PRIVATE LINE TELEPHONE SERVICE
VOICE ONLY
MULTISTATION SYSTEMS
TESTS AND ADJUSTMENTS

CONTENTS PAGE

1. GENERAL

1.01 This section contains test procedures, requirements, and adjustments applicable to multistation private line telephone circuits. Circuits for the Federal Aviation Agency (FAA) are covered in Sections 310-410-100, 310-410-300, and 310-410-500.

1.02 This section is reissued to update requirements and to include the latest types of central office and station terminating equipment. Since this is a general revision, change arrows are not used.

1.03 Section 310-405-100 contains descriptive information on multipoint private line telephone services.

1.04 Routine intervals to be applied to multistation private line telephone circuits are specified in Equipment Test List (ETL) 310-001-011.

2. DEFINITIONS OF TERMS

2.01 Various terms are used in this practice related to multistation private line services. Definitions of these terms are as follows (see Fig. 1):

Bridge: A resistance network used to interconnect more than two facilities. A bridge may be 2-wire or 4-wire.

Backbone or Main-Line Circuit: The backbone or main-line circuit is that portion of a multistation private line telephone circuit that extends from the control office to the most remote toll office. Where the circuit radiates in more than one direction from the control office, there will be more than one backbone circuit.

Mid Link: The mid links are those portions of the main-line circuit that connect the bridging offices. Connections between bridges within an office do not constitute a mid link.

End Link: The end link, or branch, includes all facilities between the central office bridge leg and the served station.

Toll Facilities: The facilities between any two toll offices are called toll facilities. These are also referred to as interexchange facilities.

Loop or Local Channel: The loop or local channel consists of all the facilities between the last toll office and the subscriber. The loop may be 4-wire or 2-wire. In the case

of 4-wire loops, the portion used for transmitting from the station is the transmit loop, and the portion used for receiving at the station is the receive loop.

Local Central Office: The local central office is the telephone office at which the exchange portion of the loop is terminated.

Subscriber Loop Facilities: These are the facilities between the local central office and the subscriber location.

Bridging Office: A bridging office is one where the circuit is routed through a bridge.

Serving Test Center (STC): The STC is a designated office responsible for testing transmission facilities, station equipment, and apparatus in response to a customer report either taken directly or received from another office. The STC is also responsible for maintaining records and preparing reports as required on circuits or links for which it has been designated STC. An STC usually, but not necessarily, has access to the circuit.

Plant Control Office (PCO): The PCO is the designated office that is responsible for all maintenance activities on a circuit or circuit link. The PCO maintains records for each circuit for which it is responsible and must be informed of all troubles and activities relating to the circuits assigned to it.

Transmission Level Point (TLP): The TLP is a point in a circuit at which the transmission level (in dB) is defined as the nominal or design gain (or loss) at 1000 Hz referenced to an arbitrary point in the system called the 0 TLP. In application to multistation private line telephone circuits, the TLPs are the testing levels to be used for transmission measurements. The TLPs are indicated on circuit layout records (CLRs).

3. SERVICE CONSIDERATIONS

3.01 The customers who use multipoint private line telephone services rely heavily on these services and place much importance on having them available and in working order. For this reason:

(a) No work or testing of any kind should be done on the circuit without the approval of the PCO except for circuit restoration activities.

(b) The customer should be contacted by the PCO (unless other mutually agreed upon arrangements have been made) to obtain releases on the circuit or portions of the circuit before performing any activity that may affect service.

(c) The circuit should not be used as an order wire during the performance of maintenance or restoral procedures if any other means of communications is available. As some stations may be equipped with loudspeakers, maintenance activities and test tones will be objectionable to people at those locations.

(d) Pre-planned reroutes and patching procedures are recommended.

3.02 Releases requested should be as short as possible and if additional time is required, it should be requested as soon as the requirement is recognized. If only one branch or end link is to be worked on, the rest of the circuit can usually be left intact and used by the customer. This should be considered when releases are requested.

3.03 The office obtaining the release, normally the PCO, must be informed of the progress of work performed so that the releases may be extended or terminated on a timely basis.

3.04 Any changes in facilities or equipment on the circuit, such as temporary carrier channel patches, should not be performed without the PCO having knowledge of the activity.

3.05 Circuit order testing on new or additional services should be performed as far in advance of the service date as practical to allow time for correcting unforeseen problems and difficulties. When adding to existing services, such as adding stations or end links, thorough testing is necessary to ensure that the rest of the circuit will not be adversely affected by the addition.

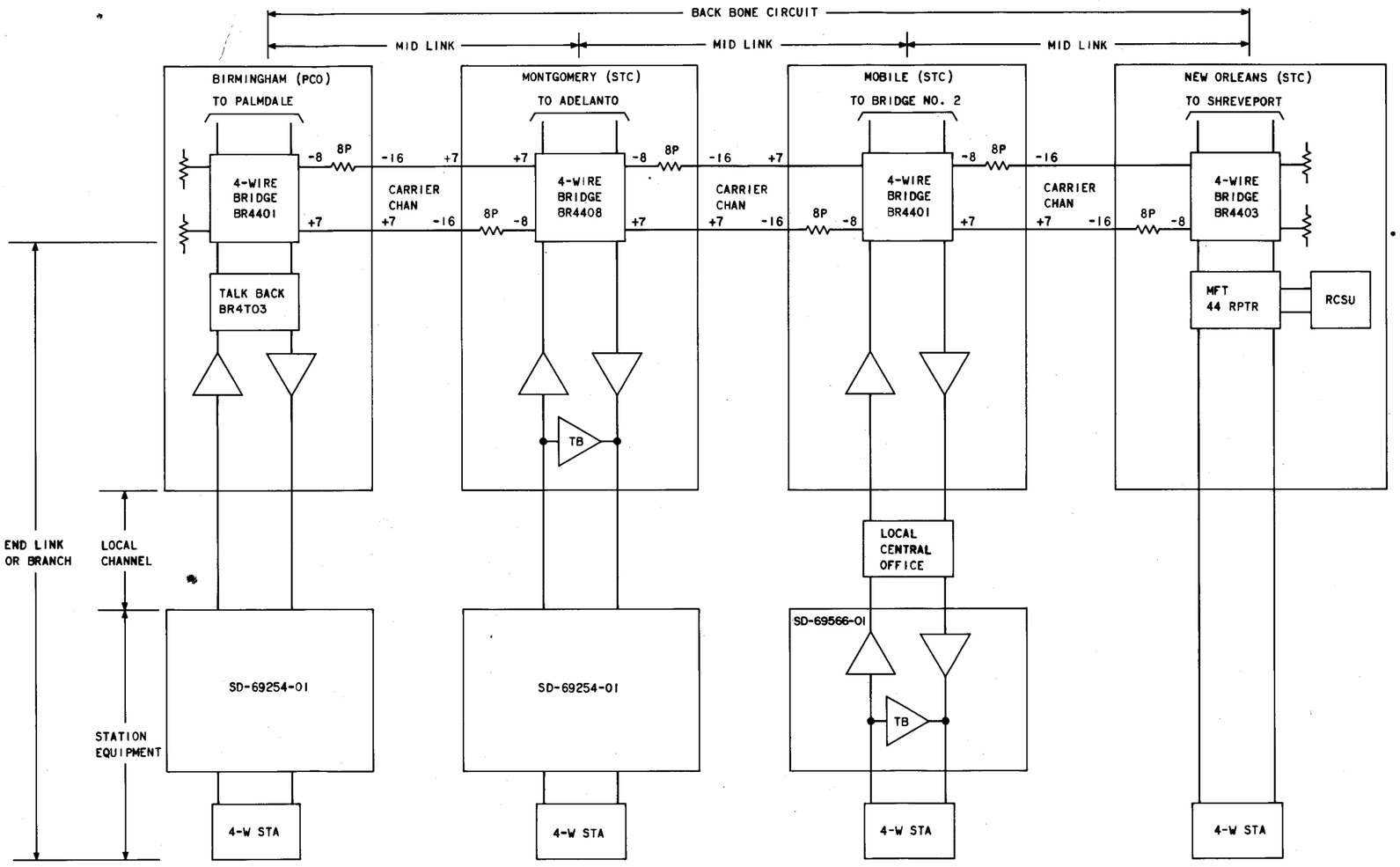


Fig. 1—Typical Multistation Private Line Telephone Circuit

4. TEST EQUIPMENT

4.01 Accurate measurements require good test equipment. All test equipment should be tested to ensure that it is working and is properly calibrated. Ample warmup time is important for stable operation of the test equipment.

