

M-164 CONVERT-A-PAK^{T.M.} MODELS - 41,- 42,- 46,- 49, AND - 50

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1. GENERAL

1.01 This technical bulletin applies to TELTONE® M-164 * CONVERT-A-PAK™ tone-to-pulse converters with item ordering numbers M-164-41, -42, -46, -49, and -50 (see figure 1). Descriptions, ordering information, installation procedures, and troubleshooting procedures are provided.

1.02 Whenever this bulletin is reissued, the reason for reissue will be listed in this paragraph.

1.03 The installation procedures in this bulletin are provided in Installer's Aids for the most common applications. The Installer's Aids provide itemized checklists for the installation and testing of their respective units. Installer's Aid 164-221 is provided with M-164-41's and -42's. Installer's Aid 164-225 is provided with M-164-46's and -50's. Installer's Aid 164-229 is provided with M-164-49's.

1.04 Technical bulletin 164-120 provides descriptions, installation procedures, and troubleshooting procedures for the M-164-43, -44, -45, and -47 configurations. The ordering information in the 164-120 bulletin covers all the M-164 configurations and mounting hardware. The other parts of the 164-120 bulletin are less applicable to the configurations covered by the 164-125 bulletin.

1.05 Technical bulletin 164-148 covers crossbar applications using the M-164-48 configuration of the CONVERT-A-PAK.

1.06 Technical bulletin 164-110 provides all the required information for M-164 units with item ordering numbers up to M-164-33.

2. CONCEPT

2.01 The M-164 is a dedicated DTMF receiver that converts any keyed digit from one through zero to an equivalent train of rotary-dial type pulses. It is packaged to

* The M-164 is manufactured under one or more of the following U.S. Patents: 3,959,598 and 3,961,141. Other Patents pending.

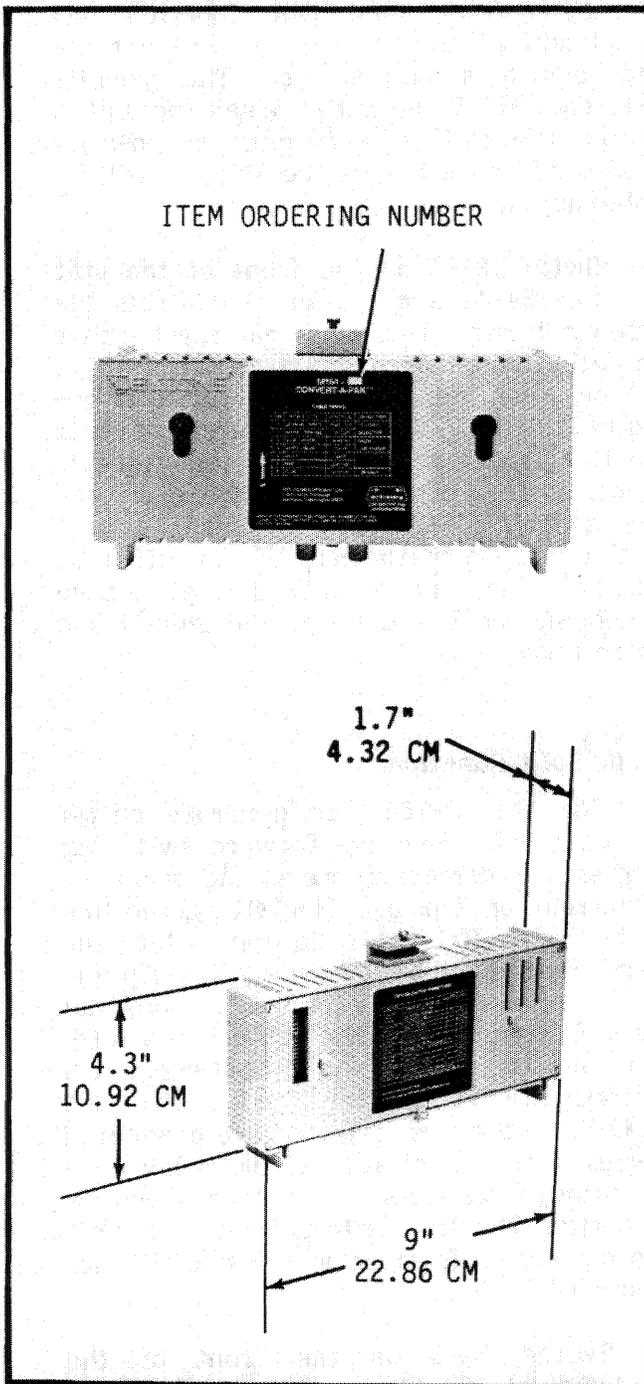


Figure 1 M-164 CONVERT-A-PAK

mount directly on the back of a switch rack to allow conversion to DTMF service without requiring additional floor space. The unit is designed for direct control (step-by-step) central office and PBX conversions. To meet this range of applications the following or-

dering options and design features have been provided.

- Installation requires connecting only the Tip and Ring pair leads and the battery and ground leads (see figure 2).
- Tip party identification (ANI) forwarding is available as an ordering option.
- Early or late (button up) line split is a switch option provided on the M-164-41 and -42 configurations. The early line split prevents DTMF tones from reaching tandem equipment sensitive to DTMF signals. The late line split does not occur until the signal has been verified as a valid digit and has ended: this avoids having the line split by spurious noise.
- Answer Supervision returns the unit to its idle condition.
- The 15-second Time Out can start when the first digit is received or when the unit detects an off-hook condition as selected by an option switch provided on the M-164-41 and -42 configurations.
- The End of Dialing feature inhibits the converter from recognizing any digits following a DTMF * or # signal. It is provided on the M-164-41, -42, and -50 configurations.

3. GENERAL DESCRIPTION

3.01 The M-164 provides dedicated tone-to-pulse conversion with a single unit for each linefinder. Any DTMF digit from one to zero is converted to a series of break pulses like those produced by a rotary dial telephone. The fixed interdigital time of the conversion decreases the total dialing

time compared to a manually operated rotary dial instrument.

3.02 As is shown in figure 3, a DTMF tone pad signals a given digit with two out of seven available frequencies. The M-164 detects and translates these two-of-seven frequencies signals as they appear on its Tip and Ring IN leads. It then outpulses the corresponding number of break pulses to the forward switching equipment wired to its Tip and Ring OUT leads.

3.03 The M-164's thermal plastic housing is 4.3 inches high (10.92 cm), 1.7 inches (4.32 cm) deep, and 9 inches (22.86 cm) wide as shown in figure 1. The housing meets UL94 V-0 requirements. The M-164 includes all the interface circuitry, logic elements, and DTMF receiver functions to convert one linefinder or selector. The unit operates on the same negative battery voltage supply as other telephone equipment.

3.04 In the idle state, when it is monitoring line conditions, the unit draws less than 40 ma (milliamperes). From detection of off-hook until the unit is released, the M-164 draws no more than 80 ma, except during outpulsing when the line is split; the M-164 may then draw up to 180 ma, which includes the battery feed current connected to Tip and Ring IN.

A. Tone Receiver

3.05 The tone receiver section of the M-164 is bridged across the Tip and Ring IN pair at all times as shown in figure 5. The input impedance of the tone receiver is above 75K ohms at all the frequencies of interest and causes no more than 0.052 dB of loss from the line. This input is filtered to separate the high group and low group DTMF frequencies which are then analyzed for possible detection as a DTMF digit.

B. Time Out Release

3.06 The 15-second Time Out Release function limits how long the M-164 will respond to incoming digits, both after the call begins and after each received digit.

3.07 After the Time Out function has inhibited the M-164, it will not respond to signals on the line. This permits end-to-end DTMF signaling. When the unit is inhibited the calling party must go on-hook and back off-hook before the M-164 will be enabled again.

3.08 Switch S1-1 on the front of the unit (M-164-41 and -42 only) controls the 15-second timer. The timer can start either upon detection of an off-hook condition (S1-1 OFF) or when the first DTMF digit is received (S1-1 ON). The latter option prevents Time Out from occurring while dial tone is present. The configurations without the option switch (M-164-46, -49, and -50) start the timer upon detection of an off-hook condition. The timer is always reset to zero as each succeeding digit is recognized and upon on-hook.

C. Line Split Function

3.09 For the M-164 to generate pulses that will drive the forward switching equipment (a complete break and make of loop current on Tip and Ring OUT), the line must be split. Relays in the unit isolate the Tip and Ring IN and OUT pairs. The Tip and Ring IN pair is connected to an internal battery feed source so the subscriber's telephone and the equipment in between still have loop current. During line split Tip and Ring OUT to the first selector are connected in series with the closed pulsing relay contacts through resistors. A further necessity for splitting the line is to prevent the digit being outpulsed from interfering with succeeding DTMF digits.

3.10 Switch S1-2 on the front of the unit (M-164-41 and -42 only) determines if the M-164 will have early line split or late line split for DTMF digits as described in paragraphs 5.07 through 5.09. Configurations without the option switch have late line split. The detection of succeeding digits holds the line split until they have all been outpulsed. The line is restored after the most recently received digit has been outpulsed.

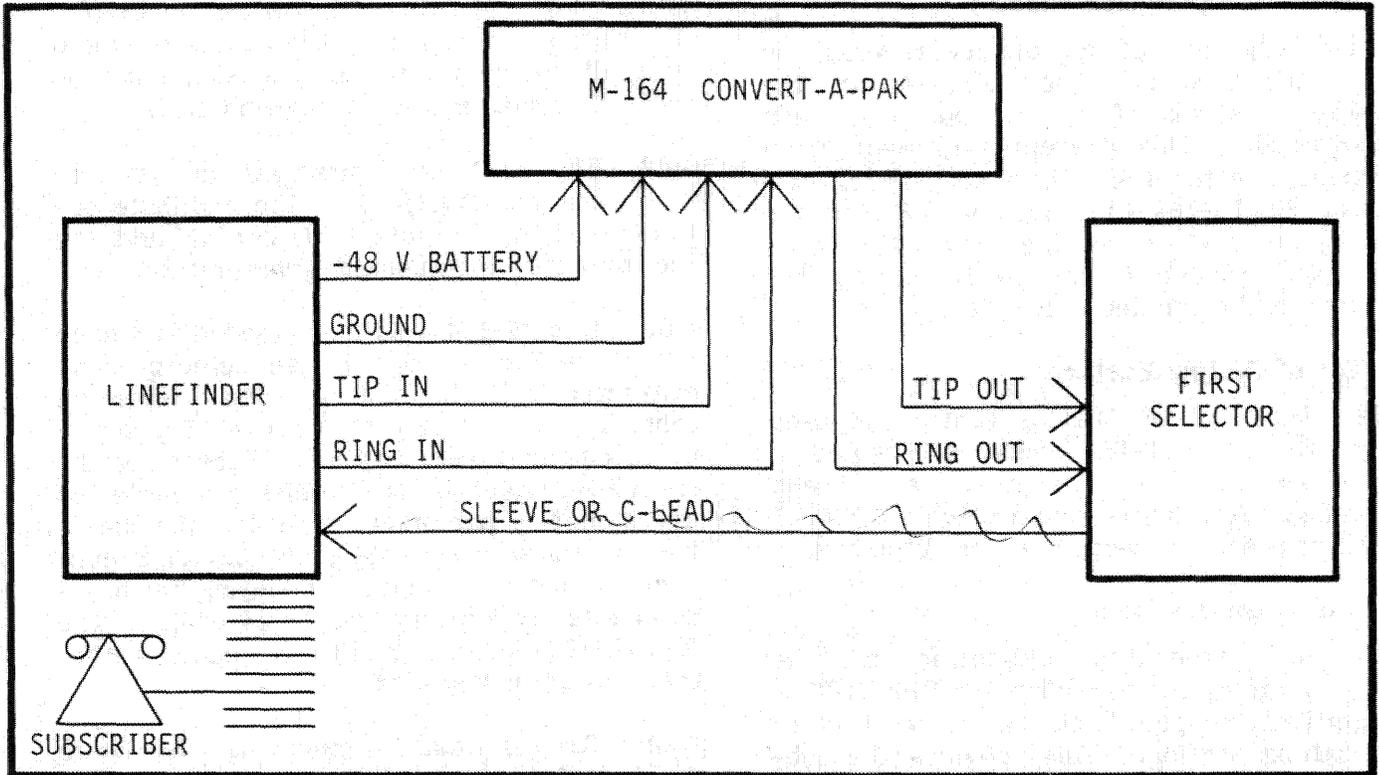


Figure 2 System Connections

		DTMF CODE			
		DIGIT	LOW FREQUENCY	HIGH FREQUENCY	
LOW GROUP OF FREQUENCIES	HIGH GROUP OF FREQUENCIES		1209	1336	1477
		697	1	ABC 2	DEF 3
		770	GHI 4	JKL 5	MNO 6
	852	PRS 7	TUV 8	WXY 9	
	941	* #	0	#	
		1	697 Hz	1209 Hz	
		2	697 Hz	1336 Hz	
		3	697 Hz	1477 Hz	
		4	770 Hz	1209 Hz	
		5	770 Hz	1336 Hz	
	6	770 Hz	1477 Hz		
	7	852 Hz	1209 Hz		
	8	852 Hz	1336 Hz		
	9	852 Hz	1477 Hz		
	0	941 Hz	1336 Hz		
	*	941 Hz	1209 Hz		
	#	941 Hz	1477 Hz		
<p>NOTE: THE CONVERT-A-PAK RESPONDS TO * OR # ONLY IN THE M-164-41, -42, AND -50 CONFIGURATIONS</p>					

Figure 3 DTMF Digit Buttons and Code

D. Answer Supervision Release

3.11 Detection of a polarity reversal on the Tip and Ring pair disables the M-164 just as if an on-hook had been recognized. This prevents the unit from outpulsing after the called party goes off-hook. The M-164-41, -42, and -46 will stop pulsing and restore the line even if the line is still split because the calling party has inadvertently signaled extra digits.

E. End of Dialing Feature

3.12 The End of Dialing feature is used when the M-164 must be disabled to allow use of DTMF tones for end-to-end signaling. Any digits keyed after a DTMF * or # signal are not recognized or outpulsed.

F. Dial Pulse Feedback

3.13 An attenuated indication of the outgoing pulses on Tip and Ring OUT is capacitively coupled back via Tip and Ring to the calling station. This provides the subscriber with an indication that the call is being processed.

G. ANI Forwarding

3.14 The optional Tip Party Identification (ANI) circuit detects and forwards an impedance imbalance across the Tip and Ring pair while the line is split if the Tip party of a two-party line is the one off-hook. Without this circuit in the M-164, the indication is not seen by the forward equipment while the line is split. The operation of this feature is compatible with most toll systems, including A.E. SATT equipment, most pay-station coin ground indications, and most electronic ANI mark systems, for example the Lorain 302 (other ANI mark systems which do not apply the ground mark until requested by the central office may not be compatible with the M-164).

4. ORDERING INFORMATION

4.01 Ordering M-164 CONVERT-A-PAK equipment requires selecting the desired configuration of options and, if they are required, mounting adapters and longer cables. Paragraphs 4.07 through 4.10 de-

scribe the mounting hardware available. Connecting cables longer than those provided with all the units, except the -50, must be ordered separately, see paragraph 4.05.

4.02 The unit configurations are different combinations of the available options as shown in table 1. Order the units by the item ordering numbers given in table 1.

4.03 One M-164 will be needed for each linefinder or key system selector to be converted. Each item ordering number in table 1, from M-164-41 through -50, designates one unit as described. Except for the M-164-50, which includes neither a cable nor any mounting hardware, each unit includes a 24-inch connecting cable, two splicing connectors, and the standard mounting hardware (available separately as M-164-23). The M-164-49 includes a 48-inch cable rather than the 24-inch standard.

4.04 The standard mounting hardware includes: the standard screw clamp bracket (part number 120-00001-01), one 8-32 x 3/8 slotted hex-head machine screw (part number 731-00032-04), and two flat-head 4-40 x 1/4 machine screws (part number 731-00035-04) or two flat-head 4-20 x 1/4 thread-forming screws (part number 731-00037-04) required to secure the bracket to the housing. The thread-forming screws are used to mount hardware onto the plastic housing while the machine screws are used in other applications.

4.05 The standard six-wire 24-inch connecting cable can be ordered separately as CA-164-05. A longer 48-inch six-wire cable is available as CA-164-06. A twelve-foot six-wire cable is available as CA-164-12. All the cable leads are color coded and made up of 22 gauge wire. The insulation on each conductor is stripped back 1 5/8 inches from the end. The outside tube of each cable is cut back 4 5/8 inches from the end. Two splicing connectors are supplied with each cable.

4.06 One M-164-49 Key System converter will be needed for each selector in the system. It can be used on most common

Table 1 Item Ordering Numbers (Sheet 1 of 2)

FEATURES	ITEM ORDERING NUMBERS				
	M-164-41	M-164-42	M-164-46	M-164-49*	M-164-50**
OUTPUT LOOP HOLDING RESISTANCE	300 ohms	300 ohms	300 ohms	150 ohms	900 ohms
OUTPUT INTERDIGITAL TIME	740 ms	740 ms	640 ms	740 ms	740 ms
END OF DIALING FEATURE	YES	YES	NO	NO	YES
DIAL PULSE FEEDBACK	YES	YES	YES	NO	YES
ANI FORWARDING	NO	YES	NO	NO	YES
SELECTABLE TIME OUT START AND SELECTABLE LINE SPLIT	YES	YES	NO	NO	NO
ANSWER SUPERVISION RELEASE DURING LINE SPLIT	YES	YES	YES	NO	NO
* M-164-49 IS INTENDED FOR KEY SYSTEM APPLICATIONS, IS DESIGNED FOR A -24 VOLT POWER SUPPLY, AND IS PROVIDED WITH A 48-INCH CONNECTING CABLE					
** MOUNTING HARDWARE AND CABLE ARE NOT INCLUDED WITH THE M-164-50, THESE ITEMS MUST BE ORDERED SEPARATELY					
ITEM ORDERING NUMBERS	CONNECTING CABLES DESCRIPTION ***		PART NUMBERS		
CA-164-05	SIX-WIRE 24-INCH CABLE		208-00032-01		
CA-164-06	SIX-WIRE 48-INCH CABLE		208-00032-02		
CA-164-12	SIX-WIRE 12-FOOT CABLE		208-00032-05		
M-164-22	LOOP-THRU PLUG		100-00032-01		
*** ALL CABLES ARE SHIPPED WITH TWO SPLICING CONNECTORS					

Table 1 (Sheet 2 of 2)

ITEM ORDERING NUMBERS	MOUNTING ADAPTERS
M-164-10	BOX FRAME ADAPTER, 1.75-INCH OPENING, MOUNTING BRACKET (PART NUMBER 120-00002-01), ONE 8-32 x 1/2 SLOTTED HEX-HEAD MACHINE SCREW (PART NUMBER 731-00032-05), TWO SLOTTED FLAT-HEAD 4-40 x 1/4 MACHINE SCREWS (PART NUMBER 731-00035-04), AND TWO SLOTTED FLAT-HEAD 4-20 x 1/4 THREAD-FORMING SCREWS (PART NUMBER 731-00037-04), USED TO MOUNT AN M-164 ONTO AN AUTOMATIC ELECTRIC COMPANY BOX CHANNEL TYPE LINEFINDER FRAME
M-164-11	DOUBLE ANGLE FRAME ADAPTER, 0.75-INCH OPENING, MOUNTING BRACKET (PART NUMBER 120-00003-01), ONE 8-32 x 1/2 SLOTTED HEX-HEAD MACHINE SCREW (PART NUMBER 731-00032-05), TWO SLOTTED FLAT-HEAD 4-40 x 1/4 MACHINE SCREWS (PART NUMBER 731-00035-04), AND TWO SLOTTED FLAT-HEAD 4-20 x 1/4 THREAD-FORMING SCREWS (PART NUMBER 731-00037-04), USED TO MOUNT AN M-164 ONTO A WESTERN ELECTRIC COMPANY DOUBLE ANGLE IRON TYPE LINEFINDER FRAME
M-164-23	STANDARD 0.25-INCH OPENING MOUNTING BRACKET (PART NUMBER 120-00001-01), ONE 8-32 x 3/8 SLOTTED HEX-HEAD MACHINE SCREW (PART NUMBER 731-00032-04), TWO SLOTTED FLAT-HEAD 4-40 x 1/4 MACHINE SCREWS (PART NUMBER 731-00035-04), AND TWO SLOTTED FLAT-HEAD 4-20 x 1/4 THREAD-FORMING SCREWS (PART NUMBER 731-00037-04)
M-164-24	EXTENDING ADAPTER PLATE (PART NUMBER 101-00038-01), AND TWO SLOTTED FLAT-HEAD 4-40 x 1/4 MACHINE SCREWS (PART NUMBER 731-00035-04), PROVIDES ADDED CLEARANCE FROM CERTAIN CAPACITOR BOLTS ON SOME LINEFINDERS MANUFACTURED BY WESTERN ELECTRIC COMPANY
M-164-26	TWO KTS RACK AND WALL MOUNTING BRACKETS (PART NUMBER 102-00105-01), FOUR SLOTTED PAN-HEAD 4-40 x 1/4 MACHINE SCREWS (PART NUMBER 731-00005-04), AND FOUR SLOTTED PAN-HEAD 4-20 x 1/4 THREAD-FORMING SCREWS (PART NUMBER 731-00036-04)

channel intercoms, including those with A.E.-70 selectors, 207 selectors (W.E. Co., Stromberg Carlson, or ITT), and 6A type single or two-link systems. The M-164-49 cannot be used in 16A systems because the selector is not connected to the Tip and Ring leads in the talking links. Also, the operation of some more recently developed systems may be adversely affected by the impedance change on the Tip and Ring pair when the M-164 restores the line after pulsing the last digit.

