-NETS	ADD COL	WIRE TYPE	WIRE LGTH	FROM PIN	TO PIN	NET ID

DEFINITION OF PRINT CHARACTERS USED ON THIS PACKAGE
* IN CHECK COLUMN INDICATES A PIN LOGICALLY DELETED FROM A NET
90T IN TYPE COLUMN IS THE REPRESENTATION FOR A TERMINATING RESISTOR
0* IN PROBE DELETE COL. DENOTES DISCRETE WIRE CONN. MAY EXIST ON PROBE SIDE
T IN THE PROBE SIDE DELETE COLUMN INDICATES A TERMINATING RESISTOR DELETE
T FOLLOWING THE PIN LOCATION INDICATES A TERMINATING RESISTOR
■ FOLLOWING THE PIN LOCATION INDICATES AN I/O PIN
* FOLLOWING THE PIN LOCATION INDICATES A PIN WITH ADDITIONAL CONNECTOR USAGE
THE DISCRETE WIRE MNEMONICS USED IN THE TYPE COLUMN ARE AS FOLLOWS
WIRE TYPE MNEMONICS
NTR
END OF DEFINITIONS FOR THIS PACKAGE

CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				AF121EJ6							
			N1A11■	P			NTR	6.0	N1A11■	K2D06	1
			K2D06	P P			NTR	7.5	K2D06	G3B06	
			G3B06	C P			NTR	5.5	G3B06	B6A04	
	~~T~~		B6A04 T	C					B6A04		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				AF121HB6							
			T2B02*	P			NTR	4.0	T2B02*	S5D05	2
			S5D05	P C			NTR	6.0	S5D05	L3D10	
	~~T~~		L3D10	~~P~~ C					L3D10		
*	~~T~~		K2B11	~~P~~							
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				AF121GM6							
	~~T~~		U2B08■	~~P~~		~~XXX~~	NTR	8.0	U2B08■	N5B02	3
*	~~T~~		L2B08	~~P~~ C	5		NTR	9.5	N5B02	C2D11	
*			N4D03	C					C2D11		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD031DA6							
*	~~T~~		D2D13*	P		~~XXX~~	NTR	5.0	J6E04■	F2D13	4
	~~T~~		F2D13	P ~~P~~		~~XXX~~	NTR	10.0	F2D13	K3B03	
	~~T~~		K3B03	~~P~~ ~~P~~		~~XXX~~	NTR	3.0	K3B03	J4D07	
	~~T~~		J4D07	~~P~~ W			NTR	3.0	J4D07	H5B11	
	~~0*~~	~~T~~	H5B11	~~P~~ W		~~XXX~~	NTR	4.5	H5B11	G3D09	
*	~~0*~~	~~T~~	H2B11	~~P~~ ~~P~~		~~XXX~~	NTR	7.0	G3D09	M4D06 T	
	~~0*~~	~~T~~	G3D09 T	C		~~XXX~~	90T		M4D06 T		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD111DA6							
	~~T~~		L3B02	~~P~~		~~XXX~~	NTR	5.0	L3B02	L2B08	5
*	~~T~~		M4B12 T	~~P~~			NTR	5.0	L2B08	N4D03 T	
						~~XXX~~	90T		N4D03 T		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD111DC6							
						~~XXX~~	NTR	9.0	H4D02	E2D09 T	6
						~~XXX~~	90T		E2D09 T		
CHECK	PROBE	CARD	PINS	NET IMAGE	NET ID	ADD	TYPE	LGTH	FROM	TO	ID
				BD111FA4							
						~~XXX~~	NTR	6.0	F3B10	G3B10	7
						~~XXX~~	NTR	10.0	G3B10	D2D11	
						~~XXX~~	NTR	4.5	D2D11	B2B04 T	
						~~XXX~~	90T		B2B04 T		

*** END OF REWORK FOR BOARD 01A-B3 ***

*** END OF REWORK FOR BOARD 01A-B3 ***

AID IN UNDERSTANDING

ADD PINS

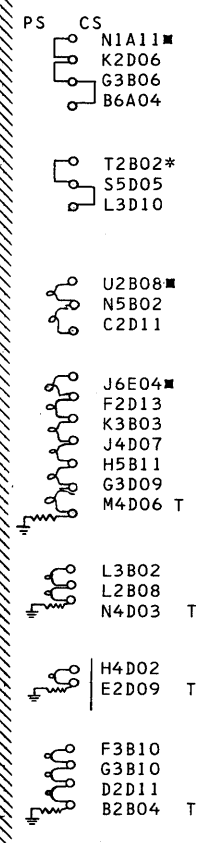


Figure 3-14. MST-2 and MST-4 Double-board Add-Delete Rework Instructions (Wire Additions Completed)

CARD ADD-DELETE LIST RUN 880 06-10-69 PAGE 1

MACHINE HPSYS PRESENT PN 5467420 EC 259782 VERS 000 XFER 259782 AK

LOCATION 01A-B2 PREVIOUS PN 5467420 EC 259781J VERS 000 XFER 259781 AE

DELETE

SOCKET	TYPE	PART NO.	SIZE	ACC.CODE
C2	1671	5856102	56-05	
F2	1674	5856135	56-05	
J2	1671	5856102	56-05	
M2	1674	5856135	56-05	
Q2	1671	5856102	56-05	SC3
T2	1674	5856135	56-05	SC3

ADD

SOCKET	TYPE	PART NO.	SIZE	ACC.CODE
C2	1671	5856169	56-05	
F2	1674	5856165	56-05	
J2	1671	5856169	56-05	
M2	1674	5856165	56-05	
Q2	1671	5856169	56-05	SC3
T2	1674	5856165	56-05	SC3
V3	A559	5800559	14-05	NSC4
V4	A559	5800559	14-05	NSC4

END OF LIST

For Instructional Use Only

Figure 3-15. Board Add-Delete Instructions for Cards

ENGINEERING CHANGE REMOVAL

The removal of an EC that fails to function requires that the cabling and board wiring be restored to the previous EC level. This is accomplished by removing all the cards, wires, and cables added during add rework and rewiring the connections removed during delete rework and replugging the original cards. The following documents are required for the removal of an EC:

1. Cable rework instructions.
2. Cable error recovery lists (cable location document).
3. Board add-delete rework instructions (includes card plugging information).
4. Board discrete wire equivalent lists.

The sequence to be followed in the removal of an EC is:

1. Remove all cards added.
2. Remove all the cables added according to the add portion of the cable rework instructions.
3. Remove all the board wires added according to the add portion of the board rework instructions.
4. Add all the connections removed according to the delete portion of the board rework instructions.
5. Add all the cables removed according to the removal portion of the cable rework instructions.
6. Check the continuity of all the cables and nets affected.
7. Replug the original cards.

Cables installed as a result of the cable add instructions are removed as specified by the entires in the add "From-To" column, and a check mark is written for each connection removed.

The board wires added according to the "XXX" entries in the add column in the board rework instructions are removed, and a check mark is written for each wire removed.

The net image column in the delete portion of the board rework instructions shows the connections that were removed during delete rework and the ones that must be reconnected. The board discrete wire equivalent list must be at the EC level of the board prior to when rework was initiated (previous EC level). Each subnet that was deleted must be located in the equivalent list and added again according to the wiring specifications. A check mark is written in the net image column for each subnet that is added again.

Cables that were removed during the cable removal procedure are added according to the cable removal "From-To" entries in the cable rework instructions. Information on the length and type of cable to be used is in the socket listing. Because via information is not specified for removed cables, the shortest route between the "From" and "To" location should be used. A check mark is written for each cable installed.

Continuity and grounding are checked according to the pins listed in the net column (delete portion of the board rework instructions), and cables are checked according to the entries in the cable removal "From-To" columns.

ERROR RECOVERY

Board Error Recovery Documentation

Damaged board wiring is repaired as specified in the wiring rules for MST to ensure efficient operation of the machine. The board discrete wire equivalent list (BDWEL) provides the information required to reconstruct any board net in discrete wire and enables the customer engineer to reestablish any damaged board net in discrete wire without violating the wiring rules.

Board Discrete Wire Equivalent List (BDWEL)

The board discrete wire equivalent list is provided for every MST board in a machine and the list is updated every time a board is affected by a change to the board wiring. The list consists of two formats: a board pin list and a board net list. The board pin list shows all board pins and their appropriate net numbers, and it serves as an entry document to the board net list. The board net list shows all board nets and their discrete wire equivalent. The two lists provide the following information:

1. The physical configurations of all board nets in which any board pin appears.
2. The delete information required to remove all connections within any board net.
3. The add information required to replace all connections in any board net with discrete wire.

Format of Board Pin List

The board pin list format is shown in Figure 3-16. The upper half of Figure 3-16 shows the following general information headings:

A. Document title.
B. Machine type.
C. Location of the board affected.
D. Part number of the board affected.
E. EC level of the board.
F. Version number of the board.
G. Number of pages in the pin list (in numeric sequence).

The lower portion of Figure 3-16 has two subheadings that are repeated for each pin list column. These subheads are:

1. *Pin:* This column lists all the board pins in an alphameric sequence by pin location. The presence of a terminating resistor is shown by a "T" next to the pin coordinate.
2. *Net No.:* This column lists the appropriate net numbers of the nets in which the pins in the pin column appear. The net number refers to a net in the board net list and is used for entry into the board net list.

Format of Board Net List

The board net list format is shown in Figure 3-17. The upper half of Figure 3-17 shows the following general information headings:

A. Document title.
B. Part number of the board affected.
C. EC level of the board.
D. Version number of the board.
E. Machine type.
F. Location of the board.
G. Special characters for I/O pin identification and terminating resistor identification.
H. Type of delete tool to be used.
J. Wire types and the associated abbreviations.

The lower portion of Figure 3-17 has seven subheadings that are repeated for each net list column. These subheads are:

1. *Net No.:* This column lists all the board nets by net number in an alphameric sequence.
2. *From Pin-To-Pin:* This column lists the "From Pin" and "To Pin" locations, and it describes the net configuration by specifying the pin-to-pin connections (subnets) in the net. The "From Pin" column shows all the pins in the net. I/O pins are identified by one of the two special characters shown in the general information heading. Terminating resistors are identified by a "T" next to the pin location coordinate.
3. *Pl:* These columns specify printed and discrete overflow wire connections to the pin and, in conjunction with the table shown in the general information heading, specify the type of delete tool to be used for deletion of the printed pin connections in the net.
4. *Wire Type:* This column lists the type of wire to be used for adding the pin-to-pin connections (subnets) specified in the "From-To" pin columns. A table in the general information heading shows a complete description of the abbreviations used in this column.
5. *Wire Length:* This column shows the length of wire to be used for the pin-to-pin connections specified in the "From-To" columns. Lengths are in inches to nearest tenth.

Error Recovery Procedure

Printed Wire Replacement

Replacement of a damaged printed connection requires the deletion of all connections in the net and the reconstruction of the total net with discrete wire. When a pin in the damaged net is located, recovery information can be obtained from the board discrete wire equivalent list. The BDWEL must be for the same part number and at the same EC level as the actual board containing the error net.