4.02 Table A is a partial listing of test equipment that may be used. Other standard equivalent test sets may be used when those listed are not available.

4.03 The application of dc voltage to the input of certain test equipment may damage the equipment and affect the accuracy of measurements. To prevent accidental exposure of the test equipment to dc potentials, a voltage measurement with a KS-14510 voltmeter should first be made across the line pair. If 1 volt dc or more is present, an isolation or holding coil arrangement must be used.

4.04 Figure 2 shows two common methods of providing dc isolation. The J94002AB (2AB) auxiliary transmission test set arrangement per Fig. 2A is preferred. To use the 2AB test set for this purpose, it should be prepared as in the following procedure.

TABLE A

RECOMMENDED TEST EQUIPMENT

MEASUREMENT/TEST	TEST EQUIPMENT	REFERENCE
1000-Hz Loss & Slope	Hewlett-Packard 3550B Portable Test Set	Mfr. Manual
	Hewlett-Packard 4940A Transmission Impairment Test Set	Mfr. Manual
	Northeast Electronics TTS4BNH	Mfr. Manual
	Northeast Electronics TTS4BNH-N	Mfr. Manual
	Northeast Electronics TTS15B	Mfr. Manual
	Northeast Electronics TTS35B	Mfr. Manual
	TTI 1103A, 1103B Digital Transmission Test Set	Mfr. Manual
	WECo 21A TMS	103-221-100, -101
	WECo 23-type TMS (detector only)	103-223-100, -101
Message Noise	Hewlett-Packard 4940A Transmission Impairment Test Set	Mfr. Manual
	Northeast Electronics TTS4BNH-N	Mfr. Manual
	TTI 1105 Level/Noise Digital Test Set	Mfr. Manual
	WECo 3-type NMS	103-611-100, -101, -102
	WECo 6F Voiceband NMS	103-626-100
DC Voltage and Ringing Voltage	KS-14510 VOM	100-520-101
Signaling	Northeast Electronics TTS26B Signaling Test Set	Mfr. Manual
	WECo 1A, 2B or 4A Signaling Test Set	100-262-101 100-263-501 100-267-101
Return Loss (Echo and Singing)	KS-20501 Return Loss Measuring Set	103-106-115
	WECo 2D or 2E Singing Point Test Set	103-106-105
	WECo 54C Return Loss Measuring Set	103-106-110
	Wiltron Model 9031 Return Loss Measuring Set	Mfr. Manual

STEP	PROCEDURE
1	Connect the line to be measured to the MEAS jack with suitable patch cords.
2	Connect the oscillator (OSC) to the OSC jack or binding posts.
3	Connect the transmission measuring set (TMS) to the TMS jack or binding posts.
4	Operate the DIAL/SLV key to the normal position.
5	Operate the 2 DB PAD IN/OUT key to the OUT position.
6	Select the mode of operation and impedance desired.

STEP	PROCEDURE
7	Allow for 0.5-dB loss in the 2AB set when reading the TMS and sending test tones.

4.05 An alternate dc isolation arrangement may be developed locally as shown in Fig. 2B. The loss in this arrangement is negligible at voice frequencies, and no corrections are required.

5. REQUIRED TESTS

5.01 The tests required on multistation private line telephone circuits are shown in Table B.

5.02 Circuit order tests are to be performed on initial installations and whenever any subsequent changes or additions are made that might affect the operating or transmission characteristics of the circuit.

5.03 Circuit order test results often prove to be valuable references during trouble locating procedures. For this reason, the results obtained during circuit order testing should be carefully recorded for use as a bench mark and filed with CLRs or at some other location readily available for reference.

5.04 Maintenance procedures on circuit components and equipment units should be scheduled

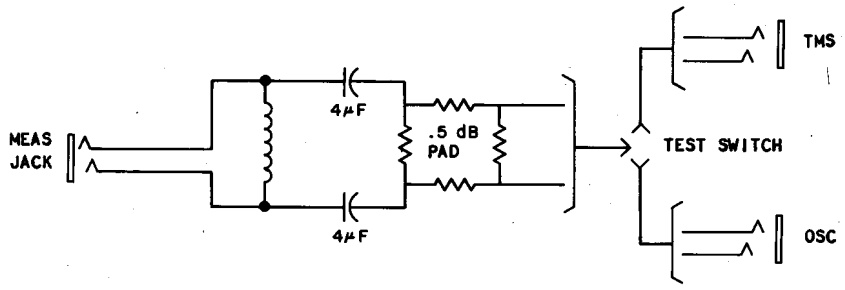


FIG. 2A 2AB SET USED FOR DC ISOLATION

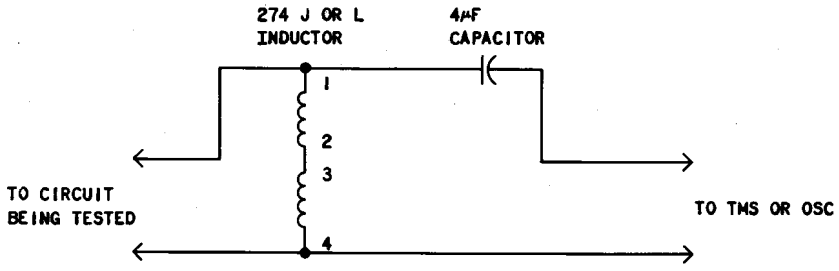


FIG. 2B LOCALLY PREPARED HOLDING ARRANGEMENT

Fig. 2—DC Isolation and Holding Coil Arrangement

and performed as called for in the appropriate ETLs.

6. TEST REQUIREMENTS

6.01 Table C gives the 1000-Hz loss deviation limits.

6.02 The frequency response requirements are given in Table D. A (−) sign indicates less loss and a (+) sign indicates more loss than the 1000-Hz actual measured loss (AML).

6.03 C-message noise requirements are given in Table E. The circuit length in miles is the length of the link or links contributing noise at the point of measurement. The length in miles is given on the CLR.

6.04 When the loop-back method is used to measure message circuit noise, the one-way mileage should be doubled to obtain limits.

6.05 Return loss measurements are required only for end links that are on 2-wire facilities or that serve 2-wire stations over 4-wire facilities. Although the requirement is stated in terms of singing return loss (SRL), and SRL is usually measured initially, if the SRL measurement does not meet the requirement, the circuit should be aligned for maximum echo return loss (ERL). Once ERL is maximized the circuit should be measured again for SRL.

Requirement: Each end link must meet a minimum SRL of 10 dB.

7. CENTRAL OFFICE EQUIPMENT TEST

A. Repeaters, Amplifiers, Equalizers

7.01 All repeaters and amplifiers should be adjusted to the gains shown on the CLRs.

7.02 Equalizers, pads, and other equipment should be exactly as called for on the CLR. Any deviations between equipment installed and equipment called for on the CLR should be referred to engineering forces for resolution.

B. Bridges

7.03 When a bridging arrangement is initially assigned to a service, it should be tested in accordance with Tables F, G, or H and Fig. 3A, 3B, or 3C.

