

## M-168\* Tone Converter

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### 1. GENERAL

**1.01** This technical practice provides descriptions, ordering information, installation procedures, and troubleshooting steps for the TELTONE® M-168-02 TONE CONVERTER.

**1.02** This practice is reissued for the reasons listed in Part 10, REVISIONS.

**1.03** The installation and troubleshooting procedures in this practice are condensed into an Installer's Aid (Technical Practice 168-201). A copy of the Installer's Aid is packaged with each M-168-02 unit.

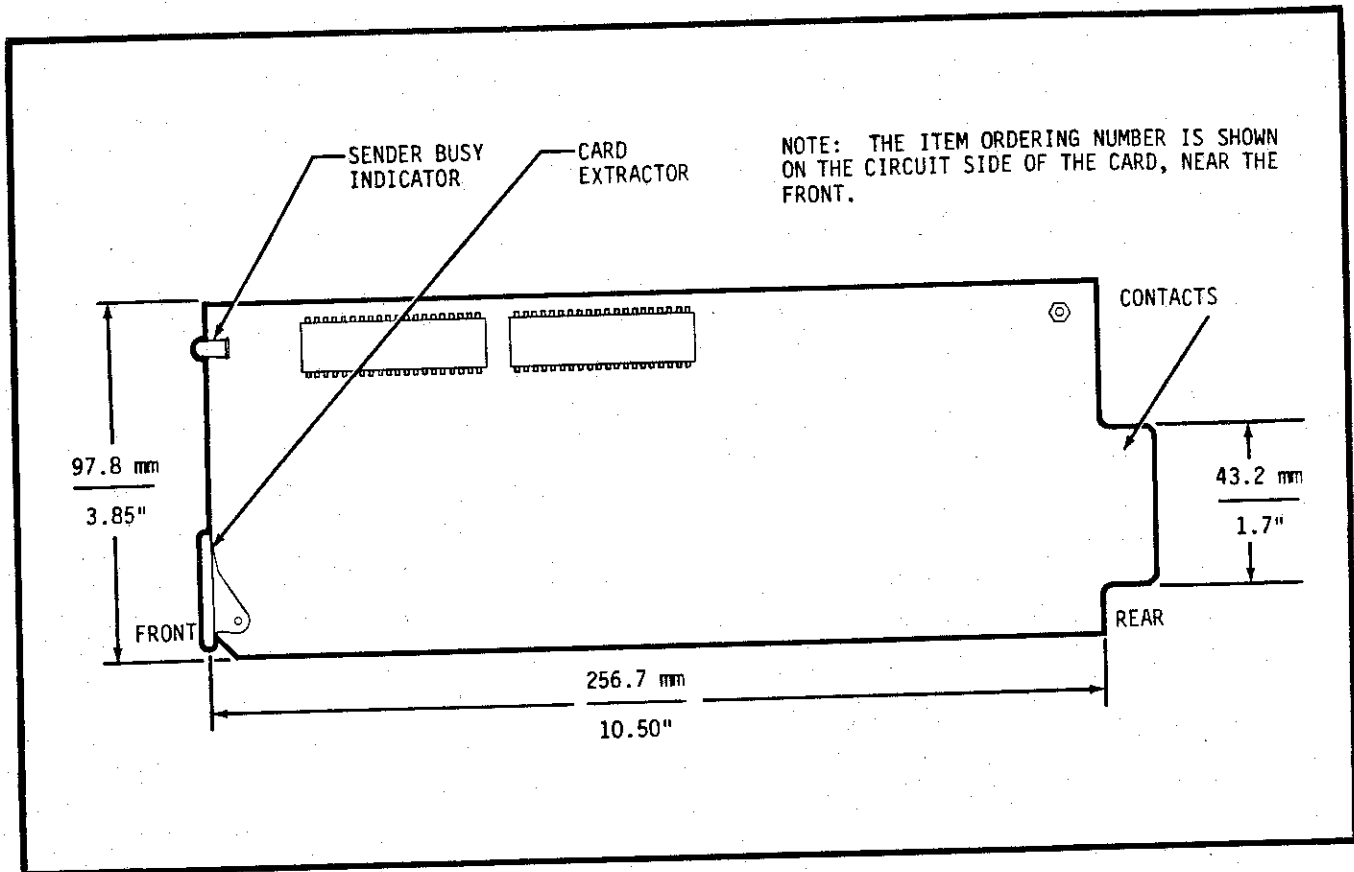


Figure 1 M-168 Circuit Card

## 2. CONCEPT

**2.01** The M-168 tone-to-pulse converter (see Figure 1) is a dedicated DTMF (Dual-Tone Multifrequency, TOUCH-TONE®) receiver circuit card that converts any keyed digit from one through zero to an equivalent train of rotary-dial type pulses. Packaging options provide a choice between relay rack mounting and mounting behind the linefinders. The unit is designed for direct control (step-by-step) central office conversions. To meet this application, the following features have been incorporated:

- Tip party identification (ANI) forwarding
- The SENDER BUSY indicator gives a visual indication of whether the unit is idle, enabled, inhibited, or outpulsing

- Dial pulse feedback gives the calling party an indication that his call is being processed
- Answer Supervision returns the unit to its idle condition
- The End of Dialing feature inhibits the converter from recognizing any digits following an \* or # character signal.

## 3. GENERAL DESCRIPTION

**3.01** Each M-168 circuit card includes all the circuitry necessary to convert one linefinder (see Figure 2). The unit operates on the same negative battery voltage supply as other telephone equipment.

**3.02** As shown in Figure 3, a DTMF digit pad signals a given digit with two out

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of seven available frequencies. The M-168 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. (The M-168 does not affect rotary dial calls.) The fixed interdigital time of the conversion decreases the total dialing time compared to a manually operated rotary dial instrument, and the precise break-to-make ratio improves switch operation.

#### A. Tone Receiver

**3.03** The tone receiver section of the M-168 is bridged across the Tip and Ring IN pair at all times. This input is filtered to separate the high group and low group DTMF frequencies, which are analyzed as a possible DTMF digit.

#### B. Time-Out Release

**3.04** The 16-second Time-Out Release timer starts timing upon detection of an off-hook and inhibits the converter at the end of its cycle. The timer is reset to zero by each succeeding DTMF digit. The M-168 does not respond to signals on the line after the Time-Out function has inhibited it, and the calling party must go on-hook and back off-hook before the M-168 unit will be enabled again. Time-Out Release will not inhibit the converter during outpulsing; however, if the timer completes its cycle during outpulsing, the unit is inhibited as soon as outpulsing ceases.

#### C. Dial Pulse Release

**3.05** The M-168 is inhibited when a caller signals rotary dial digits before any DTMF digits. Detection of loop current loss is time guarded after off-hook so that switching transients will not release the converter. If a DTMF digit is signaled first, the Dial Pulse Release does not operate and dial pulses will be ignored by the M-168.

#### D. Line Split Function

**3.06** For the M-168 to generate break pulses that will drive the forward switching equipment the line must be split. This is accomplished when 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 during line split so the subscriber's telephone and the equipment in between still have loop current. Prior to line split, the pulsing circuits are bridged across the Tip and Ring pair through resistors. During line split the pulsing circuit is connected in series (still through resistors) with the Tip and Ring OUT pair so that opening and closing the pulsing circuit (i.e., outpulsing), results in makes and breaks of loop current on Tip and Ring OUT.

**3.07** Line splitting is also necessary to prevent the digit being outpulsed from interfering with the signalling of DTMF digits. Each digit is entered into the memory of the M-168 as it is received. When all digits in the memory have been outpulsed, the line is restored. (When they are detected, answer supervision and on-hook conditions restore the line whether or not all digits in the memory have been outpulsed.)

#### E. Answer Supervision Release

**3.08** A polarity reversal on Tip and Ring OUT disables the M-168 just as if an on-hook had been recognized. This prevents the unit from outpulsing after the **called** party answers, even if the **calling** party inadvertently signals extra digits. The detection of polarity reversals is time-guarded to prevent transient reversals from disabling the converter.

#### F. End of Dialing Feature

**3.09** The End of Dialing feature is used to facilitate DTMF end-to-end signalling. Digits keyed after an \* or # signal are not recognized or outpulsed by the M-168, but digits keyed prior to an \* or # are recognized and outpulsed.

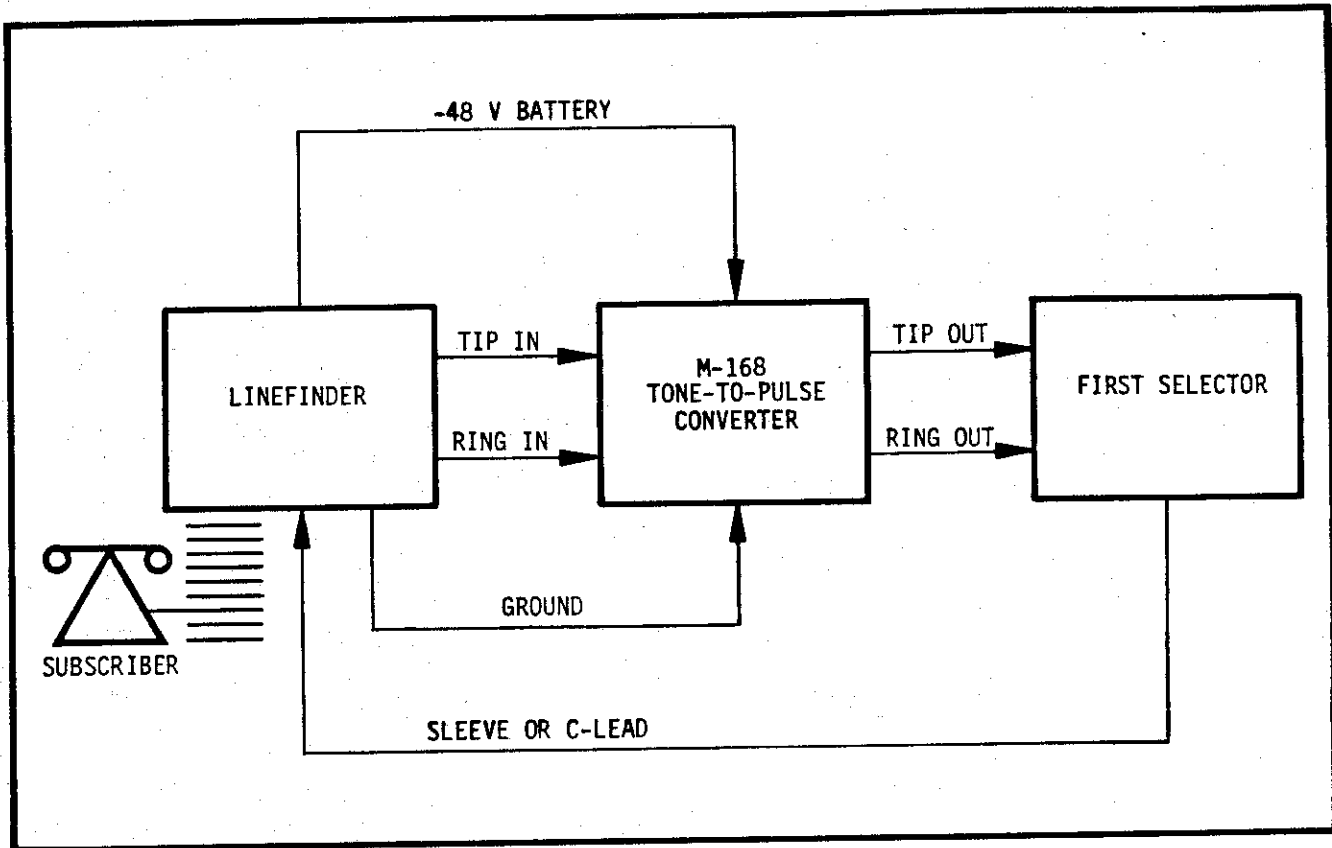


Figure 2 System Connections

DTMF CODE			
DIGIT	LOW FREQUENCY	HIGH FREQUENCY	
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	

GROUP OF HIGH 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	#

NOTE: \* AND # CHARACTERS ARE USED ONLY FOR THE END OF DIALING FEATURE; THEY ARE NOT OUT-PULSED.

