

LINE CONCENTRATOR NO. 1A  
WITH MF SIGNALING  
PREINSTALLATION TESTS  
TESTS AND INSPECTIONS AT TIME OF INSTALLATION  
AND OUT-OF-SERVICE TESTS

1. GENERAL

1.01 This is one of a group of sections pertaining to the line concentrator No. 1A when modified for use with the multifrequency signaling circuits. The tests in this section are for testing with a 100-line concentrator remote unit. When testing with combinations of 50 line and/or single groups in 100-line concentrator remote units, the same procedures may be used, but care must be taken to ensure that tests are performed in the proper group and that all option strapping has been done in accordance with SD-96536-01, SD-96537-01, and SD-95957-01.

1.02 The tests covered are:

- A. *Visual Inspection of Equipment:* This test checks the physical condition of the devices and the terminations of the wiring.
- B. *Line, Cutoff, and Sleeve Relays:* This test checks to determine that the CO-relays are operated and that the L- and SL-relays are nonoperated.
- C. *Power:* This test checks fusing, measures battery supplies, and provides a procedure for cross connection of associated equipment.
- D. *Ground Return Resistance — Control and Remote Ends:* This test checks to determine the value of resistance which exists in the signaling ground return path.
- E. *Insulation Resistance of Signaling Leads — Control End:* This test checks the insulation resistance of the signaling leads in the control end.
- F. *Insulation Resistance of Signaling Leads — Remote End:* This test checks the insulation resistance of the signaling leads in the remote end.

G. *Interference on Signaling Leads — Control End:* This test checks to determine whether ac and dc interference voltages on the control end signaling leads are within stated limits.

H. *Interference on Signaling Leads — Remote End:* This test checks to determine whether ac and dc interference voltages on the remote end signaling leads are within stated limits.

I. *DC to MF Conversion in MF Signaling Circuit — Remote End:* This test checks the conversion of the direct current signals to alternating current multifrequency signals at the remote end.

J. *DC to MF Conversion in MF Signaling Circuit — Control End:* This test checks the conversion of the direct current signals to alternating current multifrequency signals at the control end.

K. *Mark Counting in MF Signaling Circuit — Control End:* This test checks for a proper operating sequence in the mark counting circuit at the control end.

L. *Check Counting in MF Signaling Circuit — Remote End:* This test checks for a proper operating sequence in the check counting circuit at the remote end.

M. *Test Circuit — Control End:* This test checks for proper operation of the test circuit at the control end without originating calls through the concentrator.

N. *Test Circuit — Remote End:* This test checks for proper operation of the test circuit at the remote end without originating calls through the concentrator.

- O. Timing in MF Signaling Circuits — Control and Remote Ends:** This test checks for the required time in the timing circuits of the multifrequency signaling circuits at both the control and remote ends.
- P. Line Insulation:** This test checks the line insulation resistance of the line between the remote concentrator and the customer station.
- Q. Alarm Circuits:** This test checks the alarm features of the concentrator control and remote units.
- R. Circuit Operation and Line and Trunk Call Through:** This test checks the ability of each line to connect through each trunk.
- S. Trunk Transmission, Overflow Tone, Trunk Disconnect Sequence, and Trunk Load Control:** This test checks the ability of each trunk to carry information, for a trunk-overflow tone when all trunks are in use, for proper sequence of trunk disconnection, and the trunk load control feature which leaves some trunks cut through at all times.
- T. Service Denial Call:** This test checks the service denial features of the concentrator system.
- U. Dial Tone Speed Register:** This tests the connection of the dial tone speed register circuit when used with this system.
- V. Trunk Group Usage Recorder:** This tests the connections to a trunk group usage recorder from this system.
- 1.03** Preinstallation tests of ground return resistance, signaling lead leakage, and signaling lead interference are covered in Fig. 1, 2, and 3.
- 1.04** During the time that any of these tests are being conducted, no originating, terminating, service denial, or disconnect calls may be made, except as specified.
- 1.05** These tests apply to both ends except when specific reference is made either to the remote or control end.
- 1.06** Arrangements should be made to notify the control end that tests are being performed at the remote end and vice versa.
- 1.07** In these tests all actions and verifications take place at the MF signaling units, control or remote end as necessary, unless otherwise noted.
- 1.08** In the case of interruption of normal service, the sequence charts should be consulted to determine in which unit and at what point trouble may be occurring.
- 1.09** If there is an indication of signaling trouble between the remote and control ends, and carrier facilities are used, the carrier facilities should be checked for proper operation first.
- 1.10** After completion of all tests and inspections, both control and remote ends should be in normal operating condition.
- 1.11** The following reference material is required:
- CD-95957-01 — Common Systems, Line Concentrator No. 1A, Remote Circuit, 50-Line Capacity
  - CD-95971-01 — Common Systems, Line Concentrator No. 1A, Multifrequency Signaling Circuit, Control End
  - CD-95972-01 — Common Systems, Line Concentrator No. 1A, Multifrequency Signaling Circuit, Remote End
  - CD-96536-01 — Common Systems, Line Concentrator No. 1A, Control Circuit, 100-Line Capacity
  - CD-96537-01 — Common Systems, Line Concentrator No. 1A, Remote Circuit, 100-Line Capacity
  - CD-96556-01 — Common Systems, Line Concentrator No. 1A, Modification to Provide Long Lines Service
  - CD-96557-01 — Common Systems, Line Concentrator No. 1A, Modification Circuit for Additional Applications in MTWX Service
  - CD-98137-01 — Common Systems, E1L Signaling and 4-Wire Terminating Circuit

- CD-98138-01 — Common Systems, E1S Sig-
- SD-98138-01 naling and 4-Wire Terminat-
- ing Circuit
- 067-106-201 — Line Concentrator No. 1A
- with MF Signaling, Cutover
- Procedures and Addition
- and Deletion of Individual
- Lines
- 067-106-301 — Line Concentrator No. 1A
- with MF Signaling, Trouble
- Analysis
- 067-106-502 — Line Concentrator No. 1A
- with MF Signaling, System
- Tests
- — Section entitled Line Con-
- centrator No. 1A, KS-15917,
- List 3 Battery Supply

**1.12 Lettered Steps:** A letter a, b, c, etc, added to a step number in Part 4 of this section, indicates an action which may or may not be required, depending on local conditions. The condition under which a lettered step or a series of lettered steps should be made is given in the ACTION column, and all steps governed by the same condition are designated by the

same letter within a test. Where a condition does not apply, all steps designated by that letter should be omitted.

**2. APPARATUS**

- 2.01** The apparatus required for each test is shown in Table A. The details of each item are covered in the paragraph indicated by the number in parentheses.
- 2.02** Test receiver, 716C receiver (or hand test sets) attached to a W2AB cord equipped with two 360A tools.
- 2.03** Dummy fuse prepared with meter connections. (See Fig. 4 for local preparation.)
- 2.04** Three testing cords, 893 cord, 3 feet long, equipped with 360 tools at each end (1W13A cord).
- 2.05** Two testing cords, W1AP cord, 12-1/2 inches long, equipped with a No. 30 Mueller Mini-Gator clip and a No. 32 Mueller insulator at each end.
- 2.06** Patching cord, P3E cord, 2 feet long, equipped with two 310 plugs (3P7D cord).

**TABLE A**

APPARATUS	TESTS																					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
KS-14510 Volt-Ohm-Milliammeter or equivalent 20,000 Ohm-Per-Volt VOM	-	1	1	1	1	1	1	1	-	-	-	-	-	-	-	1	-	1	-	-	-	-
Test Receiver (2.02)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
Timing Test Set, J24753A (SD-25707-01)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Fuse (2.03)	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.5-Volt DC Dry Battery, KS-6570 or equivalent Cord (2.04)	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Cord (2.05)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	-	-
Cord (2.06)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
624B Tool	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-	-	-	-	-	-	-	-
1015A Spare Parts and Tool Kit (2.07)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tool (2.08)	-	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Test Leads	-	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

√ As required

## SECTION 067-106-501

**2.07** The 1015A spare parts and tool kit is required only if replacement of parts at the remote end is necessary. In addition, a soldering iron may be required.