7.04 The tests consist of applying 1000 Hz at 0 dBm to the bridge inputs and measuring the loss at the bridge outputs.

7.05 A 3-type or 6F NMS is required to measure the bridge echo path loss (−60 to −80 dB). To use the 3-type NMS in this manner, it is necessary to convert the NMS dBrn reading to dBm. This is done by subtracting the NMS reading from −90 reference. (0 dBm = 90 dBrn)

Example 1: Reference = −90
NMS reads 15 dBrn −(−15)
Level in dBm = −75

Example 2: Reference = −90
NMS reads 30 dBrn −(−30)
Level in dBm = −60

TABLE B

TEST REQUIRED ON MULTISTATION PRIVATE LINE TELEPHONE CIRCUITS

TEST	CIRCUIT ORDER	ROUTINE	TROUBLE	REFERENCE
1000-Hz LOSS DEVIATION				
End Link	X	X	X	9.01
Mid Link	X	X	X	10.02
Overall Backbone	X	X	X	10.04
FREQUENCY RESPONSE				
End Link	X		X	9.01
Backbone	X		X	10.04
C-MESSAGE NOISE				
End Link	X	X	X	9.08
Mid Link	X	X	X	10.02
Backbone	X	X	X	10.04
RETURN LOSS				
End Link (2-Wire Only)	X		X	9.11
OPERATIONAL TESTS				
Signaling	X		X	11.01
Talking	X		X	11.01
CENTRAL OFFICE EQUIPMENT				
Talk-Back Measurement	X		X	7.03
Bridge Loss	X		X	7.03
Amplifier Gains	X		X	7.01
Cross-Office Tests	X		X	7.06
STATION EQUIPMENT				
Talk-Back Measurement	X	X	X	8.02
Loss Measurements			X	8.02
LOOP TESTS				
DC Resistance	X		X	

TABLE C

1000-Hz LOSS DEVIATION
MAXIMUM DEVIATION FROM EML STATED ON CLR

	CIRCUIT ORDER	ROUTINE/TROUBLE
END LINK	±0.5 dB	±2.0 dB
MIDDLE LINK	±0.5 dB	±1.0 dB
OVERALL BACKBONE	±1.0 dB	±4.0 dB

TABLE D

FREQUENCY RESPONSE REQUIREMENTS
ALLOWABLE DEVIATION FROM 1000-Hz AML
(IN dB) MEASURED AT 400 Hz AND 2800 Hz

NO. MID LINKS ON CIRCUIT	REQUIREMENTS END LINKS	MID LINKS
0	−1.5 To +4.0	
1	−1.0 To +4.0	−1.0 To +3.5
2	−1.0 To +4.0	−1.0 To +3.5
3	−1.0 To +3.5	−0.8 To +3.5
4	−0.8 To +3.5	−0.8 To +3.0
OVERALL BACKBONE	−2.0 To +8.0	

TABLE E

C-MESSAGE NOISE REQUIREMENTS

CIRCUIT LENGTH (MILES)	MAXIMUM NOISE (dBrnc0)
0— 50	31
51— 100	34
101— 400	37
401— 1000	41
1001— 1500	43
1501— 2500	45
2501— 4000	47
4001— 8000	50
8001—16000	53
Satellite Channel	44*

* Add this figure to land line requirement on a random power basis to obtain the overall circuit requirement.

TABLE F (FIG. 3A)

44-TYPE BRIDGE

SENDING ON INPUT TERMINALS	LOSS IN DB RECEIVING AT OUTPUT TERMINALS SIDE 1	SIDE 2	SIDE 3	SIDE 4
Side 1	75*	15 ±0.5	15 ±0.5	15 ±0.5
Side 2	15 ±0.5	75*	15 ±0.5	15 ±0.5
Side 3	15 ±0.5	15 ±0.5	75*	15 ±0.5
Side 4	15 ±0.5	15 ±0.5	15 ±0.5	75*

* Loss should be at least 75 dB (maximum reading of 15 dBrn on 3-type NMS).

TABLE G (FIG. 3B)

46-TYPE BRIDGE

SENDING ON INPUT TERMINALS	LOSS IN DB RECEIVING AT OUTPUT TERMINALS SIDE 1	SIDE 2	SIDE 3	SIDE 4	SIDE 5	SIDE 6
Side 1	80*	19.5 ±0.5	19.5 ±0.5	19.5 ±0.5	19.5 ±0.5	19.5 ±0.5
Side 2	19.5 ±0.5	80*	19.5 ±0.5	19.5 ±0.5	19.5 ±0.5	19.5 ±0.5
Side 3	19.5 ±0.5	19.5 ±0.5	80*	19.5 ±0.5	19.5 ±0.5	19.5 ±0.5
Side 4	19.5 ±0.5	19.5 ±0.5	19.5 ±0.5	80*	19.5 ±0.5	19.5 ±0.5
Side 5	19.5 ±0.5	19.5 ±0.5	19.5 ±0.5	19.5 ±0.5	80*	19.5 ±0.5
Side 6	19.5 ±0.5	19.5 ±0.5	19.5 ±0.5	19.5 ±0.5	19.5 ±0.5	80*

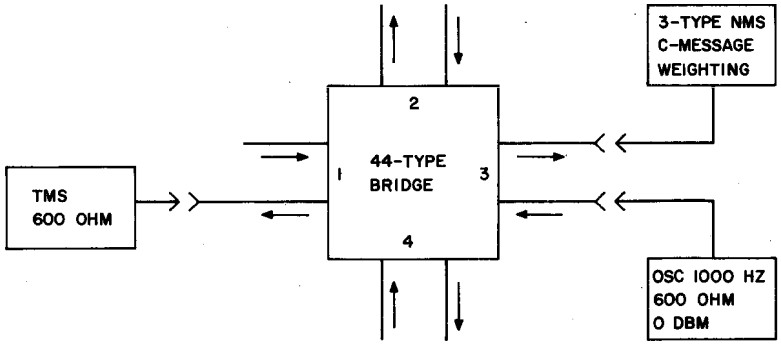
* Loss should be at least 80 dB (maximum reading of 10 dBrn on 3-type NMS).

TABLE H (FIG. 3C)

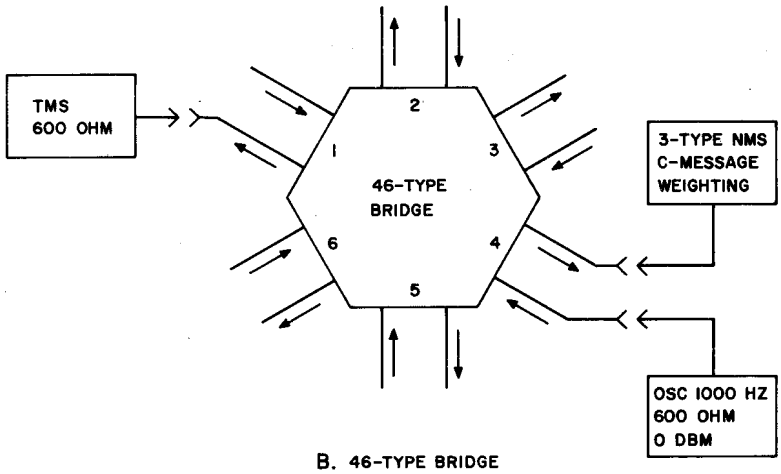
TALK-BACK BRIDGES – LOSS IN DB

SENDING TERMINAL	RECEIVING TERMINAL	LOW ECHO TYPE TALK-BACK BRIDGE (120C REP. COIL) 44 OR 46 BRIDGE	RESISTANCE TALK-BACK BRIDGE WITH 44 BRIDGE	WITH 46 BRIDGE
A (Loop)	A′ (Bridge)	2.75 ±0.5	3.0 ±0.5	1.5 ±0.5
B (Bridge)	B′ (Loop)	2.75 ±0.5	3.0 ±0.5	1.5 ±0.5
A (Loop)	B′ (Loop)	23.0 ±0.5	21.0 ±0.5	23.0 ±0.5
B (Bridge	A′ (Bridge)	62.0 ±1.0(1)*	21.0 ±0.5	23.0 ±0.5

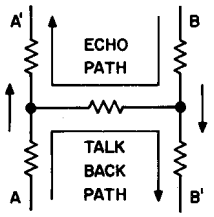
(1)* Plus twice the loss of any station loop pads used. These measurements are made with a 3-type NMS.