The EC level and part number must be checked before any attempt is made to repair the net. A detailed procedure

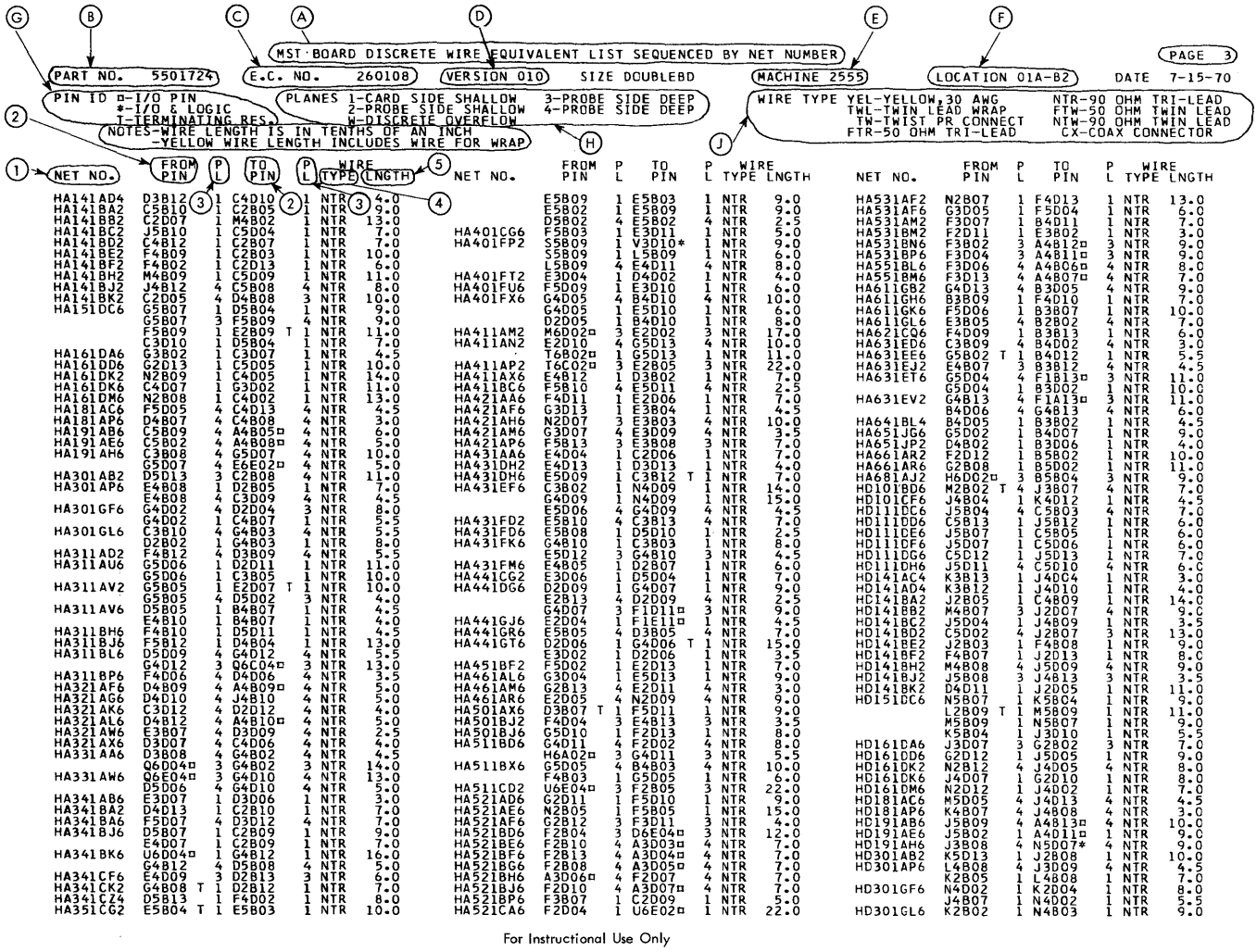
BOARD DISCRETE WIRE EQUIVALENT LIST SEQUENCED BY PIN NUMBER

PAGE 02

PART NO. 484-000 E.C. NO. 1234567 VERSION 001 SIZE MACH. TYPE 2085 LOCATION 01A-A5 DATE 99-99-99

PIN	NET NO.	PIN	NET NO.	PIN	NET NO.	PIN	NET NO.	PIN	NET NO.	PIN	NET NO.	PIN	NET NO.	PIN	NET NO.
F5D13	RV521GD2	H2D10	RV441DD2	H5D01	KV009GG2	J3B12	KV827FH2	K3B04	RV361AC6	K5D02	KV009EF2	L4B03	KV007GC4	M1E13	RV364GH4
F6A02	KV821GH4	H2D11	AV727GD4	H5D02	KV009EF2	J3B13	KV821GB2	K3B05	RV363DH4	K5D03	RV361GH4	L4B04	KV009CF2	M2B02	RH355CE2
F6A04	KV821FE1	H2D11	AV727GD4	H5D02	KV009EF2	J3D06	KV827FJ2	K3B07	RV363DK2	K5D04	KV009EJ2	L4B06	KV009GG2	M2B03	RV901AC2
F6B02	RH515CG2	H2D12	KV823GB2	H5D03	RV441GH4	J3D07	AP523FD2	K3B08	WD245CG4	K5D04	KV009EJ2	L4B07	AV731AA6	M2B04	RH325CG2
F6B04	KP051ED2	H2D12	KV823GB2	H5D04	KV009EJ2	J3D08	KV827FG6	K3B08	WD245CG4	K5D06	KV009GK2	L4B08	AV731GE2	M2B07	RV282GK2
F6C02	RV903AA2	H2D13	RV442DB4	H5D04	KV009EJ2	J3D09	KV803FK2	K3B09	RV363DB4	K5D06	KV009GK2	L4B09	AV731GL2	M2B08	RV288FF2
F6C04	KR951FA2	H3B03	RV441DH4	H5D06	KV009GK2	J3D11	KV811FK2	K3B10	WD245GE4	K5D07	RV901GG2	L4B11	KV013BD2	M2B09	RV288EF2
F6D02	RH515CE2	H3B04	RV441AC6	H5D06	KV009GK2	J3D12	KV821GA2	K3B10	WD245GE4	K5D09	RV364GK2	L4B12	KV007GD4	M2B11	RV282GD2
F6D04	RV901EJ2	H3B05	RV443DH4	H5D07	RV901GF2	J3D13	KV823GJ6	K3B12	KV009CD2	K5D11	RH355CE2	L4B13	RV903AC2	M2B12	KV013GK2
F6E02	KV811FK6	H3B07	RV443DK2	H5D08	KV827FJ6	J4B04	KV827FK4	K3B12	KV009CD2	K5D11	RH355CE2	L4B13	RV903AD2	M2B12	KV013GK2
F6E04	KV803FK6	H3B08	RV448GH2	H5D09	RV444GK2	J4B06	KV827EK6	K3B13	RV361AK6	K5D12	RV364GD2	L4B14	RV901EF2	M2B13	RV281DB4
G1A11	RV444DH4	H3B09	RV443DB4	H5D11	RH435CE2	J4B07	KD101AC2	K3D01	RV362GB4	K5D13	RV361GD2	L4B14	RV901EF2	M2B14	RV284AK6
G1A13	CM201GL6	H3B10	RV448FG2	H5D11	RH435CE2	J4B09	WD247CA4	K3D03	RV364DH4	K6A02	RV901EF2	L4D02	KP051ED2	M2D03	RV901AA2
G2B03	KV807FK6	H3B12	KV009CD2	H5D12	RV444GD2	J4B09	WD247CA4	K3D04	RV362AK6	K6A04	RV901AE2	L4D03	KV005GD4	M2D05	RV284GH4
G2B07	KD021FD6	H3B12	KV009CD2	H5D13	RV441GD2	J4D05	KV827GA2	K3D06	RV362DK2	K6B02	RV903CE2	L4D05	KV009GF2	M2D07	RV281DK2
G2B08	KC233GM6	H3B13	RV441AK6	H6A02	KD021FG6	J4D06	KV827FH6	K3D07	RV362DD2	K6B04	RV901EE2	L4D06	KV009CG2	M2D08	RH325CE2
G2B08	KC233GM6	H3D01	RV442GB4	H6A04	CM201GL6	J4D07	KR951GA2	K3D08	RV362AC6	L1D11	RV361DH4	L4D07	KV827FK4	M2D10	RV281DD2
G2B09	KD021FG6	H3D03	RV444DH4	H6B02	RH435CG2	J4D08	KN101GH2	K3D09	RV363DD2	L1D13	RV361DB4	L4D07	KV827FK4	M2D11	AV727GD4
G2B13	CM201GL6	H3D04	RV442AK6	H6B04	RV901EG2	J4D10	WD247CC4	K3D11	KV009AE2	L1E11	RV362DK2	L4D08	RV907AE2	M2D12	KV823GA2
G2B13	CM201GL6	H3D06	RV442DK2	H6C02	AP523FD2	J4D11	WD247AB4	K3D11	KV009AE2	L1E13	RV362GK2	L4D08	RV907AE2	M2D12	KV823GA2
G3B05	KV827FK4	H3D07	RV442DD2	H6C04	KD021FD6	J4D11	WD247AB4	K3D13	RV361GB4	L2B02	AV735BE2	L4D10	KV013GH2	M2D13	RV282DB4
G3B05	KV827FK4	H3D08	RV442AC6	H6D02	RH435CE2	J5B02	KV823GB2	K4B02	RV362GH4	L2B03	KV013GM2	L4D11	RV901CF2	M3B03	RV281DH4
G3B07	KV807FK2	H3D09	RV443DD2	H6D04	RV901GF2	J5B05	KV821GH4	K4B03	RV364GB4	L2B04	KV013FE2	L4D11	KV901CF2	M3B04	RV281AC6
G3B08	KV807FK6	H3D11	KV009AE2	H6E02	KR951GJ2	J5D01	KV823GA2	K4B04	RV364DB4	L2B06	KV013EL2	L4D12	RV903AC2	M3B05	RV283DH4
G3B10	KV827GA2	H3D11	KV009AE2	H6E04	KD101AC2	J5D02	KV829GB2	K4B06	KV009CG2	L2B07	AV733BE2	L4D12	RV903AC2	M3B07	RV283DK2
G3D06	KV813DA6	H3D13	RV441GB4	J1A11	KV825EF2	J5D08	KV829FE2	K4B06	KV009CG2	L2B08	KV005GC4	L4D13	RV905EE2	M3B08	WD245CC4
G3D03	KV813GE6	H4B02	RV442GH4	J1A13	KV825FB2	J5D11	KV821GF4	K4B07	KV009AB2	L2B09	KV009CC2	L4D13	RV905EE2	M3B09	RV283DB4
G4B04	KV811FK2	H4B03	RV444GB4	J1B11	KV825FD2	J5D12	KV821FE1	K4B07	KV009AB2	L2B11	KV009EF2	L5B02	WD247AH4	M3B10	RV288FG2
G4B06	KV811FK6	H4B04	RV444DB4	J1B13	KV524GH4	J5D13	KC233GM6	K4B08	WD245GG4	L2B12	KV013EH2	L5B03	WD247CG4	M3B12	KV009CC2
G4B08	WD247AD4	H4B06	KV009CG2	J1C11	KV825CB2	J6A02	RV901CD2	K4B08	WD245GG4	L2B13	RV901AD2	L5B04	KV011EJ6	M3B12	KV009CC2
G4B09	KV803FK6	H4B06	KV009CG2	J1C13	KV825FH2	J6A04	RV901GG2	K4B09	RV363GB4	L2B13	RV901AD2	L5B05	RV907CC2	M3B13	RV281AK6
G4B11	KV813GL6	H4B07	KV009AB2	J1D11	KV825CF2	J6B02	RH355CE2	K4B11	WD521BH2	L2B14	KR801DG6	L5B05	RV907CC2	M3D01	RV282GB4
G4D05	KV813GH6	H4B07	KV009AB2	J1D13	KV825ED2	J6B04	RH355CG2	K4B11	WD521BH2	L2D02	AV731FL2	L5B07	KV013CH2	M3D03	RV284DH4
G4D08	KV803FK2	H4B08	RV448GK2	J1E11	KV825DF2	J6C02	KR951GA2	K4B12	RV363AK6	L2D03	KV013AD2	L5B08	WD635GH2	M3D04	RV282AK6
G4D10	WD247AF4	H4B09	RV443GB4	J1E13	KV825DD2	J6C04	DE031CJ2	K4B13	RV363GH4	L2D05	KV013EK2	L5B08	WD635GH2	M3D06	RV282DK2
G4D11	WD247CE4	H4B11	WD521BH2	J2B02	WD635GH2	J6D02	RV901AD2	K4B14	RV363AC6	L2D06	KV013EJ2	L5B09	KV829BD2	M3D07	RV282DD2
G5B05	KV823GJ6	H4B11	WD521BH2	J2B02	WD635GH2	J6D04	RV901CG2	K4D02	KV827FJ6	L2D07	AV733DK2	L5B10	DE031DE6	M3D08	RV282AC6
G5B07	WD635GH2	H4B12	RV443AK6	J2B03	KV825FF2	J6E02	RV901CF2	K4D02	KV827FJ6	L2D08	RV903CC2	L5B12	KV009AA2	H3D09	RV283DD2
G5B07	WD635GH2	H4B13	RV443GH4	J2B04	KV825FD2	J6E04	RV901CE2	K4D03	RV364AC6	L2D08	RV903CC2	L5B13	KV011ED2	M3D11	KV009AD2
G6A02	KV827FK4	H4B14	RV443AC6	J2B06	KV825EF2	K1A11	KV825EB2	K4D05	RV364DK2	L2D10	RV901AE2	L5D01	KV011DF6	M3D11	KV009AD2
G6A04	KN101GH2	H4D02	KV827FJ6	J2B07	KV829GK6	K1A13	KV825EH2	K4D06	RV363GK2	L2D10	RV901AE2	L5D02	WD247CJ4	M3D13	RV281GB4
H1A13	RV361DD2	H4D02	KV827FJ6	J2B08	KC233GM6	K1B11	KV825DH2	K4D07	RV364DD2	L2D11	KV009EE2	L5D03	WD247AK4	M4B02	RV282GH4
H1B11	RV361GB4	H4D03	RV444AC6	J2B08	KC233GM6	K1B13	KV825DB2	K4D08	RV363GD2	L2D12	KV009CD2	L5D04	RV901EE2	M4B03	RV284GB4
H1B13	KV827FH2	H4D05	RV444DK2	J2B09	KV829GJ6	K2B02	RH435CE2	K4D10	KV013EK2	L2D13	KR801BJ6	L5D04	RV901EE2	M4D04	RV284DB4
H1C11	RV361DK2	H4D06	RV443GK2	J2B11	KV829BD2	K2B03	RV903CD2	K4D10	KV013EK2	L3B02	KV013GK2	L5D06	KV009AB2	M4B06	KV009CF2
H1C13	KV827FJ2	H4D07	RV444DD2	J2B12	KV825FB2	K2B04	RH405CG2	K4D11	KV821GB2	L3B03	KV009EJ2	L5D07	KV829GB2	M4B06	KV009CF2
H1D11	KV827FG2	H4D08	RV443GD2	J2B13	KV825FH2	K2B07	RV362GK2	K4D11	KV821GB2	L3B04	RV907AB2	L5D07	KV829GB2	M4B07	KV009AA2
H1D13	KV825FF2	H4D10	KV013EK2	J2B14	KV825CB2	K2B08	WD245EE4	K4D12	WD521BF2	L3B04	RV907AB2	L5D08	DE031FC4	M4B07	KV009AA2
H1E11	KV825CH2	H4D10	KV013EK2	J2D02	KV825CF2	K2B09	WD245CE4	K4D12	WD521BF2	L3B05	RV903AB2	L5D09	DE031DD6	M4B08	WD245GC4
H1E13	KV825CD2	H4D11	KV821GB2	J2D03	KV825ED2	K2B11	RV362GD2	K4D13	RV362DH4	L3B05	RV903AB2	L5D11	DE031CH4	M4B09	RV283GB4
H2B02	RH515CE2	H4D11	KV821GB2	J2D05	KV825DF2	K2B12	KV013GK2	K5B02	WD245AG4	L3B07	RV901CG2	L5D12	KV009GJ2	M4B11	WD521BH2
H2B03	RV901GJ2	H4D12	WD521BF2	J2D06	KV825DD2	K2B12	KV013GK2	K5B02	WD345AG4	L3B07	RV901CG2	L5D13	KV009GK2	M4B11	WD521BH2
H2B04	RH485CG2	H4D12	WD521BF2	J2D07	KV825CD2	K2B13	RV361DB4	K5B04	AV727GD4	L3B10	RV903CE2	L6D02	RV903CC2	M4B12	RV283AK6
H2B07	RV442GK2	H4D13	RV442DH4	J2D08	KV825CH2	K2B14	RV364AK6	K5B05	KV013GK2	L3B10	RV903CE2	L6D04	RV903AC2	M4B13	RV283GH4
H2B08	RV448FF2	H5B02	RV448FH2	J2D10	KV825EH2	K2D03	RV903CG2	K5B05	KV013GK2	L3D01	KV009AD2	L6E02	RV903AB2	M4B14	RV283AC6
H2B09	RV448EF2	H5B04	AV727GD4	J2D11	KV825EB2	K2D05	RV364GH4	K5B07	RV901CD2	L3D02	KV009EH2	L6E04	RV903AD2	M4D02	KV827FH6
H2B11	RV442GD2	H5B04	AV727GD4	J2D12	KV825CH2	K2D07	RV361DK2	K5B09	RV361GK2	L3D03	KV009AE2	M1A11	RV362DD2	M4D02	KV827FH6
H2B12	KV013GK2	H5B05	KV013GK2	J2D13	KV825CB2	K2D08	RH405CE2	K5B10	RH355CG2	L3D04	RV907EH2	M1A13	RV362GD2	M4D03	RV284AC6
H2B12	KV013GK2	H5B05	KV013GK2	J3B04	KR951GJ2	K2D10	RV361DD2	K5B12	WD245EG4	L3D06	RV903EG2	M1B11	RV362DB4	M4D05	RV284DK2
H2B13	RV441DB4	H5B07	RV901EG2	J3B05	AV723DF6	K2D11	AV727GD4	K5B12	WD245EG4	L3D07	AV735DJ6	M1B13	RV362GB4	M4D06	RV283GK2
H2B14	RV444AK6	H5B09	RV441GK2	J3B05	AV723DF6	K2D11	AV727GD4	K5B13	WD245AE4	L3D08	RV901CE2	M1C11	RV363DK2	M4D07	RV284DD2
H2D03	RV901GL2	H5B10	RH435CG2	J3B07	KV827FG2	K2D12	KV823GB2	K5B13	WD245AE4	L3D08	RV901CE2	M1C13	RV363DD2	M4D08	RV283GD2
H2D05	RV444CH4	H5B12	RV448GJ2	J3B08	KV827FJ6	K2D12	KV823GB2	K5D01	KV009GG2	L3D11	KV011CE2	M1D11	KV363DH4	M4D10	KV013EJ2
H2D07	RV441DK2	H5B13	RV448EE2	J3B09	DE031CJ2	K2D13	RV362DB4	K5D01	KV009GG2	L3D12	AV733DJ6	M1D13	RV363DB4	M4D10	KV013EJ2
H2D08	RH485CE2	H5D01	KV009GG2	J3B10	KV807FK2	K3B03	RV361DH4	K5D02	KV009EF2	L4B02	AV735DJ2	M1E11	RV364DH4	M4D11	KV821GA2