Figure 3 DTMF Digit Buttons and Code

## **G. Dial Pulse Feedback**

**3.10** Outgoing pulses on Tip and Ring OUT are capacitively coupled back via Tip and Ring IN to the calling station. This provides the subscriber with an attenuated but audible indication that the call is being processed.

## **H. ANI Forwarding**

**3.11** The Tip Party Identification (ANI) forwarding circuit detects and forwards an impedance imbalance across the Tip and Ring IN pair while the line is split if the Tip party of a two-party line is the one off-hook. 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-168).

## **I. SENDER BUSY Indicator**

**3.12** The SENDER BUSY indicator lights when the converter is enabled. When the converter is outpulsing, the indicator blinks off as each break pulse is generated by the M-168. When the M-168 is inhibited the indicator blinks at a 20 Hz rate. Since the indicator is lighted steadily or blinking only when an off-hook condition exists, it also provides a visual indication of whether or not the line is in use.

## **4. ORDERING INFORMATION**

### **A. Circuit Cards**

**4.01** See Table 1. One M-168 Tone Converter (order number M-168-02) is needed for each linefinder to be converted.

**4.02** To assure the specified performance of the M-168, 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. Paragraphs 6.05 and 6.06 of this practice explain the dial tone requirements in more detail.

## **B. CF-168-31 Card File for Mounting Behind the Linefinders**

**4.03** Each CF-168-31 card file can house up to four converters, is specially designed for mounting behind linefinder banks (see Figures 4, 8, and 9) and has an insulative epoxy finish. Three screw holes are provided in the back plate of the CF-168-31 card file to allow wall mounting.

**4.04** The mounting adapters shown in Figure 5 are available for special mounting requirements as described in Table 1. The standard screw clamp brackets supplied with the housings can be attached to a bar up to 0.25 inch thick.

**4.05** Installations using the M-164-27 or M-168-41 mounting adapters described in Table 1 usually require only two for each two CF-168-31 card files, since only every other mounting bar on a given rack is a large structural member.

## **C. Card Files for Relay Rack Mounting**

**4.06** Card files are available for both 19 and 23-inch relay racks (see Figure 6). All relay rack card files come with a protective rear cover, have an insulative epoxy finish, and are provided with a flip-up tracing strip. All the relay rack card files have their battery connector pins and their ground connector pins strapped together in groups of five to facilitate installation.

**4.07** An adapter (order number M-168-43) is available to allow mounting 19-inch card files on 23-inch racks or 23-inch card files on 27-inch racks.

## **5. FUNCTIONAL DESCRIPTION**

**5.01** To assist maintenance and troubleshooting, this description follows a call as it is handled by the M-168 (see Figure 7).

Table 1 Ordering Information

ITEM ORDERING NUMBER	TONE CONVERTER
M-168-02	Tone Converter Circuit Card
	<b>M-168 PACKAGES</b>
M-168-34	Four M-168-02 Tone Converter Circuit Cards in one CF-168-31 card file for mounting behind the Linefinders.
M-168-30	Ten M-168-02 Tone Converter Circuit Cards in one CF-168-12 card File for 19-inch relay rack mounting.
M-168-32	Twelve M-168-02 Tone Converter Circuit Cards in one CF-168-22 Card File for 23-inch relay rack mounting.
	<b>CARD FILES AND ADAPTERS FOR MOUNTING BEHIND THE LINEFINDERS</b>
CF-168-31	Card file for mounting behind the Linefinders holds 4 converters, with connectors installed.
M-164-27	One box frame adapter plate with bolt and nut. Two M-164-27's are needed for each CF-168-31 Card File.
M-168-41	Two double angle frame adapter, 0.75-inch opening, mounting brackets and two 8-32 x 1/2 slotted hex-head machine screws. Provide for mounting one CF-168-31 onto a W.E. Co. double angle iron type linefinder frame.
M-168-42	Two extending adapter plates, and four slotted flat-head 4-40 x 1/4 machine screws. Provide for clearance of certain capacitor bolts on some Linefinders manufactured by W.E. Co.
	<b>RELAY RACK CARD FILES AND ADAPTERS</b>
CF-168-12	Card file for 19-inch rack, holds 20 converters, with connectors installed. Includes four mounting screws.
CF-168-22	Card file for 23-inch rack, holds 25 converters, with connectors installed. Includes four mounting screws.
M-168-43	One 19-inch to 23-inch or 23-inch to 27-inch mounting adapter. Two required for mounting 19-inch card files in 27-inch relay racks. Each adapter comes with two mounting screws.

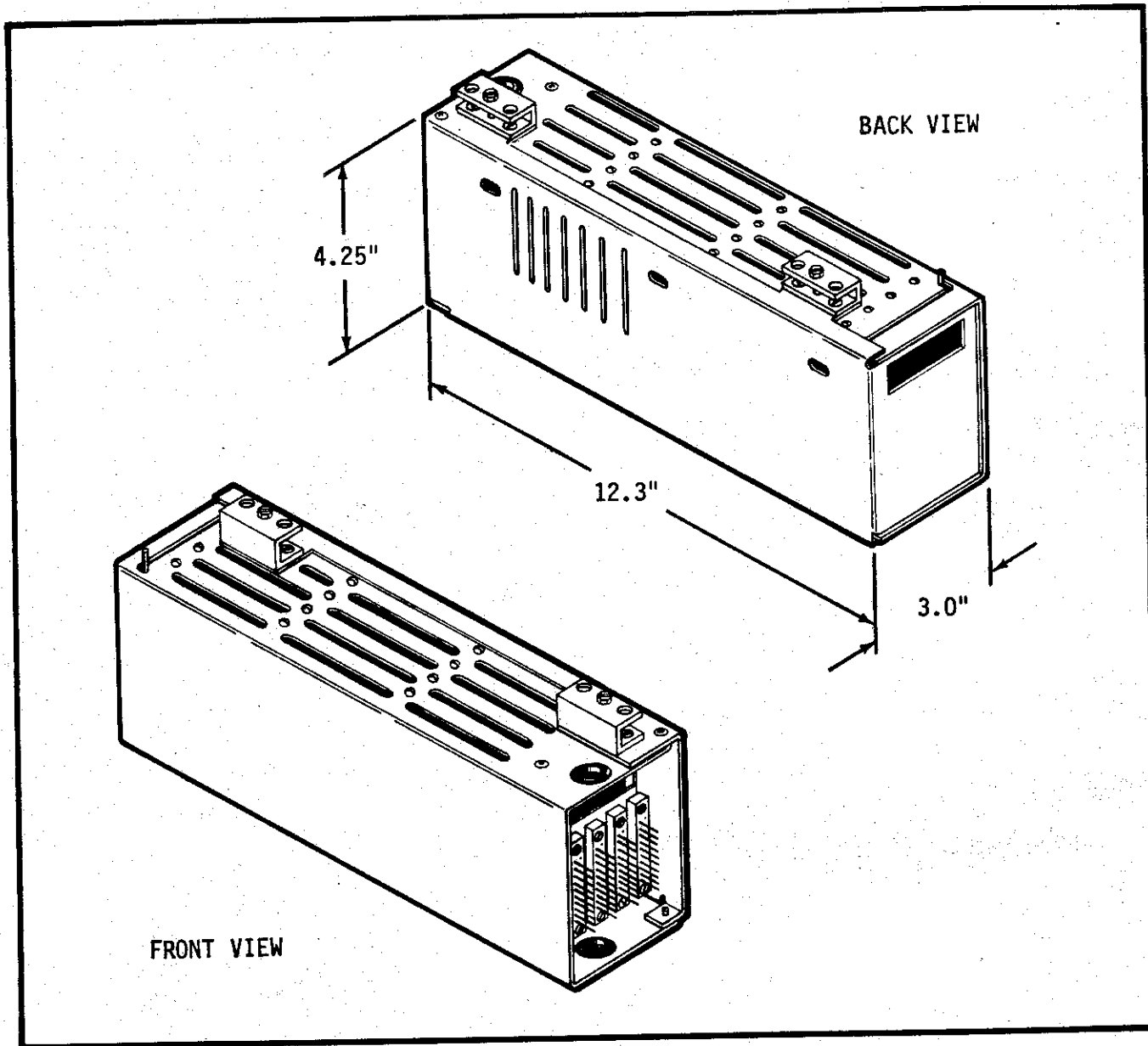


Figure 4 CF-168-31 Card File

#### 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 Filters.

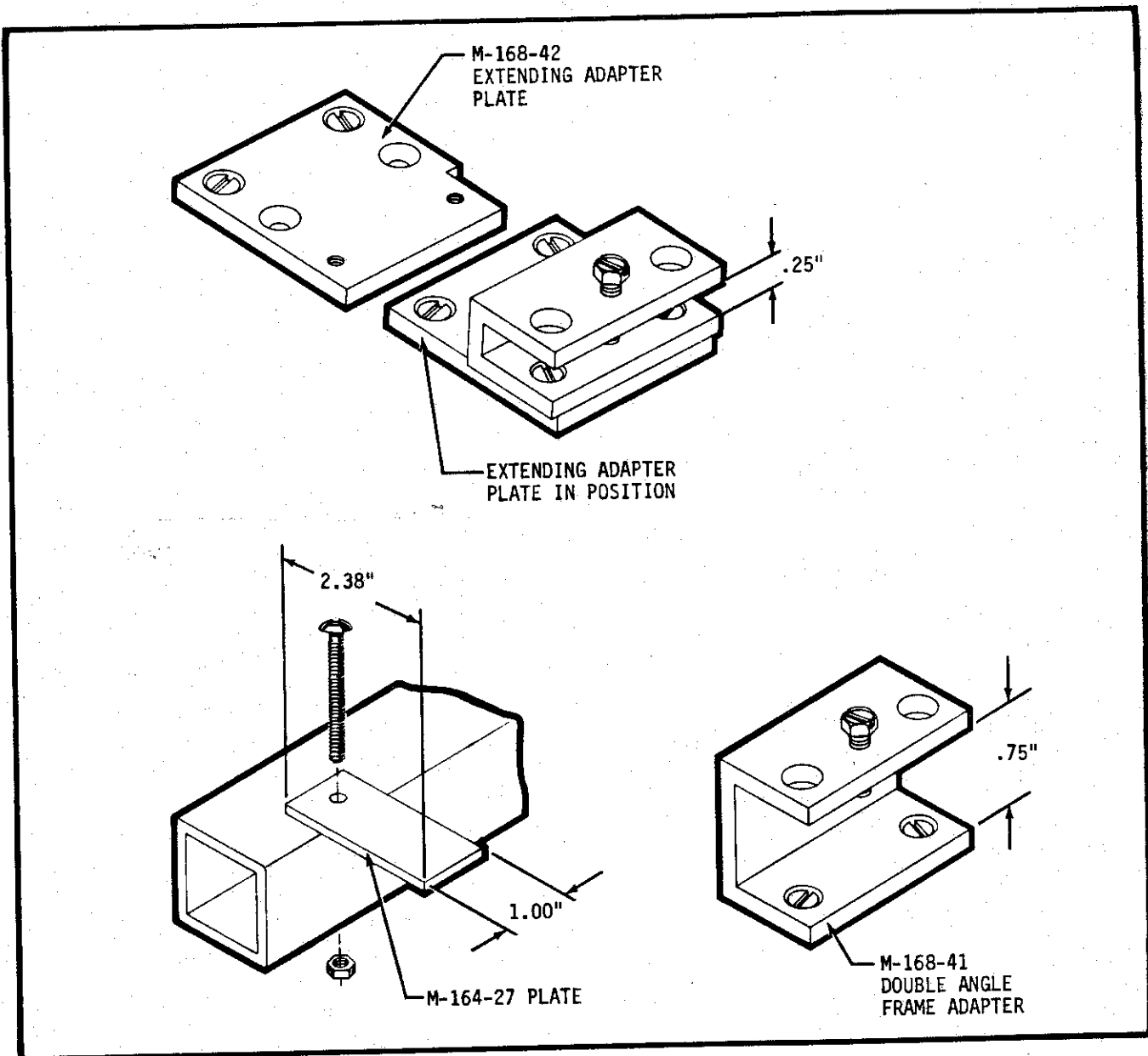
#### B. Enable Converter

**5.03** When the calling station goes off-hook and is connected to a line wired through an M-168, the Loop Current Detec-

tor on Ring IN detects forward loop current and gives an indication to the Logic Circuits. The converter is enabled to receive DTMF digits when forward loop current has persisted for 130 milliseconds (ms).