A. 44-TYPE BRIDGE



B. 46-TYPE BRIDGE



C. TALK BACK BRIDGE

Fig. 3—Bridge Testing Arrangement

C. Cross Office Tests

7.06 At each office measure the overall loss through all possible paths in both directions. Include talkback arrangements and transmission paths completed by switching relays.

7.07 The test levels to be used are the TLPs indicated on the CLRs.

Requirement: Cross office losses shall be within 0.5 dB of the losses shown on the CLRs.

8. STATION TEST PROCEDURES

8.01 Station tests are grouped into two categories:

(a) Station transmission tests

(b) Station signaling tests.

8.02 Station transmission tests are not normally required unless:

(a) The overall end link fails to meet 1000-Hz loss requirements

(b) There are amplifiers in the station terminating equipment

(c) Trouble experienced indicates a need for the tests.

8.03 When making transmission tests from the handset transmitter, a test coil arrangement must be used to match the low impedance at the transmitter to the 600-ohm oscillator. Fig. 4 shows this arrangement and the losses for which correction must be made.

8.04 Station signaling tests consist of checking that the proper audible and visual indications are received when the station is signaled, that loudspeaker cutoff arrangements operate correctly, and that the station can signal to other stations. When trouble is encountered the appropriate sections covering the specific signaling system(s) involved should be referred to.

8.05 The following test procedures should be performed when station transmission tests are made. Due to the large number of station terminations in use, only the most common ones are discussed. The procedures must be modified as required for other types of station equipment encountered.

Procedure	Transmission Test of:
A.	SD-69167-01, SD-69158-01 and similar station terminating arrangements
B.	SD-69254-01 station terminations
C.	Transmission tests and lineup of SD-69566-01 station terminations

A. Transmission Test of SD-69167-01, SD-69158-01 and Similar Station Terminating Arrangements

STEP	PROCEDURE
1	Prepare the station terminating equipment as follows (see Fig. 5): (a) Lift the straps connected to terminals 3 and 4 of the A and C pads. The wires disconnected should be labeled to avoid confusion when reconnecting. (b) Install a 15-dB pad (89BL) in the A pad socket and a 0-dB pad (89A) in the C pad socket. (c) Lift the handset of the extension being used for test from the cradle and remove the transmitter and receiver units. (d) If key equipment is used to connect the extension to the line equipment, operate the associated line key.
2	Connect a 600-ohm OSC adjusted for 1000 Hz and 0 dBm to terminals 3 and 4 of the A pad.
3	Connect a 600-ohm TMS to the handset receiver contact springs or leads with a suitable test cord equipped with alligator clips.
4	The TMS reading is the receiving terminal loss. The loss requirements are based on the number of telephone sets connected.

STEP	PROCEDURE

No. of Sets	Loss in dB
1	15.3 $\pm$0.5
2	18.5 $\pm$0.5
3	20.1 $\pm$0.5
4	21.4 $\pm$0.5

Note: Loudspeakers not disabled by switchhook operation are counted as sets connected.

5 If requirements are not met, the applicable drawings and BSP sections should be referred to for autotransformer strapping.

6 Test the idle circuit terminations of all other extensions by momentarily lifting the handset of each telephone set. The TMS reading should not change.

7 Connect the TMS to the C Pad, terminals 3 and 4.

8 Connect the OSC and test coil arrangement as shown in Fig. 4 to the handset transmitter contact springs.

9 Determine from SD drawings or by a physical check of the equipment the type of induction coil used and the capacitor value. (If two capacitors are used, add the values.) Refer to Fig. 4 to determine test coil loss.

10 Adjust the OSC output level to +3 dBm plus the test coil loss.

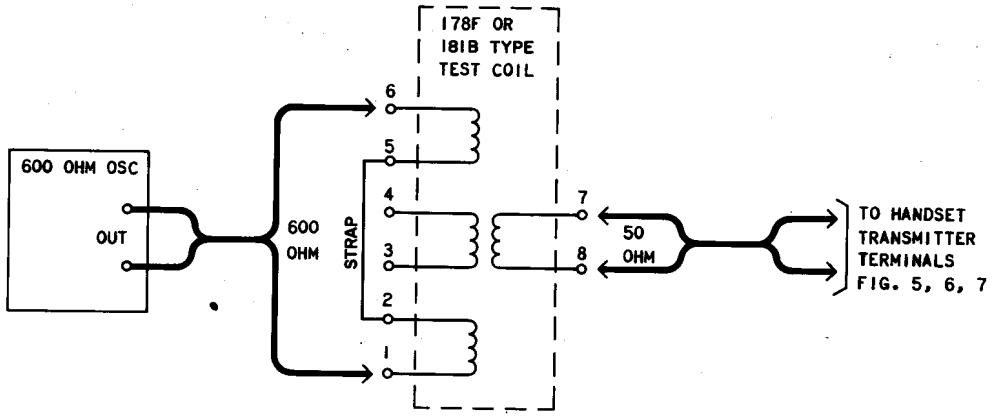
Example: If the subset has a 181B Ind. and 4 MFD capacitor, the OSC output should be:

$$\begin{aligned} \text{OSC test level} &= +3.0 \\ &\quad +1.7 \\ &\quad +4.7 \end{aligned}$$

11 Operate the "push to talk button", if so equipped.

12 Read the TMS. The TMS reading is based on the number of telephone sets connected to the line.

No. of sets	TMS reading in dB
1	+2.7 $\pm$0.5
2	$-$0.3 $\pm$0.5
3	$-$2.1 $\pm$0.5
4	$-$3.3 $\pm$0.5



TEST COIL LOSSES			
TEST COIL	SUBSET		LOSS
	COIL	CAPACITOR	
181B	181B	0 MFD	2.1 DB
181B	181B	2 MFD	2.6 DB
181B	181B	4 MFD	1.7 DB
181B	178F	0 MFD	2.5 DB
181B	178F	4 MFD	2.9 DB
181B	178F	8 MFD	1.7 DB
178F	178F	0 MFD	3.0 DB
178F	178F	2 MFD	3.1 DB
178F	178F	4 MFD	1.6 DB
178F	181B	0 MFD	2.5 DB
178F	181B	4 MFD	2.9 DB
178F	181B	8 MFD	1.7 DB

Fig. 4—Test Coil Arrangement to Send Test Tone at Station Handset Transmitter Terminals