**2.08** Blocking and insulating tools, as required. Use tools and apply, as covered in Section 069-020-801.

### 3. PREPARATION

**3.01** A portion of the tests in this section will require simultaneous testing at both the concentrator unit and its MF signaling unit.

**3.02** For those situations where the control and/or remote concentrator is not located immediately adjacent to its MF signaling unit, a talking circuit will be required between units to coordinate testing. If possible, the talking circuit should use facilities other than those assigned for concentrator use.

**3.03** Prior to performing Tests A and B, remove PF and 20A fuses from the frame fuse panel in control concentrator unit and verify that M fuse has been removed in remote concentrator unit.

**3.04** When performing any of these tests on an out-of-service basis, busy out the concentrator by block operating the RL2 relay at the control concentrator before beginning each test and remove the blocking tool after each test is completed.

**3.05** For all procedures, except preinstallation tests, this section assumes the following.

- (a) That all cable assignments have been made for trunks, signal leads, and carrier facilities.
- (b) That the control and remote concentrator units have been installed and that cross connections have been placed and terminated between the terminal blocks on the frame and on the concentrator units.
- (c) That the control and remote MF signaling units have been installed.

(d) That an E1L and E1S signaling circuit has been installed per SD-98137-01 and SD-98138-01 for each of the concentrator trunks.

(e) That if a 50-line remote unit for Group I is being installed, the designation strips (Forms E-4873-1 and E-4873-2) for lines and trunks are in place on the connecting block in the remote unit.

**3.06** For procedures covering preinstallation tests, this section assumes that cable assignments for signaling leads have been made.

**3.07 *Precautions:*** The line concentrator No. 1A contains neutral and magnetic latching dry-reed relays, mercury relays, diodes, and magnetic latching crossbar switches in both the concentrator remote and control units. Detailed precautions are listed below.

(a) ***General:*** Do not make any adjustments to relays or crossbar switches without consulting the appropriate requirement and adjusting procedure section for the particular relay or switch.

(b) ***Dry-Reed Relay:*** The cutoff (CO-) relays in the concentrator control unit and the line (L-) and CO- relays in the concentrator remote unit are of the 302 dry reed type. Before testing on contacts of these relays or the circuits containing them refer to Section 040-275-301 — Dry-Reed-Type Relays, Precautions To Be Observed When Testing. Contacts of reed relays may be damaged if test connections are made which cause these contacts to make or break 1/2 ampere or more of current.

(c) ***Mercury Relays:*** The relays in series with the signaling leads in both the remote and control units of the concentrator and MF signaling circuits are of the 303 mercury contact type. Before testing these relays or the circuits containing them, refer to Section 040-263-501 — Relays 275, 276, 291, 292, 301, and 303 Types Using Test Sets SD-95439-01 (J94725A). These signaling relays may be permanently damaged if more than 60 ma of current is caused to flow through their winding.

(d) **Magnetic Latching Crossbar Switches and Reed Relays:** The hold magnets and cut-off relays in both concentrator units are magnetic latching. These switches or relays should not be operated or released electrically or manually during testing except by normal circuit operation or in strict accordance with approved procedures. Indiscriminate operation or release of these switches and relays will cause malfunctions of the system.

(e) **Diodes:** Before testing diodes or circuits containing diodes, refer to Section 032-173-301 — Procedures To Be Followed When Working on Circuits Containing Diodes, Varistors, or Transistors.

**3.08** The battery in the remote concentrator unit does not have sufficient capacity to allow blocking a major portion of the apparatus used in making a call, or blocking the timing circuit without proper safeguards. The recommended procedure is:

- (a) Make repeated tests observing relay operation.
- (b) Determine condition of W and Z relays when operation stops.
- (c) Determine condition of RK2 and CCK relays when operation stops.
- (d) On SCs, localize trouble to the area limited by W, Z, RK2, and CCK relay operation.
- (e) On FSSs, pinpoint possible troubles.
- (f) On equipment, check for trouble pinpointed above.

**Note:** Sections 067-106-301 — Line Concentrator No. 1A With MF Signaling, Trouble Analysis, and 067-106-502 — Line Concentrator No. 1A With MF Signaling, System Tests, may be used to assist in location of trouble experienced during application of this section.

**4. METHOD**

STEP	ACTION	VERIFICATION
<b>A. Visual Inspection of Equipment</b>		
1	Inspect all relays.	All covers in place. All actuating cards in proper positions (wire spring types). All make, break springs parallel and in proper position relative to associated fixed contact (wire spring type). All mercury relays properly seated in sockets.
2	Inspect all switches.	All crossbar switch select fingers properly in cards. All latching hold magnets in released position.  <b>Note:</b> If latching hold magnets are not in released position, release manually, but only when unit is out of service.
3	Inspect wiring side of equipment.	No solder splashes, wire ends, bent terminals, etc.

STEP	ACTION	VERIFICATION
<b>B. Line, Cutoff, and Sleeve Relays</b>		
<i>Note:</i> Operate all CO relays in both units. (Concentrator units are shipped with CO relays in released condition.) To operate CO relays, place the + and - terminals of a 4.5-volt battery on terminals 1 and 6, respectively, of each CO relay.		
1	At both concentrator units — Place an ohmmeter between test terminals 2, 3 and 4, 5 of each CO- relay.	Meter should read 0 ohms (short).  <i>Note:</i> If meter does not show 0 ohms, place the positive terminal of a 4.5-volt battery on terminal 1 of CO- relay.  Place the negative terminal of the 4.5-volt battery on terminal 6 of CO- relay.  Repeat test.
2	At concentrator remote unit — Remove G, D fuses.	
3	Place ohmmeter across test terminals 2, 3 and then 4, 5 of following L- relays: 00, 09, 18, 27, 36, 45, 50, 59, 68, 77, 86, 95.	Should read infinite resistance (open).
4	At concentrator control unit — Remove L, M fuses.	
5	Place ohmmeter across contacts 5M, 5F, then contacts 4M, 4F of following even numbered SL- relays, contacts 9M, 9F, then contacts 8M, 8F of following odd numbered relays: 00, 18, 36, 50, 68, 86, 09, 27, 45, 59, 77, 95.	Should read infinite resistance (open).
6	At both concentrator units — Replace all fuses.	

**C. Power**

*Note:* Determine that all fuses are of proper rating and that caps are tight.

1	At concentrator control unit — Inspect relays.	At concentrator control unit — Determine that only TM1 relay operates. With S option — AT, RL1, RL2, SAL relays operate. AL lamp lights.
2	Operate AR key.	AL lamp extinguishes. SAL relay releases.
3	Measure battery supply between terminals 79 through 88 ground, 100 through 112 and 119 battery, on CAD 6.	Minimum of 45 volts dc.
4a	If concentrator battery is used — At concentrator remote unit — Inspect, test battery in accordance with section entitled Station Systems, Line Concentrator No. 1A, KS-15917, List 3 Battery Supply.	