Figure 3-16. Board Discrete Wire Equivalent List (Pin List)



●Figure 3-17. Board Discrete Wire Equivalent List (Net List)

for net replacement as specified in the board discrete equivalent list is shown in the flowchart in Figure 3-18.

Discrete Wire Replacement

A damaged discrete wire can and must be replaced as specified in the board discrete wire equivalent list. This list must be at the correct EC level and for the same part number. A detailed procedure is shown in the flowchart in Figure 3-18.

Note: For MST-4 packages using 50-ohm twisted pair board wires, a 50-ohm tri-lead from wire caddy (part 453900) can be used for board error recovery. Use the same lengths of 50-ohm tri-lead wire as called out in the recovery documentation for 50-ohm twisted-pair wire. The entire repaired discrete wired net on a board must be of the same type wire (all tri-lead). Be certain to use only universal housings when making the tri-lead wire net.

●*Replacement of a Connection from a Voltage Pin to a Via*

Voltage subnets from a via to a pin exist and are indicated in the discrete wire equivalency list. Deletions and additions cannot be made to a via since there is no physical pin. However, a repair capability utilizing an identical voltage pin in an adjacent socket does exist and is accomplished by using either a 1.0 inch length of yellow wire (for single-layer boards) and wire-wrapping or a 2.4 inch length of 50- or 90-ohm tri-lead wire, (effective wire length minus tuning forks is 1.3 inches for double-layer boards) reversing the ground and signal tuning forks within the housing on both ends of the wire and plugging the wire between an identical voltage pin and the affected voltage pin. A voltage pin repair wire should be tagged to identify it. This is most important in the case of a reversed tri-lead wire. Reversing the tri-lead wire in the housing allows two wires to carry the power and also reduces the mid-frequency noise.

Emergency repair to MST board voltage pins can be made along the following guidelines:

For MST-1 and MST-2 Single Boards: If a board location contains a 1-wide, 2-high card only B08 pin may be repaired with one #30 AWG wire from the adjacent socket location. The maximum length of the wire is 1.0 inch. All other pins are irreparable.

A location on a board containing a 2-wide 2 high card may have one repair to the power pins using one #30 AWG wire. Maximum length of the wire is 1.0 inch.

A location on a board containing a 4-wide 2 high card is allowed a maximum of two voltage pin repairs with one #30 AWG wire per pin. Maximum length of the wires is one 1.0 inch. (Insulation length.)

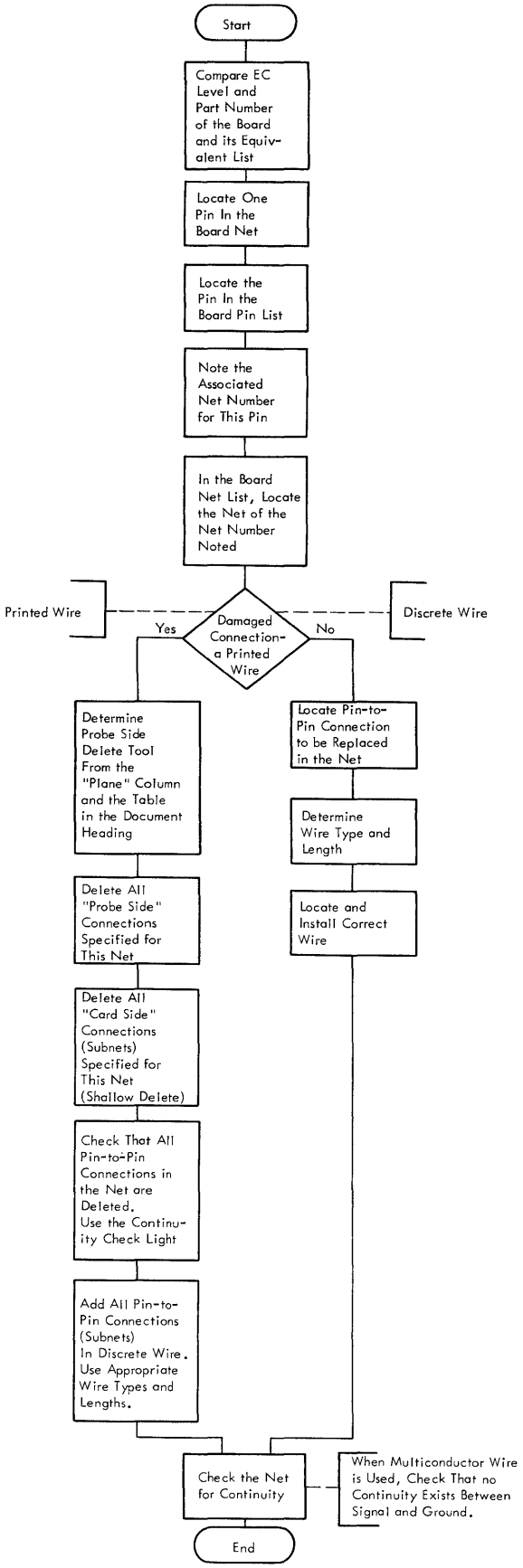


Figure 3-18. Board Error Recovery Procedure

For MST-2 Double Board: Repairs may be made to the MST-2 double board utilizing "reversed tri-lead." However, it is as limited in the number of repairs as the MST-1 and MST-2 single boards. Reversed tri-lead utilizes the two #30 AWG signal conductors to carry the power to the repaired voltage pin. The maximum allowable length of tri-lead between the power pins is 1.3 inches. (Use 2.5 inch tri-lead; total length includes housings.)