4.07 The mounting adapters shown in figure 4 are available for installations which require mounting the M-164's on large structural members. The standard screw clamp bracket (M-164-23) supplied with the housings can be attached to a bar up to 0.25 inch thick. The Box Frame Adapter allows mounting an M-164 on the type of frames commonly used in Automatic Electric equipment. The Box Frame Adapter has an opening 1.75 inches wide and is ordered as M-164-10. The Double Angle Frame Adapter permits mounting an M-164 on the type of frame commonly used in Western Electric equipment. The Double Angle Frame Adapter has an opening 0.75 inch wide and is ordered as M-164-11. The adapter item ordering numbers include the required screws.

4.08 Installations requiring the M-164-10 or -11 mounting adapters described in table 1 usually only need approximately one for each four installed units. The units stack together and normally only every other mounting bar on a given rack is a large structural member. Mounting hardware for M-164-50 units is required for only every other unit when they are to be stacked.

4.09 Installations in which the M-164 is mounted either on a wall surface or in a KTS cabinet using the KTS and Wall Mounting Adapter Bracket (part number 102-00105-01) will need two brackets and four screws (either machine screws or self-threading) for each unit to be mounted. This kit of two brackets and the required screws is ordered as M-164-26. As with the other mounting adapters, when units are being piggybacked the hardware is needed for every other installed unit.

4.10 The extending Adapter Plate (part number 101-00038-01) is used with certain Western Electric equipment to assure sufficient clearance from certain capacitor bolts on the linefinders. Two flat-head 4-40 x 1/4 machine screws (part number 731-00035-04) are provided with each plate when it is ordered as M-164-24. If the units are being stacked, only one plate is required for each two units.

4.11 The Loop-thru plug, ordered as M-164-22, is available to maintain continuity between the Tip and Ring pairs when the cable is not plugged into an M-164. Some installations which prewire the cables install these plugs on the cable connector to retain rotary dial service until the units are installed.

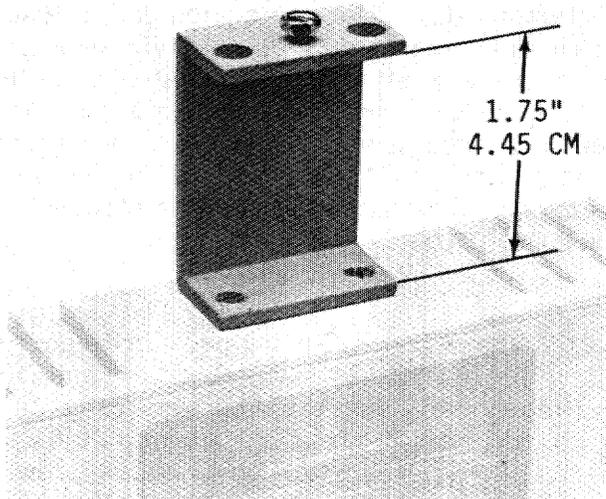
4.12 To assure the specified performance of the M-164, dial tone on the lines being converted should be 350 Hz plus 440 Hz Precise Dial Tone. Installation of a TELTONE M-904 Precise Dial Tone Generator is recommended as a means of obtaining such a dial tone. Paragraph 6.04 of this bulletin explains the dial tone requirements in more detail.

5. FUNCTIONAL DESCRIPTION

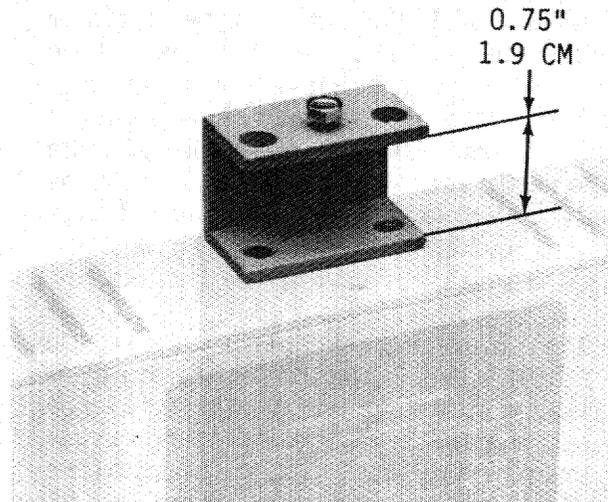
5.01 To assist maintenance and troubleshooting this description follows a call as it is handled by the CONVERT-A-PAK. As shown by the simplified block diagram, figure 5, the M-164 can be most simply described as consisting of the LSI chips and their peripheral circuits.

A. Idle Condition

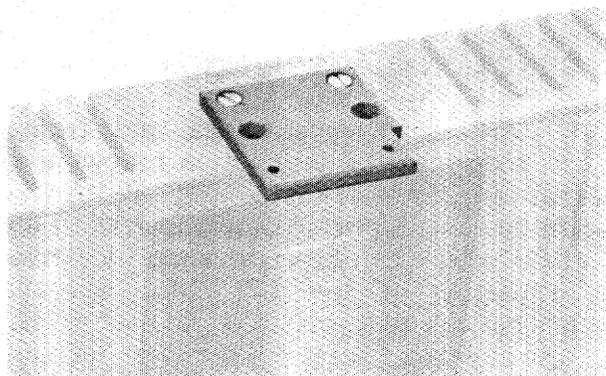
5.02 In the idle condition, before the calling station goes off-hook, the unit is disabled and power is removed from the Signal Conditioning and Input Filter stages. This reduces the idle power consumption of the unit to less than 2 watts. No relays are operated.



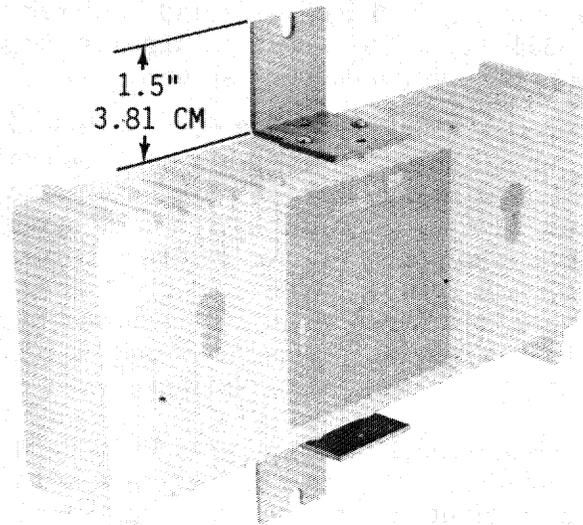
M-164-10
BOX FRAME ADAPTER



M-164-11
DOUBLE ANGLE FRAME ADAPTER



M-164-24
EXTENDING ADAPTER PLATE



M-164-26
KTS RACK AND WALL MOUNTING BRACKETS

Figure 4 Mounting Adapters

B. Enable Converter

5.03 When the calling station goes off-hook and is connected to a line wired through an M-164, the Loop Current Detector on Ring IN forwards an indication to the On-Hook/Off-Hook Logic. The converter is enabled to receive DTMF digits when the off-hook indication has persisted for 130 ms (milliseconds).

5.04 Once enabled the M-164 remains enabled unless inhibited by the occurrence of either the End of Dialing release or the Time Out release. The unit can then be enabled again only by first being returned to the idle condition. See figure 6. It can be returned to the idle condition from either the enabled or inhibited condition by recognizing either Answer Supervision or an on-hook condition. Answer Supervision inhibits an M-164-46 rather than returning it to the idle condition.

5.05 At this stage the battery feed voltage is being supplied by the forward equipment (usually a first selector) connected to Tip and Ring OUT of the M-164. Dial tone is also connected from the forward equipment. The dial tone to the calling station will be cut off when the M-164 splits the line as described in the following paragraphs. Pulses generated by the converter will then break dial tone in the selector as the selector responds to the M-164's rotary dial pulsing.

C. DTMF Digit Conversion

5.06 The signals on Tip and Ring IN from the calling station are analyzed to verify that they represent a valid DTMF digit. There must be one and only one DTMF frequency in each group and they must persist for at least 40 ms (the specified guard period).

D. Early Line Split

5.07 If the converter is set for early line split operation (S1-2 is OFF, applies only to M-164-41 and -42) the unit splits the line after a valid tone pair has persisted for only a few milliseconds.

5.08 If tandem equipment is sensitive to DTMF signals this early line split isolates the tones from that equipment. The trade-off is that the early line split occurs before the incoming tones are verified as a valid digit. If the tones do not then persist for the required guard time, indicating they are not a valid digit, the line is restored when they end. When caused by conversation this chops the talk path.

E. Late Line Split

5.09 If the converter is set for late line split operation (S1-2 is ON or the unit is an M-164-46, -49, or -50) the line is split as described here. When the tones have persisted for the required guard time the value of the digit is latched. When the incoming tones end, the line is split in preparation for outpulsing by the operation of the relays shown in figure 5. This cuts off dial tone to the calling station, connects the internal battery feed supply to the calling station, and connects the ANI forwarding feature (provided on the M-164-42 and -50) to the line. Pulses generated by the converter will pulse the selector.

F. Memory Function

5.10 As each digit is accepted it is written into a 20-digit memory register and then read out in first-in-first-out order to be outpulsed. This memory is required because valid DTMF digits can be received much faster than they can be outpulsed with the proper interdigital times. The memory function is recirculating so that any number of digits can be received and outpulsed provided the backlog of received-but-not-yet-outpulsed digits never exceeds 20.

G. Time Out Function

5.11 The Time Out function is implemented by a 15-second timer which inhibits the converter at the end of its cycle. This function assures that the converter does not remain enabled after dialing is completed in applications where Answer Supervision is not present.

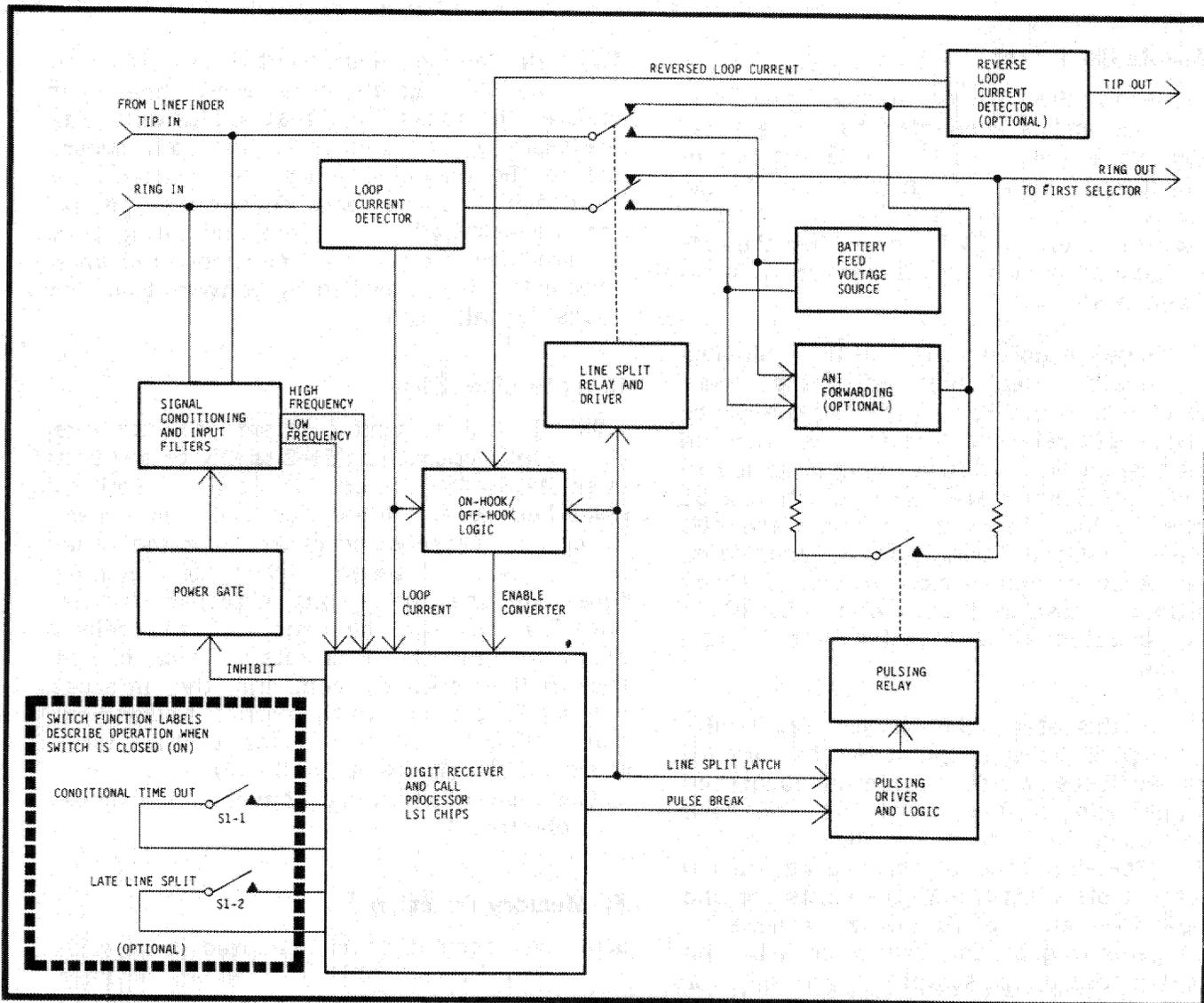


Figure 5 Simplified Block Diagram

5.12 When the Time Out timer will be initially started is selected by option switch S1-1 (M-164-41 and -42 units only). If option switch S1-1 is closed (ON), the timer does not start until the first DTMF digit has been validated by the unit. This assures that the unit is not inhibited while dial tone is still present. The timer starts when the converter is initially enabled if option switch S1-1 is open (OFF) or the unit is an M-164-46, -49 or -50 configuration.

5.13 The Time Out timer is restarted at zero as each succeeding digit is re-

ceived. All the DTMF digits received before the timer completes its cycle will be outpulsed. Should the timer complete its cycle during outpulsing, the unit is not inhibited until the line is restored after the last digit is outpulsed.

H. Outpulsing

5.14 Converted DTMF digits appear on Tip and Ring OUT as rotary-type dial pulses generated by opening and closing the

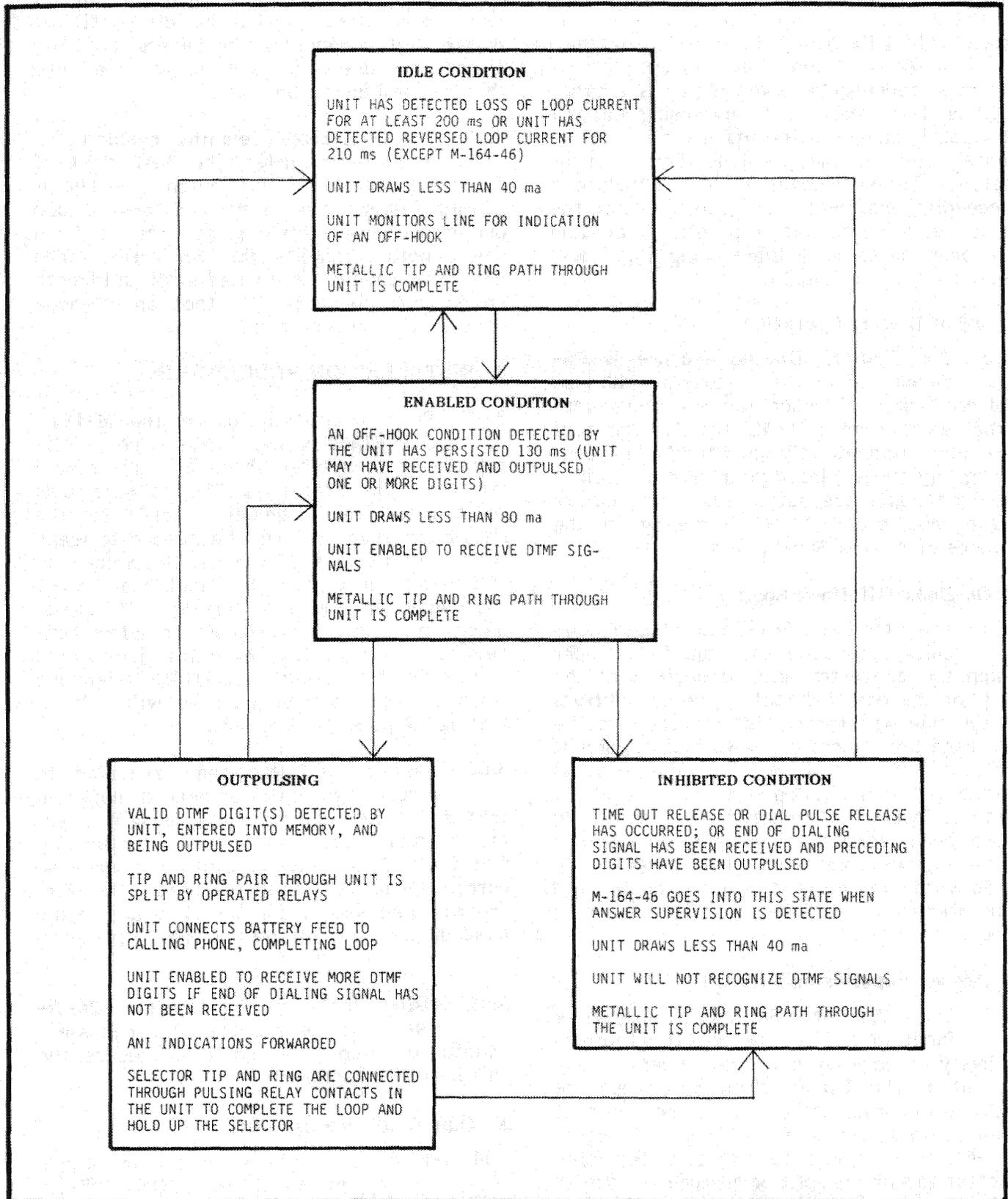


Figure 6 State Diagram

pulsing relay contacts under the control and timing of the LSI chips (see figure 5). The line is held split during the interdigital times and is restored 40 ms after the last pulse of the most recently received digit. If another digit is then received, its outpulsing will not start until one make period after the interdigital time of the previous digit is completed. To be recognized and outpulsed a succeeding digit must be received before the Time Out timer inhibits the unit. If the line has been restored a succeeding digit will cause it to be split again.

I. End of Dialing Operation

5.15 The End of Dialing feature is implemented in the M-164-41, -42, and -50 configurations when the unit recognizes either an * or an # DTMF signal. The digit receiver is immediately inhibited from recognizing any succeeding digits. The previously received digits are outpulsed. This feature allows end-to-end DTMF signaling in the absence of Answer Supervision.