**5.04** Once enabled the M-168 may be inhibited by the occurrence of the End of Dialing Release, the Time-Out Release, or the Dial Pulse Release. The unit can then be enabled again only if it is first returned to the idle condition. It is returned to the idle





**Figure 5 M-168 Mounting Adapters**

condition, from either the enabled or inhibited condition, by recognizing either answer supervision (reversed loop current) or an on-hook condition.

### **C. DTMF Digit Conversion**

**5.05** 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 of the high and low

frequency groups, and they must persist simultaneously for 40 ms.

### **D. Line Split**

**5.06** See also Paragraphs 3.06 and 3.07. Before the line is split, battery feed voltage is supplied by the forward equipment (usually a first selector) connected to Tip and Ring OUT of the M-168. Dial tone is also connected from the forward equipment. When the incoming DTMF tones end, the line

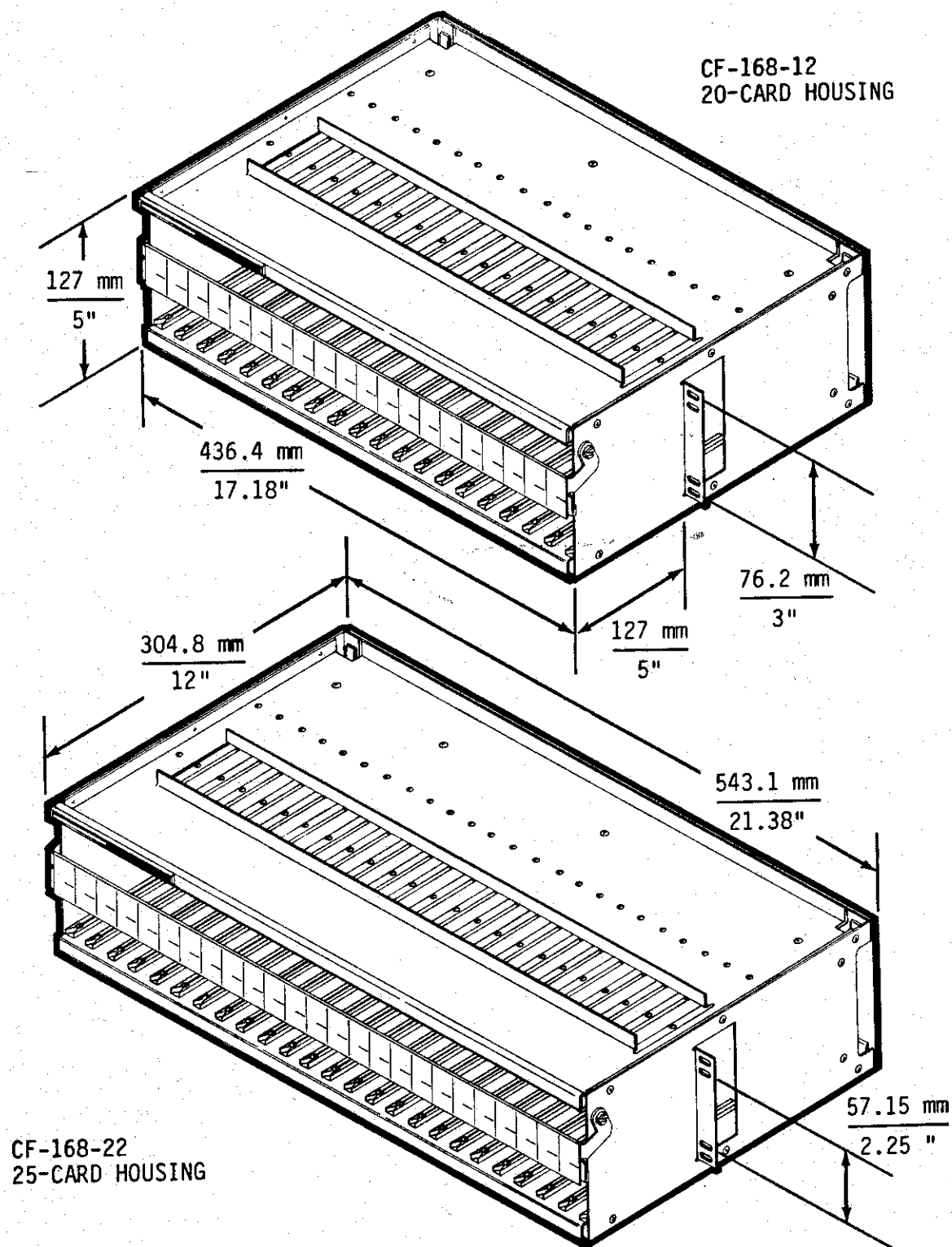


Figure 6 Relay Rack Card Files

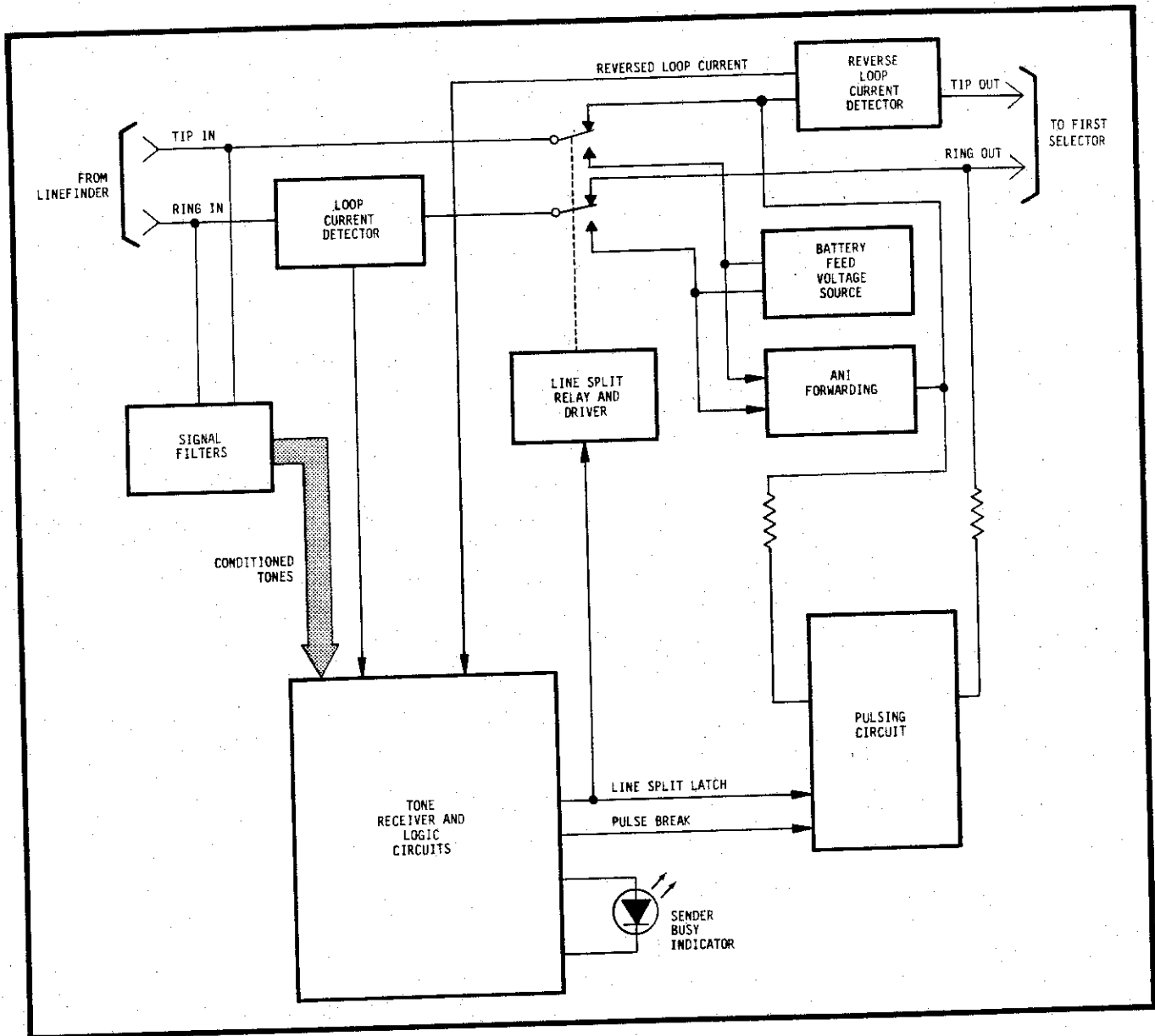


Figure 7 Simplified Block Diagram

is split for outpulsing. Dial tone is then cut off to the calling station, internal battery feed is supplied to the calling station, and the ANI forwarding feature is connected to the forward equipment. Pulses generated by the converter will then pulse the selector.

### E. Memory Function

**5.07** 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 cyclic so that any number of digits can be received and outpulsed provided the backlog of received-but-not-yet-outpulsed digits never exceeds 20.

### F. Outpulsing

**5.08** The rotary-dial type pulses are generated on Tip and Ring OUT by opening and closing the pulsing circuit under the

control and timing of the Logic Circuits. The line is held split during the interdigital time and is restored after the last pulse of the most recently received digit. If another digit is then received, its outpulsing will not start until 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.

### G. On-Hook/Off-Hook Logic

**5.09** The converter is enabled at the start of the call (when the calling party goes off-hook) and it returns to the idle condition when the calling party goes on-hook or the called party goes off-hook. A loss of loop current for over 210 ms, at Ring IN, is considered an on-hook. Thus, if the calling subscriber misdials and goes on-hook before outpulsing is completed, the outpulsing stops and the M-168 is returned to the idle condition.

## 6. INSTALLATION PROCEDURES

### GENERAL

**6.01** Prior to installation of the M-168, the equipment being converted should be fully tested for rotary dial operation. Table 2 is a checklist of the installation steps for each M-168 card.

**6.02** Inspect 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 to Table 1 of this practice to assure the correct items have been received. The item ordering numbers of the M-168 circuit cards are stamped on their circuit sides (see Figure 1).

**6.03** Avoid directly touching the components or circuit traces. Handling the cards by the edges or the extractors is recommended. Cards shipped individually are packaged in special electrically conductive bags. They should be kept in these bags until they are installed.

**6.04** The best procedure is to complete all wiring and test it before installing the circuit card. Installing and testing the wiring for one circuit card at a time will help to avoid repeated wiring errors.

### DIAL TONE REQUIREMENTS

**6.05** Precise Dial Tone is preferred for M-168 installations. M-168 units may operate successfully with other dial tones. The M-168 is designed to perform as specified with -13 dBm (0.173 VRMS) per frequency of Precise Dial Tone: pure tones of 350 Hz plus 440 Hz  $\pm 0.5$  percent and no more than  $\pm 3$  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.)

**6.06** The surest procedure is to install a Precise Dial Tone supply like a TELTONE M-904 Precise Dial Tone Generator before installing the M-168's. If Precise Dial Tone is not available the M-168's should be thoroughly tested to assure their adequate performance.

### INSTALLATION USING CF-168-31 CARD FILES

#### A. Mount the CF-168-31 Card File

**6.07** In the most common application, the CF-168-31 card file is mounted just above the linefinder cable trough (see Figure 8), but the units can be hung on almost any horizontal bar. The card file is secured to the bar by tightening the clamp screw at the top with a wrench such as a W.E. #417 relay tool or a screwdriver.

**6.08** Beginning at the left end of the linefinder rack (as you face it from the back side), mount, wire and test one card file and its cards. Leave about four inches of space, mount the next card file, wire it, and so forth. Mounting and wiring the files in this way will assure sufficient space to use wire wrap tools. Go on to Paragraph 6.12 if mounting adapters are not required.