For MST-4 Double Board: Repairs may be made to the MST-4 double board power pins utilizing both reversed tri-lead (previously described for MST-2) and also twisted pair. However, the number of repairs is limited as with the MST-1 and MST-2 single boards.

The utilization of twisted pair as a voltage repair calls for both #30 AWG wires to be commoned, enabling both to supply the voltage. The maximum allowable length of both the tri-lead and the twisted pair is 1.3 inches between the adjacent socket locations. (Use 2.5 inch twisted pair or 2.5 inch tri-lead; total length includes housings.)

Maximum Number of Repairs per Board

All systems (MST-1, MST-2, and MST-4) are limited to a maximum of ten voltage pin repairs per board.

CABLE REWORK

- Rework is directed by engineering change instructions.
- Engineering instructions include cable add and delete lists.
- Cable removal is completed prior to board net engineering change rework.
- Cable addition is completed after board net engineering change rework.

MST Cable Rework Instructions

The probe side discrete cables in MST-2 and MST-4 are in effect an extension of the board wiring as the means of communication between the various logic sections of a system. Changes to the communication paths can affect both board wires and cables.

The cable rework format and procedure provide the information and methods required for the customer engineer to change the cabling as directed by an engineering change. The procedure should be followed exactly. Deviation from the rules and sequences results in additional work and unnecessary machine downtime.

Using the cable rework instructions requires a thorough understanding of the board layout of the cable channel and node identification (Figure 3-19). A cable is changed by using the information supplied on the cable add and delete lists that are a part of the engineering change package. Figure 3-20 shows a sample of these lists, which are to be used for all cable rework operations. An example of cable connectors for MST-4 are shown in Figure 3-21.

The cable rework instructions (Figure 3-20) consist of two documents: one contains the cable add information and the other contains the cable delete information.

The general information headings (Figure 3-20) (A through J) are:

A. Document title.
B. Part number of the present listing.
C. Part number of the previous listing.
D. Machine type affected.
E. Machine version affected.
F. Location and destination of cables affected.
G. EC level of the machine after rework.
H. EC level of the machine before rework.
J. Number of pages in rework instructions (in numeric sequence).

The major column headings (Figure 3-20) (1 through 9) are:

1. *Part Number:* This column lists the part number of the cables to be used for cable additions. Information is not provided in this column for cable deletions.
2. *Total Length:* The information in this column is only for manufacturing purposes and is not to be used in field rework because the part number is associated with the length and type of the cable. Information is not provided in this column for cable removals.
3. *From F-G:* This column specifies the "From" frame and gate location coordinate.
4. *From Bd-Pin:* This column specifies the "From" board and pin location or tailgate location coordinate.
5. *To F-G:* This column specifies the "To" frame and gate location coordinate.
6. *To Bd-Pin:* This column specifies the "To" board and pin location or tailgate location coordinate.
7. *Via Pt:* This column is repeated four times and specifies the board exit/entry points and the bend points that should be used in routing a cable from the "From" location to the "To" location. Figure 3-19 shows the routing coordinate system. Via points are specified only for cable additions.
8. *Deletes-Adds:* These two subheadings denote a delete or add instruction.
9. *End of List:* This statement appears on the last page of the cable rework instructions.

Cable Rework Procedures

Cable rework is often accompanied by board rework. To ensure a minimum number of physical operations and to reduce the installation time, the following rework sequence was established:

1. Cable removals.
2. Board delete rework.
3. Board add rework.
4. Cable additions.
5. Checking of board and cable rework.

A detailed flowchart of the cable rework procedure is shown in Figures 3-22, 3-23, and 3-24.