STEP	ACTION	VERIFICATION
5	Inspect relays.	At remote concentrator unit — Determine that no switches or relays operated.
6a	If concentrator battery is used — Measure battery supply at battery terminals.	Minimum 23 volts dc.
7b	If office battery is used — Measure battery supply at M fuse terminal to GRD.	Minimum 23 volts dc.
8a	If concentrator battery is used — Measure charging current by inserting dummy fuse (see Fig. 4) into CHG fuse position to measure current.	Charging current near 140 ma in 100-line unit or 80 ma in 50-line unit but not to exceed 140 ma in either case. <i>Note:</i> Use CC potentiometer to adjust charging current per SD-96557-01.
<i>Note:</i> If 22 spare cable pairs (2 group of 12 pairs for 50-line remote units) are available and assigned at the control and remote locations, proceed with test. If sufficient spare cable pairs are not available at either location, proceed in accordance with Section 067-106-201 covering cutover procedures.		
9	At concentrator control unit — Cross connect 20 talking trunks between control concentrator terminal strip on distribution frame and feeder cable appearance on distribution frame per SD-96536-01, CADs 11, 12.	
10	At carrier location for the concentrator control unit — Insert E1L signaling unit in each of 20 talking trunks per SD-98137-01, SD-96557-01.	
11	At concentrator remote location — Cross connect the 20 talking trunks between remote concentrator terminal strip on distribution frame and feeder cable appearances on distribution frame per SD-96557-01.	
12	At carrier location for remote concentrator unit — Insert E1S signaling unit into each of 20 talking trunks per SD-98138-01, SD-96557-01.	
13	At distribution frame for control MF signaling unit — Cross connect T, R, T1, R1 leads to 4-wire voice frequency patching jacks as required per SD-95971-01, CAD 2.	
<i>Note:</i> See appropriate notes on SD-95971-01-D1 for proper strapping to be made in MF signaling unit.		

STEP	ACTION	VERIFICATION
14	<p>At distribution frame for remote MF signaling unit —            Cross connect T, R, T1, R1 leads to 4-wire voice frequency patching jacks as required per SD-95972-01, CAD 2.</p>	

**Note:** See appropriate notes on SD-95972-01-D1 for proper strapping to be made in MF signaling unit.

#### D. Ground Return Resistance — Control and Remote Ends

**Note:** This test is to be made at both the remote and control ends of the system. If the concentrator unit and its associated MF signaling circuit are located in the same office this test need not be made.

1	<p>Measure ground return resistance following procedure specified in Fig. 1.</p>	<p>Ground return resistance not more than 23 ohms.</p>
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#### E. Insulation Resistance of Signaling Leads — Control End

**Note:** If concentrator and MF signaling circuit appear on same distribution frame, cross connect between terminal strips. In this case, this test need not be made.

1	<p>At distribution frame for concentrator control unit location —            Cross connect signaling leads between concentrator terminal strip and feeder cable pairs assigned as signaling leads per SD-96557-01.</p>	
2	<p>At distribution frame for control MF signaling circuit location —            Cross connect signaling leads between signaling unit terminal strip and feeder cable pairs assigned as signaling leads per SD-95971-01, CADs 1, 2.</p>	
3a	<p>If insulation resistance test is applied as part of this test and inspection procedure or as part of out-of-service tests —            Measure insulation resistance of signaling leads following procedure specified in Fig. 2.</p>	<p>Minimum insulation resistance of 30,000 ohms to GRD or other conductor of pair.</p>
4b	<p>If insulation resistance test is applied to cable pair assigned as signaling leads prior to installation of equipment —            Measure insulation resistance of proposed signaling pairs in accordance with standard practices.</p>	<p>Minimum insulation resistance of 30,000 ohms to GRD or other conductor of pair.</p>

STEP	ACTION	VERIFICATION
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**F. Insulation Resistance of Signaling Leads — Remote End**

**Note:** If concentrator and MF signaling circuit appear on same distribution frame, cross connect between terminal strips. In this case, this test need not be made.

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|----|---|---|
| 1  | At distribution frame for concentrator remote unit location —<br>Cross connect signaling leads between concentrator terminal strip and assigned feeder cable pairs per SD-96557-01.   |   |
| 2  | At distribution frame for remote MF signaling circuit location —<br>Cross connect signaling leads between signaling unit terminal strip and feeder cable pairs assigned as signaling leads per SD-95972-01 CADs 1, 2.       |   |
| 3a | If insulation resistance test is applied as part of this test and inspection procedure or as part of out-of-service tests —<br>Measure insulation resistance of signaling leads following procedure specified in Fig. 2.    | Minimum insulation resistance of 30,000 ohms to GRD or other conductor of pair. |
| 4b | If insulation resistance test is applied to cable pair assigned as signaling leads prior to installation of equipment —<br>Measure insulation resistance of proposed signaling pairs in accordance with standard practices. | Minimum insulation resistance of 30,000 ohms to GRD or other conductor of pair. |

**G. Interference on Signaling Leads — Control End**

- |    |   |  |
|----|---|--|
| 1a | If interference test is applied as part of this test and inspection procedure or as part of out-of-service tests —<br>Measure total interference (ac plus dc) on signaling leads following procedure specified in Fig. 3.                       | Maximum interference voltage of 10 volts dc, 5 volts ac rms, or 10 volts for the sum of dc and peak ac voltages, providing ac voltage component does not exceed 5 volts rms (7.07 volts peak). |
| 2b | If interference test is applied to a cable pair assigned as signaling leads prior to installation of equipment —<br>Ground one lead of assigned signaling pair at proposed location, using this lead, apply test procedure specified in Fig. 3. | Maximum interference voltage of 10 volts dc, 5 volts ac rms, or 10 volts for the sum of dc and peak ac voltages, providing ac voltage component does not exceed 5 volts rms (7.07 volts peak). |
| 3b | Restore cable pair to original condition.   |  |

**Note:** If interference limits are exceeded, and if control concentrator unit to control MF signaling unit single lead resistance does not equal or exceed 400 ohms, use separate cable pairs to extend central office battery and ground at concentrator location to the MF signaling unit in accordance with SD-95971-01 and SD-96556-01. Test for interference as in Step 2 by using both leads of a cable pair shorted together at the MF signaling unit location and with one lead grounded at the concentrator location.

STEP	ACTION	VERIFICATION
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|---|---|--|
| 4 | Strap proper punchings on concentrator unit per SD-96536-01 to provide total signaling lead cable resistance plus inserted artificial resistance as close to 800 ohms maximum as strapping permits. |  |
|---|---|--|

*Note 1:* Determine cable resistance at 68 F based on cable pair make-up. Using the following equation, determine the predicted maximum cable resistance, based on the maximum temperature, the various lengths of cable, whether underground or aerial, the type and gauge of cable.

$$R_c = \frac{(395 + T_m) R_{68 F}}{463} \text{ ohms}$$

$R_c$  = Maximum cable resistance

$T_m$  = Maximum predicted pair temperature

$R_{68 F}$  = Pair resistance at 68 F

Required artificial resistance equals:

$$R_a = 800 - R_c$$

Insert resistance to come as close to this value without exceeding it as the strapping arrangement will allow.

*Note 2:* If little or no interference is measured in Test G, the two units may be placed at a greater distance from each other. In this case, the total signaling lead resistance should be adjusted to as close to 900 ohms maximum as the strapping permits.

#### H. Interference on Signaling Leads — Remote End

- |    |  |  |
|----|--|--|
| 1a | If interference test is applied as part of this test and inspection procedure or as part of out-of-service tests —<br>Measure total interference (ac plus dc) on signaling leads following procedure specified in Fig. 3.                          | Maximum interference voltage of 10 volts dc, 5 volts ac rms, or 10 volts for sum of dc and peak ac voltages, providing ac voltage component does not exceed 5 volts rms (7.07 volts peak). |
| 2b | If interference test is applied to a cable pair assigned as signaling leads prior to installation of equipment —<br>Ground one lead of assigned signaling pair at proposed location and using this lead, apply test procedure specified in Fig. 3. | Maximum interference voltage of 10 volts dc, 5 volts ac rms, or 10 volts for sum of dc and peak ac voltages, providing ac voltage component does not exceed 5 volts rms (7.07 volts peak). |
| 3b | Restore cable pair to original condition.  |  |

*Note:* If interference limits are exceeded, and if remote concentrator unit to remote MF signaling unit single lead resistance does not equal or exceed 400 ohms, use separate cable pairs to extend central office battery and ground from MF signaling circuit to remote concentrator in accordance with SD-95972-01 and SD-96537-01. Test for interference as in Step 2 by using both leads of a cable pair shorted together at the remote concentrator location and with one lead grounded at the MF signaling unit location.