**Table 2 Installation Checklist**

- |  |                          |
|--|--------------------------|
| 1. Line to be converted has been tested for proper rotary dial operation.  | <input type="checkbox"/> |
| 2. Correct equipment has been received.  | <input type="checkbox"/> |
| 3. Precise Dial Tone or Standard Dial Tone on lines being converted.   | <input type="checkbox"/> |
| 4. Mount card file(s), leaving air spaces between relay rack card files as required.   | <input type="checkbox"/> |
| 5. Busy out the equipment to be converted.   | <input type="checkbox"/> |
| 6. Remove the power fuse.  | <input type="checkbox"/> |
| 7. Circuit card is not installed. Connect twisted pairs of battery and ground leads from the power fuse to the card connector terminals. Battery (-48 volts) goes to terminal 2 (bottom). Ground connects to terminal 12 (sixth one up from bottom), see Figure 10. (Card connectors on relay rack card files may be strapped together for battery and ground in groups of up to five for each 1-1/3 ampere fuse.) | <input type="checkbox"/> |
| 8. Install the fuses and check polarity of the power connections as well as proper voltage at connector terminals: -43 to -56 volts.   | <input type="checkbox"/> |
| 9. If there is any doubt about common references, verify full battery voltage, when line is idle, between terminal 12 and the Ring side of the line to be converted. Then verify zero voltage, when the line is idle, between terminal 12 and the Tip side of the line.  | <input type="checkbox"/> |
| 10. Remove linefinder (or office panel) power supply fuse.   | <input type="checkbox"/> |
| 11. Wire wrap Tip and Ring pairs to the card connector and the equipment to be converted as follows:   | <input type="checkbox"/> |
| Tip IN to terminal 10 (from linefinder or equivalent)  | <input type="checkbox"/> |
| Ring IN to terminal 4 (from linefinder or equivalent)  | <input type="checkbox"/> |
| Tip OUT to terminal 8 (to first selector or equivalent)  | <input type="checkbox"/> |
| Ring OUT to terminal 6 (to first selector or equivalent)   | <input type="checkbox"/> |
| 12. Test polarity of Tip OUT and Ring OUT at the connector terminals: Tip more positive than Ring.   | <input type="checkbox"/> |
| 13. Inspect finger contacts of circuit card for cleanliness.   | <input type="checkbox"/> |
| 14. Inspect the card connector contacts.   | <input type="checkbox"/> |
| 15. Insert the circuit cards.  | <input type="checkbox"/> |
| 16. If any original IDF jumpers or any testing straps on the connectors are still in place, remove them.   | <input type="checkbox"/> |
| 17. Run the installation tests.  | <input type="checkbox"/> |
| 18. Unbusy the line and insure that the fuse(s) are installed to put the M-168 into service.   | <input type="checkbox"/> |

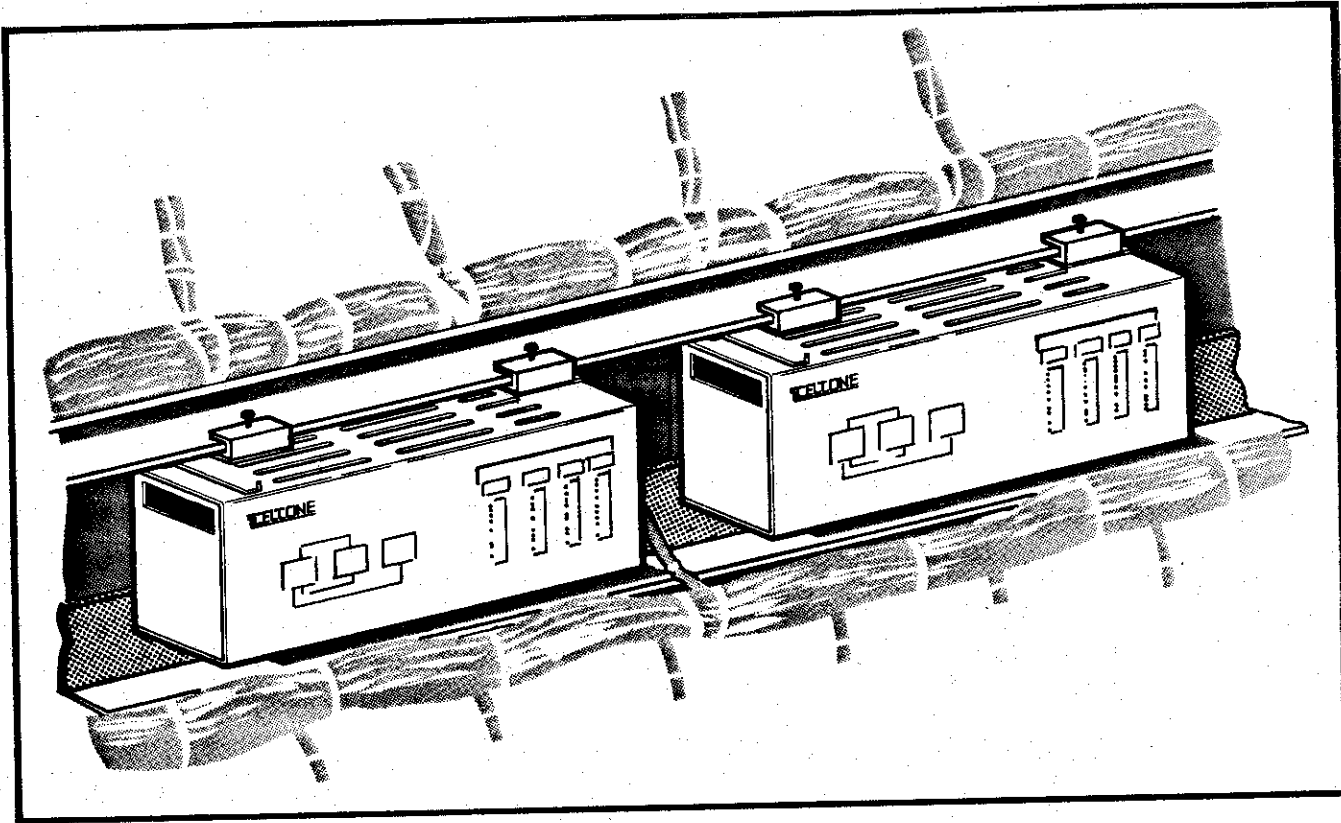


Figure 8 CF-168-31 Card Files Mounted Behind a Linefinder Bank

**6.09** If the desired mounting positions require the use of mounting adapters (except the M-164-27), the standard screw clamps on the card file housing must be removed and the special mounting adapters installed (see Figure 5).

**6.10** Certain Western Electric frames require the addition of the Extending Adapter Plates to the mounting hardware of the CF-168-31. This arrangement assures sufficient clearance between the unit and the capacitor bolts on the frame. To add the Extending Adapter Plates, first remove the existing mounting brackets. Secure the plates to the housing with the four screws that held the brackets to the housing (see Figure 5). Then secure the mounting brackets to the plates with the four 4-40 x 1/4 slotted flat-head machine screws provided with the adapter plates.

**6.11** If the CF-168-31 card file is to be wall mounted, use the screw holes provided in the back plate (see Figure 9).

#### B. Connect Battery and Ground

**6.12** The circuit cards should **NOT** be installed yet. Circuit cards should **NEVER** be connected in the card files when wiring is being done to the connectors as an accidental miswire could damage the card.

**6.13** Figure 10 gives connections to be made to the circuit card connector. Busy out the linefinder. Remove the linefinder fuse. Run the battery (-48 volts) and ground leads of 22-gauge wire from the linefinder through the cable entry opening. These leads should be in twisted pairs. If power for the M-168's will not be from the same supply as the battery connected to Tip and Ring OUT, the two supplies must have a common reference. Usually, connecting the local power supply ground to an earth ground is sufficient. A meter connected between the M-168's power supply ground and the Ring lead of the line to be converted should indicate full battery voltage when the line is idle. A meter connected between the power

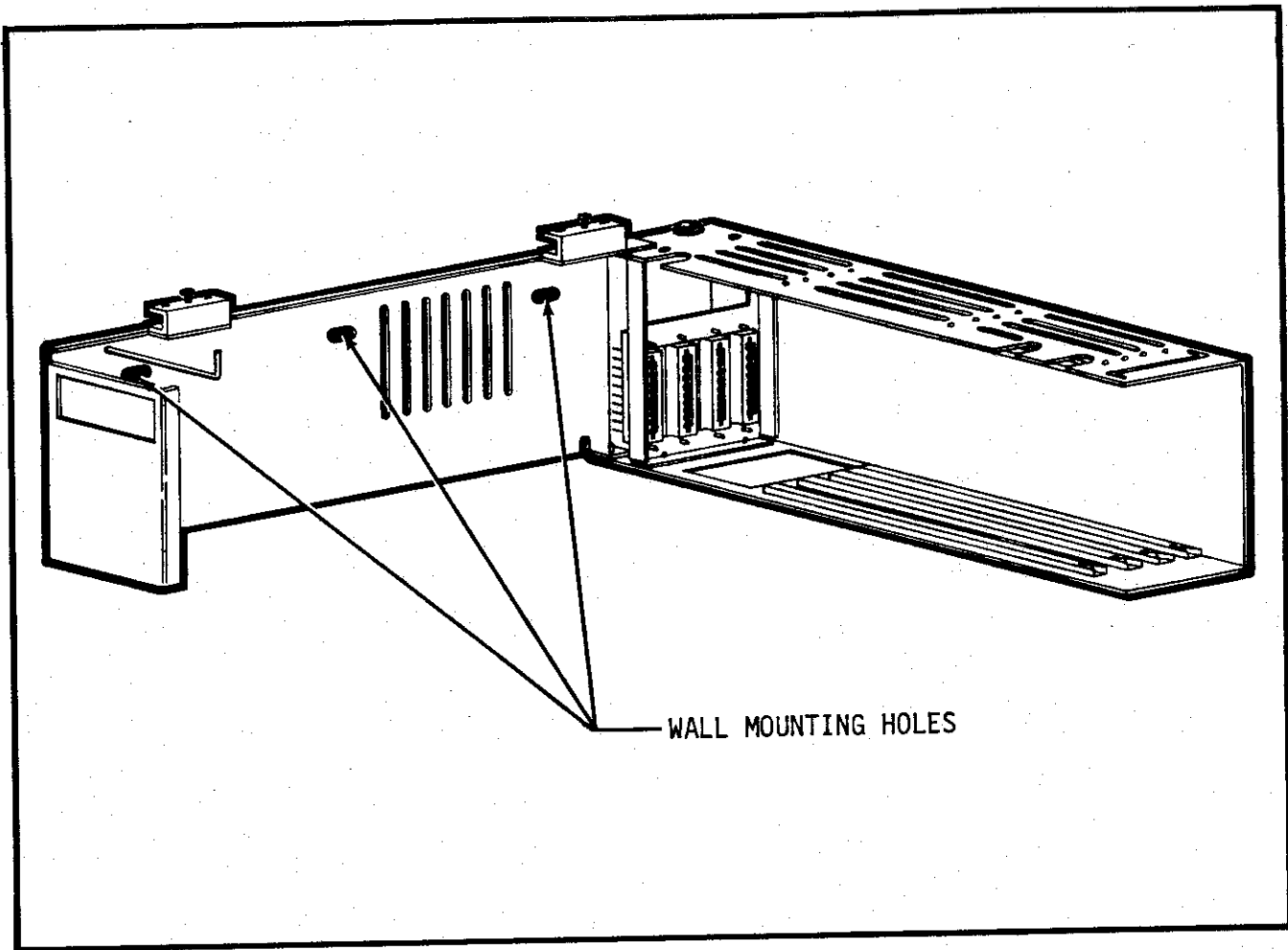


Figure 9 Wall Mounting the CF-168-31 Card File

supply ground and the Tip lead of the line to be converted should indicate no voltage present when the line is idle.

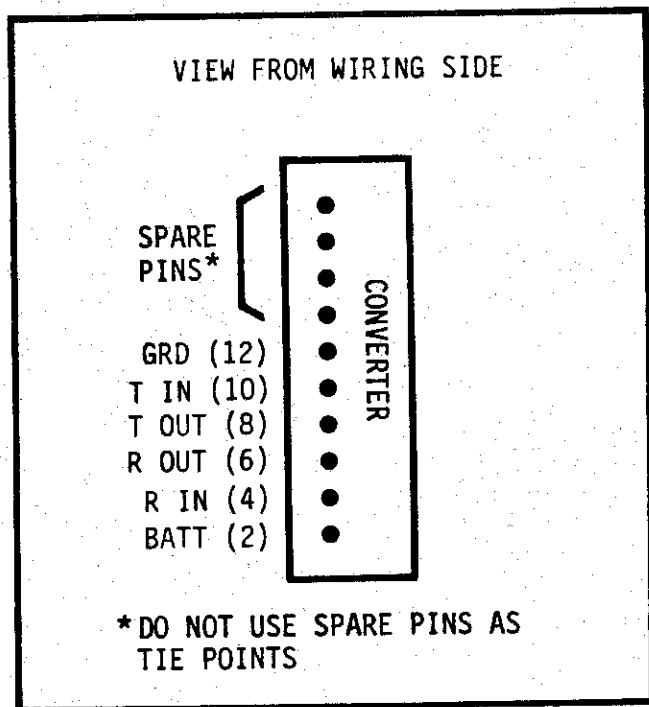
**6.14** When the battery and ground wiring is completed, install the fuse and verify the polarity of these connections. Also assure that voltage at the card connectors is within the requirements of the cards (between -43 and -56 VDC). Then remove the fuse until the cards are installed.