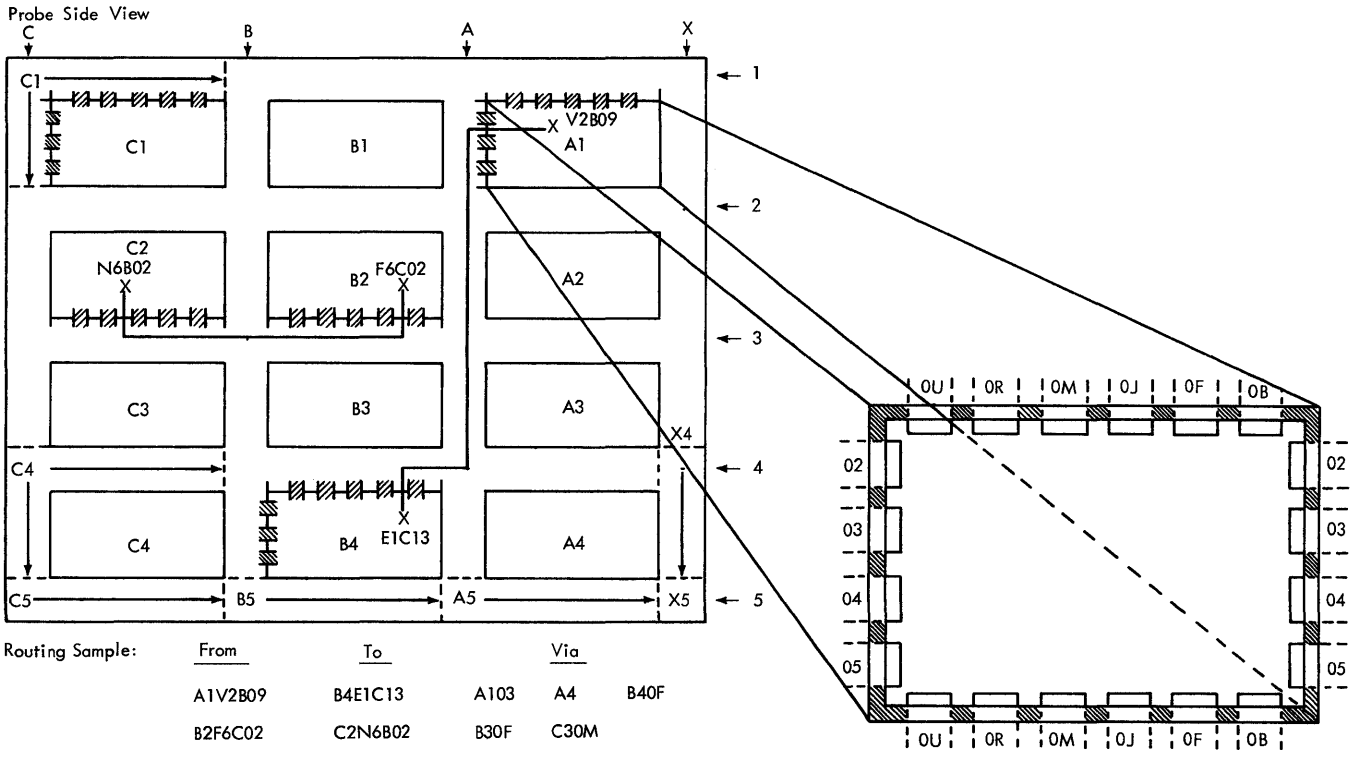


Figure 3-19. Cable Routing

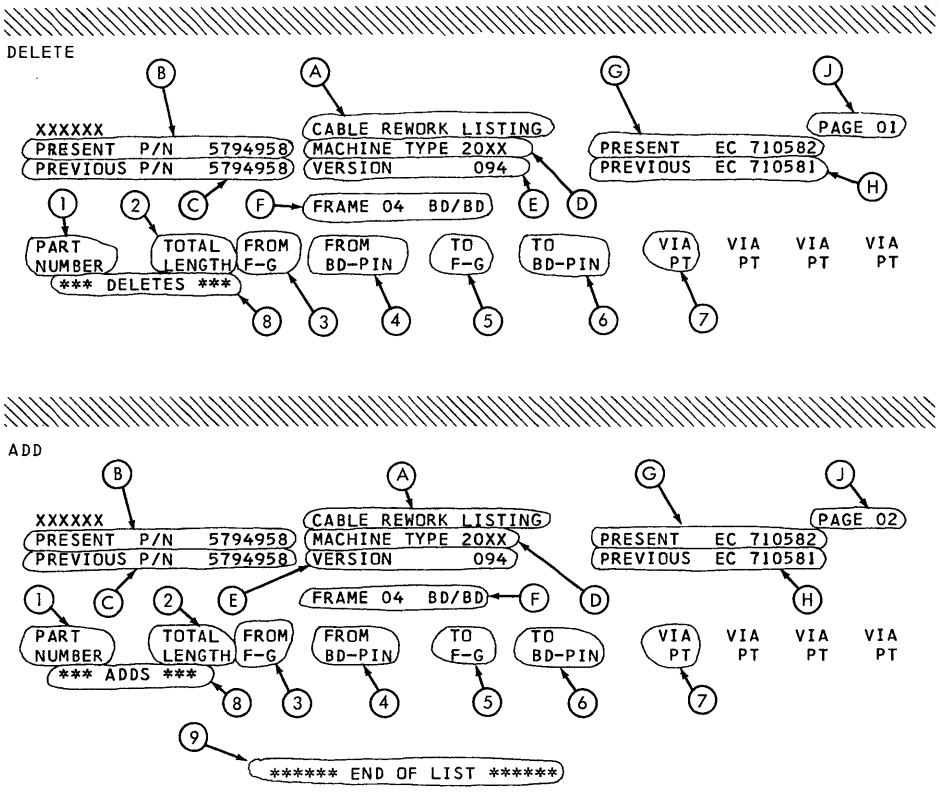


Figure 3-20. Cable Rework Format

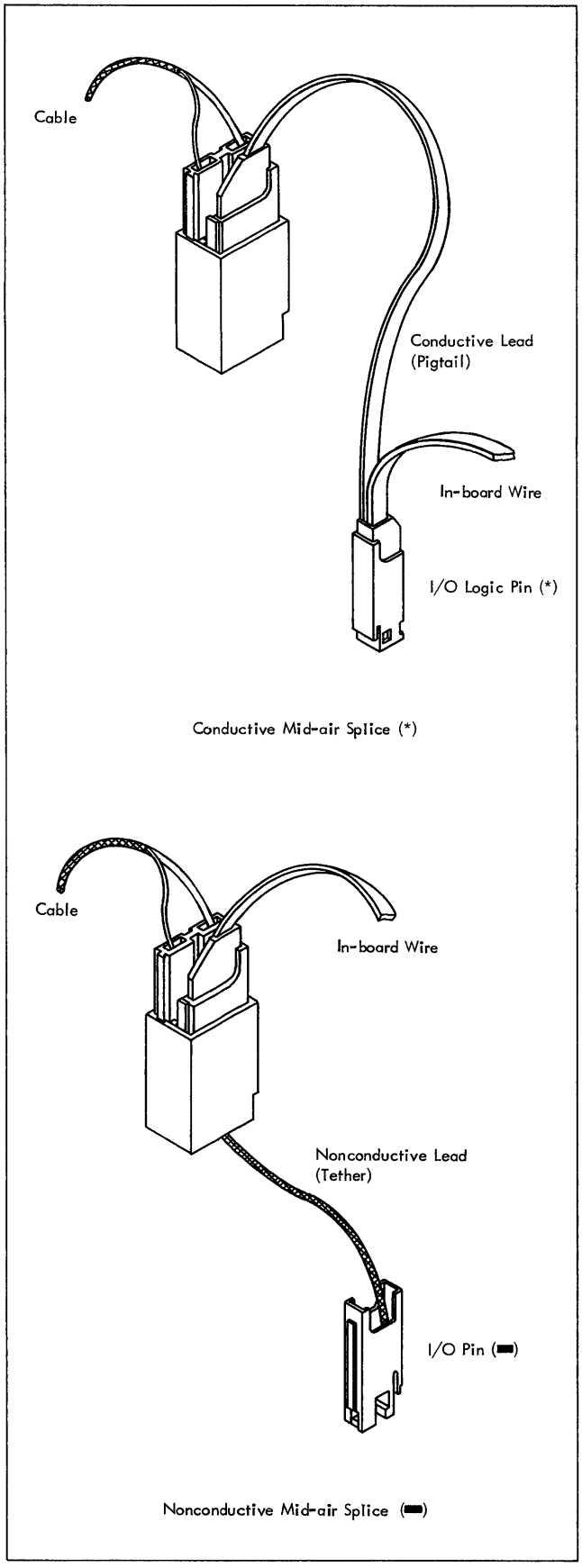


Figure 3-21. Mid-air Splice

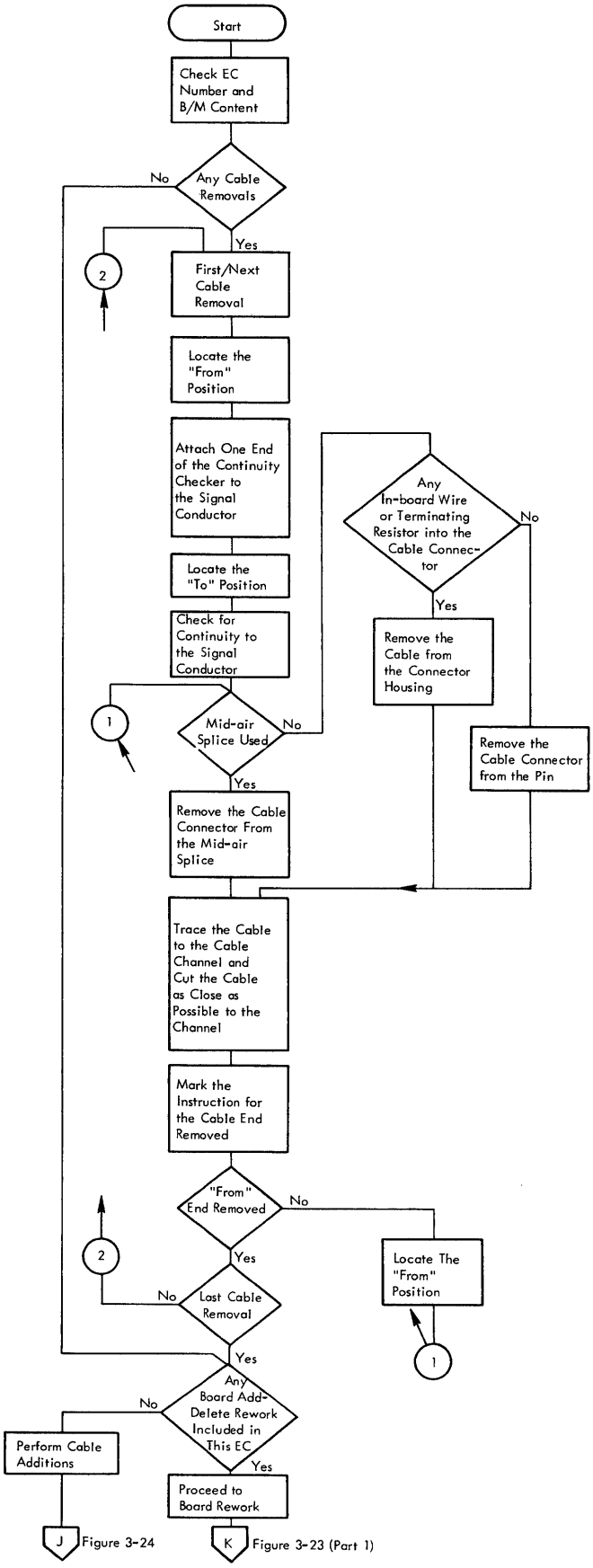


Figure 3-22. Discrete Cable Rework Procedure (Cable Removal)

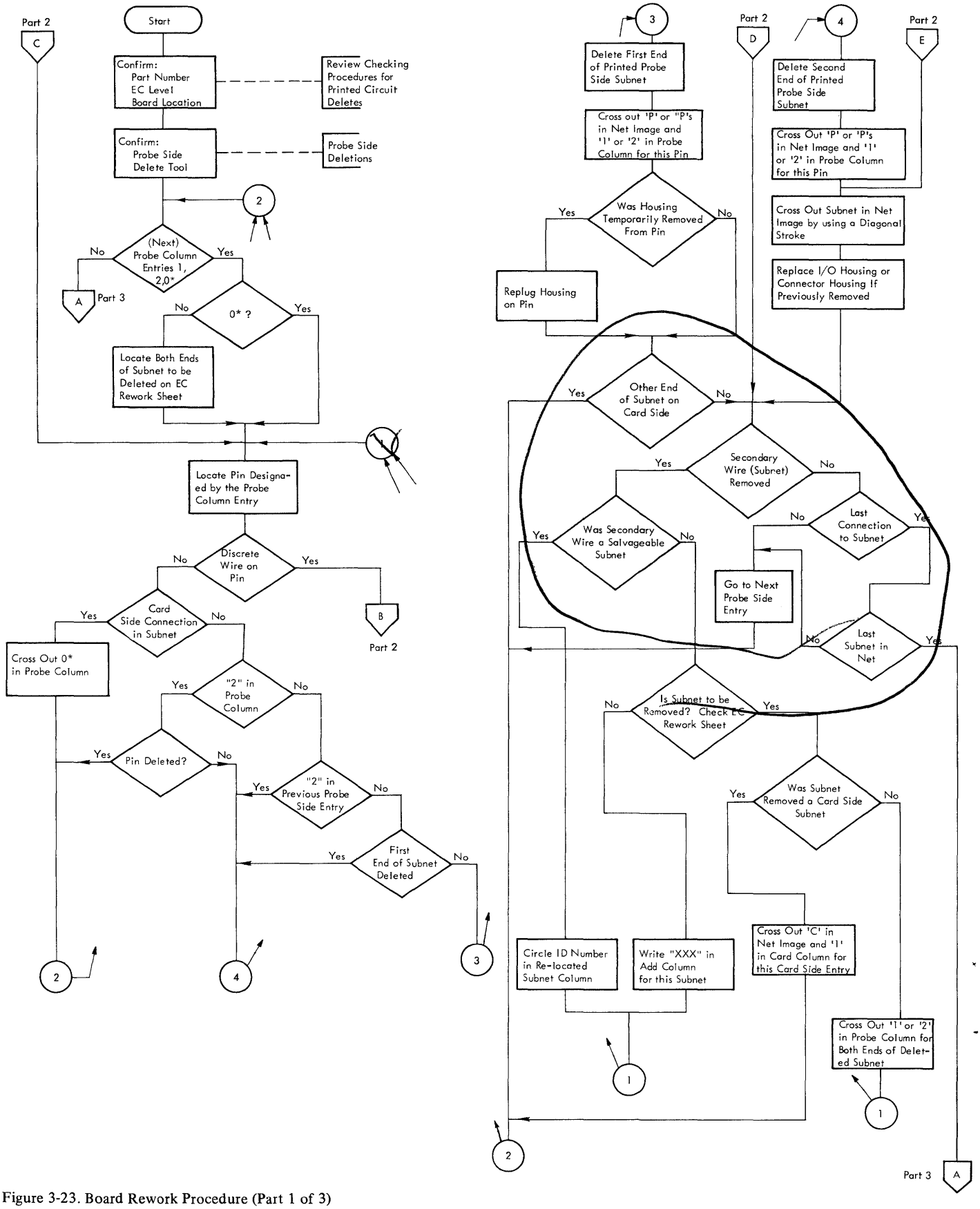


Figure 3-23. Board Rework Procedure (Part 1 of 3)

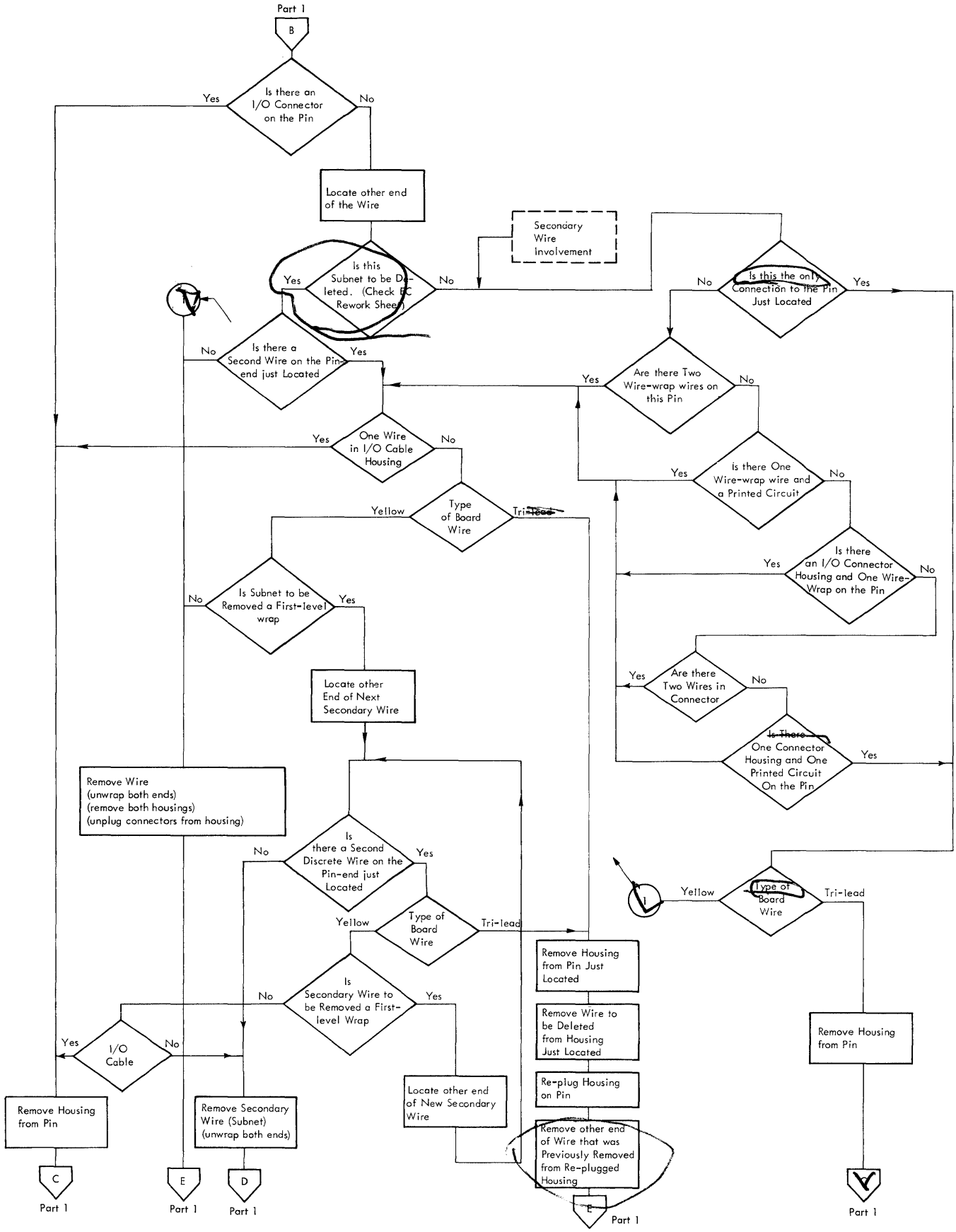


Figure 3-23. Board Rework Procedure (Part 2 of 3)