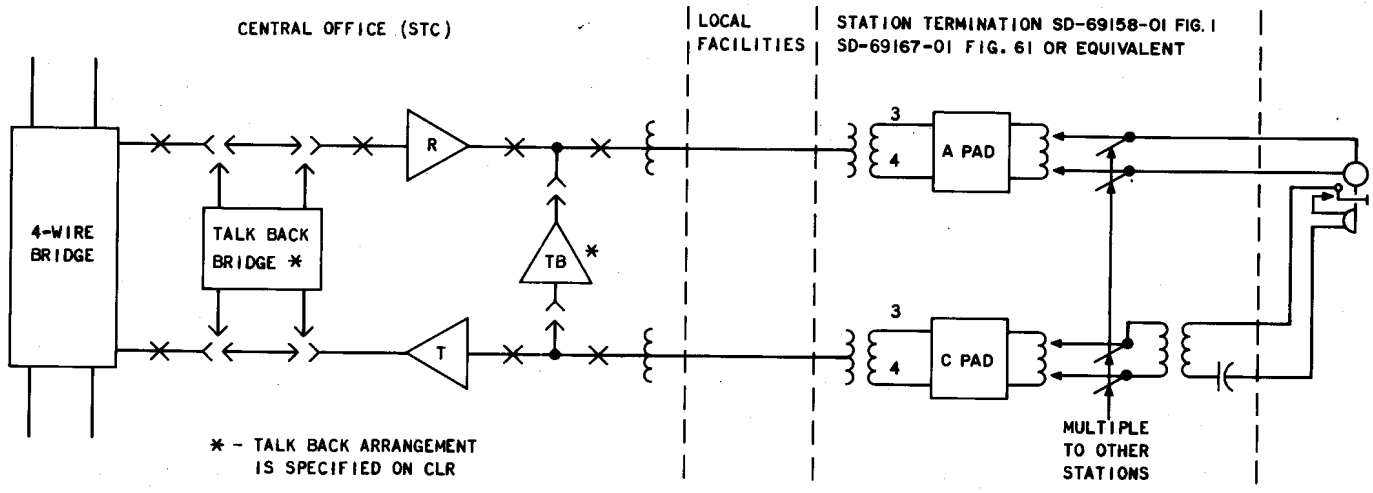


Fig. 5—Simplified Schematic—End Link—Using SD-69167-01 Station Termination

STEP	PROCEDURE
13	If requirements are not met, applicable SD drawings should be referred to for autotransformer strapping or other troubles.
14	Test the idle circuit terminations by momentarily lifting the handset of each extension. The TMS reading should not change.
15	Disconnect the TMS and reconnect the straps lifted in Step 1A.
16	Insert pads (89-type resistors) in pad sockets A and C as specified by CLR.
17	If a talk-back arrangement is provided and is to be tested, proceed to Step 18. Otherwise, disconnect test equipment and replace the handset receiver and transmitter units.
18	Adjust the OSC output level to the transmit TLP indicated on the CLR.
19	Connect the TMS to the handset receiver contact springs or leads.
20	Operate the "push to talk button", if so equipped, and read the TMS. ***Requirements:*** The TMS should read: (a) Receiving TLP $\pm$2.0 dB if only local facilities are between the station and the talk-back arrangement. (b) Receiving TLP $\pm$4.0 dB if local and toll facilities are between the station and the talk-back arrangement.
21	Remove test connections and replace the handset transmitter and receiver units.

B. Transmission Test of SD-69254-01 Station Terminations

STEP	PROCEDURE
1	Prepare the station terminating equipment as follows (see Fig. 6): (a) Lift the leads from terminals 3, 8, 15, and 20 of the 219A KTU terminal strip. The leads should be labeled to prevent confusion when reconnecting them. (b) Lift the handset from the cradle and remove the transmitter and receiver units.
2	Connect a 600-ohm OSC adjusted for 1000 Hz and -7 dBm output level to terminals 3 and 8 of the 219A KTU terminal strip.

STEP	PROCEDURE

3 Connect a 600-ohm TMS to the handset receiver contact springs or leads with a suitable cord equipped with alligator clips.

4 Read the TMS. The loss requirements are based on the number of telephone sets connected.

No. of Sets	TMS reading
1	-11.9 ± 0.5
2	-12.7 ± 0.5
3	-13.5 ± 0.5
4	-14.2 ± 0.5
5	-14.8 ± 0.5
6	-15.4 ± 0.5

Note: Loudspeakers not disabled by switchhook operation are counted as sets connected.

5 Check idle circuit terminations of all extensions by momentarily lifting the handset of each telephone set. The TMS reading should not change.

6 Connect the 600-ohm TMS to terminals 15 and 20 of the 219A KTU terminal strip.

7 Connect the OSC and test coil arrangement as shown in Fig. 4 to the handset transmitter contact springs.

8 Adjust the OSC output level to +4.7 dBm for a 181B test coil or +5.9 dBm for a 178F test coil.

9 Operate the "push to talk button," if so equipped, and read the TMS. The requirements are based on the number of telephone sets connected to the line.

No. of Sets	TMS reading in dB
1	-2.0 ± 0.5
2	-2.7 ± 0.5
3	-3.2 ± 0.5
4	-3.7 ± 0.5
5	-4.3 ± 0.5
6	-4.8 ± 0.5

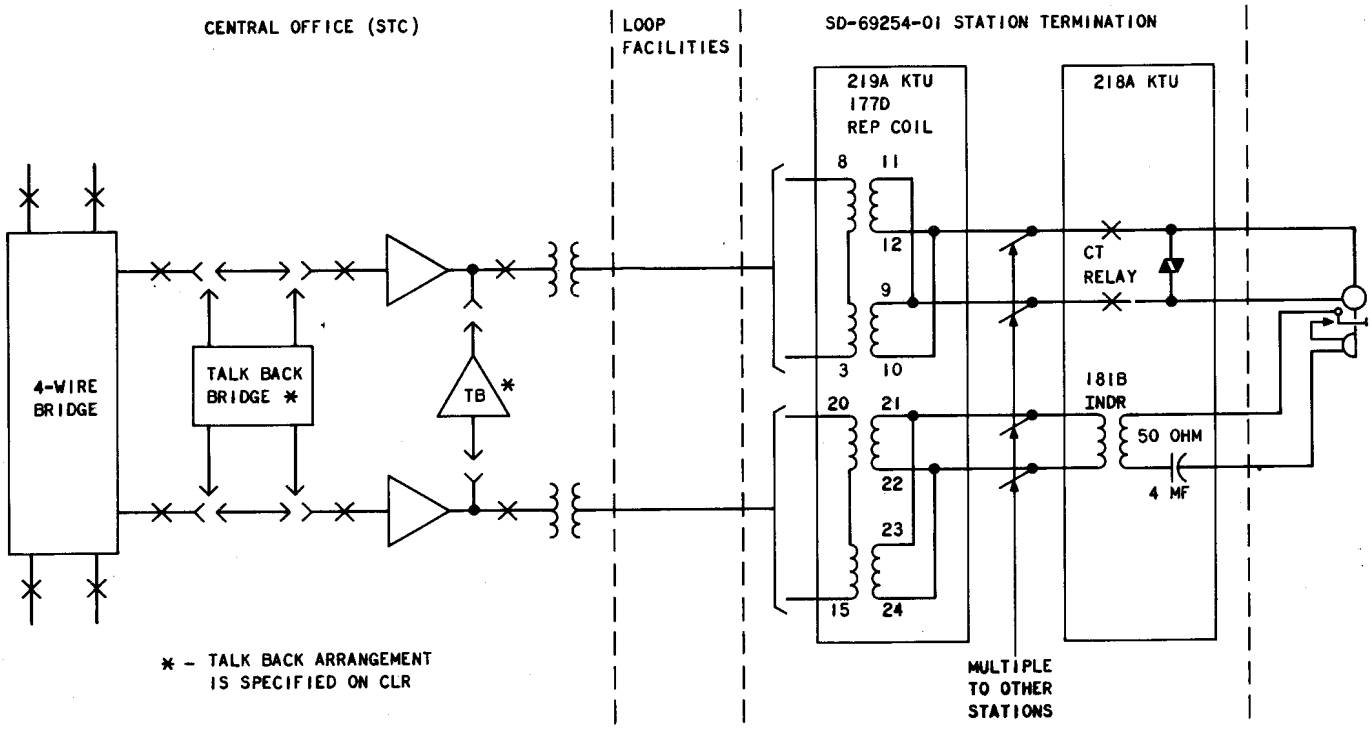


Fig. 6—Simplified Schematic—End Link—Using SD-69254-01 Station Termination

STEP	PROCEDURE
10	Test the idle circuit terminations by momentarily lifting the handset of each extension. The TMS reading should not change.
11	If a talk back arrangement is provided and is to be tested, proceed to Step 12. Otherwise, remove test connections, replace transmitter and receiver units.
12	Reconnect the leads lifted in Step 1A.
13	Determine from the CLR the TLP at the telephone transmitter. Adjust the OSC output level to this value plus the test coil loss.
14	Connect the TMS to the handset receiver contact springs or leads.
15	With the "push to talk button" operated, read the TMS. ***Requirement:*** The TMS reading should be the same as the receive TLP shown on the CLR: (a) $\pm$2.0 dB when only local facilities are included between the talk back arrangement and the station. (b) $\pm$4.0 dB when local and toll facilities are included between the talk back arrangement and the station.