#### C. Connect the Tip and Ring Pairs

**6.15** The Tip and Ring IN pins (from the linefinder) and Tip and Ring OUT leads (to the first selector) should be wire wrapped with 24-gauge solid wire. Each pair should be a twisted pair. Busy out the associated linefinder before starting to wire each converter.

**6.16** Particular care should be taken to assure the leads are properly wired, especially that Tip and Ring pairs are not reversed. Reversal of polarity between Tip and Ring will prevent proper operation of the M-168. A check with a meter should show pin 8 (Tip OUT) more positive than pin 6 (Ring OUT).

**6.17** Temporary wire straps to connect the Tip and Ring IN and OUT pairs may be added to allow testing and/or use of the associated equipment before the circuit cards are installed. Such straps **MUST BE REMOVED** before the circuit cards are tested or put into service. To connect Tip IN to Tip OUT, strap between pins 10 and 8. To connect Ring IN to Ring OUT, strap between pins 6 and 4. These strapping connections



**Figure 10 Wire Wrap Connections**

should be made last so they can be easily removed.

**Note:** When testing installations with jumpers, assure that a rotary dial call can be completed using a test phone connected to the linefinder test jack. This will assure that there are no miswires that will interrupt rotary dial service.

#### **D. Inspect the Circuit Card Contacts (Fingers) and the Connector Contacts**

**6.18** Inspect the circuit card contacts at the rear of the card (component side). These must be SUPER CLEAN to assure good connections to the outside wiring. If they show any signs of contamination, clean them before installing the card. Dirt on the card contacts contaminates the connector contacts, which are harder to clean. Alcohol on a clean cloth does the best cleaning job without the risks of more volatile solvents.

#### **E. Insert the Circuit Card**

**6.19** Having tested all the previous installation steps and visually checked the

circuit card, insert the circuit card into the card connector. As seen from the opening of the file, the circuit card goes in with the components to the right. Care should be taken to start the card in the proper card guides.

**6.20** When the installation steps have been completed, proceed to test the installation as described in Part 7 of this practice. Make sure any temporary straps (Paragraph 6.17) between the Tip and Ring pairs have been removed before testing the converter. If they are not removed the converter will not operate.

### **INSTALLATION USING RELAY RACK CARD FILES**

#### **A. Mount the Relay Rack Card File**

**6.21** Each 19-inch or 23-inch card file fills five vertical inches of the relay rack (see Figure 6). Mount the relay rack card file with the nameplate right side up. Secure the card file to the front of the rack with the four screws provided. Use mounting adapter M-168-43 for mounting a 23-inch card file in a 27-inch relay rack, or for mounting a 19-inch card file in a 23-inch rack.

**6.22** One or two mounting plate spaces should be left between the card files when more than three are being mounted on one rack. This eases the chimney effect of the lower card files heating the upper ones.

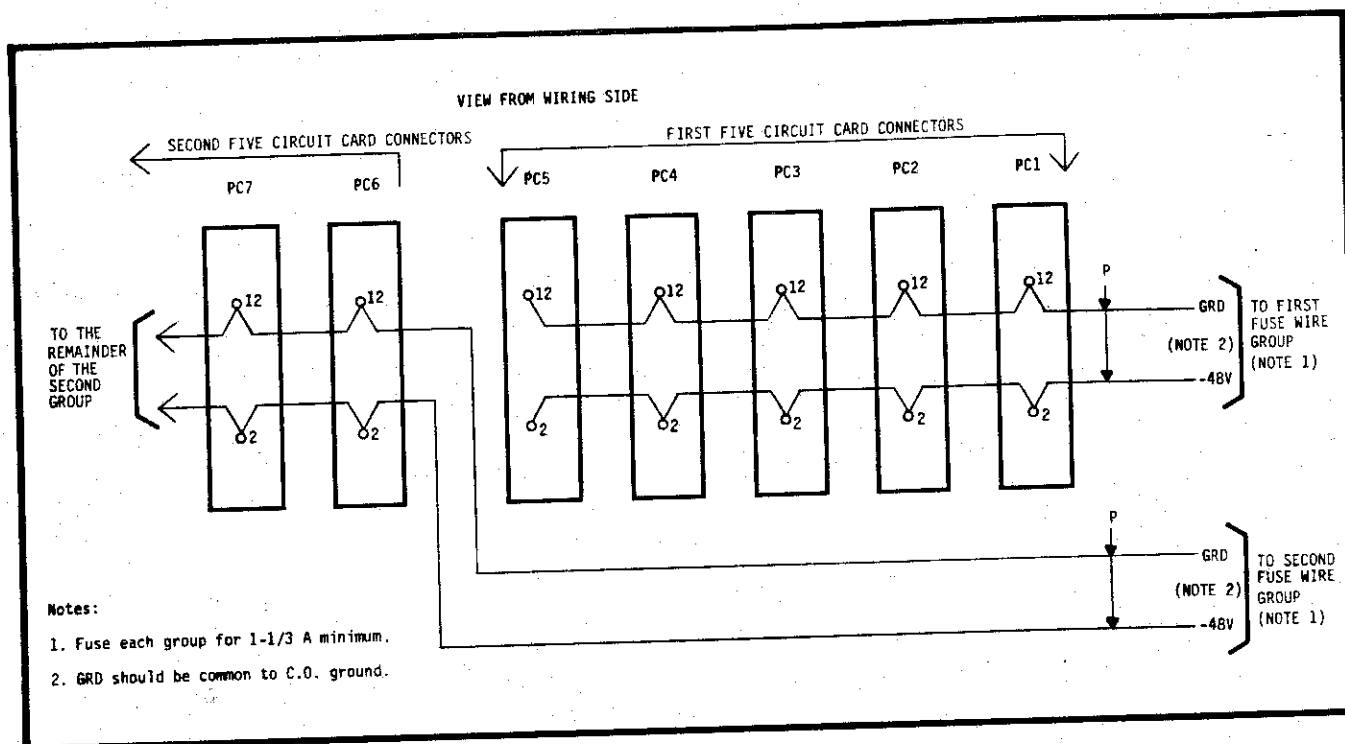
**6.23** The back cover of the relay rack card file is secured with four 1/4-turn fasteners. Remove the cover by turning the fasteners counterclockwise 1/4 turn.

#### **B. Connect Battery and Ground**

**6.24** The circuit cards should **NOT** be installed yet. Circuit cards should **NEVER** be connected in the card files when wiring is being done to the connectors as an accidental miswire could damage the card.

**6.25** Run the battery (-48 volts) and ground leads of 22-gauge wire from the





**Figure 11 Battery and Ground Wiring Diagram for Relay Racks and Card Files**

linefinder (or the office fuse panel) through the cable entry opening. These leads should be in twisted pairs. If power for the M-168's will not be from the same supply as the battery connected to Tip and Ring OUT, the two supplies must have a common reference. Usually, connecting the local power supply ground to an earth ground is sufficient. A meter connected between the M-168's power supply ground and the Ring lead of the line to be converted should indicate full battery voltage when the line is idle. A meter connected between the power supply ground and the Tip lead of the line to be converted should indicate no voltage present when the line is idle.

### C. Battery Supply and Fusing Distribution

**6.26** Wire no more than five converter cards to each 1-1/3 ampere fuse (see Figure 11). The Relay Rack card files have straps already installed connecting the battery (black wire) and ground (red wire) pins of the connectors in groups of five.

**6.27** When the wiring is completed, install the fuse(s) and verify the polarity of

the power connections. Also assure that voltage at the card connectors is within the requirements of the cards (between -43 and -56 VDC). Then remove the fuse(s) until the cards are installed.

### D. Connect the Tip and Ring Pairs

**6.28** The Tip and Ring IN leads from the linefinder and the Tip and Ring OUT leads to the first selector should be wire wrapped with 24-gauge solid wire. Busy out the associated equipment before starting to wire each converter. Disconnect the existing Tip and Ring pair, between the linefinder and the first selector. This pair must go through the M-168 card. (See Figure 10 for wire wrap pin designations).

**6.29** Particular care should be taken to assure the leads are properly wired, especially that Tip and Ring pairs are not reversed. Reversal of polarity between Tip and Ring will prevent proper operation of the M-168. A voltmeter should show pin 8 (Tip OUT) more positive than pin 6, (Ring

OUT). In rotary dial equipment the Tip and Ring pairs are occasionally wired backwards. While this does not affect rotary dial operation, it will create problems with DTMF operation.

**6.30** Temporary wire straps to connect the Tip and Ring IN and OUT pairs may be added to allow testing and/or use of the associated equipment before the circuit cards are installed. Such straps **MUST BE REMOVED** before the circuit cards are tested or put into service. To connect Tip IN to Tip OUT, strap between pins 10 and 8. To connect Ring IN to Ring OUT, strap between pins 6 and 4. These strapping connections should be made last so they can be easily removed.

**Note:** When testing installations with jumpers, assure that a rotary dial call can be completed using a test phone connected to the linefinder test jack. This is the only way to assure that there are no miswires that will interrupt rotary dial service when the linefinder is fused and unbusied.

**6.31** Two methods of wiring have come into practice in conversions of step-by-step equipment. The IDF (Intermediate Distribution Frame) wiring method, cables both the Tip and Ring pairs, IN and OUT, of the M-168's to the IDF as shown in Figure 12. The IN pairs of the M-168's are connected to their appropriate linefinders by direct connections on the IDF. The OUT pairs of the M-168's are wired to the IDF and then connected to their appropriate selectors with new jumpers on the IDF. The original jumpers can be left in place until the M-168's are to be tested. Removal of the original jumpers then puts the M-168's into service with the minimum interruption of subscriber service. The IDF wiring method has three drawbacks: it consumes space on the IDF, it requires wiring work on the IDF, and it demands updating of the cross connect records.

**6.32** The second method of wiring step-by-step conversions eliminates these

drawbacks by wiring the M-168's between the linefinder and the IDF (see Figure 13). This linefinder wiring method commits the line to full cutover immediately but requires fewer steps. The Tip and Ring leads are removed from the linefinder terminals and spliced to leads connected to Tip and Ring OUT of the M-168 (respectively, pins 8 and 6). New leads then connect the Tip and Ring terminals of the linefinder to Tip and Ring IN of the M-168 (respectively, pins 10 and 4). The Sleeve lead is not disturbed. Insertion of the M-168 card into its connector restores continuity to the switching train. The M-168's are put into service when their battery supply fuses are installed.

**6.33** The linefinder wiring method can be used in new installations without the splices. Cabling would be routed directly from the linefinders to the M-168's and then to the IDF. A separate cable of Sleeve leads would run from the linefinders to the IDF.

#### **E. Inspect the Circuit Card Contacts (Fingers) and the Connector Contacts**

**6.34** Inspect the circuit card contacts at the rear of the card (component side). These must be SUPER CLEAN to assure good connections to the outside wiring. If they show any sign of contamination, clean them before installing the card. Dirt on the card contacts is passed on to the connector contacts which are harder to clean. Alcohol on a clean cloth does the best cleaning job without the risks of more volatile solvents.

#### **F. Insert the Circuit Card**

**6.35** Having tested all the previous installation steps and visually checked the circuit card, insert it into the card connectors. As seen from the front of the file, the circuit card goes in with the components to the right. Care should be taken to start the card in the proper card guides.