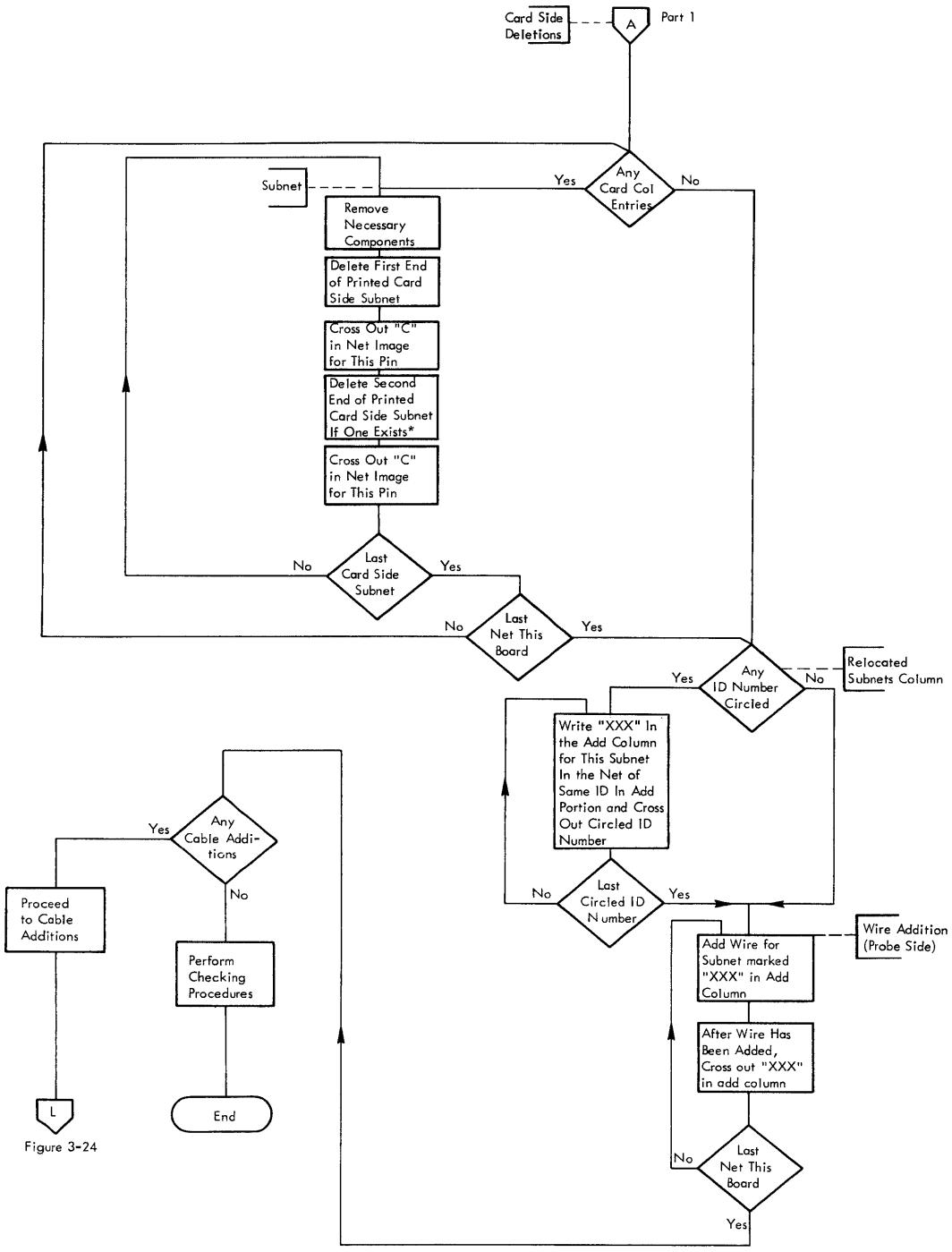


Figure 3-24

* If the subnet was a C-P construction (as shown in Figure 3-2) no second deletion is necessary.

Figure 3-23. Board Rework Procedure (Part 3 of 3)

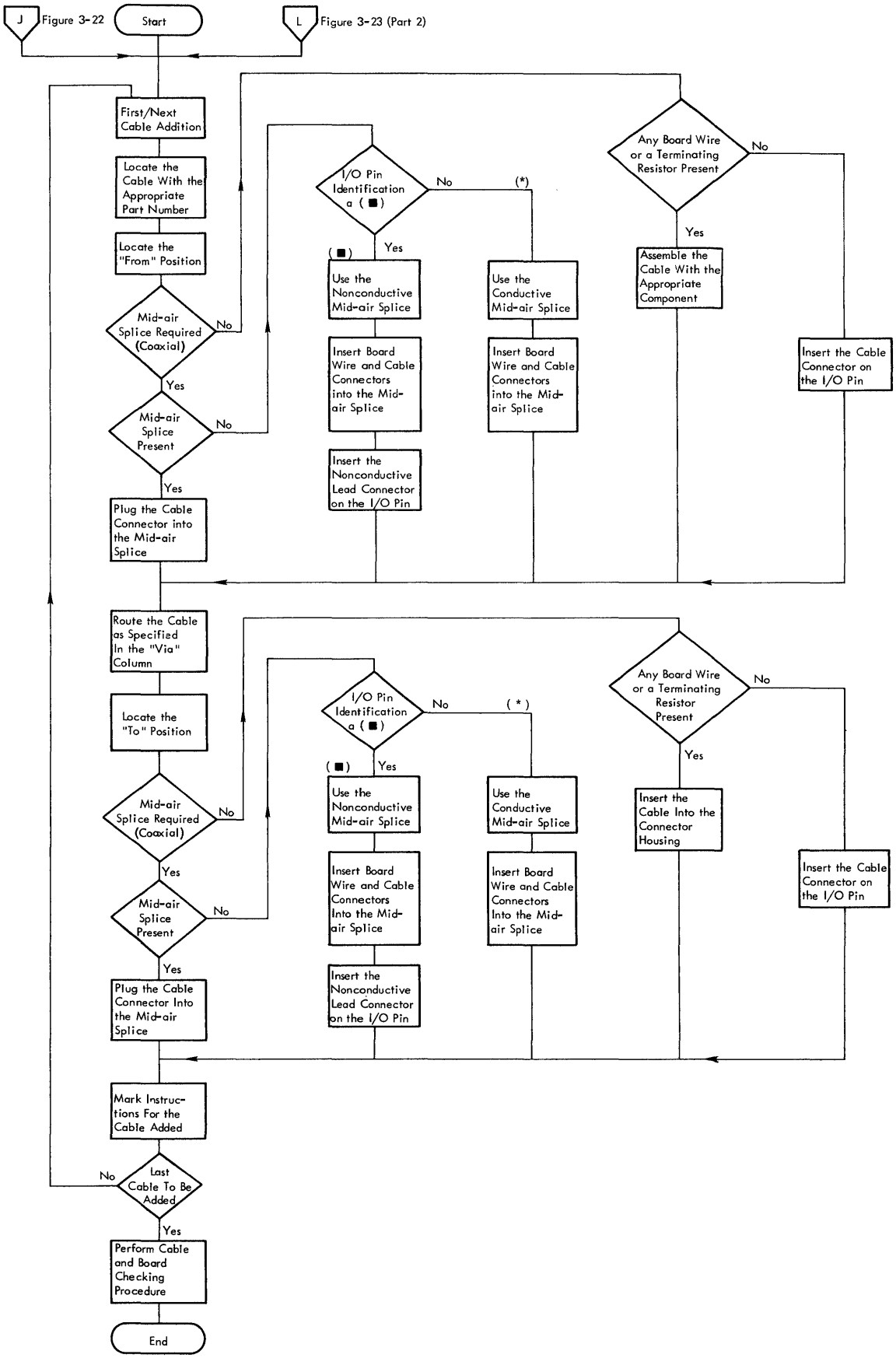


Figure 3-24. Discrete Cable Rework Procedure (Cable Additions)

Cable Removals

The removal of a cable requires that the "From" and "To" cables be located. Continuity must be checked between the signal conductors at the two locations to ensure that the correct cable is removed. Each of the cable ends is then extracted and traced to the cable channel where the cable is cut as close to the channel as possible. The sequence of removals is as listed.

Cable Additions

A cable addition requires that the cable with the correct part number be located and inserted at the "From" and "To" positions. To route the cable from the "From" location to the "To" location, use the "via" coordinates. Cables to be added are provided with the B/M package in correct types and lengths, and with the appropriate connectors attached. The B/M package must be thoroughly checked before installation to ensure that the correct types of cables by part number are available in the amount required to install the change. It is important that only the correct cable types and lengths be used in rework, because the use of improper cables causes changes in delay times and noise conditions that result in machine malfunctions. These conditions are difficult to debug and can cause a considerable increase in EC installation time.

Mid-air Splice

The mid-air splice is required for machines that use coaxial cabling when coaxial cables and board wires are to be interconnected. Two types of mid-air splices are used:

1. A nonconductive type that consists of a plastic housing that accommodates two connector housings and a nonconductive lead (tether) with a connector housing (Figure 3-21).
2. A conductive type that consists of a plastic housing which accommodates two connector housings (Figure 3-21).

The nonconductive type is used for cable additions when a "■" appears next to the pin location coordinate (01A-A1-B2D03■). The cable and board wire housings are inserted into the mid-air splice housing and the nonconductive lead connector is inserted onto the I/O pin specified.

The conductive type is used when an "*" appears next to the pin location coordinate. The cable and board wire connector housings are inserted into the mid-air splice as shown in Figure 3-21.

Terminating Resistor

The presence of a terminating resistor is shown by a "T" next to the pin location coordinate (01A-A1-R4B05 T). Terminating resistors are not removed with the cable. A cable is removed and is added to a terminating resistor using the appropriate procedure.

General Housekeeping Procedures

For each cable end removed or installed, a check mark is written next to the pin location coordinate. After the cable portion of the engineering change is installed, see "Cable and Board Rework Checking Procedure."

Cable Error Recovery Documentation

Documentation and procedures are available that provide the information required for the customer engineer to replace any damaged cable in a machine. The instructions and procedures for cable replacement must be followed to ensure efficient machine operation.

MST Cable Location List

The MST cable location list provides cable information that allows the customer engineer to replace any discrete cable in a machine. The list indicates the tailgate and board location, part number, and EC level.

The following information can be obtained from the cable location list:

1. "From-To" locations of any discrete cable.
2. Feature usage of the cables.
3. Terminating resistors associated with the cables.
4. Appropriate cable part numbers.
5. Six-pack locations and usage.
6. Reference to ALD pages.

Format

The format of the cable location list is shown in Figure 3-25. The general information headings are:

A. Machine type.
B. Part number of the board affected.
C. Location of the board affected.
D. Version number of the board.
E. Document part number.
F. Present EC level.
G. Previous EC level.
H. Document release date.
J. Features and versions included in the list.

The subheadings (1 through 5) appear twice. A description of each subheading follows:

1. *From Soc-Pin:* This column lists in alphameric sequence all the board pins that have a cable. I/O logic pins are specified by an "*" next to the pin coordinate and the presence of terminating resistors is indicated by a "T" next to the pin coordinate.
2. *Fr-Gt-Bd-Soc-Pin:* This column lists the "To" cable locations. I/O logic pins "*" and terminating resistors "T" are specified next to the "To" location coordinate.
3. *ALD Ref:* This column shows the six-pack usage and the ALD pages on which the cables are located. Six-packs are listed twice for the first location within the six-pack. The first entry "6-PAK" specifies that a six-pack is used. The following six entries are the ALD references for the single cables within the six-pack.

4. *Part Number:* The appropriate cable and six-pack part numbers that must be used for the replacement of the cables and six-packs listed in the "From-To" columns are indicated in this column. Six-pack part numbers (seven digits) can be easily recognized. Part numbers are not specified for the single cables within a six-pack.
5. *Usage:* This column lists the usage codes which describe the differences in cabling as a result of the feature combinations within a machine. Cables that do not have a usage code specified in this column are basic cables that are in all machines, regardless of the features installed on the machine.

   Feature sensitive cables are shown by a usage code or codes, which are abbreviations of the feature name; for example, EMU (emulator) and HSM (high-speed multiply). These cables are only in a machine when the features shown in the usage column are installed on the machine.

Example:

From	*To*	*ALD*	*Part Number*	*Usage*
A1B09	27Y1-02B-B10	MB501	817012	FEA1

This cable is at pin location A1B09 when feature 1 is installed on the machine. If feature 1 is not installed, pin location A1B09 is empty.

In some cases, a cable is removed or replaced by a feature cable when a feature is installed. These cables are shown in the usage column with the not feature abbreviations, NEMU (not emulator) and NHSM (not high-speed multiply). These cables are present only when the specific feature is not installed on the machine.

Example:

From	*To*	*ALD*	*Part Number*	*Usage*
A1B12	27Y1-02B-B11	MB521	817013	NFE4

This cable is at pin location A1B12 when feature 4 is not installed on the machine.