STEP	PROCEDURE
16	Remove test connections, and replace the transmitter and receiver units in the handset.

C. Transmission Tests and Lineup of SD-69566-01 Station Terminations

STEP	PROCEDURE
1	Verify that the local facilities between the STC and the station have been tested and that the measured loss of the facility is within limits. Fig. 7 shows the transmission path being tested.
2	Prepare the OSC for 600-ohm impedance, 1000 Hz, and 0 dBm output.
3	Connect the OSC output to the BUS IN jack.
4	Connect the BUS OUT jack to the 600-ohm TMS.
5	If a talk back amplifier is included, adjust the amplifier for a −16 dBm reading on the TMS.
6	Adjust the transmit amplifier until the STC receives the 1000 Hz at the level specified on the CLR (TLP at specified test point).
7	Remove the OSC from the BUS IN jack.
8	Request the STC to send 1000 Hz toward the station at the level specified on the CLR (TLP at specified test point).
9	Adjust the receive amplifier for a −16 dBm reading on the TMS.
10	Remove test equipment from jacks.

9. END LINK-TRANSMISSION TEST PROCEDURES

9.01 These procedures measure the 1000-Hz loss deviation, frequency response, C-message noise, and singing return loss of the end links of a multistation private line telephone circuit (STC to station).

9.02 The test levels used in these procedures are the TLPs indicated on the CLR.

9.03 Although there are numerous points on an end link that may be used for transmission tests, certain ones are not desirable for precise measurements because of unknown impedances or poorly defined TLPs. For this reason, only amplifier, equalizer, and pad inputs and outputs, and carrier terminals should be used, unless impedance matching devices are used.

9.04 When adjusting the OSC for test tones, the levels should be verified with a TMS before connecting to the circuit.

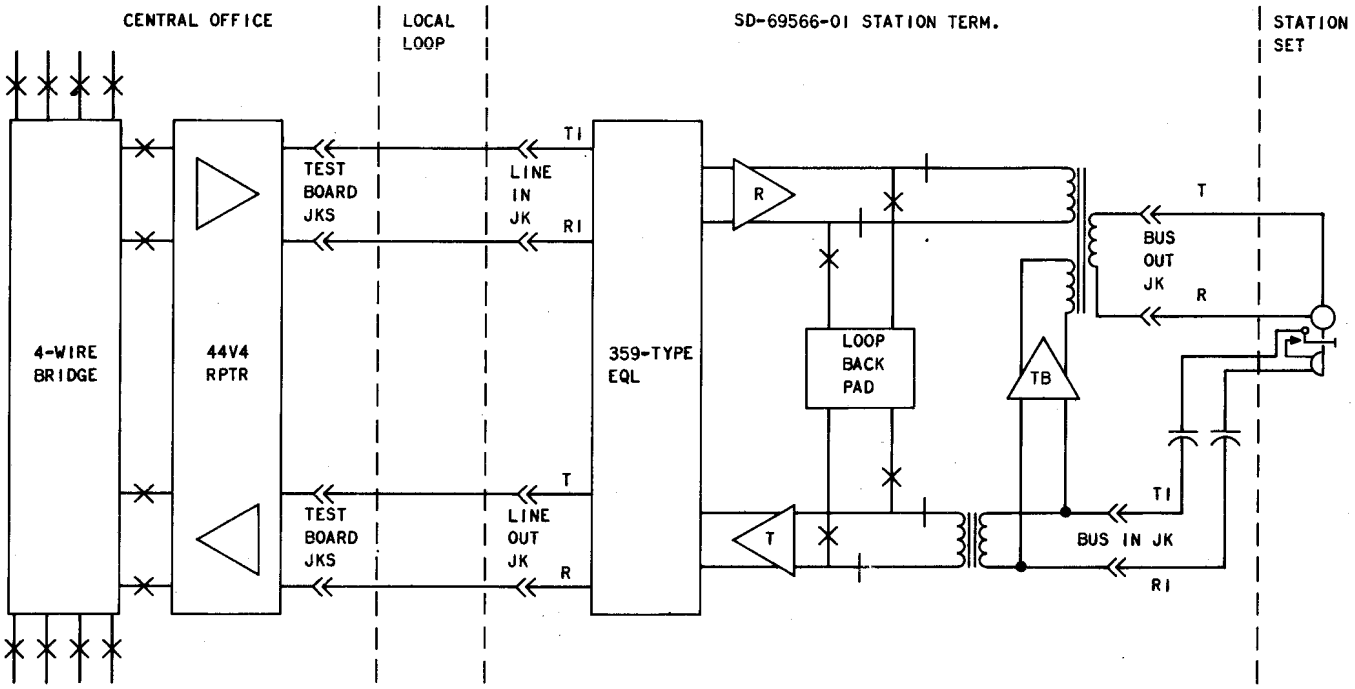


Fig. 7—Simplified Schematic—End Link—Using SD-69566-01 Station Termination

9.05 When selecting transmission test points at the STC, include all amplifiers, pads, and talk back arrangements in the path.

1000-Hz Loss Deviation and Frequency Response Tests

9.06 The following procedure measures the 1000-Hz loss deviation and frequency response of end links.

9.07 This procedure assumes that tests and adjustments of central office equipment (Part 7 of this section) and station equipment (Part 8 of this section) have been completed and requirements met.

STEP	PROCEDURE
1	At the STC, terminate the bridge leg of the end link being tested in 600 ohms.
2	At the STC connect an oscillator (OSC) to the transmit test point. Adjust the OSC for 1000 Hz, 600 ohms, and the output level to the required test level (TLP shown on CLR for the selected test point).
3	At the station, remove the receiver unit from the handset of the telephone set and connect a 600-ohm TMS to the receiver contact springs or wires. If a key telephone system (KTS) is used, operate the appropriate line key.
4	Read and record the receive level.
5	Record the 1000-Hz loss deviation.

STEP	PROCEDURE

Note: The 1000-Hz loss deviation is the difference between the Expected Measured Loss (EML) and the Actual Measured Loss (AML). Excess loss is assigned a (+) sign and excess gain is assigned a (−) sign. Remember, we are talking about loss.

Example: The CLR shows the receive test point, TLP = −10 dB. If level measured is −10.8 dB, the 1000-Hz loss deviation is +0.8 dB.

Refer to Table C for requirements.

6 Adjust the OSC for 400 Hz.

7 Read and record the TMS indication.

8 Note the difference between the value recorded in Step 4 and the value recorded in Step 7. If the loss at 400 Hz is more than the loss at 1000 Hz, assign a (+) sign. Assign a (−) sign if the loss at 400 Hz is less than the loss at 1000 Hz. The result is frequency response deviation.

Example:	TMS at 1000 Hz reads	−10.8 dB
	TMS at 400 Hz reads	−12.6 dB
	The frequency response deviation =	+ 1.8 dB

9 Refer to Table D for requirements.

10 Adjust the OSC for 2800 Hz and repeat Steps 7 through 9.

11 Remove the OSC connection at the STC and the TMS at the station.

12 At the station, remove the transmitter unit from the hand set and connect the OSC and test coil per Fig. 4 to the transmitter contact springs.