J. On-Hook/Off-Hook Logic

5.16 The On-Hook/Off-Hook Logic circuits determine the conditions under which the converter will be enabled at the start of the call and that certain conditions on the line will return the converter to the idle condition. Loss of forward loop current for over 200 ms, at Ring IN, is considered an on-hook. This implements the on-hook inhibit feature, which is required if the calling subscriber misdialled and went on-hook before outpulsing was completed. The reappearance of forward loop current will not enable the converter unless the loop current has been absent for at least 200 ms.

K. Answer Supervision Release

5.17 The Answer Supervision Release function disables the converter for the majority of calls by detecting reversed loop current on the Tip and Ring pair when the called party goes off-hook. A loop current reversal (must persist for 210 ms) will return an -41 or -42 unit to the idle condition whether the line is split or restored. The -49 and -50 units recognize the reversal (must

persist for 210 ms) only when the line is restored and then goes to the idle condition. A -46 unit recognizes the reversal, during either line condition, in 50 ms and goes into the inhibited condition.

5.18 The converter remains enabled for 15 seconds after the last digit if Answer Supervision is not present, the End of Dialing feature is not used, and forward loop current persists. After 15 seconds the Time Out function inhibits the converter. The converter cannot be enabled again until both an on-hook condition and then an off-hook condition are recognized.

6. INSTALLATION PROCEDURES

6.01 Prior to installation of the M-164 CONVERT-A-PAK units, the equipment being converted should be fully tested for rotary dial operation. The standard tools to connect and disconnect leads on the switching equipment will be needed to make the installation. A DTMF test telephone also will be needed to test the installation before the converter goes into service. This telephone must have an adapter to allow connecting it at the linefinder test jack or an equivalent test point. A DTMF telephone which is not polarity guarded will help in testing for polarity reversals.

6.02 Examine all the items received to assure they have not been damaged in transit. Compare the item ordering numbers of the units to those listed on the packing slip and table 1 of this bulletin to assure the correct items have been received. The item ordering numbers of the M-164 's are on the label on the back of the housing. See figure 7.

6.03 Using table 2, Installation Checklist, will assure that all necessary installation steps are completed before the unit is put into service.

A. Dial Tone Requirements

6.04 Precise Dial Tone is preferred for M-164 installations. CONVERT-A-PAK units may operate successfully with

other dial tones which do not include components within the DTMF frequency range above the specified noise tolerance level. The M-164 is designed to perform as specified in part 9 of this bulletin with -12 dBm (0.195 VRMS) per frequency of Precise Dial Tone: pure tones of 350 Hz plus 440 Hz ± 0.5 percent and no more than ± 3 dB of amplitude variation. (The dBm reading is obtained using a standard voltmeter calibrated to provide a scaled voltage measurement in dBm for a 600 ohm impedance. No termination should be applied for this measurement.)

6.05 The surest procedure is to install a Precise Dial Tone supply like a TEL-TONE M-904 Precise Dial Tone Generator before installing the M-164's. If Precise Dial Tone is not available the M-164's should be thoroughly tested to assure their adequate performance.

6.06 Another consideration of the line being connected is to assure it does not encounter wink start or stop dial signals. Any reversal of loop current which persists for 200 ms (50 ms with the M-164-46) or longer at Tip OUT of the M-164 will shut off the converter. The installations most likely to encounter this problem are PBX conversions and trunk circuit conversions. If tone-to-pulse conversion is desired on lines which require wink start or stop dial operation, TELTONE M-161's or an M-112 should be installed instead of M-164's.

B. Set the Option Switches

6.07 The operating options of M-164-41 and -42 configurations can be selected with miniature switches at the left end of the front cover of the unit. See figure 7. The option switches package, S1, has four switches numbered from top to bottom. Switches 3 and 4 are spares.

6.08 The switches may be either rocker or slider types. The ON and OFF positions of the switches are indicated on the housing. Specifically, the sliders are moved, or the rockers are tipped, away from the

numbers on the housing when they are set to the ON position.

6.09 As shown in table 3, the second switch down on the option switches package, S1-2, sets the Line Split option. When S1-2 is ON or not provided, the M-164 operates with late line split as described in paragraph 5.09. This is the recommended setting if tandem equipment does not recognize DTMF signals. When S1-2 is OFF the unit operates with early line split as described in paragraph 5.07.

6.10 The Time Out Start options to inhibit the DTMF receiver are selected with the uppermost switch on the option switches package, S1-1. When S1-1 is ON, the 15-second timer is started as part of the outpulsing process for the first DTMF digit received. When S1-1 is OFF, or not provided, the 15-second timer starts when off-hook is first recognized. Which of these two options should be used in a given application depends on the type of line being converted.

6.11 The preferred Time Out Start option is with S1-1 in the ON position so the timer does not start until the first DTMF digit is received. This assures that the converter is not inhibited while dial tone is present on the line. The only case where S1-1 must be moved to the OFF position would be a conversion of a bothway trunk to avoid having an incoming call enable the M-164 and no further digits would be signaled.

C. Wire the Connecting Cable

6.12 This step constitutes the cutover of the line to DTMF service. If the installation is in a KTS system go to paragraph 6.28. Scheduling this step during a period of low traffic is recommended. If nonstandard mounting requires hardware changes to the housing as described in paragraphs 6.24 through 6.27 this should be done before the wiring is begun to minimize the time the linefinder(s) must be made busy. Assure that the linefinder has been made busy

Table 2 Installation Checklist

1. Recommended Precise Dial Tone supplied to selector being converted, paragraphs 6.04 and 6.05.	<input type="checkbox"/>
2. Converted trunks do not require stop dial or wink start functions, paragraph 6.06.	<input type="checkbox"/>
3. Line Split option selected, S1-2 (M-164-41 and -42 only), paragraph 6.09.	<input type="checkbox"/>
4. Time Out Start option selected, S1-1 (M-164-41 and -42 only), paragraphs 6.10 and 6.11.	<input type="checkbox"/>
5. Make linefinder busy and remove its fuse, paragraphs 6.12 through 6.14. If installing the unit in a key system see paragraphs 6.28 through 6.34.	<input type="checkbox"/>
6. Remove and identify the Tip and Ring leads going to the first selector from the linefinder jack.	<input type="checkbox"/>
7. Splice the ORANGE-WHITE cable lead to the Ring lead from the first selector.	<input type="checkbox"/>
8. Splice the WHITE-ORANGE cable lead to the Tip lead from the first selector.	<input type="checkbox"/>
9. Connect the BLUE-WHITE cable lead to Ring on the linefinder jack.	<input type="checkbox"/>
10. Connect the WHITE-BLUE cable lead to Tip on the linefinder jack.	<input type="checkbox"/>
11. Connect the WHITE cable lead to -48 volt (-24 volt for the M-164-49) battery on the linefinder jack.	<input type="checkbox"/>
12. Connect the RED cable lead to office ground on the linefinder jack.	<input type="checkbox"/>
13. Plug the connecting cable into the socket on the bottom of the M-164 .	<input type="checkbox"/>
14. Mount the M-164 within 30 degrees of vertical plumb, paragraphs 6.21 through 6.27.	<input type="checkbox"/>
15. Do the installation tests, start at paragraph 7.03.	<input type="checkbox"/>
16. Unbusy the linefinder to put the M-164 into service.	<input type="checkbox"/>

and its fuse removed before beginning the wiring.

6.13 At many installations there are several linefinders associated with each fuse. Before removing such a fuse, busy out all the linefinders associated with it. Then do the wiring described in paragraphs 6.15 through 6.20 for all those linefinders,

plug the connecting cables into the M-164's, and mount the units. Then replace the fuse.

6.14 The usual procedure when wiring several linefinders at once is to then leave each linefinder busied out until the installation of each associated M-164 has been tested. It may not be desirable to leave a quantity of linefinders busied out that long. In that case, test all the newly wired line-

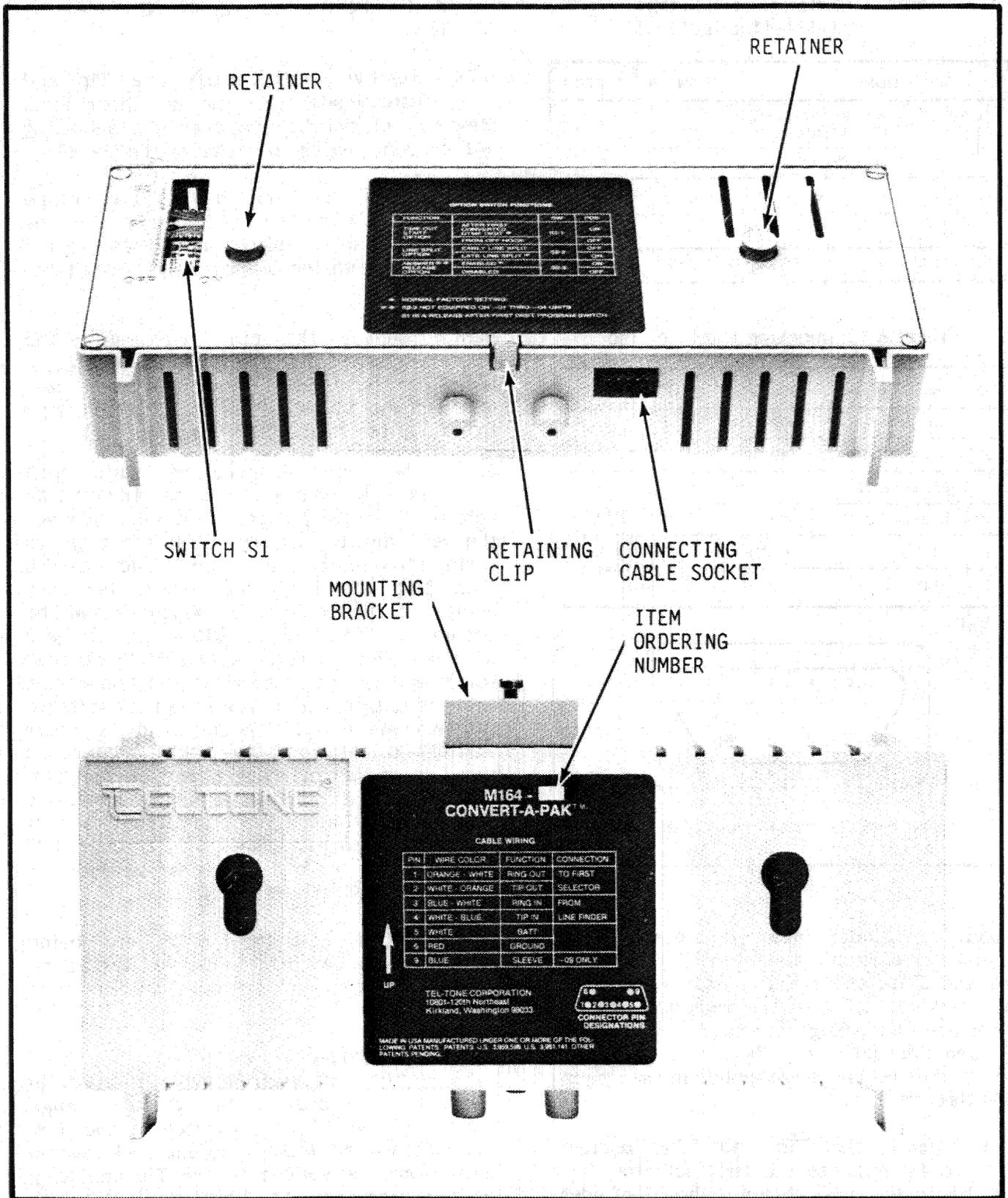


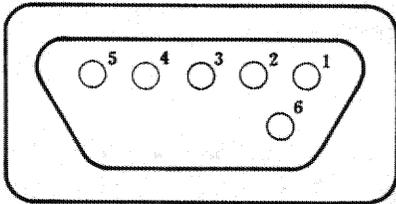
Figure 7 Views of CONVERT-A-PAK

**Table 3 Option Switch Settings
(M-164-41 and -42 Only)**

FUNCTION		POSITION	SWITCH
TIME OUT START OPTION	AFTER FIRST DIGIT (CONDITIONAL) *	ON	S1-1
	FROM OFF-HOOK	OFF	
LINE SPLIT OPTION	LATE LINE SPLIT *	ON	S1-2
	EARLY LINE SPLIT	OFF	
* NORMAL FACTORY SETTING FOR M-164-41 AND -42			

Table 4 Connecting Cable Wiring

PIN	WIRE COLORS	FUNCTION	CONNECTION
1	ORANGE-WHITE	RING OUT	TO FIRST SELECTOR
2	WHITE-ORANGE	TIP OUT	
3	BLUE-WHITE	RING IN	FROM LINEFINDER
4	WHITE-BLUE	TIP IN	
5	WHITE	BATTERY	LINEFINDER TERMINAL BLOCK
6	RED	GROUND	



CONNECTOR PIN DESIGNATIONS ON M-164

finders for proper rotary dial operation by completing a rotary dialed call through each one and place those that pass the test back into service. The same procedure applies when Loop-thru plugs are used. Then return to each linefinder to fully test the installation of the M-164 as described in paragraphs 7.04 through 7.21.

6.15 Locate the Tip and Ring connections going to the first selector from the linefinder jack behind the linefinder. Then locate the battery and ground terminals

which will be used to supply power to the M-164 .

6.16 Remove and identify the Tip and Ring leads from the linefinder jack. Reversal of polarity between Tip and Ring will prevent proper operation of the M-164 .

6.17 Splice the Ring lead to the orange wire with the white stripe in the connecting cable. Splice the Tip lead to the white wire with the orange stripe. See table 4.

6.18 Connect the blue wire with the white stripe in the connecting cable to the Ring terminal of the linefinder jack. Connect the white wire with the blue stripe to the Tip terminal of the linefinder jack.

6.19 The white connecting cable wire must be connected to the -48 volt (-24 volt for M-164-49) battery source. Connect the red wire to ground. Test the previous wiring steps according to local practices and then plug the miniature rectangular connector of the cable into the socket on the bottom of the M-164 . Note that it locks with a definite click. Assure that the first selector does not seize when the connecting cable is plugged in or when the first selector fuse is installed. If the unit is in its proper vertical orientation when this occurs and there is not an off-hook phone on the line, such a seizure indicates a wiring error, see paragraph 8.15 and figure 18. Mount the unit as described in paragraphs 6.21 through 6.27 and then test the installation as described in paragraphs 7.03 through 7.04.

Note: If Loop-thru plugs are being used, the wiring should be tested by completing a rotary-dial call on each line.

6.20 The connecting cable can be wired at the first selector jack if desired. In that case, the orange-white and white-orange cable leads would be connected at the jack terminals while the blue-white and white-blue leads would be spliced to the Tip and Ring leads coming from the linefinder. Refer to table 4.

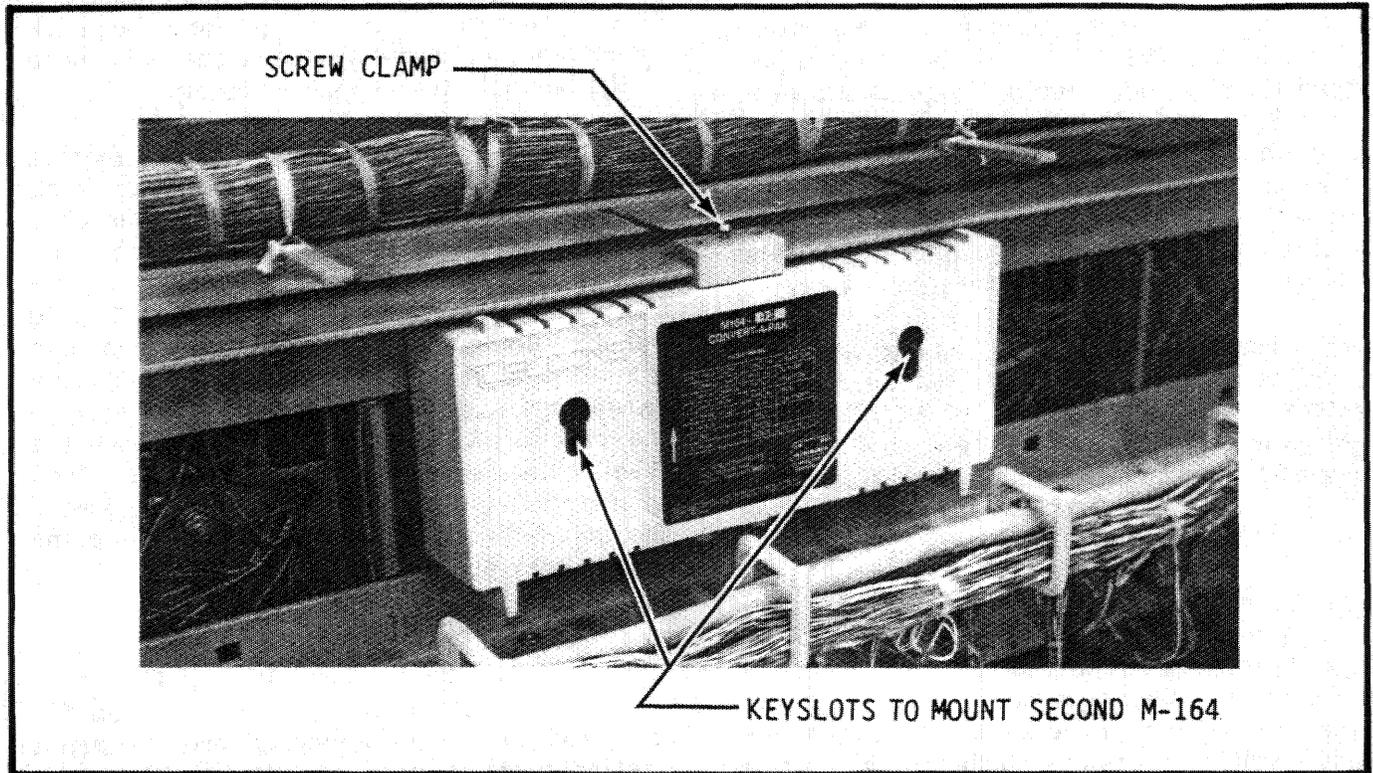


Figure 8 Mount M-164 Behind Linefinders

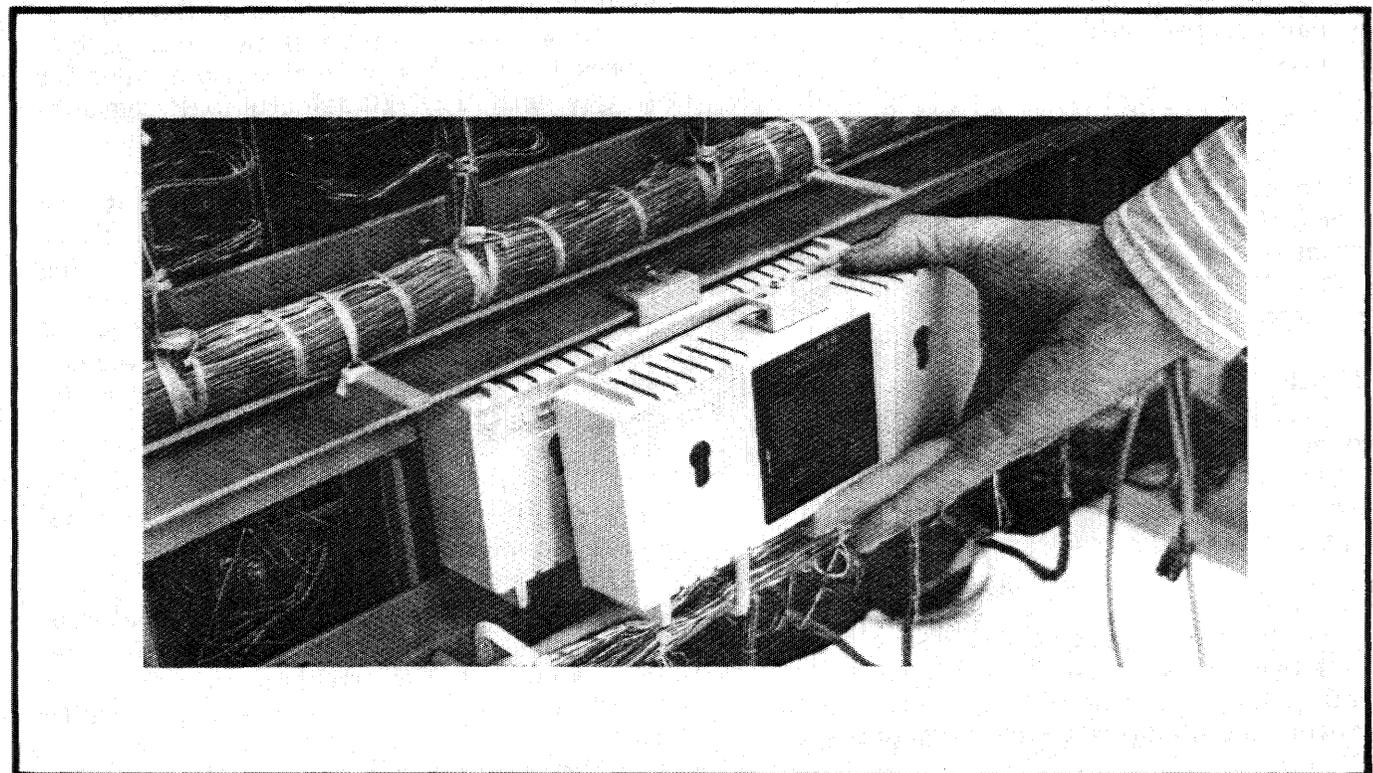


Figure 9 Second M-164 Secures to First Unit

D. Mount the M-164

6.21 In the most common application the CONVERT-A-PAK is mounted just above the linefinder cable trough as shown in figure 8. In practice the units can be hung on almost any horizontal bar within reach of the cable as long as the proper vertical orientation is maintained. The units must be vertical to avoid having the mercury-wetted pulsing relay place a shunt across the line.