Combinations of features and "not" features usually exist and a cable location can be listed several times in the location list when the cable is affected by more than one feature. For this condition, a decision must be made as to which cable should be in a specific machine. However, only one or none of the cable locations applies to a given machine.

Example:

From	*To*	*ALD*	*Part Number*	*Usage*
A2B12	04A–C4N2D11	KM001	817025	NEMU,NHSM
A2B12	04A–C3N2D11	KX001	817042	EMU
A2B12	04A–C4N2B11	KX069	817030	HSM,EMU

Three entries are listed for pin location A2B12, each has a different usage code associated with the cable. The first entry has the usage codes NEMU (emulator feature not installed) and NHSM (high-speed multiply feature not installed), which means that this cable is present in a machine that does not have the emulator and high-speed multiply feature installed. The second entry describes the cable that is present only when the emulator feature is installed. The third entry describes the cable that is present only when the high-speed multiply and emulator features are installed.

Six-pack cables are described in the first line entry of the six-pack locations and all cables within the six-pack have the identity specified in the first entry.

Cable Error Recovery Procedure (for Discrete Cables)

Replacement of a damaged cable can be required in both rework and maintenance of a machine. When either end of a damaged cable is found and the location is known, the cable information necessary to locate the other end of the cable and to replace the cable is obtained from the cable location list. The damaged cable is removed as described under "Cable Removals." A new cable for the same part number as shown for that cable is installed and checked as described under "Cable Additions." Via information is not specified for error recovery; therefore, the shortest possible route should be used.

In emergency situations when a cable for the required part number is not available, a temporary cable can be made from two or more cables by using the mid-air splice, part 818591. The total length of the spliced cable must be the same as the original cable. A cable for the correct part number must be ordered as soon as possible so that the spliced cable can be replaced.

The following ground rules should be used in determining how many splices could be used in a net.

Cable Length	*Splice Allowed**
up to 25"	1
26" to 37"	2
38" to 49"	3
over 50"	4

* Always use as few splices as possible in making the repair.

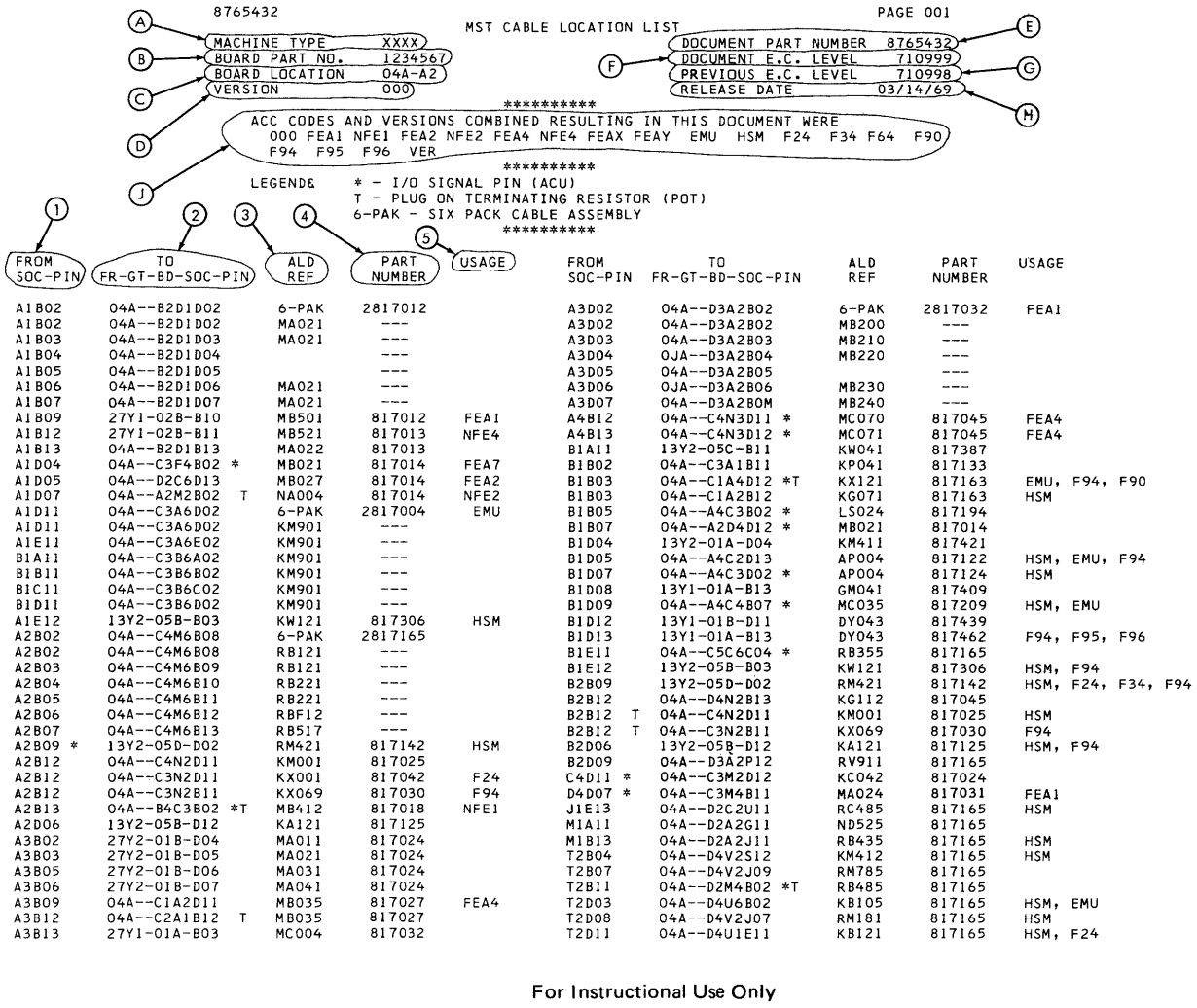
•MST-1 BOARD REPLACEMENT

Board Removals

Card Side Operations

1. Remove board card cover.
2. Remove board card cover mounting hardware.
3. Unplug all flat cables and leave hanging in raceway.

Note: Cards may be left in board or removed and identified for replugging.



8765432 MST CABLE LOCATION LIST PAGE 001

MACHINE TYPE XXXX
BOARD PART NO. 1234567
BOARD LOCATION 04A-A2
VERSION 000

DOCUMENT PART NUMBER 8765432
DOCUMENT E.C. LEVEL 710999
PREVIOUS E.C. LEVEL 710998
RELEASE DATE 03/14/69

****
ACC CODES AND VERSIONS COMBINED RESULTING IN THIS DOCUMENT WERE
000 FEA1 NFE1 FEA2 NFE2 FEA4 NFE4 FEAX FEAY EMU HSM F24 F34 F64 F90
F94 F95 F96 VER
****

LEGEND& * - I/O SIGNAL PIN (ACU)
T - PLUG ON TERMINATING RESISTOR (POT)
6-PAK - SIX PACK CABLE ASSEMBLY
****

FROM SOC-PIN		TO FR-GT-BD-SOC-PIN		ALD REF	PART NUMBER	USAGE
A1B02		04A--B2D1D02		6-PAK	2817012	
A1B02		04A--B2D1D02		MA021	---	
A1B03		04A--B2D1D03		MA021	---	
A1B04		04A--B2D1D04			---	
A1B05		04A--B2D1D05			---	
A1B06		04A--B2D1D06		MA021	---	
A1B07		04A--B2D1D07		MA021	---	
A1B09		27Y1-02B-B10		MB501	817012	FEA1
A1B12		27Y1-02B-B11		MB521	817013	NFE4
A1B13		04A--B2D1B13		MA022	817013	
A1D04		04A--C3F4B02	*	MB021	817014	FEA7
A1D05		04A--D2C6D13		MB027	817014	FEA2
A1D07		04A--A2M2B02	T	NA004	817014	NFE2
A1D11		04A--C3A6D02		6-PAK	2817004	EMU
A1D11		04A--C3A6D02		KM901	---	
A1E11		04A--C3A6E02		KM901	---	
B1A11		04A--C3B6A02		KM901	---	
B1B11		04A--C3B6B02		KM901	---	
B1C11		04A--C3B6C02		KM901	---	
B1D11		04A--C3B6D02		KM901	---	
A1E12		13Y2-05B-B03		KW121	817306	HSM
A2B02		04A--C4M6B08		6-PAK	2817165	
A2B02		04A--C4M6B08		RB121	---	
A2B03		04A--C4M6B09		RB121	---	
A2B04		04A--C4M6B10		RB221	---	
A2B05		04A--C4M6B11		RB221	---	
A2B06		04A--C4M6B12		RBF12	---	
A2B07		04A--C4M6B13		RB517	---	
A2B09	*	13Y2-05D-D02		RM421	817142	HSM
A2B12		04A--C4N2D11		KM001	817025	
A2B12		04A--C3N2D11		KX001	817042	F24
A2B12		04A--C3N2B11		KX069	817030	F94
A2B13		04A--B4C3B02	*T	MB412	817018	NFE1
A2D06		13Y2-05B-D12		KA121	817125	
A3B02		27Y2-01B-D04		MA011	817024	
A3B03		27Y2-01B-D05		MA021	817024	
A3B05		27Y2-01B-D06		MA031	817024	
A3B06		27Y2-01B-D07		MA041	817024	
A3B09		04A--C1A2D11		MB035	817027	FEA4
A3B12		04A--C2A1B12	T	MB035	817027	
A3B13		27Y1-01A-B03		MC004	817032	
A3D02		04A--D3A2B02		6-PAK	2817032	FEA1
A3D02		04A--D3A2B02		MB200	---	
A3D03		04A--D3A2B03		MB210	---	
A3D04		0JA--D3A2B04		MB220	---	
A3D05		04A--D3A2B05			---	
A3D06		0JA--D3A2B06		MB230	---	
A3D07		04A--D3A2B0M		MB240	---	
A4B12		04A--C4N3D11	*	MC070	817045	FEA4
A4B13		04A--C4N3D12	*	MC071	817045	FEA4
B1A11		13Y2-05C-B11		KW041	817387	
B1B02		04A--C3A1B11		KP041	817133	
B1B03		04A--C1A4D12	*T	KX121	817163	EMU, F94, F90
B1B03		04A--C1A2B12		KG071	817163	HSM
B1B05		04A--A4C3B02	*	LS024	817194	
B1B07		04A--A2D4D12	*	MB021	817014	
B1D04		13Y2-01A-D04		KM411	817421	
B1D05		04A--A4C2D13		AP004	817122	HSM, EMU, F94
B1D07		04A--A4C3D02	*	AP004	817124	HSM
B1D08		13Y1-01A-B13		GM041	817409	
B1D09		04A--A4C4B07	*	MC035	817209	HSM, EMU
B1D12		13Y1-01B-D11		DY043	817439	
B1D13		13Y1-01A-B13		DY043	817462	F94, F95, F96
B1E11		04A--C5C6C04	*	RB355	817165	
B1E12		13Y2-05B-B03		KW121	817306	HSM, F94
B2B09		13Y2-05D-D02		RM421	817142	HSM, F24, F34, F94
B2B12		04A--D4N2B13		KG112	817045	
B2B12	T	04A--C4N2D11		KM001	817025	HSM
B2B12	T	04A--C3N2B11		KX069	817030	F94
B2D06		13Y2-05B-D12		KA121	817125	HSM, F94
B2D09		04A--D3A2P12		RV911	817165	
C4D11	*	04A--C3M2D12		KC042	817024	
D4D07	*	04A--C3M4B11		MA024	817031	FEA1
J1E13		04A--D2C2U11		RC485	817165	HSM
M1A11		04A--D2A2G11		ND525	817165	
M1B13		04A--D2A2J11		RB435	817165	HSM
T2B04		04A--D4V2S12		KM412	817165	HSM
T2B07		04A--D4V2J09		RM785	817165	
T2B11		04A--D2M4B02	*T	RB485	817165	
T2D03		04A--D4U6B02		KB105	817165	HSM, EMU
T2D08		04A--D4V2J07		RM181	817165	HSM
T2D11		04A--D4U1E11		KB121	817165	HSM, F24

Figure 3-25. Cable Location List

Probe Side Operations

1. Remove all voltage crossover connectors and minibus connectors (label if required).
2. Remove any additional jumpers or sense wires (label if required).
3. Remove board mounting screws.
4. Remove board.