**6.36** When the installation steps have been completed, proceed to test the installation as described in Part 7 of this practice. Make sure any temporary straps (Paragraph 6.30) or original IDF jumpers (Paragraph 6.31)

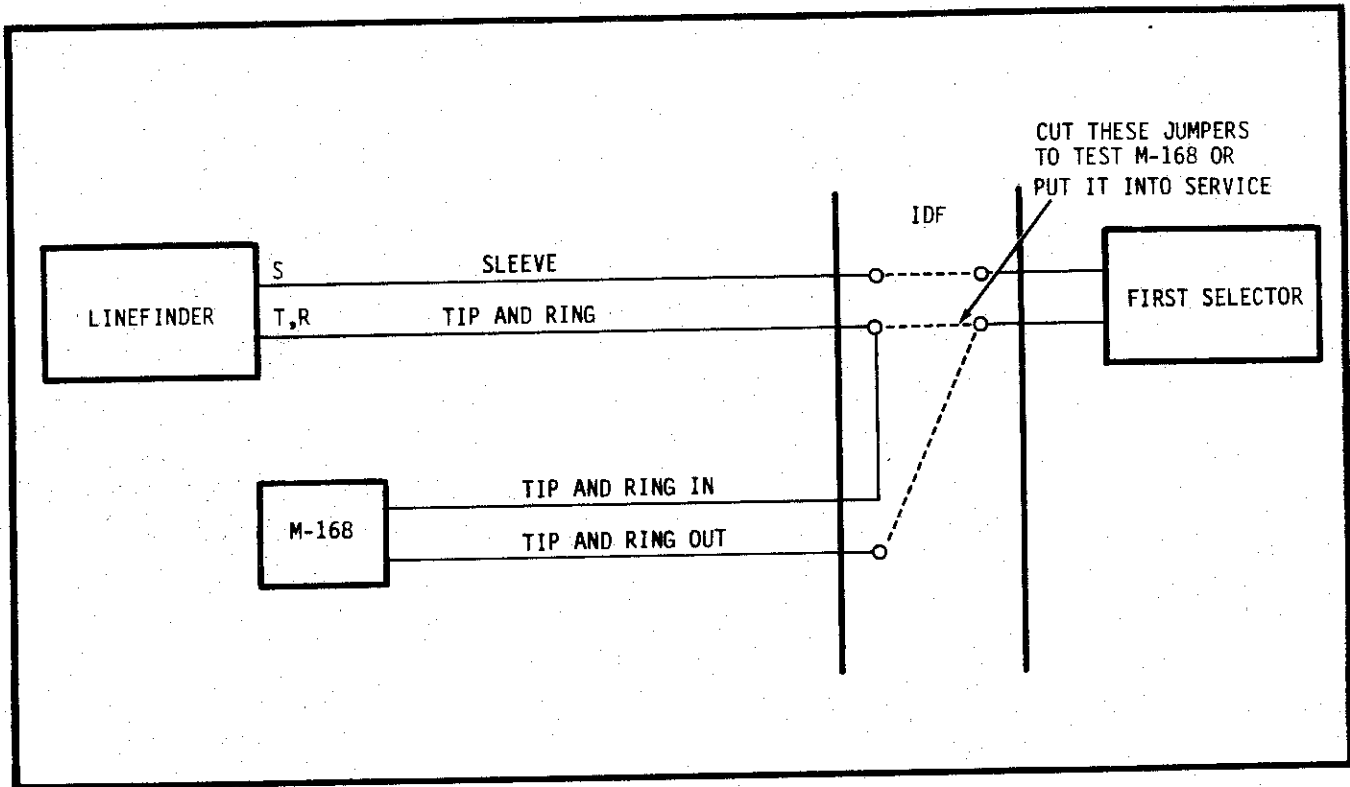


Figure 12 IDF Wiring Installation Method

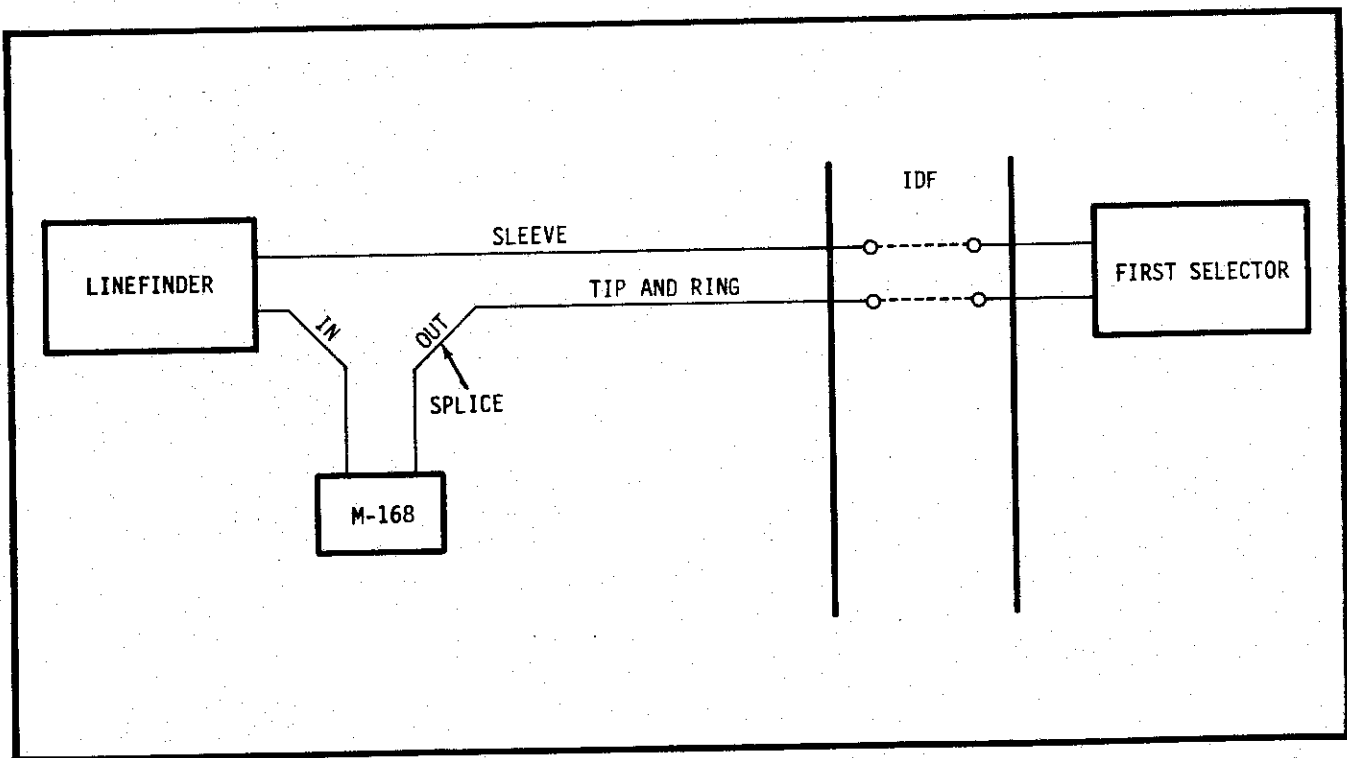


Figure 13 Linefinder Wiring Installation Method

**Table 3 Installation Test Checklist**

- |   |                          |
|---|--------------------------|
| 1. Verify that card connector jumpers or any IDF jumpers have been removed.   | <input type="checkbox"/> |
| 2. Rotary dial operation is not impaired with or without power fuse installed.  | <input type="checkbox"/> |
| 3. DTMF telephone at linefinder's test jack gets dial tone when off-hook.   | <input type="checkbox"/> |
| 4. Going on-hook and off-hook for each one, all ten numerical digits break dial tone and drive the forward equipment. | <input type="checkbox"/> |
| 5. Called party can be heard in the test telephone.   | <input type="checkbox"/> |
| 6. Time-Out Release exercise completed.   | <input type="checkbox"/> |
| 7. Dial Pulse Release exercise completed.   | <input type="checkbox"/> |
| 8. Answer Supervision Release exercise completed.   | <input type="checkbox"/> |
| 9. On-Hook Inhibit exercise completed.  | <input type="checkbox"/> |
| 10. End of Dialing feature exercise completed.  | <input type="checkbox"/> |
| 11. ANI Forwarding feature exercise completed.  | <input type="checkbox"/> |
| 12. Test phone disconnected, linefinder unbusied, and M-168 put into service.   | <input type="checkbox"/> |

between the Tip and Ring pairs have been removed before testing the converter. If they are not removed the converter will not operate. It is not good practice to do any wiring on the card connector pins with the circuit card connected.

## 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. Before it is put into service, each converter and its installation should be tested as described in the following paragraphs. Use of Table 3 as a checklist will assure that all the tests are completed. Turn to the troubleshooting part of this practice if a converter does not perform as described in each applicable test.

**7.02** An M-168 does not require special maintenance. Routine exercising according to local practices should assure

that all the testable functions of each converter are operating.

**7.03** Any jumpers on the card connectors between the Tip and Ring IN and OUT pairs (and/or any original Tip and Ring IDF jumpers) must be removed before the converters are tested. The converters will not operate with the jumpers in place. To verify removal of any jumpers, connect the test phone at the linefinder's test jack. Go off-hook and assure that dial tone is connected. Go on-hook and temporarily unjack the converter card. Go off-hook again. Dial tone will not be connected if the jumpers have been removed. Reconnect the converter card.

### A. Test for Proper Rotary Dial Operation with the Circuit Card Installed

**7.04** Since installation of an M-168 requires disconnecting and reconnecting the Tip and Ring leads, the first test must assure

that rotary dial operation has not been impaired. Before installing the linefinder fuse or whatever other power source is being used, assure that the circuit card is inserted and go off-hook with a test telephone connected at the linefinder test jack. 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-168 installation. Either dial a rotary digit or flash the switchhook. Note that dial tone is cut off. If the dial tone is not cut off, there is a fault that must be traced. Part 8 of this Practice provides troubleshooting steps.

**7.05** If dial tone was cut off in the previous test, install the power fuse and repeat the test.

#### **B. Exercise the Conversion Function**

**7.06** Assure that the fuses applying power to the M-168 and the forward equipment are installed. Connect a DTMF test telephone to the linefinder test jack. Go off-hook with the test phone. Dial tone from the forward equipment will be heard in the test phone. Signal a DTMF numerical digit. The SENDER BUSY indicator should indicate outpulsing and the dial tone should be cut off. Repeat this test for each digit to assure that they all break dial tone.

**7.07** Signal the office test number to assure that a complete DTMF call can be processed.

#### **C. Exercise the Time-Out Release**

**7.08** The converter must outpulse any valid DTMF digit (except digits signaled after \* or # character) received while the Time-Out timer is running. The converter must also reset the timer to its starting state after each digit is received. After the timer has completed its 16-second cycle, the SENDER BUSY indicator should blink continuously and rapidly (at a 20 Hz rate) and

the converter should not respond to any digits until the calling party goes on-hook and back off-hook. (If Answer Supervision reversal appears for 210 ms or longer and is then removed, the converter will be reenabled and the SENDER BUSY indicator will be lighted steadily again.)

**7.09** In order to test the Time-Out Release, go off-hook, wait ten seconds, and then signal a DTMF digit. Verify that the digit is outpulsed by observing the SENDER BUSY indicator or the forward equipment. Wait 20 seconds and signal another digit. This second digit must not be outpulsed.

#### **D. Exercise the Dial Pulse Release**

**7.10** To test the Dial Pulse Release feature, go off-hook, wait three or four seconds, then signal a rotary digit or flash the switchhook of the phone to simulate a rotary dial pulse. Verify that dial tone is broken and that the SENDER BUSY indicator blinks at the 20 Hz rate. Signal a DTMF digit and verify that the converter does not respond to it.

#### **E. Exercise the Answer Supervision Release**

**7.11** The M-168 includes an Answer Supervision Release capability when the line is split. Testing this feature is practical only if the test station returns answer supervision and will answer within a very few seconds after the final digit is signaled. Signal all but the final digit of the test number. Assure these digits have been outpulsed. Signal the final digit and several digit 0's—count them. Observe that the SENDER BUSY indicator begins to blink at the 20 Hz rate after the final digit of the test number is signaled, or listen to the dial pulse feedback to verify that the Answer Supervision Release inhibits the unit before all the 0's are outpulsed. (If the test number reverses polarity every few seconds, the SENDER BUSY indicator will light steadily again, but all the 0's will not be outpulsed.) If this test is not successful, repeat it signaling 10 digit 0's to give the test number more time to answer.

## F. Exercise the On-Hook Inhibit

**7.12** The M-168 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 the SENDER BUSY indicator goes out (or, if it is more convenient, that the switching train drops) before all the digits are outpulsed.