6.22 The M-164 is just about as long as the width of two linefinder switches. Two M-164's are mounted behind each pair of linefinders. The first M-164 is secured to the mounting bar by tightening the clamp screw at the top with a wrench such as a W.E. number 417 relay tool.

6.23 The second unit is secured by slipping the retainers on the front into the keyslots in the back of the first unit as shown in figure 9. When the second unit is being secured it will be necessary to press downward until the units are flush at the top and bottom. To separate the units later, the retaining clip at the center of the lower front edge of the second unit must be pulled toward the back as the unit is lifted up out of the keyslots.

6.24 Some linefinder shelves may not have enough clearance below the angle iron to mount the M-164's. In these installations the screw clamp is moved to the bottom of the housing as shown in figure 11 and the M-164's are then mounted above the angle iron.

6.25 If the desired mounting positions of the M-164's require either of the two mounting adapters, M-164-10 or M-164-11, the standard screw clamps on the housings must be removed and the special mounting adapters installed as shown in figure 12.

6.26 An alternative mounting procedure allows hanging the M-164's on a relay rack mounting bar. The screws securing the screw clamp to the M-164 housing are removed, the clamp is turned 90 degrees, and

the screws are retightened. See figure 10. This allows the units to fill the relay rack space more efficiently. Each one is secured to the bar with its own screw clamp.

6.27 Certain Western Electric frames require the addition of the Extending Adapter Plate to the mounting hardware of the M-164. This arrangement assures sufficient clearance between the unit and certain capacitor bolts on the linefinder. To add the Extending Adapter Plate, first remove the existing mounting bracket. Secure the Extending Adapter Plate to the housing with the two screws formerly used to secure the bracket to the housing. See figure 13. Then secure the mounting bracket to the plate with the two 4-40 x 1/4 flat-head slotted machine screws provided in the M-164-24 kit.

E. KTS Installation Wiring

6.28 Wiring the connecting cable in a Key System intercom installation for an M-164-49, is approached differently than a linefinder conversion. An M-164-49 can be used on most common channel intercoms, including those with A.E. -70 selectors, 207 selectors (W.E. Co., Stromberg Carlson, or ITT), or a 6A type single or two-link system. Figures 14 and 15 provide wiring diagrams for 207 type and A.E. -70 selectors. Paragraphs 6.29 through 6.33 describe the wiring steps.

6.29 The CONVERT-A-PAK cannot be used in 16A systems because the -70 selector is not connected to the Tip and Ring leads in the talking links. Use of the M-164-49 may adversely affect the operation of some other systems due to the impedance change imposed when the unit restores the line after outpulsing the last digit.

6.30 Identify the terminals to the selector for Tip, Ring, talk battery, and ground. Remove power from the selector.

6.31 Remove the incoming Tip lead and splice it to the white wire with the blue stripe. Remove the incoming Ring lead and splice it to the blue wire with the white stripe.

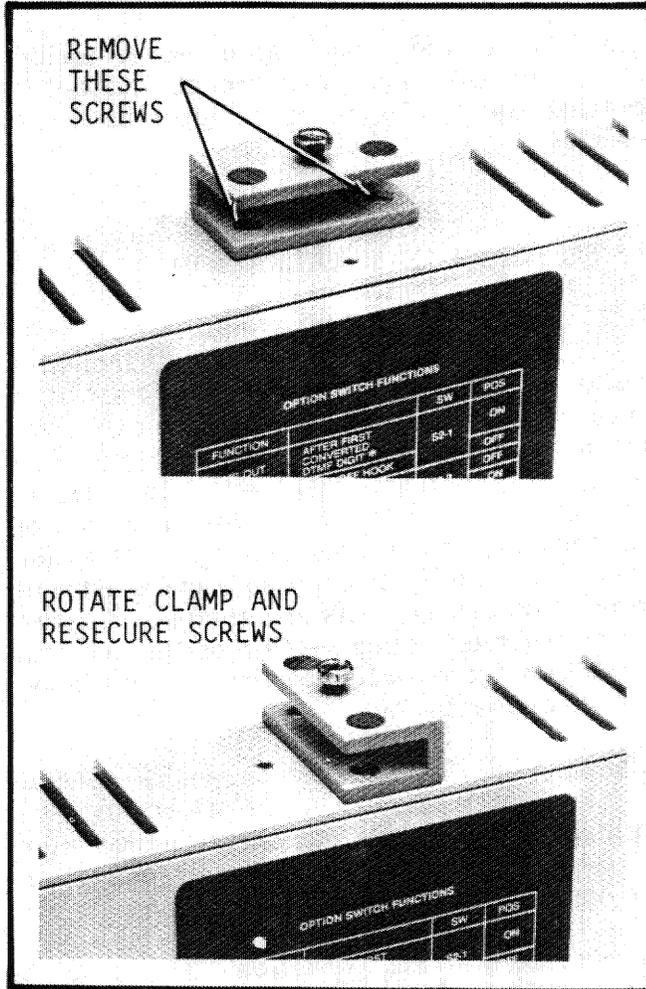


Figure 10 Remount Screw Clamp for Relay Rack Mounting

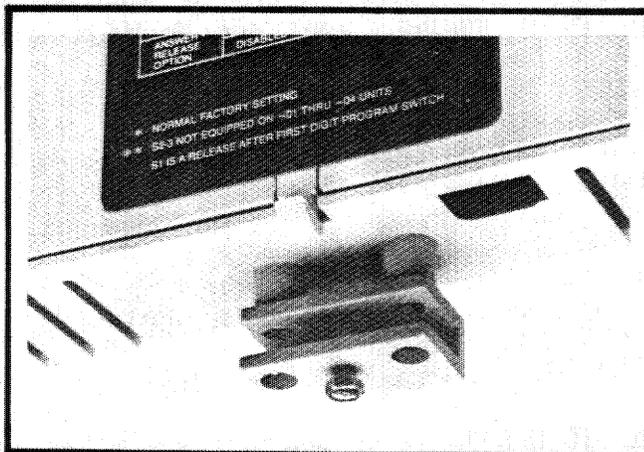


Figure 11 Remount Screw Clamp on Bottom of Housing

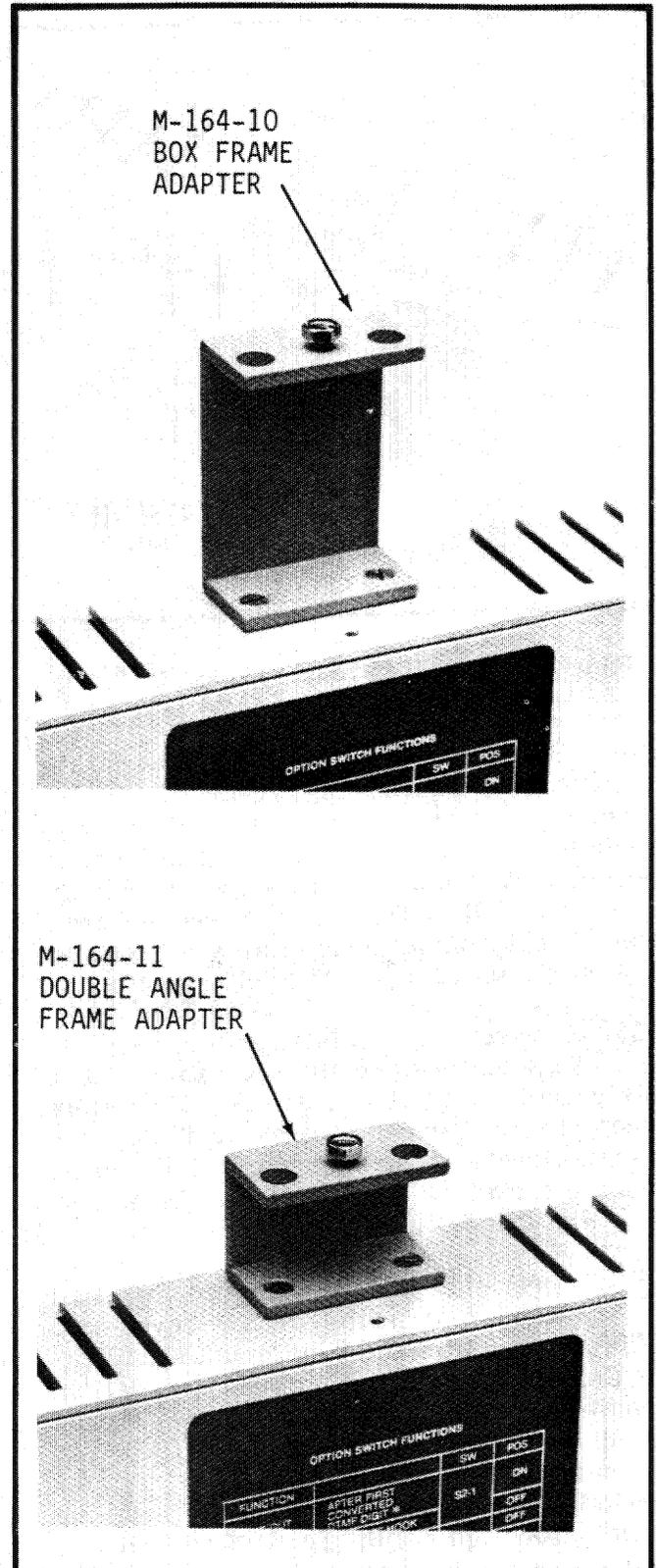


Figure 12 Install Mounting Adapter on Housing

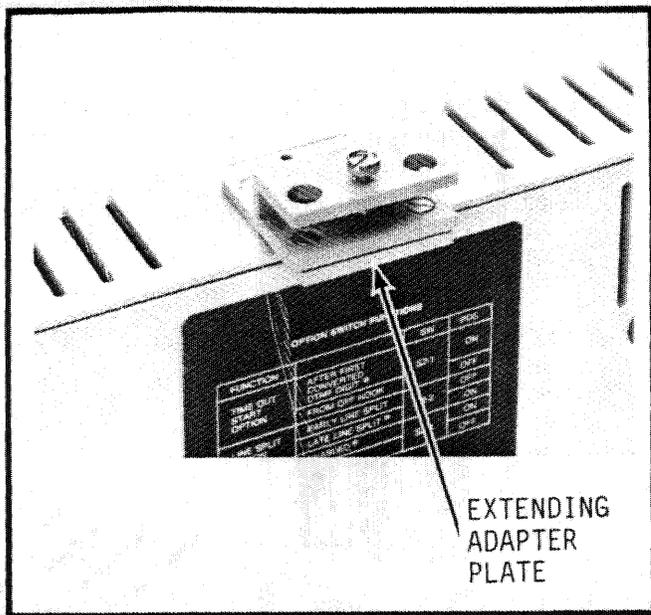


Figure 13 Install Extending Adapter Plate on Housing

6.32 Connect the white wire with the orange stripe (Tip OUT) to the terminal from which the incoming Tip lead was removed. This is terminal 1 on a 207 or -70 selector. Connect the orange wire with the white stripe (Ring OUT) to the terminal from which the incoming Ring lead was removed. This is terminal 2 on a 207 or -70 selector.

6.33 Connect the white cable lead to talk battery and the red cable lead to talk ground. Test the previous wiring steps according to local practices and plug the miniature rectangular connector of the cable into the socket on the bottom of the M-164. Note that it locks with a definite click.

6.34 When the M-164's are to be wall mounted or installed on a seven-inch KTS rack, two KTS and Wall Mounting Adapter Brackets are used in each location. Remove any existing mounting hardware from the M-164. The brackets can be attached to the unit either of two ways to mount it either parallel or perpendicular to the mounting surface (see figure 16). Secure the brackets to the plastic housing with thread-forming screws, otherwise use the provided machine screws.

6.35 Test the installation as described in paragraphs 7.03 through 7.21 before putting the linefinder or selector back into service.

7. TESTING THE INSTALLATION

7.01 Normal DTMF and rotary dial traffic through the equipment indicates proper operation of the converter when it is in service. The installation of each converter should be tested, as described in the following paragraphs, before it is put into service. These tests also verify both the operation of the converter and proper setting of its option switches. Use of table 5 as a checklist will assure that all the tests are completed. Turn to the troubleshooting section of this bulletin if a converter does not perform as described in each applicable test.

7.02 An M-164 does not require special maintenance. Routine exercising according to local practices should assure that all the testable functions of each converter are operating.

A. Test Rotary Dial Operation

7.03 Since installing an M-164 requires disconnecting and reconnecting the Tip and Ring leads, the first test is that a rotary dial digit can still break dial tone. Before installing the linefinder fuse or whatever other power source is being used, go off-hook with a test telephone connected at the linefinder's test jack or an equivalent test point. Dial tone should be heard in the earpiece of the test telephone. There is definitely a fault if the dial tone is not connected. However, dial tone alone does not completely verify the wiring of an M-164 installation. Either dial a rotary digit or flash the hookswitch. Note that dial tone is cut off. If the dial tone is not cut off there is a fault. Go to paragraph 8.15 and figure 18.

7.04 If the dial tone was cut off in the test described in the preceding paragraph then install the fuse and repeat that test.

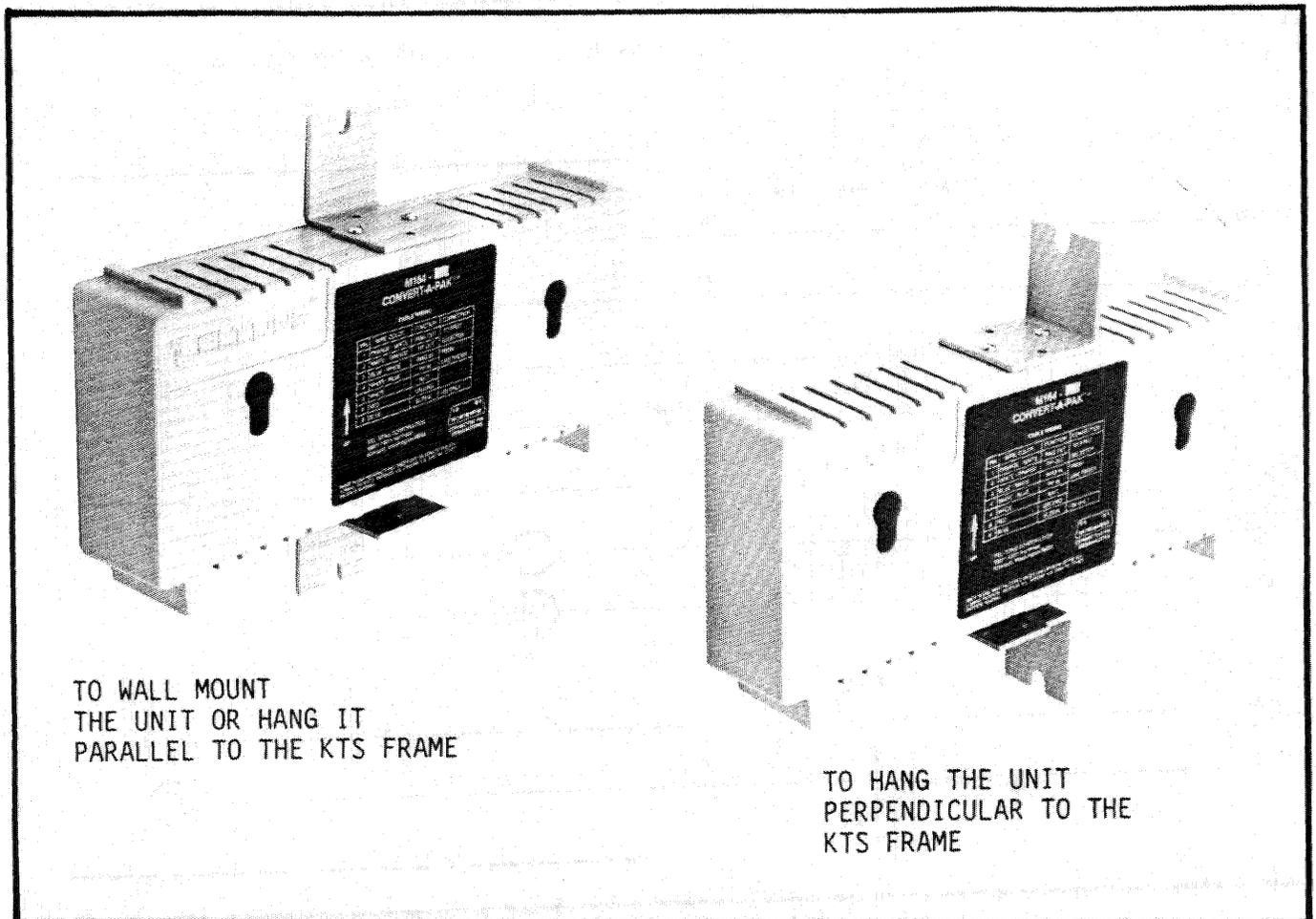


Figure 16 Install the KTS and Wall Mounting Brackets on Housing

D. Exercise the On-Hook Inhibit

7.11 The CONVERT-A-PAK must inhibit itself when the calling party goes on-hook. To test this function, go off-hook with the test phone and quickly signal several large digits (say 8's or 9's). Go on-hook with the test phone. Observe that outpulsing stops and the switching train drops before all the digits are outpulsed.

7.12 The next exercise is not applicable to M-164-46 and -49 units. In these cases, go to paragraph 7.14. All other installations should proceed with testing as directed in the following paragraphs.

E. Exercise the End of Dialing Feature

7.13 The End of Dialing feature should be exercised as described here for the

M-164-41, -42, and -50 configurations. Go off-hook with the DTMF test phone and signal any two numerical digits. Follow those digits with a DTMF * character. Signal two more numerical digits. Listen to the dial pulse feedback or watch the forward equipment to verify that only the first two digits are outpulsed. Go on-hook and back off-hook with the test phone. Repeat the test signaling a DTMF # character after the first two digits.