<b>STEP</b>	<b>ACTION</b>	<b>VERIFICATION</b>
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- 4 Strap proper punchings on MF signaling circuit per SD-95972-01 to provide total signaling lead cable resistance plus inserted artificial resistance as close to 800 ohms maximum as strapping permits.

*Note 1:* Determine cable resistance at 68 F based on cable pair make-up. Using the following equation, determine the predicted maximum cable resistance, based on the maximum temperature, the various lengths of cable, whether underground or aerial, the type and gauge of cable.

$$R_c = \frac{(395 + T_m) R_{68 F}}{463} \text{ ohms}$$

$R_c$  = Maximum cable resistance

$T_m$  = Maximum predicted pair temperature

$R_{68 F}$  = Pair resistance at 68 F

Required artificial resistance equals:

$$R_a = 800 - R_c$$

Insert resistance to come as close to this value without exceeding it as the strapping arrangement will allow.

*Note 2:* If little or no interference is measured in Test H, the two units may be placed at a greater distance from each other. In this case, the total signaling lead resistance should be adjusted to as close to 900 ohms maximum as the strapping permits.

#### I. DC to MF Conversion in MF Signaling Circuit — Remote End

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|----|--|---|
| 1  | At control concentrator —<br>Block operated RL2, TM1 relays.               |   |
| 2  | At control MF signaling circuit —<br>Remove ABC relay.                     |   |
| 3  | At remote MF signaling circuit —<br>Block operated RL relay.               | At remote MF signaling circuit —<br>All other relays release. |
| 4  | At remote concentrator —<br>Block operated RRA relay.                      |   |
| 5  | At remote MF signaling circuit —<br>Insulate 6B, 8B contacts of CC3 relay. |   |
| 6  | Block nonoperated CC3 relay.   |   |
| 7  | Connect J5 jack to J7 jack using 3P7D cord.                                |   |
| 8  | Block operated R0, R1 relays.  |   |
| 9  | Remove blocking tool from RL relay.  | T1 relay operates.  |
| 10 | Remove blocking tool from R0, R1 relays.                                   | R0, R1 relays remain operated.                                |
| 11 | Block operated RL relay.   | All relays release.   |
| 12 | Block operated R0, R2 relays.  |   |

**SECTION 067-106-501**

<b>STEP</b>	<b>ACTION</b>	<b>VERIFICATION</b>
13	Remove blocking tool from RL relay.	T2 relay operates.
14	Remove blocking tool from R0, R2 relays.	R0, R2 relays remain operated.
15	Block operated RL relay.	All relays release.
16	Block operated R1, R2 relays.	
17	Remove blocking tool from RL relay.	T3 relay operates.
18	Remove blocking tool from R1, R2 relays.	R1, R2 relays remain operated.
19	Block operated RL relay.	All relays release.
20	Block operated R0, R4 relays.	
21	Remove blocking tool from RL relay.	T4 relay operates.
22	Remove blocking tool from R0, R4 relays.	R0, R4 relays remain operated.
23	Block operated RL relay.	All relays release.
24	Block operated R4, R7 relays.	
25	Remove blocking tool from RL relay.	T5 relay operates.
26	Remove blocking tool from R4, R7 relays.	R4, R7 relays remain operated.
27	Block operated RL relay.	All relays release.
28	Block operated R2, R4 relays.	
29	Remove blocking tool from RL relay.	T6 relay operates.
30	Remove blocking tool from R2, R4 relays.	R2, R4 relays remain operated.
31	Block operated RL relay.	All relays release.
32	Block operated R0, R7 relays.	
33	Remove blocking tool from RL relay.	T7 relay operates.
34	Remove blocking tool from R0, R7 relays.	R0, R7 relays remain operated.
35	Block operated RL relay.	All relays release.
36	Block operated R1, R7 relays.	
37	Remove blocking tool from RL relay.	T8 relay operates.
38	Remove blocking tool from R1, R7 relays.	R1, R7 relays remain operated.
39	Block operated RL relay.	All relays release.
40	At remote concentrator — Block operated CK relay.	R1, R10 relays operate.
41	Remove blocking tool from CK relay.	All relays release.
42	At remote MF signaling circuit — Remove 3P7D cord from J5, J7 jacks.	
43	At remote concentrator — Remove blocking tool from RRA relay, release relay by hand.	

STEP	ACTION	VERIFICATION
44	At remote MF signaling circuit — Remove insulators from 6B, 8B contacts of CC3 relay.	
45	Remove blocking tool from CC3 relay.	
46	Remove blocking tool from RL relay.	S2A, S4A, T6, GBA relays operate. At control MF signaling circuit — R2, R4 relays operate.
47	At control MF signaling circuit — Replace ABC relay.	
48	At control concentrator — Remove blocking tools from TM1, RL2 relays.	

#### J. DC to MF Conversion in MF Signaling Circuit — Control End

1	At control concentrator — Block operated RL2, TM1, SB2 relays.	
2	Block nonoperated M, W1 relays.	
3	At control MF signaling circuit — Remove ABC relay.	
4	Connect J5 jack to J7 jack using 3P7D cord.	At control MF signaling circuit — R2, R4 relays release.
5	Insulate 1M, 2M contacts of MC1 relay.	
6	Block nonoperated MC2 relay.	
7	Block operated MC1, MC3 relays.	T6 relay operates.
8	Operate RLSA relay momentarily.	All relays release.
9	Block operated R0, R1 relays.	T1 relay operates.
10	Remove blocking tools from R0, R1 relays.	R0, R1 relays remain operated.
11	Operate RLSA relay momentarily.	All relays release.
12	Block operated R0, R2 relays.	T2 relay operates.
13	Remove blocking tools from R0, R2 relays.	R0, R2 relays remain operated.
14	Operate RLSA relay momentarily.	All relays release.
15	Block operated R1, R2 relays.	T3 relay operates.
16	Remove blocking tools from R1, R2 relays.	R1, R2 relays remain operated.
17	Operate RLSA relay momentarily.	All relays release.
18	Block operated R0, R4 relays.	T4 relay operates.
19	Remove blocking tools from R0, R4 relays.	R0, R4 relays remain operated.
20	Operate RLSA relay momentarily.	All relays release.

**SECTION 067-106-501**

<b>STEP</b>	<b>ACTION</b>	<b>VERIFICATION</b>
21	Block operated R4, R7 relays.	T5 relay operates.
22	Remove blocking tools from R4, R7 relays.	R4, R7 relays remain operated.
23	Operate RLSA relay momentarily.	All relays release.
24	Block operated R2, R4 relays.	T6 relay operates.
25	Remove blocking tools from R2, R4 relays.	R2, R4 relays remain operated.
26	Operate RLSA relay momentarily.	All relays release.
27	Block operated R0, R7 relays.	T7 relay operates.
28	Remove blocking tools from R0, R7 relays.	R0, R7 relays remain operated.
29	Operate RLSA relay momentarily.	All relays release.
30	Block operated R1, R7 relays.	T8 relay operates.
31	Remove blocking tools from R1, R7 relays.	R1, R7 relays remain operated.
32	Operate RLSA relay momentarily.	All relays release.
33	At control concentrator — Remove blocking tool from M relay.	
34	Block operated M relay.	R2, R7 relays operate.
35	Remove blocking tool from M, W1 relays.	All relays release.
36	At control MF signaling circuit — Block nonoperated S2A, S4A relays.	
37	At control concentrator — Operate RR1 relay momentarily.	R0, R10 relays operate momentarily.
38	At control MF signaling circuit — Operate RLSA relay momentarily.	All relays release.
39	Remove blocking tools from S2A, S4A relays.	
40	Operate momentarily, release by hand RL1 relay.	R1, R10 relays operate momentarily.
41	Block operated RLSA relay.	
42	Remove blocking tools from MC1, MC2, MC3 relays.	
43	Remove insulators from MC1 relay.	
44	Remove 3P7D cord from J5, J7 jacks.	
45	At control concentrator — Remove blocking tool from SB2 relay.	