## G. Exercise the End of Dialing Feature

**7.13** The End of Dialing feature should be exercised as described here. Go off-hook with the DTMF test phone and signal any two numerical digits. Follow those two digits with an \* character and then several more digits. Observe that the SENDER BUSY indicator pulses at the 20 Hz rate after the first two digits are outpulsed, 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 an # character after the first two digits.

## H. Exercise the ANI Forwarding Feature

**7.14** The M-168 must forward ANI indications when it holds the line split. It holds the line split while outpulsing and during the interdigital times when there are any digit(s) stored in memory. This feature should be tested according to the appropriate BSP or local practice.

**Note:** 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 M-168).

## I. Put the Converter into Service

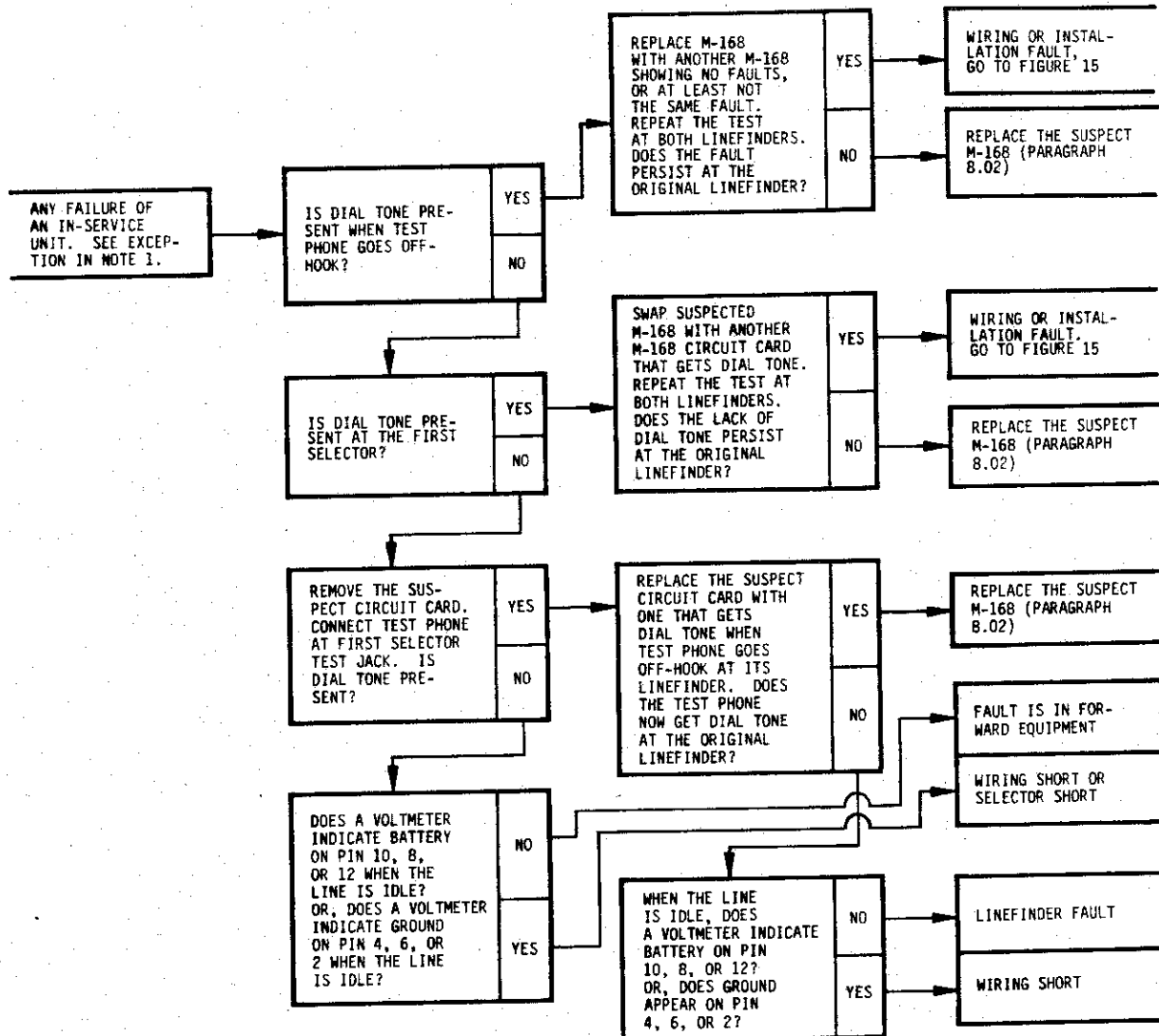
**7.15** When all the applicable tests have been successfully completed, the M-168 can be put into service. Disconnect the test telephone and assure that the linefinder is not left made busy.

## 8. TROUBLESHOOTING THE M-168

**8.01** The M-168 circuit card must be sent to the appropriate service center if these troubleshooting procedures indicate that it is faulty. There are no field-serviceable or field-replaceable components on the M-168 card.

**8.02** Troubleshooting can be greatly simplified if a known-good M-168 is available. Swap the known-good and suspected units between their respective locations and test their performance. If the fault then appears only with the known-good unit, there is a wiring fault. Compare the wiring with Figure 10. Continue with these procedures if you do not find the error. If the performance failure appears only at the location of the suspected unit (in its new location), but not at the location of the known-good unit, clean the contacts of the suspected unit with alcohol and inspect the connector contacts to see if any are bent or damaged. Retest. If the unit still malfunctions, it is faulty and must be replaced. Failure of both cards is probably caused by damaged or dirty card connector contacts.

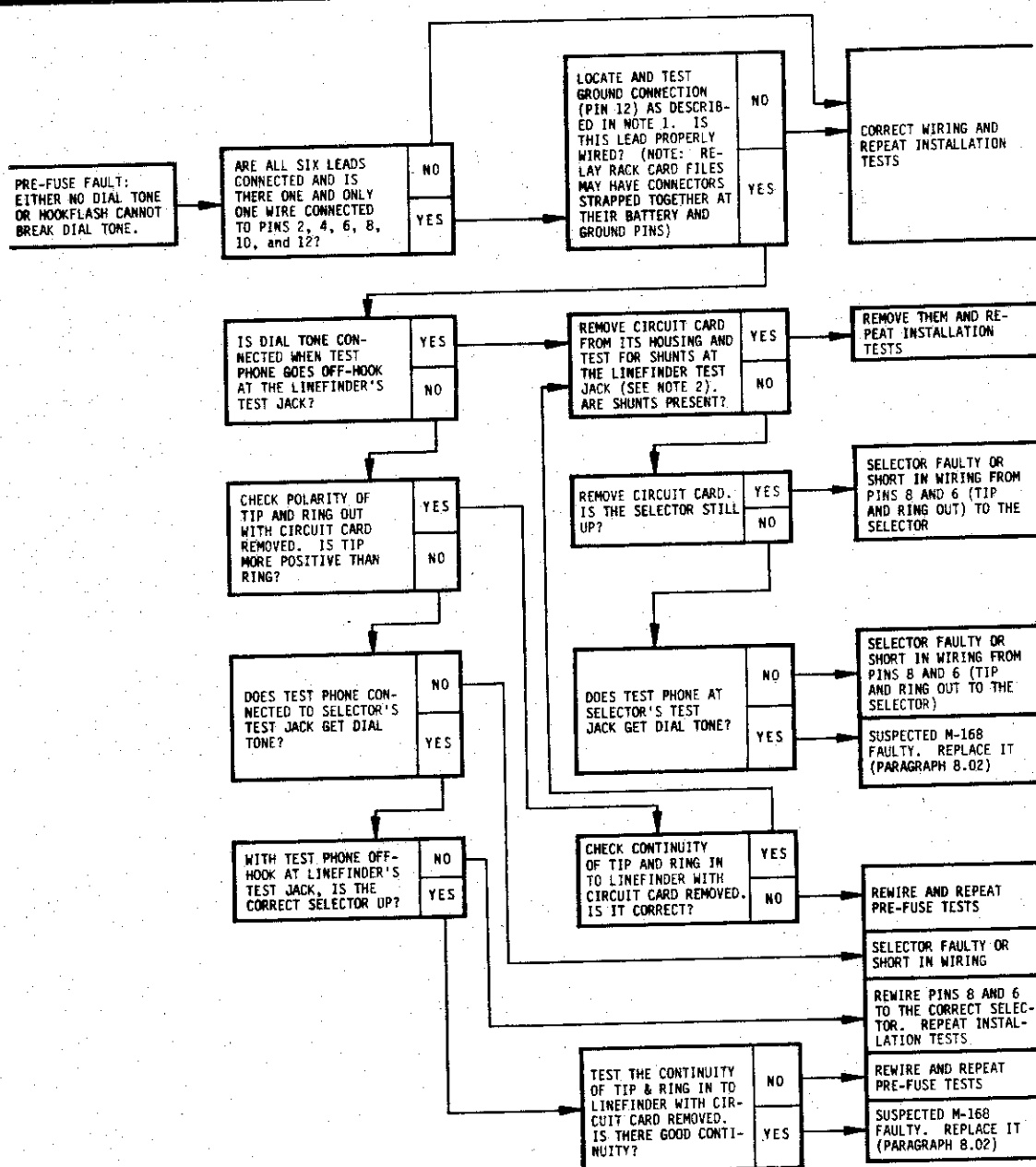
**8.03** The procedures for isolating faults depend on whether the unit is in service and had been operating properly or is a unit that does not pass its initial installation tests. If the unit had been in service and operating, proceed as described in Figure 14. If the problem is with an initial installation, go to Figure 15 for failures that occur before the power fuse is installed and Figure 16 for failures that occur only after the fuse is installed.



NOTE 1: UNDER CERTAIN CIRCUMSTANCES AN M-168 MAY OUTPULSE ONLY PART OF THE SIGNALLED 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-168 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.

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 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.

Figure 14 Troubleshooting Procedure for In-Service Units



NOTE 1: TEST THE GROUND CONNECTION (AT PIN 12 OF THE CARD CONNECTOR) WITH A VOLTMETER CONNECTED TO A HARD BATTERY SOURCE. FULL BATTERY DEFLECTION SHOULD BE INDICATED UNLESS PIN 12 IS MISWIRED. TO ASSURE THAT THE LEAD AT PIN 12 IS NOT MISWIRED TO TIP FROM THE SELECTOR OR SOME OTHER NON-HARD GROUND SOURCE, CHECK THE CONTINUITY (WITH AN OHMMETER) BETWEEN THE BATTERY SUPPLY GROUND TERMINAL OF THE LINEFINDER AND PIN 12. IF THIS IS NOT CONVENIENT, CHECK THE CONTINUITY BETWEEN PIN 12 AND ANY HARD GROUND (NOT SELECTOR TIP). IN EITHER CASE, NEAR PERFECT CONTINUITY SHOULD BE INDICATED.

IF THE M-168 HAS STRAPS CONNECTING ITS BATTERY AND GROUND PINS TO OTHER CONVERTERS IN THE CARD FILE, BE SURE TO UNJACK THOSE CARDS BEFORE MAKING THESE TESTS.

NOTE 2: TEST FOR SHUNTS BY GOING OFF-HOOK AT THE LINEFINDER WITH A TEST PHONE, REMOVING THE CIRCUIT CARD FROM ITS HOUSING, AND TESTING FOR GROUND AND BATTERY WITH A VOLTMETER AT THE LINEFINDER'S TEST JACK. IF GROUND OR BATTERY APPEARS ON EITHER THE TIP OR THE RING SIDE OF THE TEST JACK, A SHUNT IS PRESENT AND MUST BE REMOVED. REWIRE AND REPEAT THE PRE-FUSE INSTALLATION TESTS.