F. Exercise the Answer Supervision Release

7.14 The Answer Supervision release feature is implemented differently in the M-164-49 and -50 configurations than in the others. If either of these two configurations is being tested, exercise the Answer

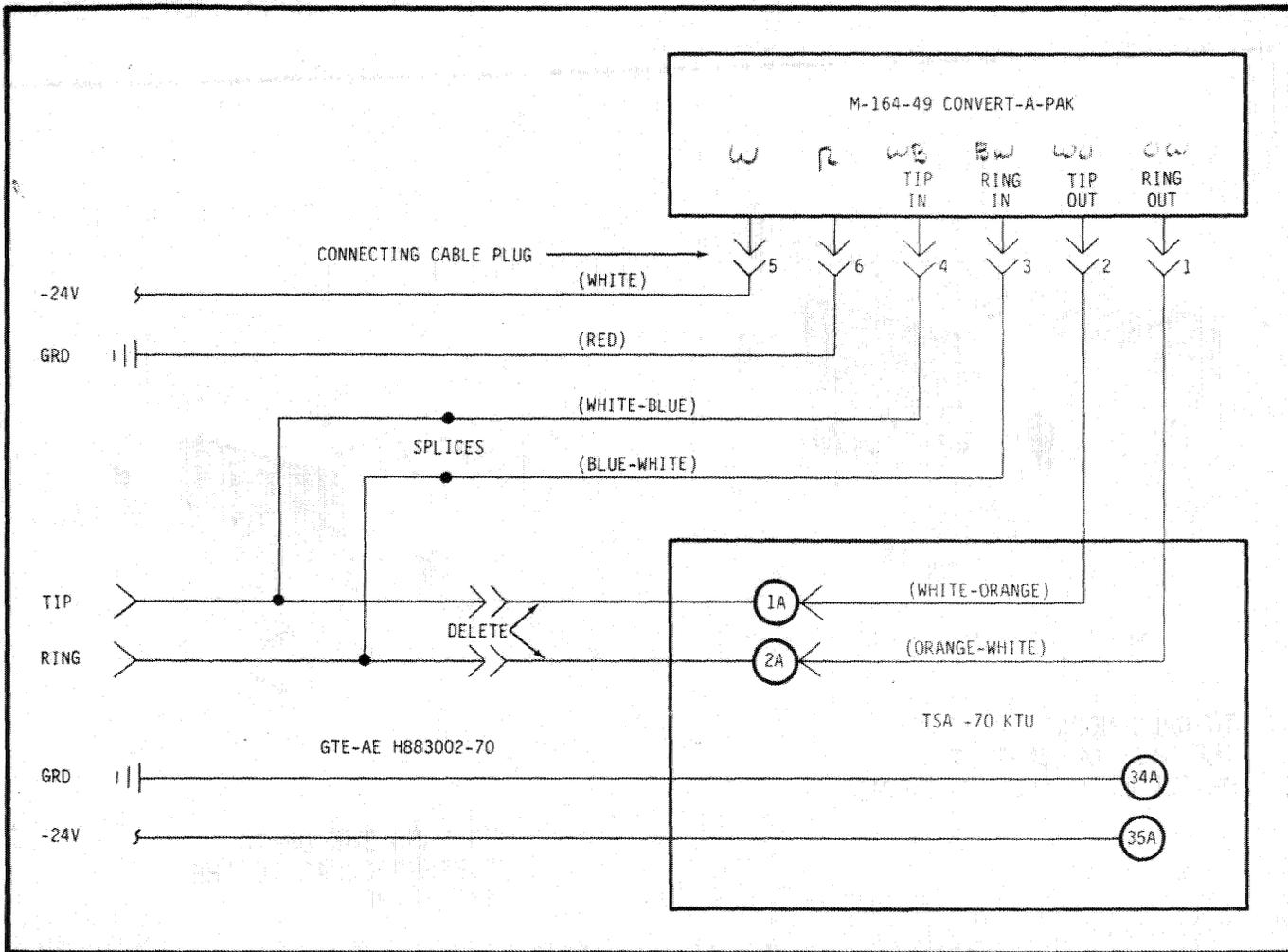


Figure 15 -70 KTU Wiring Diagram

the calling party goes on-hook and back off-hook (or if Answer Supervision reversal appears and is removed).

7.08 If the Time Out Start option is set to start the timer as the first digit is outpulsed (S1-1 is ON), go off-hook, wait 20 seconds, and then signal a digit to start the timer. Signal another digit in ten seconds. Verify that both digits are outpulsed. Wait another 20 seconds before signaling a third digit. That digit must not be outpulsed.

7.09 If the Time Out Start option is set to start the timer when the subscriber goes off-hook (S1-1 is OFF or not provided), go off-hook and wait 20 seconds before signaling the first DTMF digit. The digit must not be outpulsed.

7.10 Go on-hook and back off-hook. Wait ten seconds and signal a DTMF digit. Verify that the digit is outpulsed. Wait 20 seconds and signal another digit. The second digit after this off-hook must not be outpulsed.

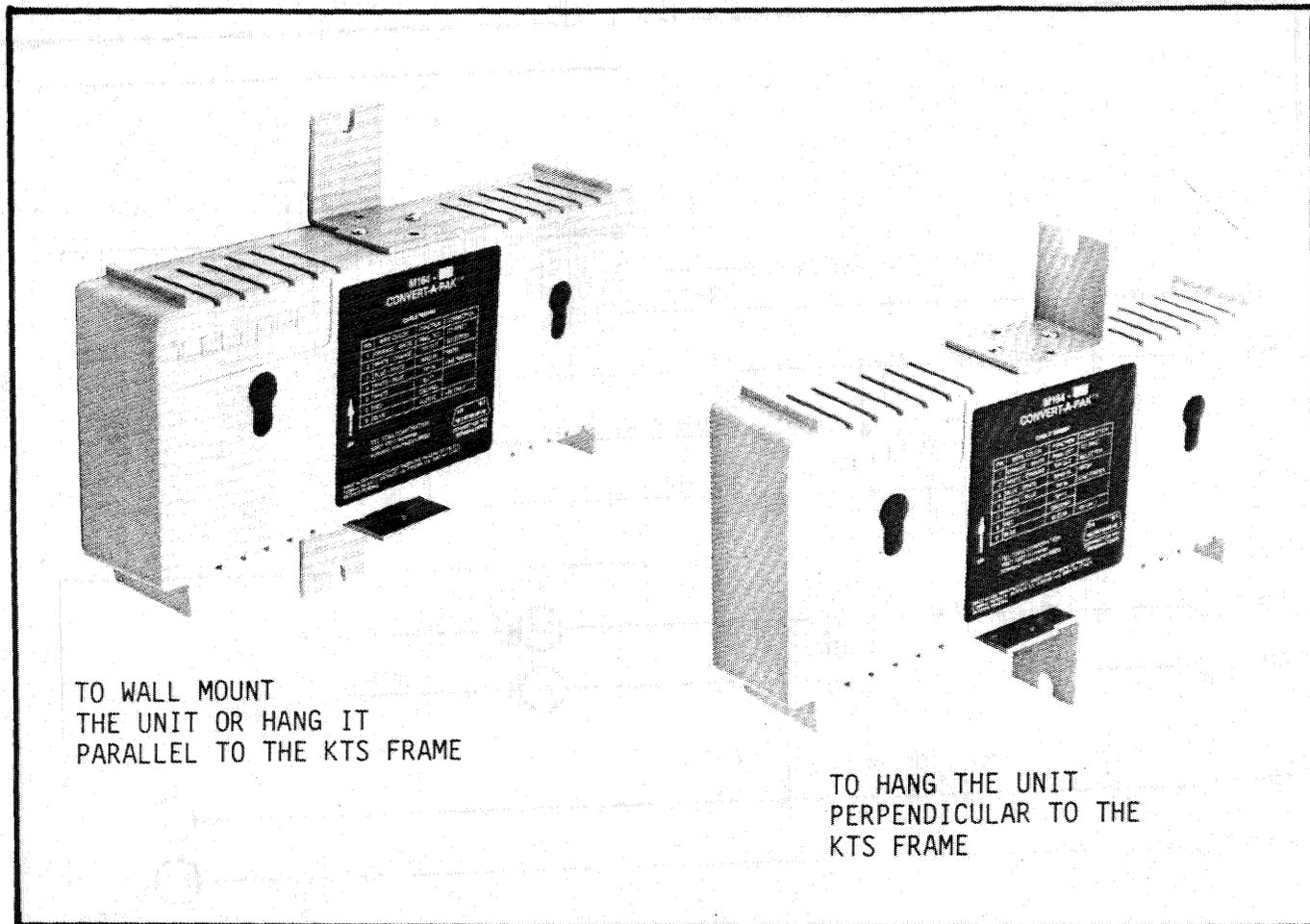


Figure 16 Install the KTS and Wall Mounting Brackets on Housing

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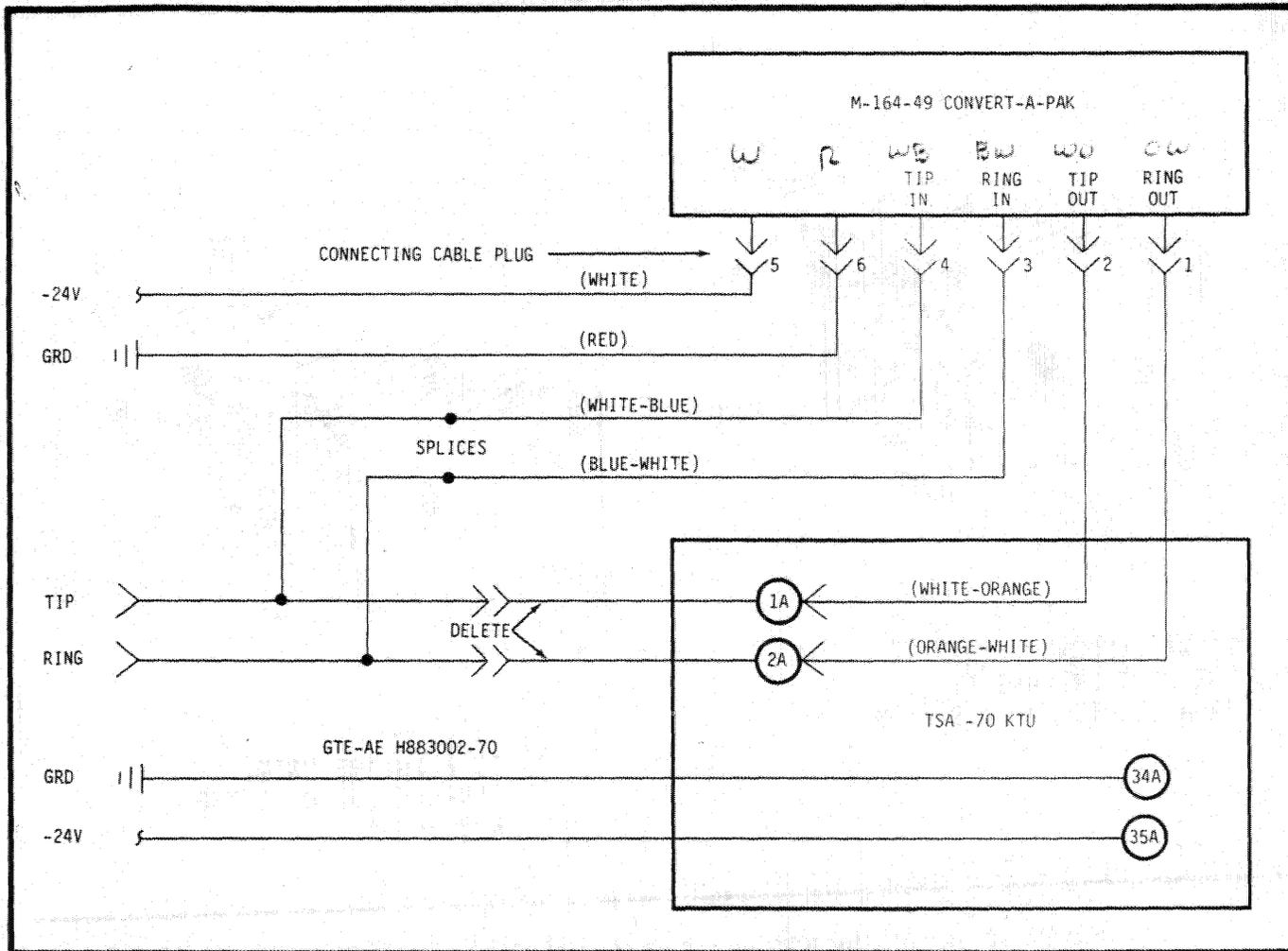


Figure 15 -70 KTU Wiring Diagram

the calling party goes on-hook and back off-hook (or if Answer Supervision reversal appears and is removed).

7.08 If the Time Out Start option is set to start the timer as the first digit is outpulsed (S1-1 is ON), go off-hook, wait 20 seconds, and then signal a digit to start the timer. Signal another digit in ten seconds. Verify that both digits are outpulsed. Wait another 20 seconds before signaling a third digit. That digit must not be outpulsed.

7.09 If the Time Out Start option is set to start the timer when the subscriber goes off-hook (S1-1 is OFF or not provided), go off-hook and wait 20 seconds before signaling the first DTMF digit. The digit must not be outpulsed.

7.10 Go on-hook and back off-hook. Wait ten seconds and signal a DTMF digit. Verify that the digit is outpulsed. Wait 20 seconds and signal another digit. The second digit after this off-hook must not be outpulsed.

7.20 Signal another DTMF digit as soon as the called station goes off-hook. Assure that the phone used does actually generate tones. The M-164 should neither split the line nor output the digit: no clicks, pops, or pulses should follow the digit. Some office test numbers switch the polarity after a few seconds. Care must be taken to signal the test digit only during the reversed portion of this cycle. The two-phone arrangement adds considerable certainty in such cases, as the reversal is indicated by the change in which phone will operate.

G. Exercise the ANI Feature

7.21 The M-164-42 and -50 configurations include the Tip Party Identification (ANI) feature. As this feature is associated with toll billing, it must be tested when applicable. Connect an ANI equipped test telephone in parallel with the DTMF test telephone at the linefinder test jack if the DTMF telephone is not ANI equipped. Test for presence of the ANI indication at the forward equipment as described in the appropriate BSP or local practice while the line is split by the M-164. To hold the line split, signal three numerical DTMF digits in quick succession and do not release the button for the third digit. The third digit must be signaled before the outputting of the second digit is completed. The line will remain split as long as the phone is off-hook and the button is held down. The success of this procedure, that the third digit was signaled quickly enough to hold the line split, can be verified by the absence of the digit tones at the forward equipment.

H. Place Converter in Service

7.22 When all the applicable tests have been successfully completed, the M-164 can be put into service. Disconnect the test telephone(s) and assure that the linefinder is unbusied.

8. TROUBLESHOOTING THE M-164

8.01 Operation faults in equipment associated with the M-164 converters must first be traced to the particular linefinder or

equivalent unit connected to each CONVERT-A-PAK. Most faults traceable to the M-164's themselves are exclusively associated with DTMF calls or DTMF signals on the line.

8.02 The unit may be sent to the appropriate service center if the troubleshooting procedures described in this section determine that an M-164 is faulty. There are no field serviceable or field replaceable components within the M-164 housing.

8.03 A fault unique to the M-164 is the possibility of its placing a shunt across the line if the unit is improperly mounted or if the mounting is altered. If a CONVERT-A-PAK is more than 30 degrees out of vertical plumb the mercury in the pulsing relay will connect the line-holding resistance across the line. Under these circumstances a visual check of the converters should make this problem immediately apparent.

8.04 The procedures for isolating faults depend on whether the unit is in service and had been operating properly or is a unit that does not pass its initial installation tests. If the unit has been in service and operating, proceed as described in the following paragraphs and figure 17. If the problem is with an initial installation, go to paragraph 8.14.

A. Service Faults

8.05 Failure of a converter installation that had been operating requires identification of the exact nature of the fault to assure that the suspect unit is actually the one at fault. If necessary, make the installation tests applicable to the configuration of M-164 installed and described in section 7 of this bulletin to identify the fault and associate it with a particular piece of hardware. There is one exception: if the problem is complaints of a unit not completing the dialed number, see paragraph 8.11.

8.06 First, note that dial tone is connected when a test phone connected at the

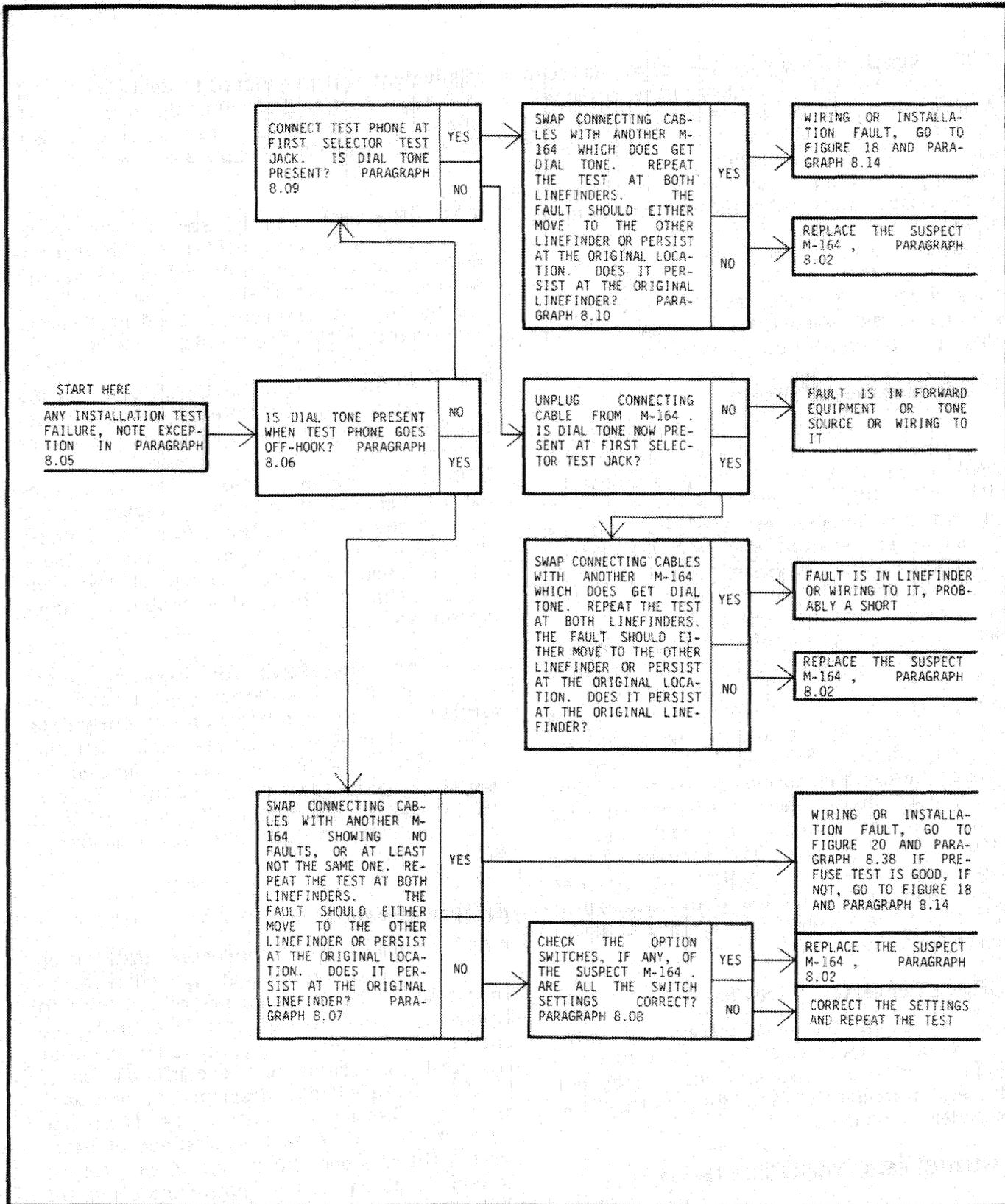


Figure 17 Troubleshooting Procedure

linefinder's test jack, or an equivalent test point, is taken off-hook. If dial tone is not present check the first selector as suggested in figure 17 and paragraph 8.09. If dial tone is present then continue the installation tests until a failure occurs. Then swap connecting cables with another M-164 that does not fail its installation tests. To disconnect the miniature rectangular cable connectors, pry downward with a screwdriver blade slipped between the housing and one of the ears on the ends of the connectors.

Note: Some local translation of terms will be required at key system installations of M-164-49's. The troubleshooting procedures in this bulletin refer to the Tip and Ring IN and OUT pairs being connected, respectively, to linefinders and first selectors. This is not applicable to a key system, but those terms are directly applicable to the majority of central office and PBX installations.

8.07 Assure that both cable connectors snap into place with a definite click and that both converters are still properly mounted. Repeat the failed installation test at both linefinders. Note whether the test failure now occurs at the other linefinder or persists at the original linefinder. If the fault persists at the original linefinder there is either a wiring fault or a fault in the switch train: go to paragraph 8.14 and figure 18.

8.08 Check the option switch settings of the suspect unit (M-164-41 and -42 only) to assure that incorrect settings are not causing the failure if it now appears at the other linefinder. If the option switch settings are correct or no switches are provided then the suspect M-164 is at fault and must be replaced.