STEP	ACTION	VERIFICATION
46	At control MF signaling circuit — Remove blocking tool from RLSA relay.	R2, R4, S2A, S4A relays operate. At control concentrator — S2A, S4A relays operate. No other wire-spring relays should operate.
47	At control MF signaling circuit — Replace ABC relay.	
48	At control concentrator — Remove blocking tools from TM1, RL2 relays.	TM1 relay remains operated (if S option is provided).

#### K. Mark Counting in MF Signaling Circuit — Control End

1	At control concentrator — Block operated RL2, TM1 relays.	
2	Block nonoperated W1 relay.	
3	At control MF signaling circuit — Remove ABC, S2, S4 relays.	At control MF signaling circuit — S2A, S4A relays release.
4	Block nonoperated T9, T10 relays.	
5	At control concentrator — Operate M relay momentarily.	MC1, MC2 relays operate.
6	At control MF signaling circuit — Operate RLSA relay momentarily.	All relays release.
7	At control concentrator — Operate M relay four times momentarily.	MC1, MC3 relays operate. MC2 relay releases.
8	At control MF signaling circuit — Operate RLSA relay momentarily.	All relays release.
9	At control concentrator — Operate RR1 relay momentarily.	MC1, MC3 relays operate.
10	At control MF signaling circuit — Operate RLSA relay momentarily.	All relays release.
11	Remove blocking tools from T9, T10 relays.	
12	Replace ABC, S2, S4 relays.	S2A, S4A relays operate.
13	At control concentrator — Remove blocking tools from TM1, W1, RL2 relays.	

#### L. Check Counting in MF Signaling Circuit — Remote End

1	At control concentrator — Block operated RL2, TM1 relays.
2	At control MF signaling circuit — Remove ABC relay from socket.
3	At remote MF signaling circuit — Block nonoperated T11 relay.

**SECTION 067-106-501**

<b>STEP</b>	<b>ACTION</b>	<b>VERIFICATION</b>
4	Remove S2, S4 relays.	At remote MF signaling circuit — T6 relay releases. S2A, S4A relays release.
5	At remote concentrator — Operate HMK relay momentarily.	CC1, CC2 relays operate.
6	At remote MF signaling circuit — Operate RL relay momentarily.	All relays release.
7	At remote concentrator — Operate HMK relay four times momentarily.	CC3 relay operates.
8	At remote MF signaling circuit — Operate RL relay momentarily.	All relays release.
9	Operate RR relay momentarily.	CC3 relay operates.
10	Operate RL relay momentarily.	All relays release.
11	Replace S2, S4 relays.	S2A, S4A relays operate.
12	Remove blocking tool from T11 relay.	
13	At control MF signaling circuit — Replace ABC relay in socket.	
14	At control concentrator — Remove blocking tools from TM1, RL2 relays.	

**M. Test Circuit — Control End**

1	At control concentrator — Block operated RL2, TM1 relays.	
2	At control MF signaling circuit — Remove ABC relay from socket.	
3	Connect J5 jack to J7 jack using 3P7D cord.	At control MF signaling circuit — S2A, S4A relays release.
4	Operate TEST key to L49 position.	TEST lamp lights. No test call is originated.
5	Return TEST key to neutral position.	TEST lamp extinguishes.
6	Block nonoperated AC relay.	
<i>Note:</i> Steps 7, 8 and 9, 10 may be repeated as many times as necessary for verification of momentary relay operations.		
7	Operate TEST key to L49 position.	R2, R10 relays operate momentarily. TR1 relay operates.
8	Restore TEST key to neutral position.	R2, R10 relays operate momentarily. TR1 relay releases.
9	Operate TEST key to L99 position.	R4, R10 relays operate momentarily. TR2 relay operates.

STEP	ACTION	VERIFICATION
10	Restore TEST key to neutral position.	R2, R10 relays operate momentarily. TR2 relay releases.
11	Remove blocking tool from AC relay.	
12	Remove 3P7D cord from J5, J7 jacks.	S2A, S4A relays operate.
13	Replace ABC relay in socket.	
14	At control concentrator — Remove blocking tool from TM1, RL2 relays.	

#### N. Test Circuit — Remote End

1	At remote MF signaling circuit — Insulate 4M contact of CL49 relay.	
2	Insulate 4M contact of CL99 relay.	
3	Block operated R2, R10 relays.	TT1, DL relays operate. CL49 relay operates momentarily.
4	Remove blocking tools from R2, R10 relays.	TT1, DL relays release.
5	Block operated R4, R10 relays.	TT2, CL99 relays operate.
6	Remove blocking tools from R4, R10 relays.	TT2 relay releases.
7	Operate DL relay momentarily.	CL99 relay releases.
8	Remove insulation from CL49, CL99 relays.	

#### O. Timing in MF Signaling Circuits — Control and Remote Ends

1	Perform all timing tests per SD-95971-01, SD-95972-01, timing requirements tables.	Requirements of table are met.
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#### P. Line Insulation

**Note:** This test may be omitted if customer facilities between remote concentrator and customer are the same as those used before concentrator installation and are trouble free.

1	At remote concentrator unit cross connecting terminal — Measure assigned customer line insulation with ohm-meter, by connecting ohm-meter across tip and ring terminals.	Minimum insulation resistance 15,000 ohms.
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**Caution:** *Be sure no potential appears across tip and ring terminals before connecting ohmmeter.*

#### Q. Alarm Circuits

1	At control concentrator unit — Block nonoperated CCK relay.	
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SECTION 067-106-501

STEP	ACTION	VERIFICATION
2	At remote concentrator unit — Initiate call.	At control concentrator unit — CAL alarm relay operates. AL lamp lights. At central office — Alarms operate.
3	At control concentrator unit — Remove blocking tool from CCK relay.	
4	Operate AR (alarm release) key.	At control concentrator unit — CAL relay releases. AL lamp extinguished. At central office — Alarms retired.
5	Block nonoperated RK2 relay.	
6	At remote concentrator unit — Initiate call.	At control concentrator unit — RAL alarm relay operates. AL lamp lights. At central office — Alarms operate.
7	At control concentrator unit — Remove blocking tool from RK2 relay.	
8	Operate AR key.	At control concentrator unit — RAL relay releases. AL lamp extinguished. At central office — Alarms retired.
9	Block nonoperated CCK, RK2 relays.	
10	At remote concentrator unit — Initiate call.	At control concentrator unit — SAL alarm relay operates. AL lamp lights. At central office — Alarms operate.
11	At control concentrator unit — Remove blocking tool from CCK, RK2 relays.	
12	Operate AR key.	At control concentrator unit — SAL relay releases. AL lamp extinguished. At central office — Alarms retired.
13	Block operated CCK, RK2 relays.	
14	At remote concentrator unit — Initiate call.	At control concentrator unit — SAL relay operates. AL lamp lights. At central office — Alarms operate.

STEP	ACTION	VERIFICATION
15	At control concentrator unit — Remove blocking tools from CCK, RK2 relays.	
16	Operate AR key.	At-control concentrator unit — SAL relay releases. AL lamp extinguished. At central office — Alarms retired.
17	Block nonoperated S2A relay.	
18	At remote concentrator unit — Initiate call.  <i>Note:</i> When S option is provided a call should not be initiated, since it is unnecessary.	At control concentrator unit — SAL relay operates. AL lamp lights. At central office — Alarms operate.
19	At control concentrator unit — Remove blocking tool from S2A relay.	
20	Operate AR key.	At control concentrator unit — SAL relay releases. AL lamp extinguished. At central office — Alarms retired.
21	Repeat Steps 17 through 20 for S4A relay observing S option caution.	Same as Steps 17 through 20.
22	At control concentrator unit — Insert and remove operated fuse in each fuse location.  <i>Note:</i> After each removal of operated fuse AR key must be operated to retire alarms and extinguish FA lamp.	At control concentrator unit — FA alarm relay operates for each insertion of fuse. FA lamp lights. At central office — Alarms operate.
23	At remote concentrator unit — Insert operated fuse into CHG fuse holder.	At remote concentrator unit — CF relay operates. FA lamp lights. At remote central office — Alarms operate.
24	Remove operated fuse from CHG position and replace with original fuse.	At remote concentrator unit — CF relay releases. FA lamp extinguishes. At remote central office — Alarms retire.