13 Adjust the OSC for 1000 Hz, 600 ohms and the output level to the TLP shown on the CLR plus the loss in the test coil (test coil losses are shown on Fig. 4).

14 At the STC, connect a 600-ohm TMS to the receive test point.

15 Repeat Steps 4 through 10.

16 Remove the OSC and TMS from the circuit, replace the transmitter and receiver units, and remove the bridge terminations.

C-Message Noise Tests—End Link

9.08 The 1000-Hz loss deviation tests should be made and requirements met before performing noise tests.

9.09 As circuit noise is in part a result of crosstalk and cross modulation, it should be measured during periods of normal to high traffic when possible.

9.10 The noise requirements specified in Table E are expressed in dBrnc0. The noise measuring set (NMS) indication is in dBrnc. To convert dBrnc to dBrnc0, determine from the CLR the TLP at the point where the measurement is being taken. Subtract the TLP value from the NMS reading. The difference is the noise level expressed in dBrnc0.

Example 1:

NMS reads	33 dBrnc
TLP = −8	−(−8)
Noise =	41 dBrnc0

Example 2:

NMS reads	53 dBrnc
TLP = +7	−(+7)
Noise =	46 dBrnc0

9.11 The following procedure measures the C-message noise on the end link of a multistation private line telephone circuit.

STEP	PROCEDURE
	C-Message Noise Measurements—End Link
1	At the STC, prepare the NMS to measure C-message noise at 600-ohms impedance. Rotate the DBRN switch to the 85 position and the meter switch to NORM. Plug the monitoring headphone into the MON jack of the NMS.
2	At the STC, terminate the bridge leg of the end link in 600 ohms. Connect the NMS to the receive test point.
3	At the station, terminate the transmit path in 600 ohms. If a BUS IN jack is available, a 600-ohm plug in this jack is preferred. When jacks are not available, terminate the loop at the telephone set terminals and leave the set on-hook.
4	Rotate the DBRN switch on the NMS for a midrange reading on the NMS meter.
5	Monitor the circuit with the monitoring headphone. Intelligible crosstalk is an indication of trouble which should be corrected.
6	The setting of the DBRN switch plus the meter reading is the noise level present expressed in dBrnc.
7	Correct the dBrnc measurement to dBrnc0 as outlined in 9.10.
8	Refer to Table E for requirements.
9	At the STC, remove the NMS from the receive test point and terminate the transmit path in 600 ohms. ***Note:*** The NMS is a good termination for this purpose.
10	At the station prepare the NMS to measure C-message noise at 600-ohm impedance. Rotate the DBRN switch to the 85 position and the meter switch to NORM. Plug the monitoring headphone into the MON jack of the NMS.

STEP	PROCEDURE
11	Connect the NMS to the receive test point. If a BUS OUT jack is available it should be used. When using the BUS OUT jack, insert a 600-ohm termination into the BUS IN jack. When the BUS OUT jack is not available, remove the receiver unit from the handset of the telephone set connected to the line and connect the NMS to the contact springs or wires. Remove the transmitter unit from the handset.
12	Rotate the DBRN switch on the NMS for a midrange reading on the NMS meter.
13	Monitor the circuit with the monitoring headphone. Intelligible crosstalk is an indication of trouble which should be corrected.
14	The setting of the DBRN switch plus the meter reading is the noise level present expressed in dBrnc.
15	Correct the dBrnc measurement to dBrnc0 as outlined in 9.10.
16	Refer to Table E for requirements.
17	Remove the NMS connections and restore the circuit to normal.

RETURN LOSS MEASUREMENTS—END LINK

9.12 Return loss tests are required on end links that are entirely or partially 2-wire.

9.13 The KS-20501 return loss measuring set (RLMS) is the recommended test set for making singing return loss tests. When other test equipment must be used, these instructions should be modified as necessary.

STEP	PROCEDURE
	RETURN LOSS MEASUREMENTS
1	Connect the KS-20501 RLMS to the end link as shown in Fig. 8. The station to be measured should be on-hook. (IF Idle Termination is Provided). IF NOT go off hook remove TRANSMITTER & replace with 1 WATT 90Ω RES.
2	Adjust the RLMS switches as follows:

THL	0
TEST LOCATION	+0 dB or TST HYB
ADD DB	0
TEST TYPE	SRL (singing return loss low)
POWER	ON

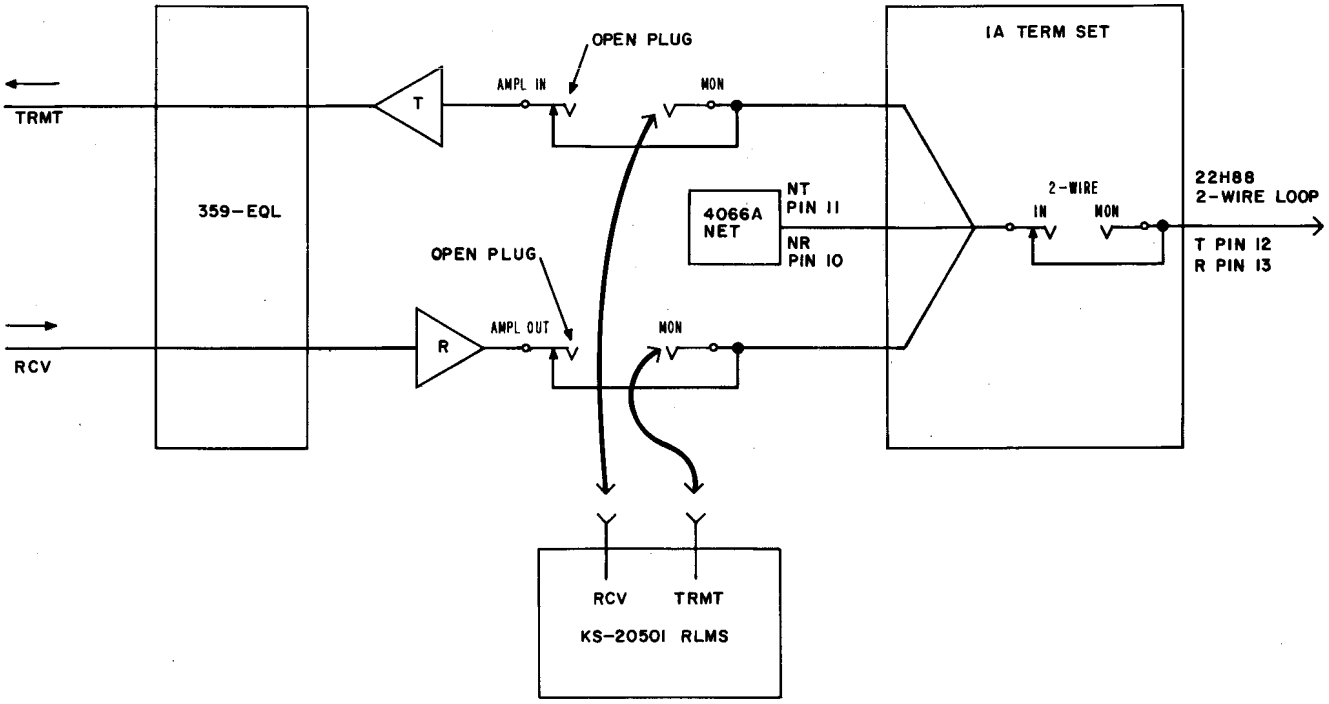


Fig. 8—Test Arrangement For Measuring Return Loss

STEP	PROCEDURE
3	Insert a shorting plug into the 2-WIRE IN jack of the 24V4 repeater or short pins 12 and 13 (T & R leads) of the terminating set with a clip lead.
4	Adjust the THL controls of the RLMS for a zero meter reading.
5	Remove the T & R short installed in Step 3.
6	Adjust the ADD DB switch on the RLMS for an on-scale reading of the meter.
7	Read and record the return loss. The return loss is the sum of the ADD DB switch and the meter reading.
8	Adjust the TEST TYPE switch to the SRL-HI position (singing return loss high).
9	Read and record the return loss.
10	The lowest of the readings recorded in Steps 7 and 9 is the singing return loss (SRL). ***Requirement:*** The SRL shall be equal to or greater than that specified on the CLR. If not specified, 10 dB or more.
11	If the requirement is met, disconnect the KS-20501 RLMS. If the requirement is not met, adjust the balancing network and NBOC capacitor as follows.