8.09 If dial tone was not connected when the test phone at the linefinders test jack went off-hook, repeat the test at the test jack of the first selector or wherever the dial tone should be coming from. If dial tone is present at this second test point then swap connecting cables between the suspect M-164 and another unit that does get dial

tone. If dial tone is not present at this second test point, unplug the cable from the M-164 and test for dial tone at the test point again. If the dial tone is now present there is a short either in the converter or the linefinder wiring: to tell which, swap cables with another unit. If unplugging the cable did not cause the dial tone to return at the second test point the converter is not at fault and the problem lies in the converted equipment or the wiring. To disconnect the miniature rectangular cable connectors, pry downward with a screwdriver blade slipped between the housing and one of the ears on the ends of the connectors.

8.10 Assure that both cable connectors snap into place with a definite click when reconnected. Go off-hook with the test phone at each linefinder. Note whether the lack of dial tone persists at the original linefinder or moves to the other linefinder. If the lack of dial tone moves to the other linefinder and the connecting cable plug is properly inserted, then the suspect M-164 is faulty and must be replaced. If the problem persists at the original linefinder there is a wiring or switch train fault: go to paragraph 8.14 and figure 18 to isolate the problem.

B. Converter Does Not Complete the Signaled Number

8.11 Under certain circumstances an M-164 may outpulse only part of the signaled number (say the first three digits of a seven-digit number) and then stop. This is usually caused by a reversed Tip and Ring pair in the forward switching equipment that did not affect rotary dial operation but appears to the M-164 as Answer Supervision. The problem tends to follow particular digits and is associated with individual selector positions. Since a given selector does not always connect to the same position the fault will appear intermittently.

8.12 When the converter is stopped in mid-number by a wiring reversal the line remains connected to the faulty selector position until the calling station goes on-hook. A test phone connected with

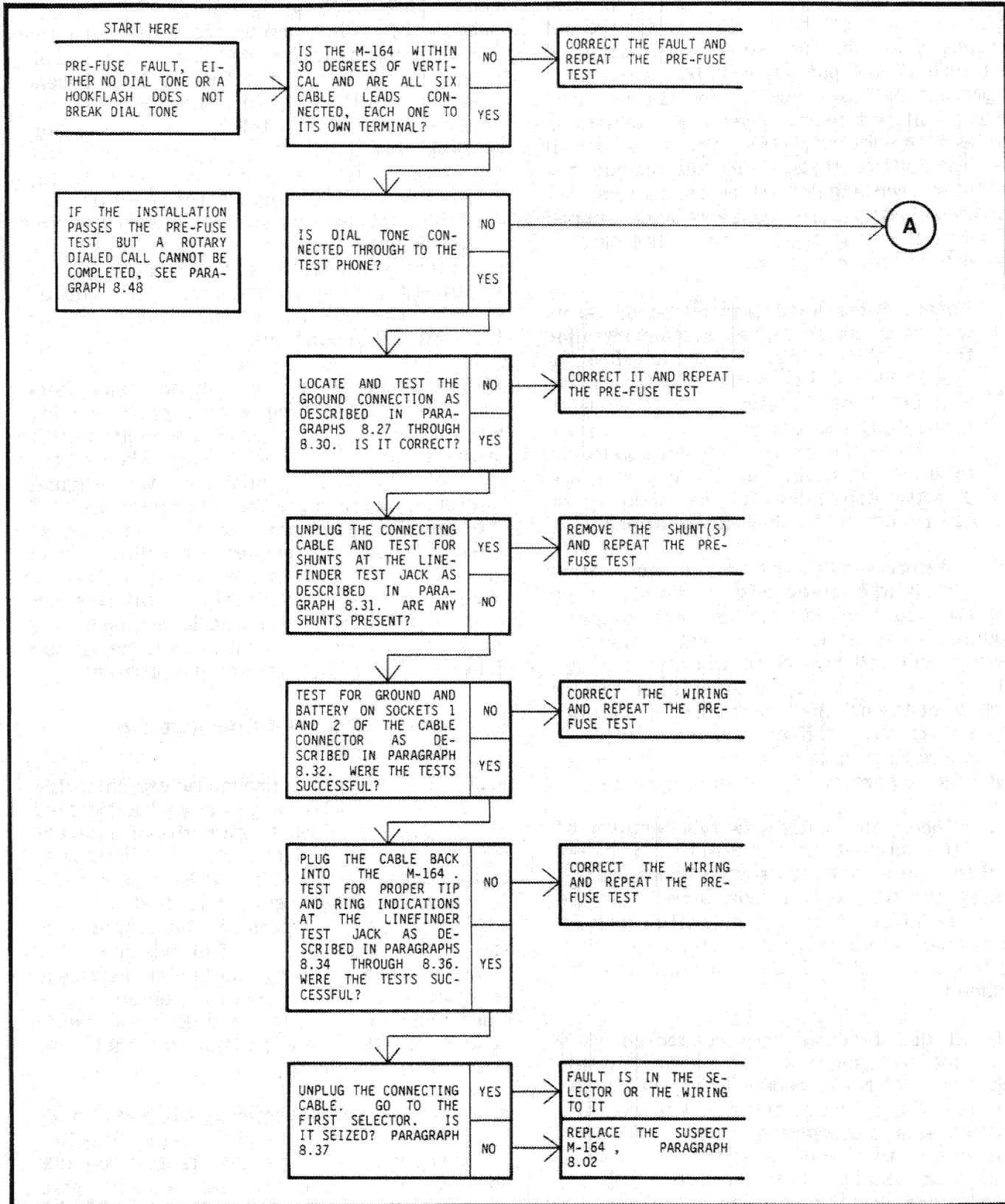


Figure 18 Pre-Fuse Fault Isolation (Sheet 1 of 2)

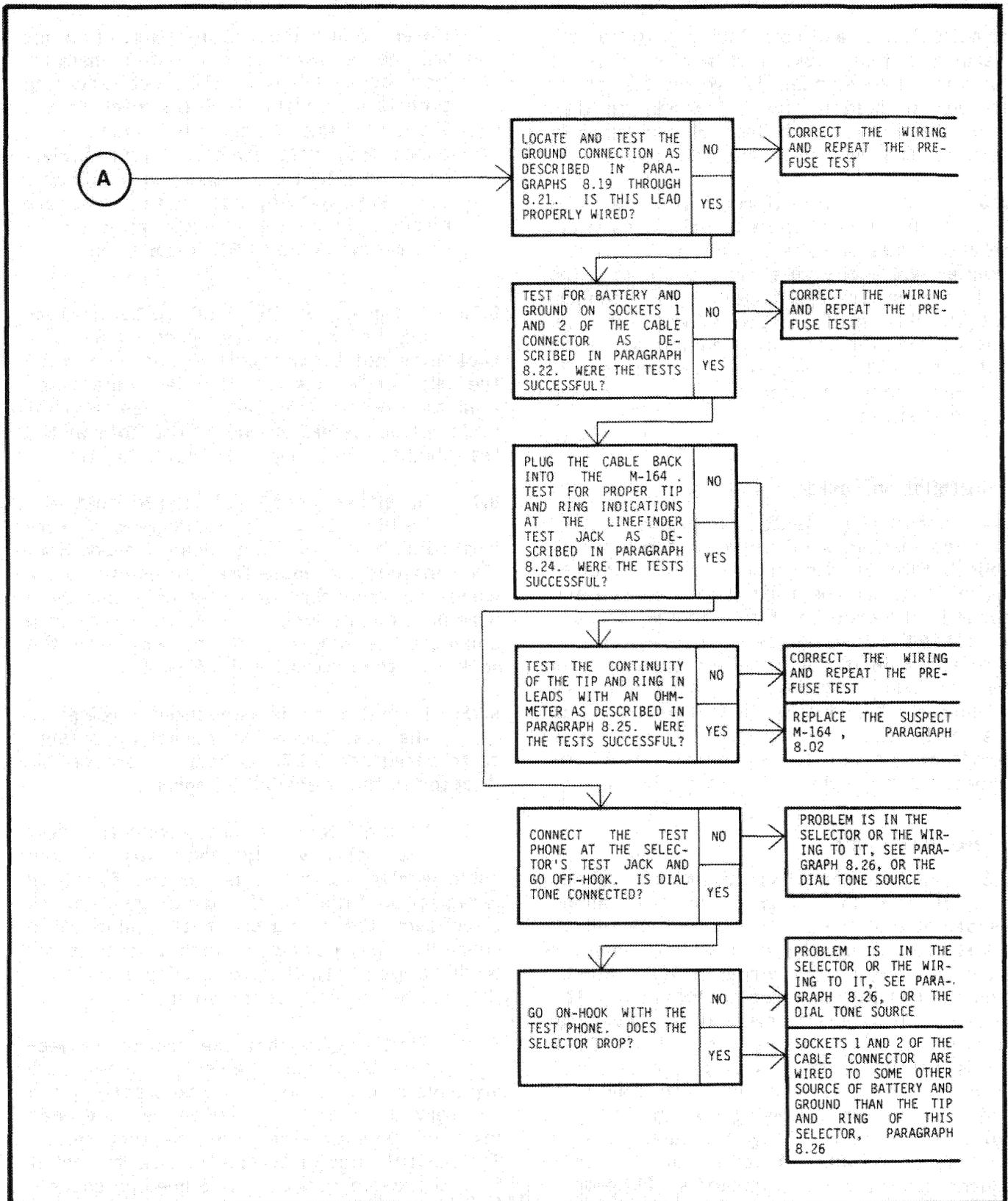


Figure 18 (Sheet 2 of 2)

normal polarity, and no polarity guard, at the linefinder's test jack, will not be able to generate DTMF signals. Leave the test phone off-hook to hold up the selectors and then trace the line to the last closed selector position. That will be the reversed pair.

8.13 If attempting to replicate the fault with a test phone when the converters are M-164-49's or -50's (which don't detect a reversal while the line is split), signal the digits far enough apart (say, three seconds) that the line will restore after each one. Proceed until the test phone cannot signal the next digit. Then leave the test phone off-hook and trace the line to the last closed selector position.

C. Installation Faults

8.14 Installation fault symptoms should be distinguished between those which occur before the linefinder (or other power source) fuse is installed and those which appear in the process of testing the installation after the fuse has been installed. Go to paragraph 8.38 if the installation passed the pre-fuse test described in paragraph 7.03 (off-hook test phone at linefinder test jack gets dial tone and can break it with a hookflash) but not the post-fuse tests (described in paragraphs 7.05 through 7.20).

D. Pre-Fuse Faults

8.15 Pre-fuse fault symptoms include any of the following: the test phone cannot get dial tone, the dial tone cannot be broken with a hookflash, the first selector seizes either when the wiring is being done or when the connecting cable is plugged into the M-164. These symptoms may be caused by faults which might destroy the M-164 if the fuse is installed; they also impair rotary dial service. Isolate and clear these faults as described in the following paragraphs and figure 18, before installing the fuse. Due to the absence of applied power and the consequent lack of active symptoms, this procedure can only distinguish between M-164 faults and wiring faults and cannot specify the exact wiring faults.

Note: Some local translation of terms will be required at key system installations of M-164-49's. The troubleshooting procedures in this bulletin refer to the Tip and Ring IN and OUT pairs being connected, respectively, to linefinders and first selectors. This is not applicable to a key system, but those terms are directly applicable to the majority of central office and PBX installations.

8.16 Instances of the first selector seizing before the test phone goes off-hook may not be immediately noticed when the selector is in some other equipment bay than the M-164 installation. Then the first fault noticed is either lack of dial tone at the test phone or an inability to break dial tone.

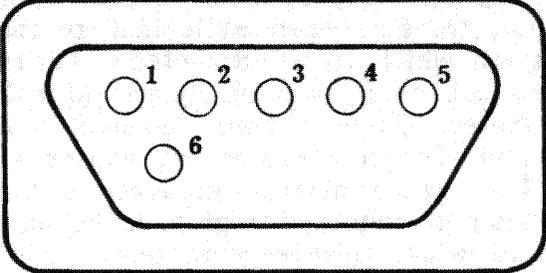
8.17 In either case first assure that the M-164 is within 30 degrees of vertical plumb in its final mounting position. Then inspect the cable leads to assure all six wires are connected and that only one cable wire is at each terminal. Make sure the cable connector is plugged all the way into the socket on the bottom of the M-164.

8.18 If dial tone is connected through to the test phone but cannot be broken, go to paragraph 8.27. Otherwise, proceed as directed in the following paragraphs.

8.19 If dial tone is not connected test the polarity and continuity of the cable wiring as described in the following paragraphs. Unplug the connecting cable. To disconnect the miniature rectangular cable connector, pry downward with a screwdriver blade slipped between the housing and one of the ears on the ends of the connector.

8.20 First, verify that the ground connection is properly wired. Connect the negative side of a voltmeter to a battery bus not served by the fuse which has not been installed because the pre-fuse test failed. The positive side of the meter goes to socket 6 of the cable connector. Since the sockets in the connector are very small, extending the meter probe with a short length of unstranded hook-up wire may be required.

PIN	WIRE COLORS	FUNCTION	CONNECTION
1	ORANGE-WHITE	RING OUT	TO FIRST SELECTOR
2	WHITE-ORANGE	TIP OUT	
3	BLUE-WHITE	RING IN	FROM LINEFINDER
4	WHITE-BLUE	TIP IN	
5	WHITE	BATTERY	LINEFINDER TERMINAL BLOCK
6	RED	GROUND	



CABLE CONNECTOR SOCKET DESIGNATIONS

Figure 19 Connector Cable Sockets

Locate socket 6 in the row of four sockets. Socket six is at the left when the four-socket row is at the bottom as shown in figure 19. The diagram of the connector pins on the label of the unit correctly identifies the pins of the connector on the unit. The sockets of the cable connector as shown in figure 19, however, are the mirror image of the connector on the unit. With the positive side of the voltmeter at socket 6 the meter should indicate full battery deflection.

8.21 Whether ground is present on socket 6 or not, trace the red cable lead to the terminal to which it is connected. Verify that terminal to be power supply ground with a voltmeter. If the red lead is connected to ground and the ground does not appear at socket 6, the cable must be replaced. If the red lead is not connected to ground, that wiring fault must be corrected.

8.22 When the power supply ground has been verified, test for presence of ground on socket 2 of the cable connector with the voltmeter. This ground is the Tip connection from the first selector. If ground is not present at socket 2 there is a wiring fault. Try sockets 1, 3, 4, and 5 to identify the Tip connection from the selector and then correct the wiring. If ground was at socket 2, connect the positive side of the voltmeter to ground and the negative side to socket 1 of the cable connector. The meter should indicate battery voltage. This battery is the Ring connection from the first selector. If it is not present at socket 1 there is a wiring fault. Try sockets 3, 4, and 5 to identify the Ring connection and then correct the wiring.

8.23 After making any necessary wiring correction, make sure all six cable leads are connected to one terminal each. Then repeat the pre-fuse test.

8.24 If battery and ground were present on pins 1 and 2, respectively, then plug the connecting cable into the M-164 and test the Tip and Ring pair at the linefinder test jack. Test the Tip Terminal for ground and the Ring Terminal for battery as described previously. If both are present go to paragraph 8.26. Mere reversal of these two connections is a wiring fault and should be corrected but is not the cause of the problem at hand (absence of dial tone at the linefinder). The absence of either battery or ground at the linefinder test jack indicates a definite fault which may be the wiring or the unit. If continuity is present on the cable leads the unit is faulty.

8.25 Test the continuity of the cable wires from the cable connector to the linefinder jack. Unplug the cable connector. Connect an ohmmeter from socket 3 on the connector to the terminal to which the blue-white cable lead is connected and observe that continuity is present. Then test for continuity from that linefinder jack terminal to the Ring terminal of the linefinder's test jack. Test the Tip IN lead by connecting the ohmmeter from socket 4 to the linefinder

jack terminal to which the white-blue cable lead is connected and then from that terminal to the Tip terminal of the linefinder test jack. If continuity is present in all these tests yet either battery or ground did not appear at the test jack when the cable was plugged in, then the M-164 should be replaced. If continuity was not present there is a wiring fault that must be corrected and the pre-fuse test must be repeated.

8.26 If the battery and ground tests at the linefinder's test jack were successful then go to the first selector associated with the converter. Connect the test phone to the selector's test jack and go off-hook. If dial tone is not connected the fault lies in the selector or its connection to the dial tone source. If dial tone is connected then go on-hook with the test phone and observe that the selector drops. If it does not drop, there is a fault in the selector or the wiring to it and the fault is not directly associated with the M-164 which can be demonstrated by unplugging the cable and repeating the test. Whether the selector drops or not, if it puts out dial tone when it is seized, the inescapable conclusion is that the Tip OUT and Ring OUT leads of the connecting cable have been wired to some other sources of ground and battery than the Tip and Ring leads of this selector.

E. Dial Tone Does Not Break

8.27 If the installation failed the pre-fuse test because dial tone could not be broken then first unplug the connecting cable and test the ground connection. To disconnect the miniature rectangular cable connector, pry downward with a screwdriver blade slipped between the housing and one of the ears on the ends of the connector.

8.28 Connect the negative side of a voltmeter to a battery bus not served by the fuse which has not been installed because the installation failed the pre-fuse test. The positive side of the meter goes to socket 6 of the cable connector. Since the sockets in the connector are very small, extending the meter probe with a short length of solid hook-up wire may be required.

8.29 Locate socket 6 in the row of four sockets. Socket 6 is at the left when the row of four sockets is at the bottom as shown in figure 19. The diagram of the connector pins on the label of the unit correctly identifies the pins of the connector on the unit. The sockets of the cable connector shown in figure 19, however, are the mirror image of the unit's connector. With the positive side of the voltmeter at pin 6 the meter should indicate full battery deflection.

8.30 If ground is present on socket 6 or not, trace the red cable lead to the terminal to which it is connected. Verify that terminal to be power supply ground with the voltmeter. If the red lead is connected to ground and the ground does not appear at socket 6 the cable must be replaced. If the red lead is not connected to ground, that is a wiring fault which must be corrected.

8.31 A likely situation when dial tone cannot be broken, is shunts around the converter installation which mask the actual fault. Leave the cable unconnected and test the Tip and Ring terminals of the linefinder test jack for both battery and ground. If either is present on either terminal, remove the shunts and repeat the pre-fuse test with the cable plugged back in.

8.32 If no shunts are present and the proper connection of the power supply ground has been verified then test the Tip and Ring connections to the converter. Test for presence of ground at socket 2 of the cable connector with the voltmeter as was done for the power supply ground. This ground is the Tip connection from the first selector. If ground is not present at socket 2 there is a wiring fault. Try sockets 1, 3, 4, and 5 to identify the Tip connection from the selector and then correct the wiring. If ground was at socket 2 then connect the positive side of the voltmeter to ground and the negative side to socket 1 of the cable connector. The meter should indicate battery voltage. This battery is the Ring connection from the first selector. If it is not present at socket 1 there is a wiring fault. Try sockets 3, 4, and 5 to

identify the Ring connection and then correct the wiring.

8.33 After making any wiring correction make sure all six cable leads are connected to one terminal each. Then repeat the pre-fuse test.

8.34 If battery and ground were present on pins 1 and 2, respectively, then plug the connecting cable into the M-164 and test the Tip and Ring pair at the linefinder test jack. Test the Tip terminal for ground and the Ring terminal for battery as described previously. If both are present go to paragraph 8.37.

8.35 Mere reversal of the pair at the linefinder test jack is a wiring fault and should be corrected, but is not the cause of the fault being experienced (inability to break dial tone). The absence of either battery or ground at the linefinder test jack definitely indicates a fault in either the wiring or the converter. If continuity is present from the sockets of the cable connector to the terminals of the test jack, the unit is faulty and must be replaced.

8.36 Test the continuity of the cable wires. Unplug the cable connector. To test the Ring IN lead connect an ohmmeter from socket 3 on the cable connector to the terminal to which the blue-white cable wire is connected and observe that continuity is present. Then test for continuity from that linefinder jack terminal to the Ring terminal of the linefinder's test jack. Test the Tip IN lead by connecting the ohmmeter from socket 4 to the linefinder jack terminal to which the white-blue cable lead is connected and then from that terminal to the Tip terminal of the linefinder's test jack. If these continuity tests were all successful but either battery or ground was not present at the linefinder's test jack, the unit must be replaced. If the continuity tests were not successful there is a wiring fault that must be corrected and the pre-fuse test must be repeated.