STEP	ACTION	VERIFICATION
25	<p>Insert and remove operated fuse in each fuse location, one at a time, except at CHG, M fuse positions.</p> <p><i>Note:</i> After removing operated fuse, replace the original fuse. This will cause the FAL relay to release, FA lamp to extinguish, and alarms to retire. If alarms do not retire, follow local procedures to achieve this.</p>	<p>FAL relay operates for each insertion of fuse.</p> <p>FA lamp lights.</p> <p>At remote central office —</p> <p>Alarms operate.</p>

#### R. Circuit Operation and Line and Trunk Call Through

1	<p>At control concentrator unit —</p> <p>Cross connect terminals 3, 7 of TLC0 relays and terminals 3, 7 of TLC1 relays using cord W1AP equipped with No. 30 Mueller Mini-Gator clips or equivalent.</p>	
2	<p>Activate one directory number, associated line equipment for use as temporary test line.</p> <p><i>Note:</i> In addition, a telephone set which can be used to terminate calls to the temporary test line should be available at the control concentrator unit location. The spare telephone jack on the control concentrator unit may be cross connected to a line equipment at the concentrator spare jack terminal block on the distribution frame and used for this purpose.</p>	
3	<p>At control concentrator unit on distributing frame —</p> <p>Cross connect temporary test line equipment to concentrator line terminal 00 on concentrator terminal strip.</p>	
4	<p>At remote concentrator unit —</p> <p>Place dial hand test set across concentrator screw terminals for line terminal 00.</p>	
5	<p>Place dial hand test set in off-hook condition.</p>	Dial tone received.
6	<p>Dial one or two digits.</p>	Dial tone removed.
7	<p>Return test set to on-hook condition, observe that call disconnects.</p>	Crosspoints should release and the CO-relay in both concentrator units should operate. (See Test B.)
8	<p>At control concentrator unit —</p> <p>Dial temporary test line directory number.</p>	Ringling heard at both concentrator units.
9	<p>Release test call, observe that call disconnects.</p>	Crosspoints should release and the CO-relay in both concentrator units should operate. (See Test B.)

*Note:* This test assures that the line is capable of completing a call to one trunk. Calls using another trunk may fail due to bent select fingers, crosspoints not closing correctly (mechanical or dirt), or crosses in the vertical pile up. Therefore, it seems desirable to use additional testing efforts which would assure the completion of calls from each line to each trunk.

STEP	ACTION	VERIFICATION
	<i>Caution: If any CO- relay is found released at the start of a test, the cause should be found. It may be necessary to reoperate the CO- relay and make all the previous operational tests and observe after each test whether this CO- relay will release due to a call on a line not associated with the CO- relay.</i>	
10	At remote concentrator unit — Move dial hand test set to line terminal 01.	
11	At control concentrator unit — Remove cross connections between frame terminal strip and control concentrator unit terminal strip for line 00.	
12	Cross connect temporarily T, R, and S of line 00 to T, R, and S of line 01 on frame terminal strip, using 1W13A test cords equipped with 360, 624B tools.	
	<i>Note:</i> Frame terminal strip to control concentrator unit terminal strip cross connections should only be removed for line 00; other lines are open at the distributing frame concentrator terminal strip.	
13	Repeat Steps 5 through 12 until all lines in each group, except lines 49 and 99, have been tested.	Same as Steps 5 through 12.
	<i>Note:</i> See Section 067-106-502, System Tests, for method of testing lines 49 and 99 for originating service. Terminating requests can be made as above.	
14	Check that all CO- relays are operated.	See Test B.
15	At control concentrator unit on frame terminal strip — Remove cross connections between line terminals 00 and last line tested.	
16	At control concentrator unit — Remove jumpers from TLC0, TLC1 relays and assure all hold magnets unblocked, released.	

**S. Trunk Transmission, Overflow Tone, Trunk Disconnect Sequence, and Trunk Load Control**

1	At control concentrator unit — Cross connect line terminal 00 from frame terminal block to control concentrator unit terminal block temporarily, using 1W13A test cords equipped with 360, 624B tools.	
2	At remote concentrator unit — Place hand set across line terminal 00, simulating on-hook condition.	
3	At control concentrator unit — Dial temporary test line directory number.	Receive ringing at both concentrator ends. Trunk 00 will be selected, connected.

SECTION 067-106-501

STEP	ACTION	VERIFICATION
4	Block operated TB00 relay.	
5	At remote concentrator unit — Place hand set in off-hook condition when ringing received.	By means of conversation, verify talking path and transmission.
6	Place receivers at both locations on-hook.	
7	At control concentrator unit — Remove temporary test cord cross connections between frame and control concentrator unit terminal strips for line 00.	
8	Cross connect temporarily line terminals 00, 01 using test cords on frame terminal strip.	
9	At remote concentrator unit — Remove dial hand test set from line terminal 00, place on line terminal 01.	
10	Repeat Steps 3 through 9 for lines 01 through 09.	Same as Steps 3 through 9.
	<b>Note:</b> TB relays 00 through 09 should be blocked operated and trunks 00 through 09 should be connected to lines 00 through 09. Trunks are selected in order from 00 to 09.	
11	Repeat Steps 7, 8 for line 10.	Same as Steps 7, 8.
12	At control concentrator unit — Place terminating call to line 10.	Terminating call receives overflow tone.
13	Block nonoperated DP0 relay.	
14	Remove blocking tools from TB00 through 09 relays.	
15	Remove blocking tool from DP0 relay.	Observe that trunks 00 through 05 or 06 disconnect and that they disconnect in order from zero up, one disconnect occurs about every 6 seconds.
16	Repeat Steps 1 through 13 for lines 50 through 60 (group 1).  <b>Note:</b> Cross connection in Step 1 shall be between line terminals 00 and 50 on frame terminal strip, then between 00 and 51 etc.	
17	Remove all temporary test lead cross connections.	
18	Replace regular cross connections between frame and control concentrator unit terminal strips for line 00.	

STEP	ACTION	VERIFICATION
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**T. Service Denial Call**

*Note:* This is only a test procedure. Service denial calls should be placed in accordance with Section 067-106-502 — Line Concentrator No. 1A with MF Signaling System Tests.

- |   |   |   |
|---|---|---|
| 1 | At control concentrator unit —<br>Cross connect terminal A69 of concentrator unit terminal block to terminal 3 of CO- relay in group 0 temporarily. |   |
| 2 | Operate T0 key, release as soon as COK lamp lights.   |   |
| 3 | Remove cross connection between CO- relay, terminal A69.  |   |
| 4 | At remote concentrator unit —<br>Initiate call from line which has been denied service.   | Service request will not be served.<br>No dial tone received. |
| 5 | At control concentrator unit —<br>Place terminating call to line denied service to restore cutoff relay.  |   |
| 6 | Repeat Steps 1 through 5 for any line in group 1.   | Same as Steps 1 through 5.                                    |

*Note:* T1 key is used for service denial calls in group 1.

**U. Dial Tone Speed Register**

*Note:* The central office dial tone speed register circuit must be operating when performing Test U. Block relays only as long as required for this test. Traffic should be notified of the number of registrations because of this test.

- |   |  |  |
|---|--|--|
| 1 | At control concentrator unit —<br>Block operated TGB0 relay. | One registration on meter associated with group 0. |
| 2 | Remove blocking tool from TGB0 relay.                        |  |
| 3 | Block operated TGB1 relay.                                   | One registration on meter associated with group 1. |
| 4 | Remove blocking tool from TGB1 relay.                        |  |

**V. Trunk Group Usage Recorder**

*Note:* For procedures to follow when performing Test V, refer to section entitled Concentrator Trunk Usage Recorder (SD-96549-01) Miscellaneous Tests.