Figure 15 Troubleshooting Procedure for Pre-Fuse Faults



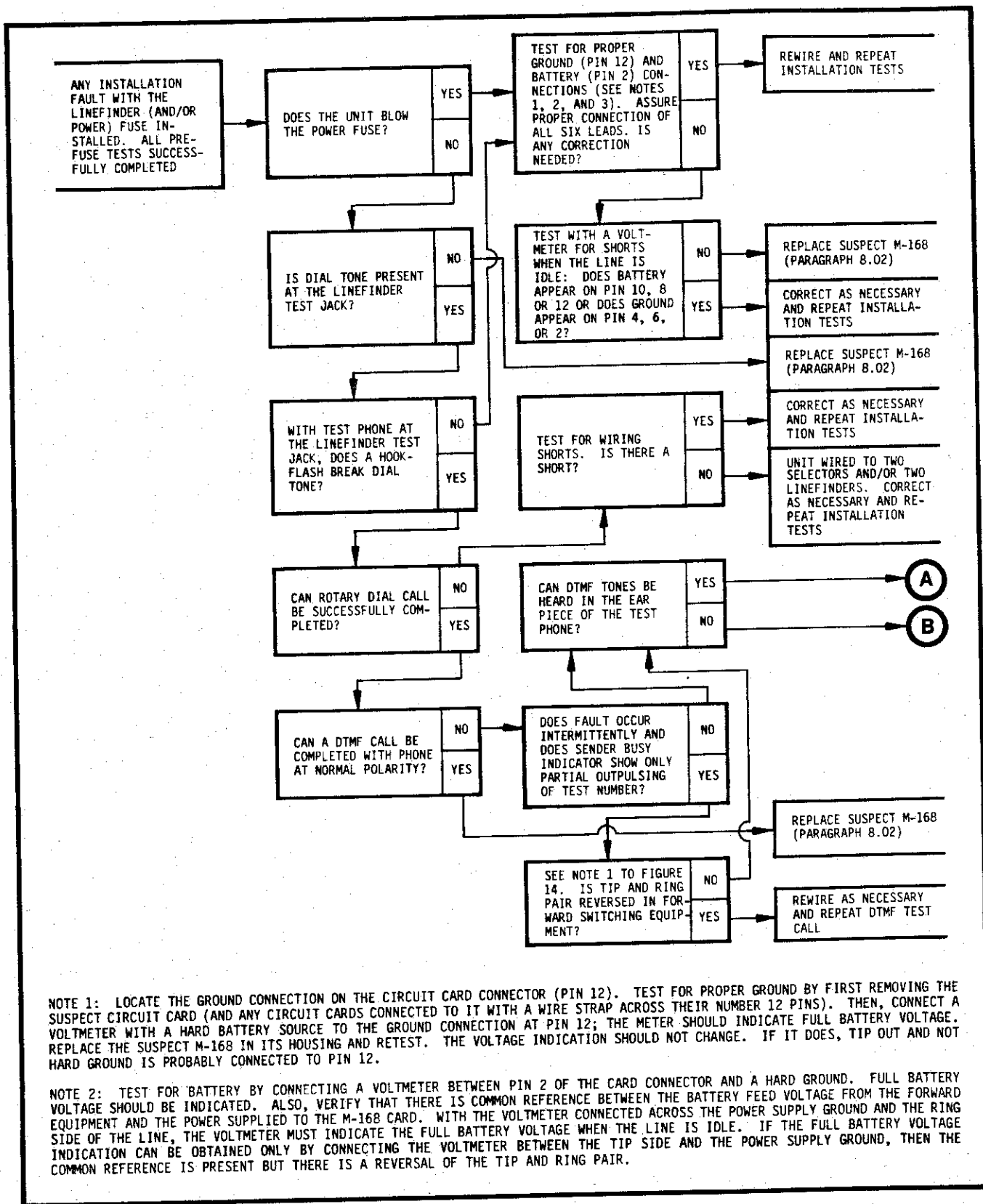


Figure 16 Troubleshooting Procedure for Post-Fuse Faults (Sheet 1 of 2)

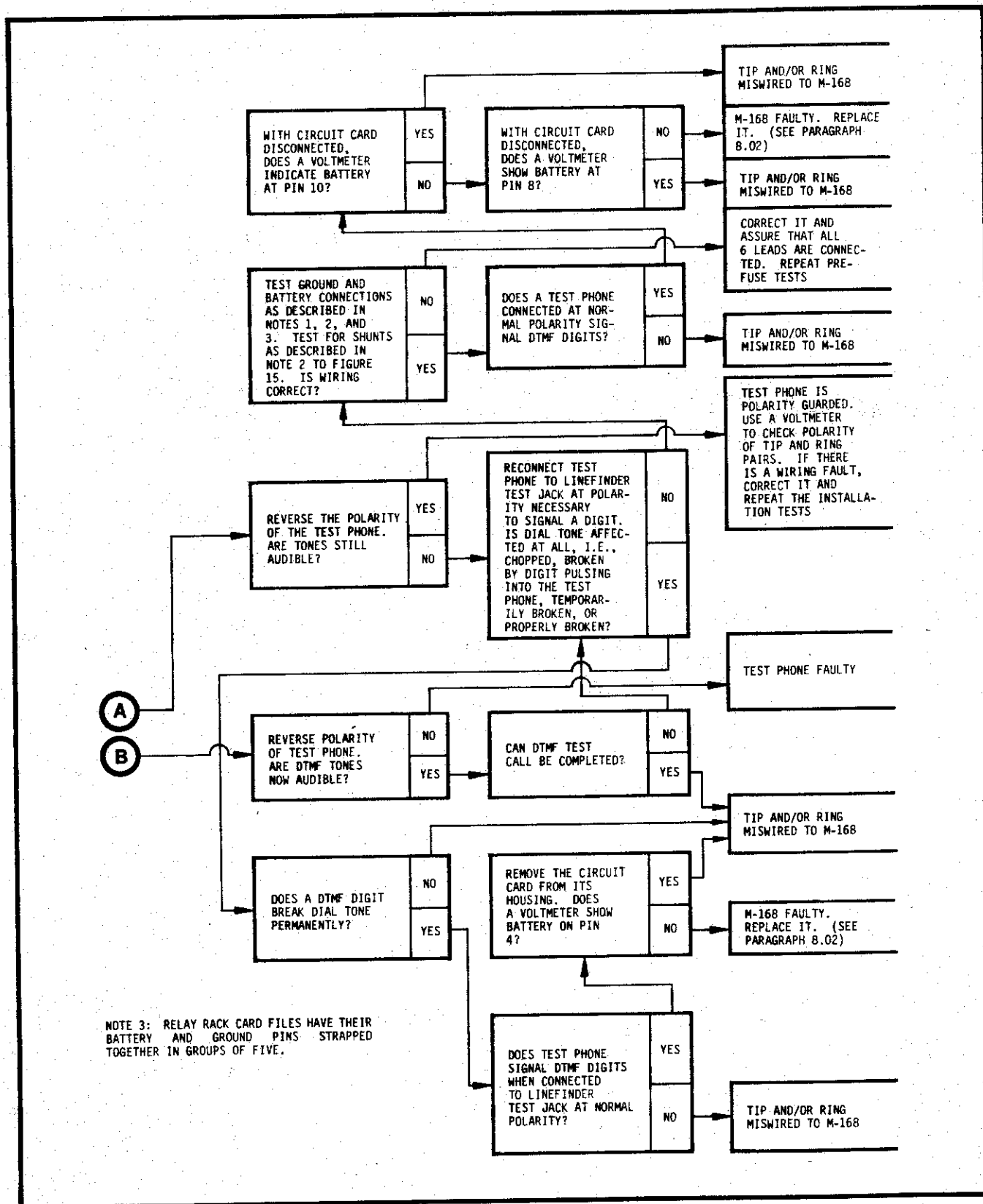


Figure 16 Troubleshooting Procedure for Post-Fuse Faults (Sheet 2 of 2)

**9. SPECIFICATIONS****Input Impedance  
(tone receiver)**

circuit card number  
201-381-06  $\geq 150K$  ohms

circuit card number  
201-323-02  $\geq 75K$  ohms

**Input DTMF Signal Requirements**

Signal level (per  
frequency)  
accept

-22 to +6 dBm  
(0.062 to 1.55  
VRMS) see note 1

reject

$\leq 0.0138$  VRMS  
( $\leq -35$  dBm)

Tone bandwidth  
accept  
reject

$\pm(1.5\% + 2 \text{ Hz})$   
3.5%

Signal duration  
accept  
reject

$\geq 40$  ms  
 $\leq 20$  ms

Interdigital  
pause duration  
accept  
reject

$\geq 40$  ms  
 $\leq 20$  ms

Signal cycle time

$\geq 85$  ms

Amplitude difference  
(twist)

+6 dB maximum  
-8 dB maximum,  
see note 2

Precise dial tone  
tolerance

-12 dBm per tone  
maximum (0.194  
VRMS) see note 1

Noise tolerance

-20 dB, see note 3

DTMF blanking after  
off-hook  
accept  
reject

$\geq 130$  ms  
 $\leq 80$  ms

**Register Capacity**

20 digits recir-  
culating, see  
note 4

**Interface Characteristics**

Insertion loss 0.1 dB maximum

Longitudinal balance  
with 30 mA of loop  
current

talk-through

60 dB minimum at  
1000 Hz

signaling during  
line split

50 dB minimum at  
1000 Hz

Loop current  
recognition  
accept  
reject

$\geq 12$  mA  
 $\leq 5$  mA

ANI offset  
recognition  
accept  
reject

$\leq 2700$  ohms  
 $\geq 5400$  ohms

ANI offset forwarding

1500 150 ohms

**Input DC Signaling**

Off-hook recognition  
accept  
reject

$\geq 22$  ms  
 $\leq 10$  ms

Dial pulse release  
guard (after off-  
hook)  
active  
inactive

>3 seconds  
<1 second

Dial pulse break  
recognition  
accept  
reject

$\geq 30$  ms  
 $\leq 10$  ms

## SECTION 168-100

### Answer Supervision recognition

accept	$\geq 210$ ms
reject	$\leq 145$ ms

### On-hook recognition

accept	$\geq 210$ ms
reject	$\leq 145$ ms

### Output Signaling

Pulse rate	$10 \pm 0.5$ PPS
Pulse ratio	58% to 62% break
Outpulse interdigital time	$740 \pm 30$ ms
Outpulse loop holding resistance	900 ohms $\pm 10\%$
Time-Out Period	$16 \pm 1$ seconds

### Line Switching Characteristics

DTMF line split	within 40 ms of loss of DTMF tones
-----------------	--

Line restoral time  
after the last break  
pulse of the most  
recently received  
digit

circuit cards with number 201-323-02 and Rev. B or higher, or with num- ber 201-381-06	670 to 730 ms
---	---------------

other 201-323-02 cards  $39 \pm 4$  ms

### Power Requirements

#### Voltage

circuit card number 201-381-06	-42 to -56 VDC
circuit card number 201-323-02	-43 to -56 VDC

### Current

idle/inhibited	
circuit card number 201-381-06	40 mA typical
circuit card number 201-323-02	55 mA typical
enabled	90 mA typical
outpulsing	200 mA maximum

Fusing requirement	1-1/3 ampere minimum (per 5 cards)
--------------------	--

### Environmental Requirements

Temperature	0° to 55° C
Relative humidity (noncondensing, at 0° to 55° C for periods up to 72 hours)	$\leq 85\%$
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 cali-  
brated to provide a scaled voltage mea-  
surement in dBm for a 600-ohm impedance  
No termination should be applied for this  
measurement.

**Note 2:** Level of high frequency signal  
with respect to level of low frequency  
signal. Combined level of random, dif-  
ference, and harmonic noise components at  
least -40 dB below the lowest level DTMF  
component.

**Note 3:** Relative to lowest level DTMF  
component. Twist  $\pm 1$  dB. Noise level is not  
to exceed -35 dBm.

**Note 4:** Digit register is recirculating such that any number of digits may be received and outputted as long as the backlog of received but not yet outputted digits does not exceed 20 digits.

## 10. REVISIONS

September 1, 1979  
Issue 2

Addendum date June 14, 1979 incorporated. (Deleted all references to M-168-01 circuit card. Pulse ratio specification corrected. Signal Cycle time specification added. Specifications for 201-00381-06 cards added. Circuit Board Material specification deleted. ANI forwarding compatability explained in greater detail.) Practice substantially revised for clarity.

All references to M-168-11, -13, -21, and -23 card files deleted.

November 27, 1979  
Issue 3

M-168 Packages added to Table 1, Ordering Information. Deleted incorrect direction arrow from Figure 15. Deleted M-168-53 (10-pin connector) from Table 1.

June 9, 1980  
Issue 4

Revised Figures 1, 14, and 16 (Sheet 2). Corrected paragraph 8.03 and the temperature and relative humidity requirements in the Specifications.