CAUTION
If cards have been left in board, care must be used in handling board.

Board Installation

Probe Side Operation

1. Replace board using screws previously removed.
2. Replace voltage crossover connectors and minibus connectors.
3. Replace any other wires previously removed.

Card Side Operations

1. Replace flat cables.

Note: On short crossover cables, check other end for proper seating.

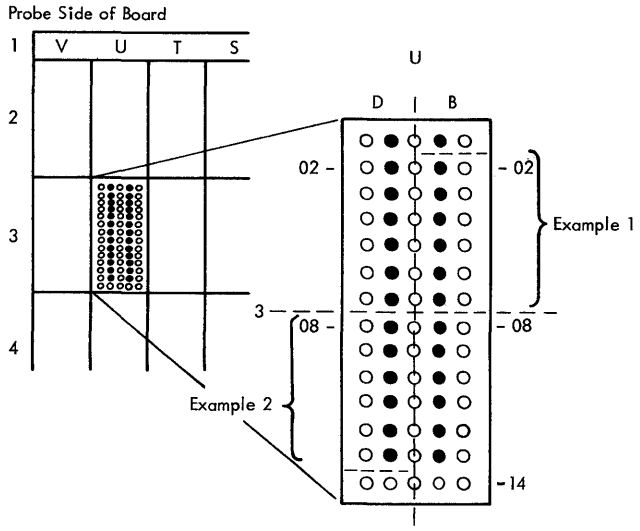
2. Plug cards from removed board into their corresponding positions in the new board.
3. Replace board card cover mounting hardware.
4. Replace cover.

Note: After card side operations have been completed, check the probe side of the removed board for discrete components. If any are present, remove and install on new board in their corresponding locations.

MST-2 AND MST-4 BOARD REPLACEMENT PROCEDURES

Preparation of the *new board* for installation can be done before system power is turned off (MST-2 and MST-4):

1. All tri-lead or twisted-pair overflow wires on the board which are plugged to pins in the I/O area (rows 1 and 6) in card columns A, B, U, and V) must be tagged with a label marked with the socket and pin number of the I/O pin on which the connector is located. The cable location list can be used to determine the exact cable locations on the board.
2. Locate the board to be replaced and visually examine the board to determine whether any additional socket positions (other than A, V, 1, and 6) are used for cabling. If additional socket positions are used, check the replacement board for overflow wires to the socket positions used and tag the wires as in step 1.
3. When all wires into the cable area have been tagged, check the tags against the cable location list. As the location is confirmed, remove the wire connectors from the I/O pins to allow positioning of the cable connectors when the board is installed. Terminating resistors should not be removed from the I/O pins.



Example of Six-pack Locations:
1 is U3B02.
2 is U3D08.
● = Pins
O = Via

Note: Pin positions 1 and 14 are not available on MST-2 boards. Pin position 14 is never available.

●Figure 3-26. Six-pack Socket Quadrants

MST-2 Probe Side Removal (Boards with Permanent Six-packs)

Note: For MST-2 boards without permanent six-packs, follow the MST-4 probe side removals using temporary six-packs and the retaining device.

Removal of the *board to be replaced* can now be initiated. Starting from the center of the board and working toward the outer edges, begin removing all cables. During removal, each socket quadrant (Figure 3-26) must be examined:

1. If less than three cables (not in six-packs) are in the socket quadrant, tag each of the cables with a label marked with the socket and pin number of the I/O pin on which the connector is located. After each cable has been labeled, remove it. If any overflow wire or terminating resistor is mated with the cable, remove as defined under "Physical Operations."
2. If three or more discrete cables (not in six-packs) are in the socket quadrant, the unused pins are to be populated with "dummy housings." After the dummy housings have been installed, check the quadrant for overflow wires and terminating resistors mated with the cables. If any are found, unplug the cable connector from the board and remove the overflow wire or terminating resistor from the housing. Use proper removal procedure as defined under "Physical Operations." Reposition the cable connector on the correct pin. When all overflow wires and terminating resistors in the quadrant have been removed, use the temporary six-pack for removal of the cables.

   The temporary six-packs are to be identified by placing a piece of masking tape on the flat side of the six-pack and writing the socket number and low-order pin number on the tape (U3B02, U3D08, U3D02, U3B08, etc.).

   The temporary six-packs are inserted manually (no tool required) on the T-bars of the housings in the quadrant. When the six-pack has been positioned, pull the six-pack straight out to depopulate the quadrant.

Note: If any pins within a quadrant that would normally require "dummy housings" have two wrapped terminations, *do not* install the dummy housings on these pins.

If the quadrant has a permanent six-pack, remove the housings by grasping the top of the six-pack retainer with duckbill pliers or fingers and pulling it straight out. Remove any overflow wires or terminating resistors within the six-pack using the proper removal procedure as defined under "Physical Operations."

As each row of cables is removed from the board, tie the cables back into the raceway.

Repeat this procedure as necessary until the entire board has been cleared of cables.

Check board for discrete voltage jumpers and sense wires. Tag all such wires with a label marked with the socket and pin number on which the housing is located. After tagging, reverify all locations and remove the housings.

MST-2 Card Side Operations

1. Remove all the cards from the board to be replaced and place them in the card caddy (Figure 3-27).
2. Remove the decoupling capacitors from card columns A and V.
3. Remove the card guidance retention system.
4. Remove the voltage crossover connections from rows 1 and 6 by using duckbill pliers.
5. Remove the remaining screws to extract the old board.
6. Install the new board by following the preceding steps in reverse order.

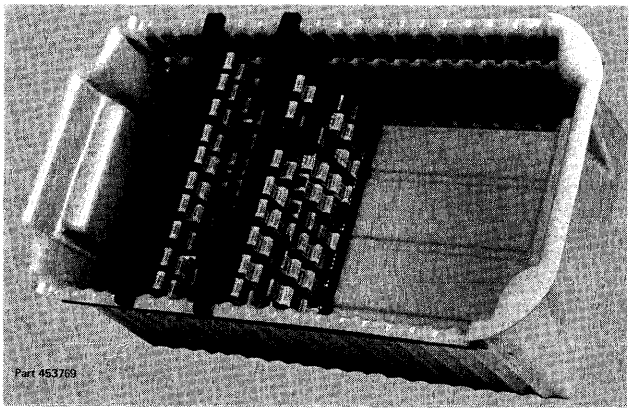


Figure 3-27. Card Caddy

MST-2 Probe Side Installation

Starting from the outer edges of the board and working toward the center, install the cables:

1. Install the cables according to their labels (discrete and ganged). *Note:* If a terminating resistor is in the quadrant being plugged with cables, locate the proper housing in the six-pack and remove the housing from the six-pack. Remove the cable connectors from the housing on the cable and remove the terminating resistor from the board pin. Install the cable connectors into the housing with the terminating resistor. Replace the housing into the six-pack and plug the six-pack onto the board. For the temporary six-pack, the clip is removed when the cables are positioned.
2. When all cables have been installed, begin mating the overflow wires to the cables as required. Overflow wires that must be mated to cables are identified by tags. Remove the necessary six-pack from the board. Remove the housing from the six-pack, remove the cable connectors from their housing, and discard the housing. Insert the cable connectors into the overflow wire housing. Install the housing that has the two sets of connectors into the six-pack and plug the six-pack onto the board.
3. When all overflow wires have been mated with their appropriate cables, remove the dummy housings.
4. Check the board for any wires not connected and perform the necessary operations.

MST-4 Probe Side Removal (Boards without Permanent Six-packs)

Note: For MST-4 boards with permanent six-packs, follow the MST-2 probe side removals:

1. Determine which I/O pins are connected to on-board jumper assemblies.
2. Delete all I/O connections to on-board jumper assemblies.

   Note: If any in-board cabling is on the board to be replaced, the cables are freed from the mid-air splice or pin, tagged and labeled, checked against the cable location list, and left hanging.

   Deletion for machines with coaxial cabling is performed by dismantling the mid-air splice and removing the tether of the mid-air splice from the I/O pin. After the tether is removed from the pin, place the cable connector onto the I/O pin.
3. Install the dummy housings (part 453838) on all unused pins in the socket positions used for cabling, so that all cable socket positions have a full complement of connector housings.
4. After steps 2 and 3 have been completed, begin removing the cable connectors from the board by using the six-pack ganging clip. One clip is allocated for each group of six pins, starting at row 2, pin 2, regardless of the presence of cable connectors on the pins. The two vias between socket positions 3 and 4 are counted as pins. The clips are removed so that the connectors on the pins in subcolumn B of the four-position socket in card column V are totally removed prior to the connectors on the pins in subcolumn D of the four-position socket in card column V. Nine clips are required to depopulate a vertical row of pins. Twelve clips are required to depopulate a horizontal row of pins.

   As each clip of six connectors is removed from the board, it is placed in a retaining device. When the entire row of connectors has been removed and snapped into the retaining device, the retainer is hooked onto the raceway to allow access to the next column of pins. Label the retainer to indicate the card column and pin column.

   Clips are removed so that the most in-board column of cable connectors are removed first. Then work back toward the board edge.
5. Check board for discrete voltage jumpers and sense wires. Tag all such wires with a label marked with the socket and pin number on which the housing is located. After tagging, reverify all locations and remove housings.

6. After all the cable connectors are removed from the board, the board is removed from the card side of the gate. See "MST-4 Card Side Operations."
7. After the new board is mounted in the gate, all cable connectors are replaced in reverse order of removal; that is, the connectors on the pins in subcolumn D are replaced prior to the connectors on the pins in subcolumn B.
8. After all cables are placed on the new board, begin mating the cables with the on-board jumper assemblies. All connections to the board jumper assemblies for machines with coaxial cabling are made by the mid-air splice, using conductive or nonconductive splices, whichever is applicable. *Note:* To reinstall an in-board cable onto the new board, the cable is plugged directly to a pin or it may be mated with an on-board jumper assembly. If the jumper assembly is at the pin involved, and coaxial cabling is used, then: locate the in-board I/O pin, locate the "extra" connector and conductive mid-air splice associated with the in-board I/O pin, and install the cable connector into the mid-air splice.

MST-4 Card Side Operations

1. Remove all the cards from the board to be replaced and place them in the card caddy.
2. Remove the decoupling capacitors from card columns A and V.
3. Remove the card guides.
4. Remove the capacitors from rows 1 and 6 and place them in the replacement board in the same positions.
5. Clamp the hoses attached to the voltage regulator, which is to the left of the board being replaced.
6. Remove the four screws that attach the voltage regulator to the board.
7. Remove the hose from the top of the regulator, leaving the clamp and hose on the cooling tube.
8. Remove the bottom hose from the cooling tubing, leaving the hose and the clamp on the voltage regulator to prevent water from running out of the regulator. Carefully position the regulator so that the water stays in the regulator.
9. Remove the regulator sense wires from the probe side of the board.
10. Remove the two screws that connect the laminar bus to the cables from the main power supply (note the orientation of the cables).
11. Remove the regulator.
12. Remove the four board mounting screws and remove the board.
13. Install the new board by following the preceding steps in reverse order.

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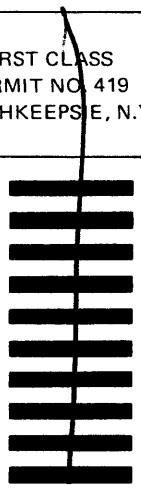

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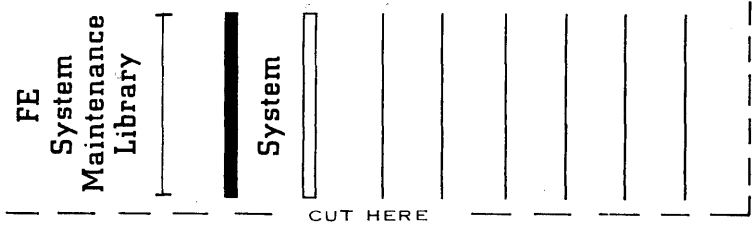

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