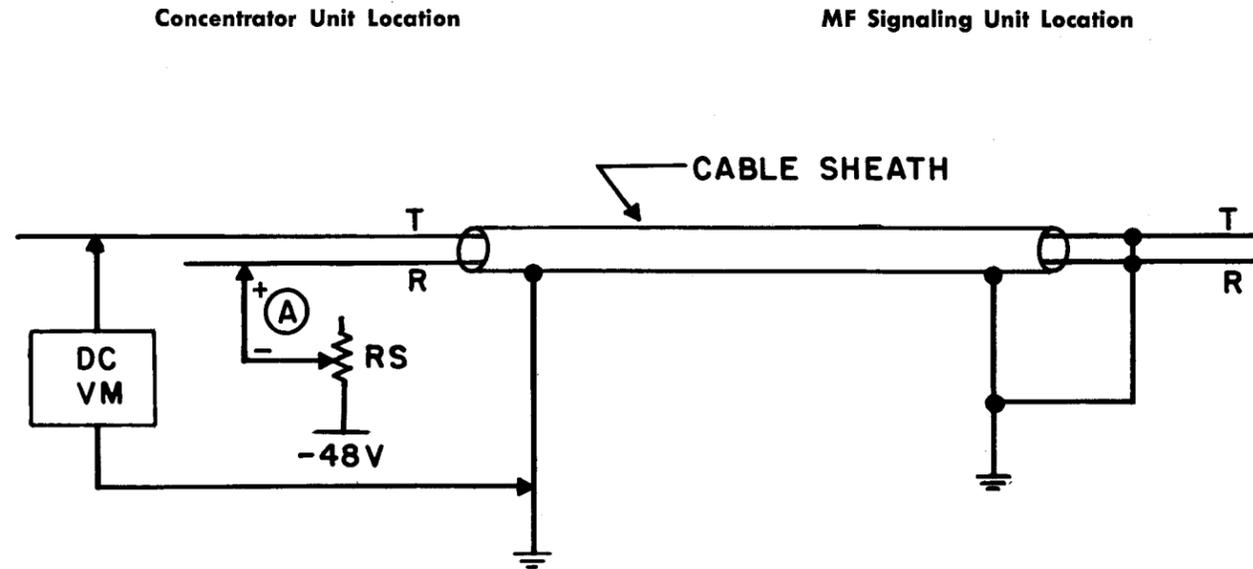


Fig. 1 - Measurement of Ground Return Resistance

**METHOD**

STEP	ACTION	VERIFICATION
<p><i>Note:</i> This test is to be made at the remote end if the remote concentrator and remote MF signaling circuit are not in the same office. This test is to be made at the control end if the control concentrator and control MF signaling circuit are not in the same office.</p>		
1	Establish a cable pair between the concentrator unit location and MF signaling unit location for test purposes.	
2	At the MF signaling unit location — Ground the tip and ring leads of the test pair to cable sheath ground.	
3	At the concentrator unit — Measure dc voltage $E_1$ from tip lead to building ground determining polarity of voltage relative to ground. [Plus (+) for positive, minus (-) for negative.]	
4	Connect 48 volts to ring lead in series with sufficient resistance (RS) to maintain current (I) between 40 MA and 140 MA. (Wattage rating of (RS) should be equal to $I^2(RS)$ watts.)	
5	Measure current I.	
6	Measure dc voltage $E_2$ from tip lead to building ground with about 140 MA ring lead current flowing. (Determine polarity as in Step 3.)	

STEP	ACTION	VERIFICATION
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7	Resistance of group return (approximate) $= \frac{\pm E_2 \pm E_1}{I} \text{ ohms.}$	
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**Example:**

$E_1 = -0.4\text{V}$  (Step 3)

$E_2 = +3.2\text{V}$  (Step 6)

$I = 0.140\text{A}$  (Steps 4 and 5)

Ground return resistance =  $\frac{+3.2-0.4}{0.140} = 20 \text{ ohms}$  (Step 7)

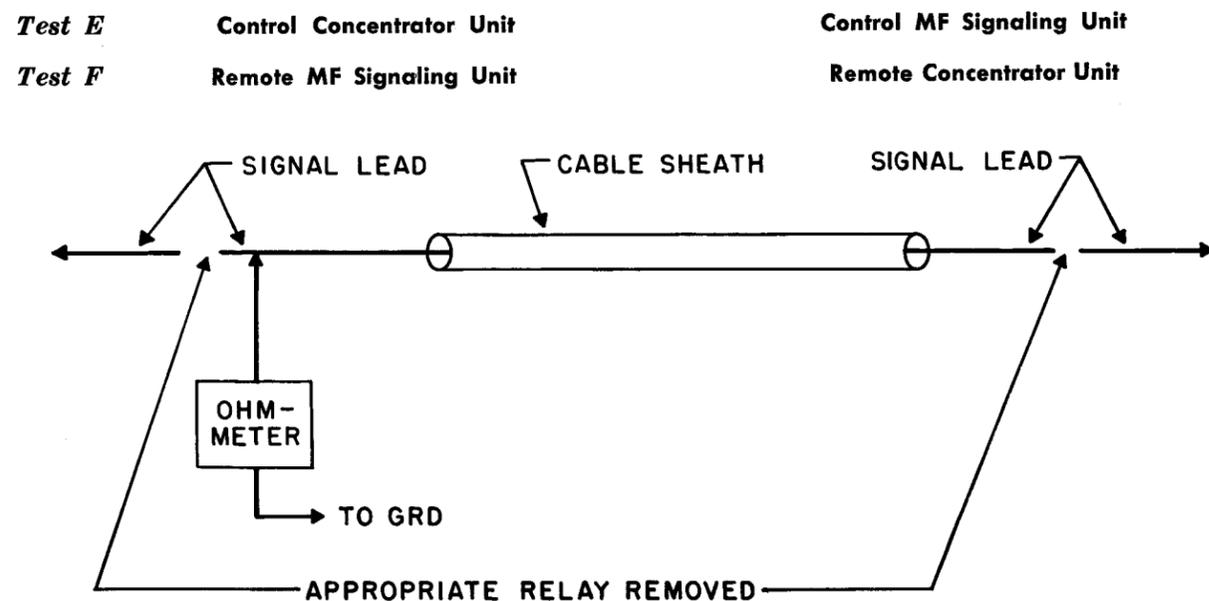


Fig. 2 - Measurement of Signal Lead Insulation Resistance

**METHOD**

STEP	ACTION	VERIFICATION
<b>E. Measurements at Control Concentrator Unit</b>		
1	Remove S1 relays in both units.	
2	Measure leakage of TS0 at CAD 6 terminal 70.	
3	Remove S3 relays in both units.	
4	Measure leakage of RS0 at CAD 6 terminal 60.	
5	Remove M relay in control MF signaling unit.	
6	Measure leakage of TS1 at CAD 6 terminal 71.	
7	Remove RS1 lead from terminal at control MF signaling unit.	
8	Measure leakage of RS1 at CAD 6 terminal 61.	
9	Correct any leakage found less than 30,000 ohms.	
10	Replace all relays.	

STEP	ACTION	VERIFICATION
<b>F. Measurements at Remote MF Signaling Unit</b>		
1	Remove S1 relays in both units.	
2	Measure leakage of TS0 at CAD 1 terminal 52.	
3	Remove S3 relays in both units.	
4	Measure leakage of RS0 at CAD 1 terminal 42.	
5	Remove M relay in remote concentrator unit.	
6	Measure leakage of TS1 at CAD 1 terminal 32.	
7	Remove RS1 lead from screw terminal in remote concentrator unit.	
8	Measure leakage of RS1 at CAD 1 terminal 22.	
9	Correct any leakage found less than 30,000 ohms.	
10	Replace all relays.	