STEP	PROCEDURE

(a) Adjust the RLMS TEST TYPE switch to the ERL position (echo return loss).

(b) At the customer station, remove the handset from the cradle and wrap the transmitter with sound-deadening material to exclude room noises.

(c) Note the return loss (ADD DB switch plus the meter reading).

(d) Maximize the return loss by adjusting the balancing network and/or the NBOC screws on the 1-type terminating set.

(e) Repeat Steps 2 through 10 to verify that the SRL meets requirements.

10. BACKBONE CIRCUIT OVERALL TEST PROCEDURES

10.01 Backbone circuit tests are performed in two parts:

(a) Mid link tests

(b) Overall backbone circuit tests.

Mid Links

10.02 The mid link tests are performed before the overall backbone tests. Since mid link tests are essentially facility lineups and tests, they will not be described in this section. Appropriate practices covering the facility involved should be referenced.

10.03 The test requirements for multistation private line circuit facilities may be more stringent than those specified by other practices. For this reason, the requirements in Part 6 of this section are applicable.

Overall Backbone Tests

10.04 The following procedures cover the transmission tests required on the backbone portion of a multistation private line telephone circuit.

10.05 The performance of these tests will require that the entire circuit be removed from service.

STEP	PROCEDURE

1000-HZ LOSS DEVIATION AND FREQUENCY RESPONSE TESTS BACKBONE CIRCUIT

1 Terminate all bridge legs on the circuit feeding end links in 600 ohms.

2 At the control office, adjust an OSC for 600 ohms, 1000 Hz and the output level to the TLP shown on CLR cards for bridge inputs. This is usually +7 dBm but may vary in some offices.

3 Connect the OSC output to a spare bridge leg input.

4 At the last office (most remote) on the circuit, connect a 600-ohm TMS to a spare bridge leg output.

STEP	PROCEDURE
5	Measure the received signal. The level measured should be (TLP) $\pm$1.0 dB for circuit order tests and (TLP) $\pm$4.0 dB for routine and trouble tests. Record the measurement.
6	Record the 1000-Hz loss deviation. ***Note:*** The 1000-Hz loss deviation is the difference between the expected measured loss (EML) and the actual measured loss (AML). Excess loss is assigned a plus (+) sign and excess gain is assigned a minus (−) sign. Remember, we are talking about loss. ***Example:*** The CLR shows the receive TLP = −8 dBm. If the TMS reads −8.8 dBm, the deviation is +0.8 dBm. Refer to Table C for requirements.
7	Adjust the OSC to 400 Hz
8	Read and record the TMS indication.
9	Note the difference between the value recorded in Step 5 and the value recorded in Step 8. If the loss at 400 Hz is more than the 1000 Hz, assign a (+) sign. Assign a (−) sign if the 400 Hz loss is less than the 1000 Hz loss. The result is frequency response deviation. Record the deviation. *Example:* TMS at 1000 Hz reads −8.8 dBm TMS at 400 Hz reads −(−10.2 dBm) The frequency response at 400 Hz = +1.4 dB Refer to Table D for requirements.
10	Adjust the OSC frequency to 2800 Hz, and repeat Steps 8 and 9.
11	Repeat Steps 2 through 10 in the opposite direction with an OSC connected at the remote office and a TMS connected at the control office.

STEP	PROCEDURE
	C-MESSAGE NOISE MEASUREMENTS—OVERALL CIRCUIT
1	At each end of the backbone circuit, prepare a NMS to measure C-message noise at 600-ohm impedance. Rotate the NMS DBRN switch to the 85 position, the meter switch to NORM and plug the monitoring headphone into the MON jack.
2	Connect the NMS to a spare bridge leg output port at each end of the circuit.
3	Make sure that all stations on the circuit are on-hook.

STEP	PROCEDURE
4	At each NMS, rotate the DBRN switch for a midrange indication on the meter, and monitor the circuit with the headphones. Intelligible crosstalk is an indication of trouble which should be cleared.
5	Measure the noise at each end of the circuit. The DBRN switch setting plus the meter reading is the noise level present expressed in dBrnc.
6	Correct the dBrnc reading to dBrnc0. ***Note:*** To convert dBrnc to dBrnc0, determine from the CLR the TLP at the bridge leg output. Subtract the TLP value from the NMS reading. The difference is the noise level expressed in dBrnc0. *Example:* NMS reads 33 dBrnc TLP = −8.0 −(−8) Noise = 41 dBrnc0
7	Determine from the CLR the total mileage of the circuit. Refer to Table E for C-message noise requirements.

11. OPERATIONAL TESTS

11.01 The objectives of the operational tests are:

(a) To determine that the circuit talks satisfactorily between all stations

(b) To verify that the circuit signals between stations as designed

(c) To check operation of switching relays when provided

(d) To verify that the customer knows how to use the circuit and is familiar with its limitations.

(e) To determine that the stations are properly and sufficiently designated

(f) To verify that the customer is knowledgeable of trouble reporting procedures.

11.02 The satisfactory completion of these tests will require that the person coordinating the tests have a thorough knowledge of circuit operation.

11.03 Sources of information to be considered are:

(a) Circuit layout records

(b) System service orders

(c) Applicable SD and CD drawings

(d) Pertinent BSP sections

(e) Training brochures provided by the traffic department

(f) Local instructions.

11.04 Preferably, these tests will be performed by the customer under the direction of the control office.

11.05 During these tests, the control office should monitor the circuit noting any problems or difficulties encountered at the various customer locations.

11.06 Depending on the complexity of the circuit and coordination difficulties, judgment should be used as to whether to clear troubles encountered immediately or proceed with the tests and clear them later. For instance, if one station experiences signaling or talking difficulties, it may be wise to terminate that end link at the bridge and proceed with the tests rather than hold everyone involved while the trouble is cleared.

STEP	PROCEDURE
	OPERATIONAL TESTS
1	Verify that all STCs have completed their cross office and end link tests and that all patch cords, test equipment, and plugs have been removed from the circuit.
2	From the control office test board, place a test call to each station on the circuit. If the test board is not equipped with the necessary signaling capability, the tests may be made from any station on the circuit equipped with outward signaling capability.
3	At each station called, check for: (a) visual and/or audible signals (b) loudspeaker operation and loudspeaker cutoff feature, if so equipped (c) talking volume (d) echo and singing tendencies (e) noise and crosstalk (f) circuit designations.
4	Request each station in turn to place a test call to two other stations (fed from bridges at each end of the backbone circuit), and check for: (a) talking volume (b) echo and singing tendencies (c) noise and crosstalk.
5	From the test board or any station with signaling capabilities, signal all stations on the circuit to check conferencing capability. Verify that all stations can communicate with all others without objectionable echo and noise.
6	At the test board or selected station, dial conference/group codes as specified on CLR to test code selectors if equipped.
7	If switching relays are involved in the circuit, verify that they can be operated as designed. Place test calls as necessary to check that switch relay functions are performed as intended.