8.37 If the battery and ground tests at the linefinder's test jack were success-

ful then unplug the connecting cable and go to the first selector associated with the suspect converter. If the selector is seized and its A and B relays are operated there is a fault in the selector or the wiring to it. If the selector is not seized the fault is in the M-164 which can be verified by plugging in the cable (test phone is on-hook) and observing that that causes the selector to seize.

F. Post-Fuse Faults

8.38 The following paragraphs describe a troubleshooting procedure for installation test failures other than the pre-fuse test. When known-good units are available the procedure described in paragraphs 8.05 through 8.07 and figure 17 should be done first. That procedure will isolate M-164 faults more efficiently than the following procedure.

8.39 The following procedure assumes that the pre-fuse installation test described in paragraph 7.03 was successful and that all six cable leads are connected with no more than one of them at any terminal. From that starting point the procedure will identify the failure as being either a bad converter, a selector fault, or a cable lead routing fault. Cable faults besides lack of continuity may also occur. On the premise that operating company craftsmen are practiced at correcting wiring faults when certain they are present, the main intent of the procedure is to distinguish between wiring faults and bad converters. Cable wiring faults are specifically identified where possible. After correcting any of the wiring or converter faults identified in this procedure, always repeat the installation tests both to verify the correction and to protect against multiple faults. The procedure is designed to detect multiple faults by going through it again until all the applicable installation tests are passed.

Note: Some local translation of terms will be required at key system installations of M-164-49's. The troubleshooting procedures in this bulletin refer to the Tip and Ring IN and OUT pairs being

connected, respectively, to linefinders and first selectors. This is not applicable to a key system, but those terms are directly applicable to the majority of central office and PBX installations.

G. Fuse Blows

8.40 The first condition to be checked is that the fuse is installed and has not blown. Go to paragraph 8.43 if the fuse holds. Wiring faults that do blow the fuse have both the battery and ground connections miswired, so if the ground connection appears at socket 6 of the cable connector the fault is not the cable wiring. Unplug the connecting cable and test socket 6 as described in paragraphs 8.19 through 8.21.

8.41 If ground is present at socket 6 verify that there is no continuity between socket 5 and ground when the fuse is removed. If any such continuity is present there is a short in the wiring that must be identified and removed. If ground is not present at socket 6 test the other cable leads to find the fault. After correcting the fault assure that all six cable leads are connected and repeat the pre-fuse test.

8.42 Having established that the wiring is correct suspicion falls on the M-164. To test this, swap connecting cables with another unit which is supplied from some other fuse. Observe which fuse now blows. If the other fuse blows, replace the suspect M-164.

H. Fuse Holds

8.43 Go off-hook with the test phone at the linefinder test jack and verify that dial tone is connected. If dial tone is not connected and the installation passed the pre-fuse test, the M-164 is faulty and must be replaced. If dial tone is connected, flash the hookswitch and verify that dial tone breaks. Go to paragraph 8.47 if the dial tone breaks.

8.44 If the dial tone did not break and the installation passed the pre-fuse test, the unit is probably faulty. However, to assure that there is no wiring error unplug the

connecting cable and verify that battery is present on socket 5 of the cable connector. Leave the fuse installed.

8.45 To disconnect the miniature rectangular cable connector, pry downward with a screwdriver blade slipped between the housing and one of the ears on the ends of the connector. Locate socket 5 at the corner of the connector as shown in sheet one of figure 20. The diagram of the connector pins on the label of the unit correctly identifies the pins of the connector on the unit. The sockets of the cable connector, however, are the mirror image of the label diagram when testing the assembled cable.

8.46 Connect the positive side of a voltmeter to ground and the negative side to socket 5 of the connector. The meter should indicate full battery voltage. As the sockets in the connector are quite small, extending the meter probe with a short length of unstranded hook-up wire may be required. If battery is present at socket 5, the M-164 is faulty and must be replaced. Before replacing the M-164 check the cable and connected wiring for shorts or other faults. Verify that battery is present on sockets 1 and 5. Then assure it is not present on any other socket. Verify that ground is present on sockets 2 and 6 and not present on sockets 3 and 4. If battery is not present at socket 5 test the other leads and make any corrections required. Then assure that all six cable leads are connected and repeat the pre-fuse test.

I. Flashing Hookswitch Breaks Dial Tone

8.47 Go off-hook with a rotary dial test phone at the linefinder test jack. Place a rotary dialed call to a station which will return Answer Supervision. If the call can be successfully completed try the same thing with a DTMF test phone. In most cases the fault is that DTMF tones cannot complete a call or often can't break dial tone.

8.48 If a rotary dialed call cannot be completed it usually indicates that, somehow, the converter has been wired to two selectors or two linefinders or both. Depending on the type of supervision in the

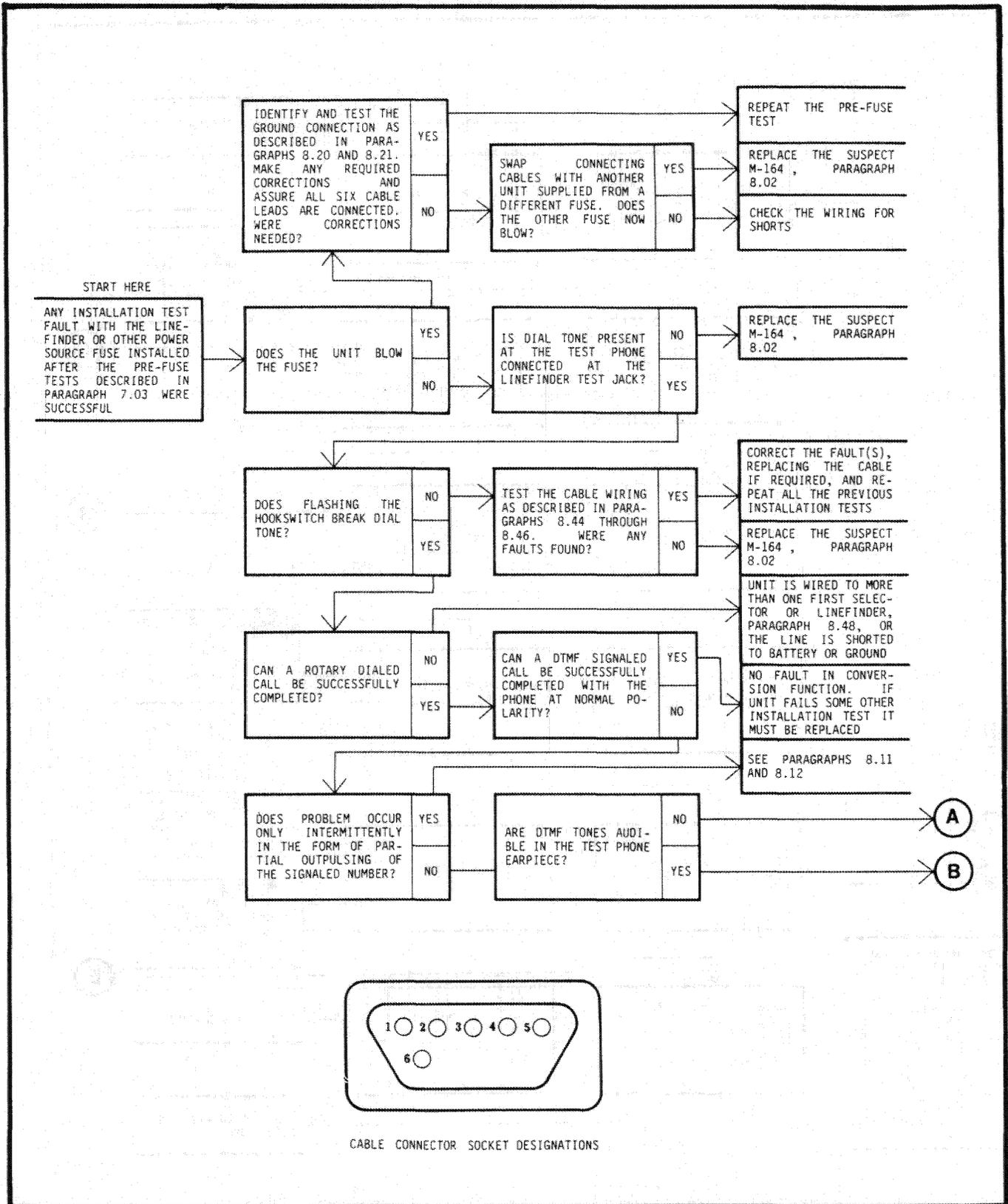


Figure 20 Installation Test Post-Fuse Faults (Sheet 1 of 4)

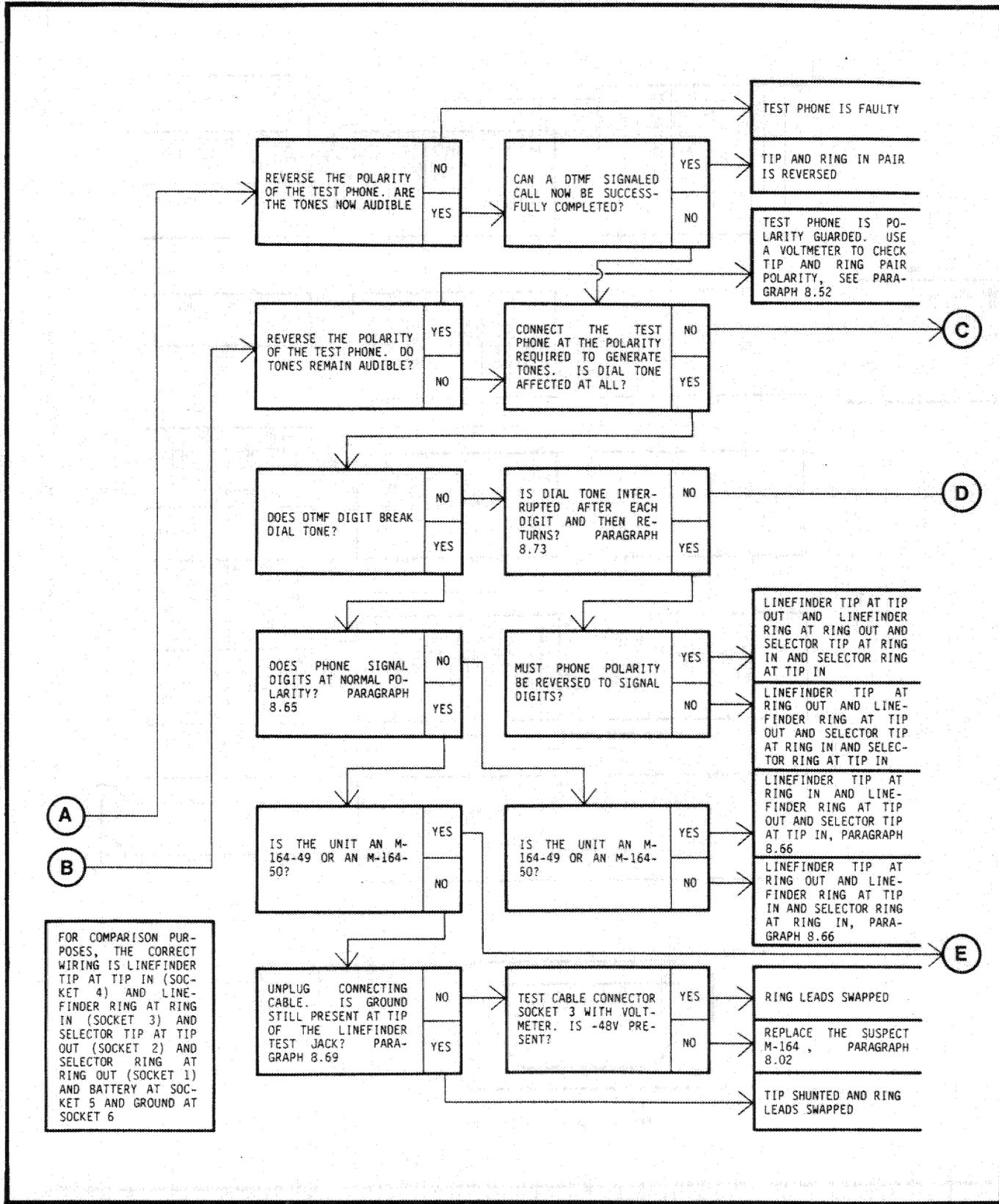


Figure 20 (Sheet 2 of 4)

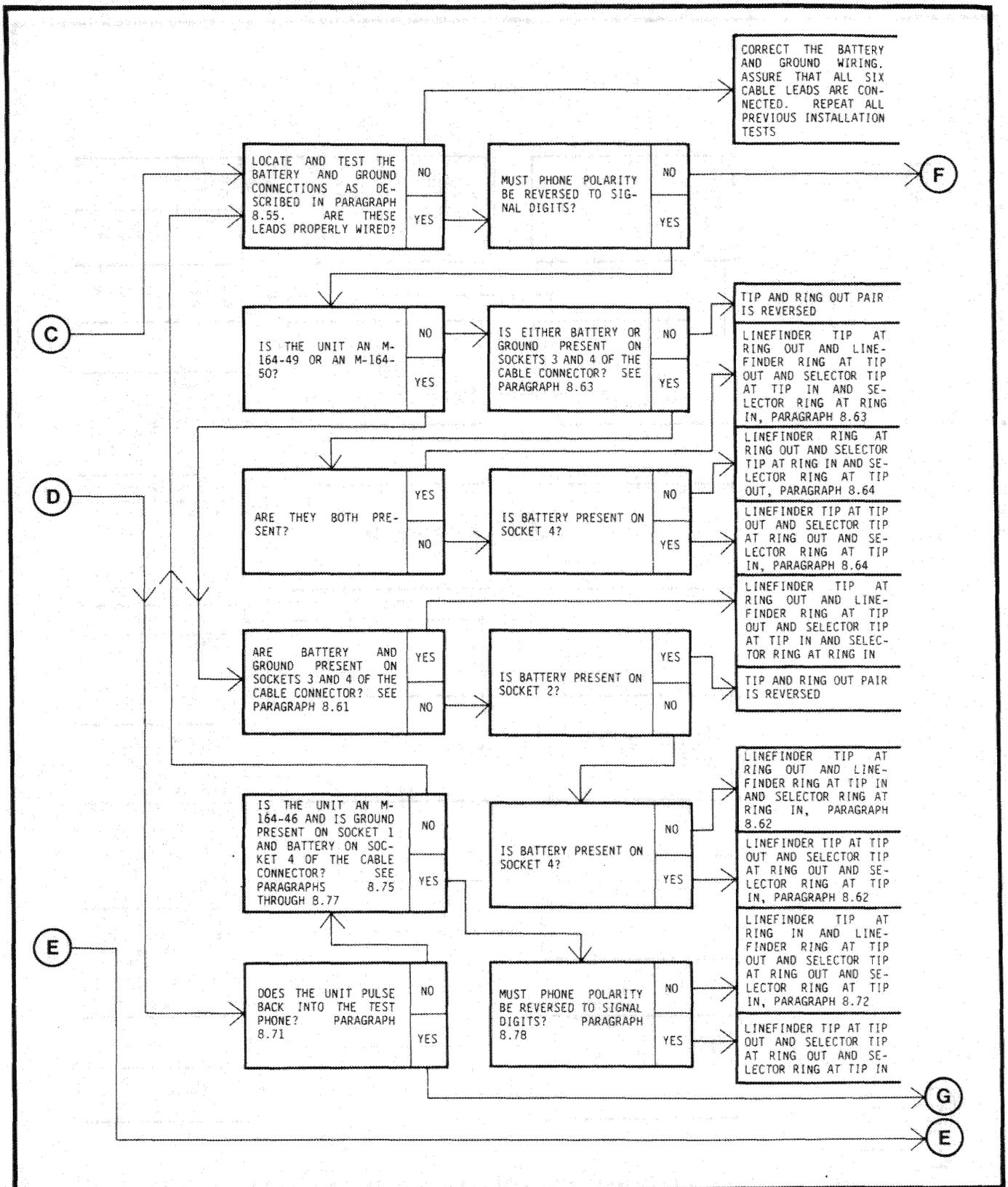


Figure 20 (Sheet 3 of 4)

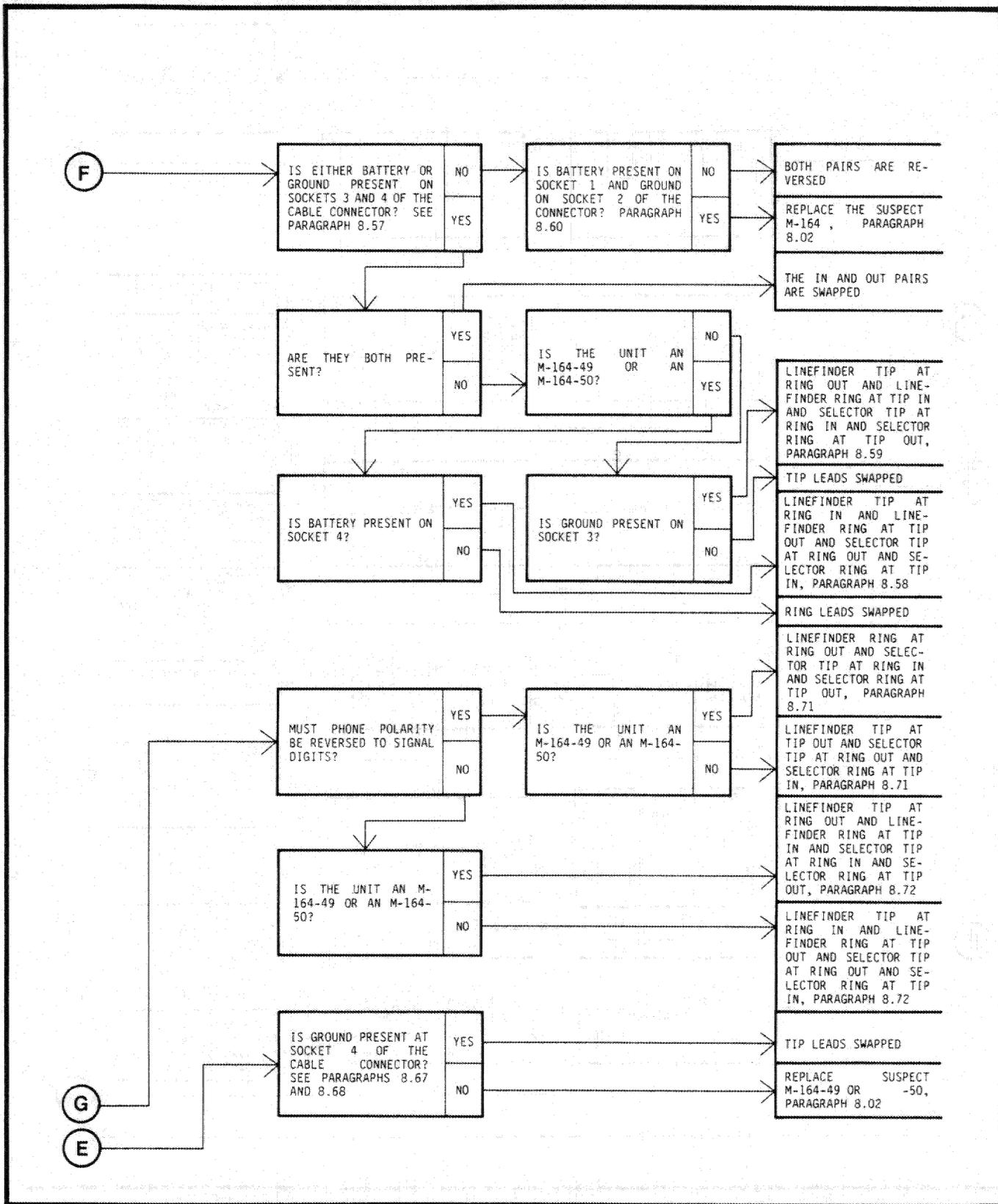


Figure 20 (Sheet 4 of 4)

office, this may cause the phone to go dead after the last digit is dialed, or reorder tone to be connected, or dial tone to be returned, or some combination of those results. In any case, a rotary call definitely cannot be completed. Similar symptoms, particularly the phone going dead after the last digit of the number, result if there is a short to battery or ground on either side of the line.