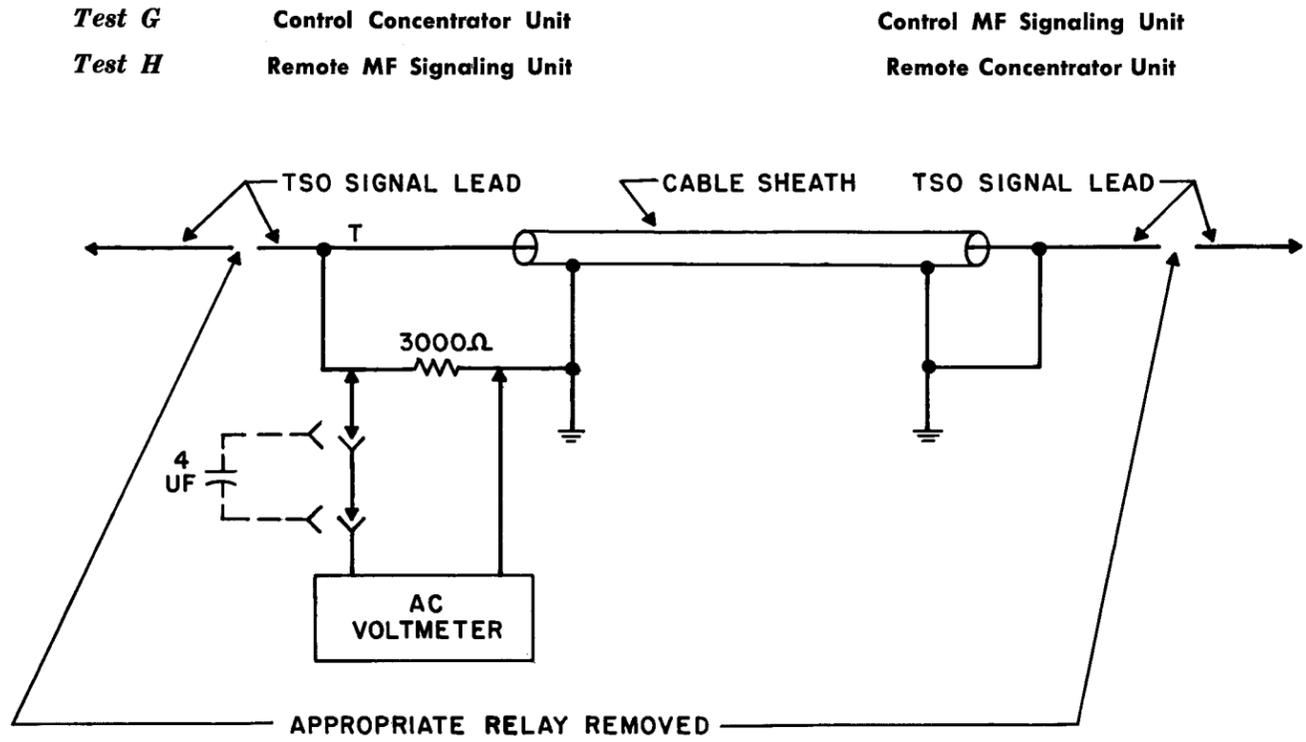


Fig. 3 - Measurement of Total Interference on Signal Leads

STEP	ACTION	VERIFICATION
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- | STEP | ACTION  | VERIFICATION         |
|------|---|----------------------|
|      |   | <b>H. Remote End</b> |
| 1    | Remove S1 relays in both units.   |                      |
| 2    | At remote concentrator —<br>Ground TSO lead to cable sheath ground.                       |                      |
| 3    | At MF signaling unit —<br>Terminate TSO lead to ground with 3000 ohms as shown in Fig. 3. |                      |
| 4    | Measure ac voltage across 3000 ohms.  |                      |

**Note:** AC voltmeter should isolate ac from dc. If meter does not isolate dc, A 4 uf capacitor should be placed in series with the voltmeter leads as shown by the dotted lines in Fig. 3.

**Example:**

Signaling current = 0.100 AMP (for all cases)  
 Ground return resistance (obtained in Test D) = 20 ohms  
 DC voltage = (0.100) x 20 = 2 volts  
 Total interference (ac + dc) = 2 volts + 1.414 (ac voltage)

**Note:** AC voltage component must be 5 volts RMS or less.

**METHOD**

STEP	ACTION	VERIFICATION
------	--------	--------------

- | STEP | ACTION   | VERIFICATION          |
|------|--|-----------------------|
|      |  | <b>G. Control End</b> |
| 1    | Remove S1 relay in concentrator, S2 relay in MF signaling unit.                          |                       |
| 2    | At MF signaling unit location —<br>Ground TSO lead to cable sheath ground.               |                       |
| 3    | At the concentrator —<br>Terminate TSO lead to ground with 3000 ohms as shown in Fig. 3. |                       |
| 4    | Measure ac voltage across 3000 ohms.   |                       |

**Note:** AC voltmeter should isolate ac from dc. If meter does not isolate dc, a 4 uf capacitor should be placed in series with the voltmeter leads as shown by the dotted lines in Fig. 3.

**Example:**

Signaling current = 0.100 AMP (for all cases)  
 Ground return resistance (obtained in Test D) = 20 ohms  
 DC voltage = (0.100) x 20 = 2 volts  
 Total interference (ac + dc) = 2 volts + 1.414 (ac voltage)

**Note:** AC voltage component must be 5 volts RMS or less.

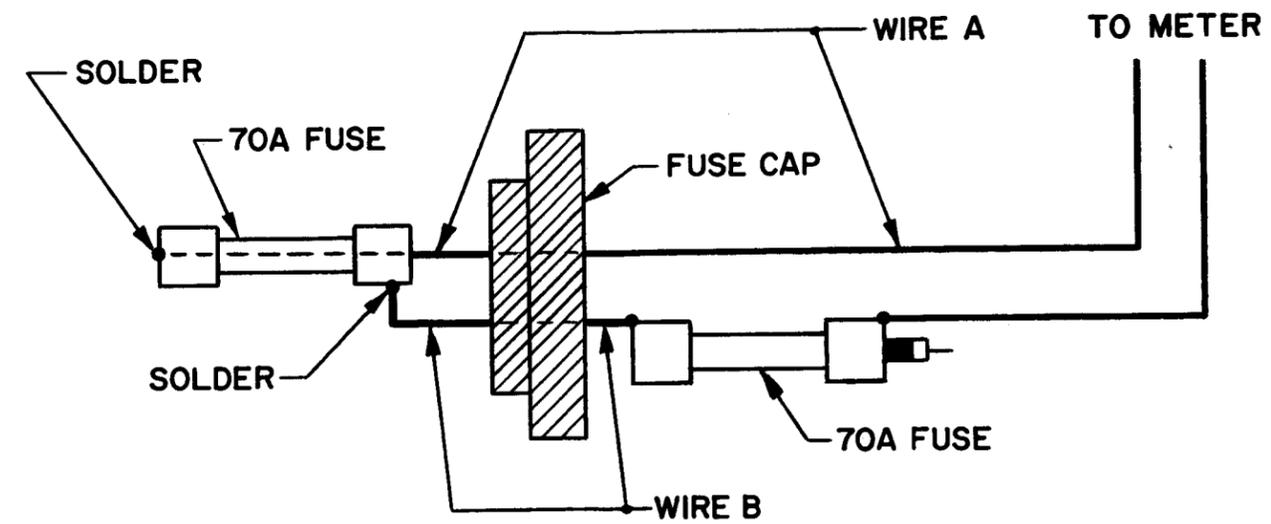


Fig. 4 - Construction of Dummy Fuse for Charge Current Measurements

**METHOD**

STEP	ACTION	VERIFICATION
1	Unsolder fuse element of 70A fuse.	
2	Remove element, spring, cap, plastic tip, etc.	
3	Replace fuse element with wire connections as shown.	
4	Thread wire through fuse cap.	
5	Solder 70A fuse into circuit with B wire.	
6	Tape bare parts of fuse.	