8.49 If a DTMF signaled call can be successfully completed there is no fault in the conversion function of the installation. If the fault was failure of an installation test later in the procedure than that, the unit must be replaced (see paragraph 8.02). If a DTMF signaled call cannot be completed and a rotary dialed call can, note exactly what is happening when the DTMF buttons are pressed. First, can DTMF tones be heard in the earpiece of the test phone when a button is pressed?

8.50 If tones cannot be heard, reverse the polarity of the phone's connection to the linefinder test jack and try again. If the phone doesn't generate tones at either polarity it is faulty. If the phone generates tones only when the polarity is reversed there is a fault. It is worth attempting to complete a call at this point. If the call goes through it indicates the Tip and Ring connecting cable leads to the linefinder jack are reversed and that is the only fault. If the call is not completed, further observations are required as described in paragraph 8.53.

8.51 Since identifying the polarity of the Tip and Ring pair at the linefinder test jack is a major diagnostic aid, if the phone generated tones at the proper polarity, reverse the polarity and assure the phone does not then generate tones. If the phone generates tones at either polarity it is polarity guarded and the polarity must be checked with a voltmeter.

8.52 To check the polarity of the linefinder test jack with a meter, leave the test phone connected and go off-hook. Connect the positive side of the voltmeter to ground. If the polarity is correct, the Ring

terminal will be more negative than the Tip terminal. If it is reversed the Tip terminal will be the more negative. Note which condition exists and proceed with the observations as described in the following paragraphs.

J. Test for Active Symptoms

8.53 Connect the test phone at whichever polarity is required to generate tones. Go off-hook, get dial tone, signal any numerical digit, and note what effect the digit has on the dial tone, if any. If the unit is an M-164-41 or -42, switch S1-2 should be ON to assure the validity of this observation. Identify which of the following four symptoms occur when a DTMF digit is signaled and the button is let up: the dial tone breaks but the call does not go through; the unit pulses the digit back into the test phone; the dial tone is briefly interrupted and returns; the dial tone is not affected at all.

8.54 If the dial tone breaks, go to paragraph 8.65. If the unit pulses back to the test phone, go to paragraph 8.71. If the dial tone is only interrupted, go to paragraph 8.73. If the digit does not affect dial tone at all, proceed as described in the following paragraphs.

K. Dial Tone Not Affected

8.55 Initial suspicion falls on the power supply connections when DTMF digits have no affect on dial tone. Remove the supplying fuse and unplug the connecting cable from the M-164. To disconnect the miniature rectangular cable connector, pry downward with a screwdriver blade slipped between the housing and one of the ears on the ends of the connector. With an ohmmeter verify that continuity is present between socket 6 of the cable connector and the terminal to which the red cable lead is connected. Since the sockets are quite small, extending the meter probe with a short length of hook-up wire may be required. Locate socket 6 by the inserted figure on sheet one of figure 20 rather than the label on the unit. Also test for continuity between socket 5 of the connector and the terminal to which the white cable lead is connected. If either of

these continuities is not present, correct the cable wiring. If both continuities are present, install the fuse and verify that the white cable wire is connected to -48 volt battery and the red cable wire is connected to ground. If not, correct the wiring, assure all six cable leads are connected, and repeat the tests and observations. If the power connections appear satisfactory, assure there are no shunts in the wiring by leaving the cable disconnected and testing at the linefinder test jack with the meter that neither battery or ground are present on the Tip or Ring terminals.

8.56 With confidence established that the power connections are correct the next step depends on whether the Tip and Ring polarity at the linefinder test jack is correct or reversed. If the polarity is reversed and the converter is an M-164-49 or -50, go to paragraph 8.61. If the polarity is reversed and the converter is an M-164-41, -42, or -46, go to paragraph 8.63. If the polarity was correct, proceed as described in the following paragraphs.

8.57 With a voltmeter test for both battery and ground on both sockets 3 and 4 of the cable connector. If either is present there is a misplaced Tip or Ring connection from the selector. If they are both present the IN and OUT pairs have been swapped: the cable leads that should have been connected to Tip and Ring of the selector have been connected to Tip and Ring of the linefinder and vice versa. If neither is present go to paragraph 8.60.

8.58 If just one or the other is present the next test depends on which configuration of the M-164 is being tested. If the converter is either an M-164-41, -42, or -46, go to paragraph 8.59. If the converter is an M-164-49 or -50, proceed as described here. The results of the previous tests and observations indicate that one of two wiring faults exists. These can be distinguished by testing for battery, actually selector Ring, on socket 4 of the cable connector. The absence of battery indicates that the Ring leads are swapped. If the battery is present the

following condition exists: the Tip IN socket of the cable connector is wired to selector Ring, the Ring IN socket is wired to linefinder Tip, the Tip OUT socket is wired to linefinder Ring, and the Ring OUT socket is wired to selector Tip.

8.59 The results of the previous tests and the absence of one of the indications on sockets 3 and 4 when the converter is an M-164-41, -42, or -46 suggests that one of two wiring faults exists. They can be distinguished by testing for ground, actually selector Tip, at socket 3 of the connector. The absence of ground indicates the Tip leads are swapped. Presence of ground on socket 3 indicates the following condition: the Tip IN socket of the cable connector is wired to linefinder Ring, the Ring IN socket is wired to selector Tip, the Tip OUT socket is wired to selector Ring, and the Ring OUT socket is wired to linefinder Tip.

8.60 If neither a battery or ground indication was present on sockets 3 or 4, test for battery on socket 1 and ground on socket 2 of the connector. These indications demonstrate the leads to the selector are correctly wired. The previous tests and observations therefore indicate the M-164 is faulty and must be replaced. The same previous observations indicate the polarity on these sockets will be reversed if not correct and that both Tip and Ring pairs are reversed. That is, Ring is connected where Tip should be and vice versa in both the IN and OUT pairs.

8.61 Test the installation as described here if the power connections were correct, the polarity at the linefinder was reversed, and the unit is an M-164-49 or -50. Test cable connector sockets 3 and 4 for both battery and ground. If both indications are present the following condition exists: the Tip IN socket of the connector is wired to selector Tip, the Ring IN socket is wired to selector Ring, the Tip OUT socket is wired to linefinder Ring, and the Ring OUT socket is wired to linefinder Tip.

8.62 If both battery and ground are not present on sockets 3 and 4, test for battery on socket 2. If battery is present on socket 2 then the previous tests results combine to indicate that the Tip and Ring OUT pair to the selector is reversed. The absence of battery at socket 2 leaves two possible faults which can be distinguished by testing for battery at socket 4. If battery, actually selector Ring, is present at socket 4 the following condition exists: the Tip IN socket of the cable connector is wired to selector Ring, the Tip OUT socket is wired to linefinder Tip, and the Ring OUT socket is wired to selector Tip. If battery is not present on socket 4: the Tip IN socket of the connector is wired to linefinder Ring, the Ring IN socket is wired to selector Ring, and the Ring OUT socket is wired to linefinder Tip.

8.63 Test the installation as described here if the power lead connections were correct, the polarity at the linefinder was reversed, and the unit being tested is an M-164-41, -42, or -46. Test cable connector sockets 3 and 4 for both battery and ground. If neither indication is present the previous observations point to the Tip and Ring OUT pair being reversed, the leads to the selector. If both indications are present the fault is that: the Tip IN socket of the connector is wired to selector Tip, the Ring IN socket is wired to selector Ring, the Tip OUT socket is wired to linefinder Ring, and the Ring OUT socket is wired to linefinder Tip.

8.64 The absence of one of the indications on sockets 3 and 4 in combination with the previous tests indicates one of two wiring faults, both of which involve three wires, is present. Identify which by testing for battery on socket 4. Presence of battery indicates that: the Tip IN socket of the cable connector is wired to selector Ring, the Tip OUT socket is wired to linefinder Tip, and the Ring OUT socket is wired to selector Tip. Absence of battery at socket 4 indicates that: the Ring IN socket of the connector is wired to selector Tip, the Tip OUT socket is wired to selector Ring, and the Ring OUT socket is wired to linefinder Ring.

L. DTMF Digit Breaks Dial Tone

8.65 Isolate the fault as described in the following paragraphs if DTMF digits break dial tone but do not complete the call while rotary dialed digits do complete a call. This can be caused by a defective converter or one of several wiring faults which vary depending on the unit configuration. In the case of wiring faults, any of several things may be occurring when the converter splits the line. Loop current to the selector may be broken, or loop current to the converter's loop current sense circuit may cease, or splitting the line may create a reversal that the converter sees as Answer Supervision.

8.66 If the digits were signaled with the phone at normal polarity go to paragraph 8.67. If the digits could be signaled only when the phone polarity was reversed and the converter is an M-164-49 or -50 the problem is that: the Tip IN socket of the connecting cable is wired to Tip of the selector, the Ring IN socket is wired to linefinder Tip, and the Tip OUT socket is wired to linefinder Ring. If the test phone polarity had to be reversed to signal the digits and the converter is an M-164-41, -42, or -46 the problem is that: the Tip IN socket of the connector is wired to linefinder Ring, the Ring IN socket of the connector is wired to selector Ring, and the Ring OUT socket is wired to linefinder Tip.

8.67 If the dial tone was broken by digits signaled at normal polarity and the converter is an M-164-49 or -50, test for ground at connector cable socket 4 as described here. If the converter is an M-164-41, -42, or -46 go to paragraph 8.69. To disconnect the miniature rectangular cable connector, pry downward with a screwdriver blade slipped between the housing and one of the ears on the ends of the connector. Locate socket 4 on the connector as shown on sheet one of figure 20. The diagram of the connector pins on the label of the unit correctly identifies the pins of the connector on the unit. The sockets of the cable connector, however, are the mirror image of the label diagram.

8.68 Connect the negative side of a voltmeter to the battery bus and the positive side to socket 4 of the connector. As the connector sockets are quite small, extending the meter probe with a short length of solid hook-up wire may be required. If ground, actually selector Tip, is present a full battery deflection will be observed on the meter. This deflection, in consideration of the previous observations, indicates the Tip leads are swapped. The absence of the ground indicates the M-164-49 or -50 is faulty and must be replaced.

8.69 If the unit discussed in paragraph 8.67 is an M-164-41, -42, or -46, proceed as described here. Unplug the connecting cable and test for ground at Tip of the linefinder test jack. See the preceding paragraph for the required particulars of this process. Presence of the ground indicates that the Tip side of the line is shunted around the converter installation and that the Ring leads are swapped.

8.70 In the absence of ground at the linefinder test jack, test for battery at socket 3 of the cable connector. Presence of this battery, actually Selector Ring, indicates the Ring leads are swapped. Absence of this battery, in consideration of the previous tests, indicates the M-164 is faulty and must be replaced (see paragraph 8.02).

M. Unit Pulses Into Test Phone

8.71 Proceed to isolate the fault as described here if the converter pulses back into the test phone when a DTMF digit is signaled. If the phone polarity had to be reversed to signal the digits or the voltmeter test indicates that polarity is reversed at the linefinder test jack, go to the next paragraph. If polarity was normal and the unit is an M-164-49 or -50 the problem is that: the Tip IN socket of the connecting cable is wired to linefinder Ring, the Ring IN socket is wired to selector Tip, the Tip OUT socket is wired to selector Ring, and the Ring OUT socket is wired to linefinder Tip. If the unit is an M-164-41, -42, or -46 the fault is that: the Tip IN socket of the cable connector is wired to selector Ring, the Ring IN socket is wired

to linefinder Tip, the Tip OUT socket is wired to linefinder Ring, and the Ring OUT socket is wired to selector Tip.

8.72 If the polarity at the linefinder is reversed and the unit is an M-164-49 or -50 the fault is that: the Ring IN socket of the cable connector is wired to selector Tip, the Tip OUT socket is wired to selector Ring, and the Ring OUT socket is wired to linefinder Ring. If the converter is an M-164-41, -42, or -46 the fault is that: the Tip IN socket of the cable connector is wired to selector Ring, the Tip OUT socket is wired to linefinder Tip, and the Ring OUT socket is wired to selector Tip.

N. Dial Tone Interrupted

8.73 Proceed to isolate the fault as described here if the dial tone is cut off after the digit button is let up and then returns. The interruption is quite perceptible and varies in length as different digits are signaled and the interruption follows every digit unless the unit has timed out or otherwise been inhibited. This symptom indicates one of two wiring faults as described in the next paragraph. If the converter is an M-164-46 some ambiguity may develop whether an interruption is occurring as it can be very brief and occurs only after the first digit signaled after going off-hook. This may indicate other wiring faults, but they are hard to distinguish from cases not affecting dial tone at all. If such uncertainty is the case, go to paragraph 8.75.

8.74 The two wiring faults that clearly cause an interruption of dial tone are identified by the polarity at the linefinder test jack. If the digits were signaled with the phone at normal polarity, the following condition exists: the Tip IN socket of the cable connector is wired to selector Ring, the Ring IN socket is wired to selector Tip, the Tip OUT socket is wired to linefinder Ring, and the Ring OUT socket is wired to linefinder Tip. If the digits were signaled with the phone's polarity reversed, the fault is that: the Tip IN socket of the cable connector is wired to selector Ring, the Ring IN socket is wired to selector Tip, the Tip OUT socket is

wired to linefinder Tip, and the Ring OUT socket is wired to linefinder Ring.

8.75 If the converter is an M-164-46 and uncertainty is present whether dial tone is being interrupted, test for ground on socket 1 and battery on socket 4 of the cable connector with a voltmeter. Remove the fuse supplying power to the converter. If both these indications are not present, the unit is not interrupting dial tone. In that case, go to paragraph 8.55. Make the test as described in the following paragraphs.

8.76 To disconnect the miniature rectangular cable connector, pry downward with a screwdriver blade slipped between the housing and one of the ears on the ends of the connector. Locate sockets 1 and 4 of the connector by referring to the diagram on sheet one of figure 20. Don't use the diagram on the label of the unit, it shows the pins of the connector on the unit. The cable connector sockets are the mirror image of the unit label. It may be necessary to extend the meter probe with a short length of solid hook-up wire as the connector sockets are quite small. It isn't called a miniature connector for nothing.

8.77 Connect the positive side of the meter to ground and the negative side to socket 4. Note the meter indication. Connect the negative side of the meter to battery (at this stage, installing the power supply fuse won't invalidate the test) and the positive side to socket 1. If full battery deflection is observed for both tests identify the wiring faults as described in the next paragraph. If not, go to paragraph 8.55.

8.78 Having established that the M-164-46 is interrupting the dial tone, which of the two wiring faults exists is distinguished by the polarity at the linefinder test jack. If linefinder polarity is correct the fault is that: the Tip IN socket of the cable's connector is wired to selector ring, the Ring IN socket is wired to linefinder Tip, the Tip OUT socket is wired to linefinder Ring, and the Ring OUT socket is wired to selector Tip. If the linefinder polarity is reversed the problem is

that: the Tip IN socket of the cable connector is wired to selector Ring, the Tip OUT socket is wired to linefinder Tip, and the Ring OUT socket is wired to selector Tip.

8.79 After correcting any of the wiring or converter faults identified in the preceding paragraphs, always repeat the installation tests to both verify the correction and to protect against multiple faults. The procedure is designed to detect multiple faults by going through it again until all the installation tests are passed.

9. SPECIFICATIONS

To simplify these specifications many of them are given as minimum and maximum quantities in the excursion direction believed to be of most concern to the reader. The qualifiers minimum and maximum are understood to indicate, respectively, that the associated numerical quantity will not be less than or will not exceed the number given. When applied to temporal input signal requirements, the minimums given only imply that the signal in question may not be detected in less time than the specification and to assure detection the signal must persist for at least the duration stated.

Input Impedance	
(tone receiver)	75K ohms minimum, AC coupled
Input DTMF Signal Requirements	
Signal level (per frequency)	-22 to +6 dBm (0.062 to 1.55 VRMS), see note 1
Tone accept bandwidth	+1.5% + 2 Hz -1.5% -2 Hz
Tone reject bandwidth	±2.5%
Signal duration	40 ms minimum
Input interdigital time	40 ms minimum

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Amplitude difference (twist), high frequency relative to low frequency	+6 dB maximum -8 dB maximum, see note 2	Blanking of dial pulse recognition after off-hook (M-164-41 and -42)	2 seconds minimum
Precise Dial Tone tolerance	-12 dBm per tone maximum (0.0194 VRMS), see note 1	Answer Supervision recognition (M-164-41 and -42)	210 ms minimum
Noise tolerance (C-message weighted)	-22 dB, see note 3	Answer supervision recognition (M-164-49 and -50 when line is restored)	200 ms minimum
Harmonic tolerance	-28 dB, see note 4	Optional answer supervision recognition (M-164-46 only)	50 ms minimum
Difference frequency tolerance	-18 dB, see note 4	On-hook recognition	200 ms minimum
DTMF blanking after off-hook	130 ms minimum		
Register Capacity	20 digits, see note 5		
Interface Characteristics			
Allowable loop resistance	2K ohms maximum	Output Signaling	
Insertion loss	0.1 dB maximum	Pulse rate	10 ± 0.5 PPS
Longitudinal balance with 30 ma of loop current		Pulse ratio	61.5% to 65.5% break
talk-through	60 dB minimum at 1000 Hz	Outpulse interdigital time (M-164-41, -42, -49, and -50)	710 ms minimum 760 ms maximum
signaling during line split	50 dB minimum at 1000 Hz	Optional outpulse interdigital time (M-164-46 only)	610 ms minimum 660 ms maximum
Loop current recognition	7 ma minimum	Outpulse loop resistance	300 ohms ±10%
ANI offset recognition	2700 ohms maximum, see note 6	Optional outpulse loop resistance (M-164-49 only)	150 ohms ±10%
ANI offset rejection	5400 ohms minimum	Optional outpulse loop resistance (M-164-50 only)	900 ohms ±10%
ANI offset forwarding	1500 ohms		
Input DC Signaling		Time Out Period	16 ± 1 seconds
Off-hook recognition	20 ms minimum		

Line Switching Characteristics

DTMF early line split (M-164-41 and -42 only, S1-2 must be OFF) within 16 ms of a valid DTMF signal

DTMF late line split (all units, on M-164-41 and -42 S1-2 is ON) within 40 ms of loss of DTMF tones

Line restoral time after the last break pulse of the most recently received digit 39 ± 4 ms

Power Requirements

Voltage -43 to -56 VDC

Optional voltage (M-164-49 only) -18 to -28 VDC

Current
idle or inhibited 40 ma maximum
enabled 80 ma maximum
outputing 180 ma maximum

Fusing requirement 1/3 ampere

Environmental Requirements

Temperature limits (up to 50% relative humidity and 700 to 800 mm Hg) 0° to 55° C

Relative humidity limits (at 0° to 55° C and 700 to 800 mm Hg for periods up to 72 hours) 0 to 85%

Mechanical shock 6 inch drop maximum

Vibration 1.5 g's maximum sinusoidal at 5.5 to 500 Hz

Specifications are subject to change without notice.

Note 1: Voltage levels stated in dBm are obtained using a standard voltmeter calibrated to provide a scaled voltage measurement in dBm for a 600 ohm impedance. No termination should be applied for this measurement.

Note 2: Combined level of random, difference, and harmonic noise components at least -40 dB below the lowest level DTMF component.

Note 3: Relative to lowest level DTMF component with DTMF test tones at centerband, twist ± 1 dB with combined harmonics and difference frequencies at -32 dB below lowest level DTMF component. For test covering the entire accept bandwidth the noise level tolerance is -40 dB relative to the lowest level DTMF component.

Note 4: Relative to lowest level DTMF component over entire accept bandwidth, twist at ± 1 dB and random noise at -32 dB below lowest level DTMF component. With DTMF test tones at centerband, the harmonic and difference frequency tolerance is -16.7 dB relative to the lowest level DTMF component.

Note 5: Digit register is recirculating such that any number of digits may be received and outputed as long as the backlog of received but not yet outputed digits does not exceed 20 digits.

Note 6: ANI offset specifications apply only to M-164-42 and -50 configurations.

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF CHEMISTRY

REPORT OF THE
COMMISSION ON THE
FUTURE OF THE
DEPARTMENT OF CHEMISTRY

1984-1985

CHICAGO, ILLINOIS
1985

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