TWO-POINT PRIVATE LINE TELEPHONE CIRCUITS

VOICE ONLY

TEST REQUIREMENTS AND OBJECTIVES

CONTENTS PAGE

1. GENERAL

1.01 This section contains the testing considerations to be applied to two-point private line telephone circuits used for voice communications only. Included are typical equipment layouts defining testing points, required tests, and test objectives applicable to circuit order, maintenance, and trouble testing.

1.02 When this section is reissued, the reasons for reissue will be given in this paragraph.

1.03 The transmission parameters given in this section are to ensure:

(a) That the circuit will talk up satisfactorily

(b) That the noise present on the circuit will not be objectionable or distracting to the user

(c) That signals present will not interfere with other circuits sharing common facilities

(d) That the circuit meets design requirements.

1.04 The circuits discussed in this section are served over nonswitched facilities with no access to the message network. A two-point private line involves a channel between two terminal locations. The channel may or may not be entirely a metallic path.

2. REQUIRED TESTS

2.01 The tests required on two-point private line voice-only circuits are shown in Table A.

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

2.03 Circuit order test results often prove to be valuable bench marks during trouble locating procedures. For this reason, the results obtained should be recorded and filed with circuit layout records (CLRs) or at some other location readily available for reference.

LOOP TESTS

2.04 The dc loop resistance of cable pairs between the STC and station should be measured and recorded for use as a bench mark to be used in future trouble locating procedures.

1000-HZ LOSS MEASUREMENTS

2.05 The 1000-Hz overall measurements are required to determine that the circuit will talk up satisfactorily, not cause cross talk on other circuits due to overloading, and meet design requirements.

FREQUENCY RESPONSE

2.06 Frequency response sometimes referred to as slope, attenuation distortion, or frequency attenuation is the departure from uniform response

TABLE A

TEST	CIRCUIT ORDER	ROUTINE	TROUBLE
Loop Tests	X		X
1000-Hz Loss	X	X	X
Frequency Response	X		X
Message Circuit Noise	X	X	X
Singing Return Loss*	X		X
Trouble Tests			X
Final Tests	X		X

* Singing Return loss tests are required only when a 2-wire station is used in conjunction with 4-wire facilities.

of the circuit referenced to 1000 Hz within a given frequency band. The normal frequency band used for telephone services is approximately 300 to 3000 Hz. Tariffs presently in effect call for measurements to be made at 400 Hz and at 2800 Hz. These measurements are usually sufficient to assure satisfactory voice communication. Frequency response is expressed in dB loss relative to 1000 Hz. Therefore, frequencies with losses greater than the 1000-Hz loss are + deviations and frequencies with less loss are – deviations.

MESSAGE CIRCUIT NOISE (C-MESSAGE NOISE)

2.07 Message circuit noise sometimes called background, steady state, white, and gaussian noise, is the noise power that is present on a circuit in the idle or terminated condition. Message circuit noise is usually measured with a Western Electric 3-type noise measuring set using a C-message weighting filter. The noise power is measured in dBrnC (decibels referred to reference noise with C-message weighting).

RETURN LOSS TESTS

2.08 Return loss tests (echo and singing) are measurements of the degree of impedance match or balance that exist at the junction point of two facilities. Return loss may be defined as the balance between a 2-wire loop and the balancing network used with a 4-wire terminating set. Echo return loss is an average of the return losses at all frequencies in the echo range (500 to 2500 Hz). Singing return loss is the return loss at a single frequency anywhere in the voiceband; but it usually occurs in the 300 to 500 Hz or 2500- to 3000-Hz ranges. Return loss measurements are normally made on the 4-wire side of the 4-wire terminating set. The distant end of the 2-wire loop is terminated and the balancing network in the 4-wire terminating set is adjusted for maximum return loss.

2.09 The KS-20501 return loss measuring set is the recommended test set for making these tests. A noise generator which has the effect of producing a broad frequency band with a flat power spectrum is used as the test power source. Filters are provided to select the particular band of frequencies required for the return loss measurement desired. The filter selection is controlled by the TEST TYPE switch. Echo return loss (ERL) measurements are made in the 500- to 2500-Hz band (ERL switch position). Singing return loss (SRL) measurements are made in the 200- to 500-Hz band (SRL switch position) and the 2500- to 3200-Hz band (SRL-HI switch position). The lowest of the two readings is the SRL.

TROUBLE TESTS

2.10 Even with adequate and comprehensive circuit maintenance programs, there will be occasions when trouble is experienced or suspected. When this occurs, it will be necessary to determine the source or cause of the problem through methodical and logical testing of the service. This can only be done by persons having knowledge of and responsibility for the equipment involved.

2.11 Generally, trouble reports will fall into two basic categories: transmission and signaling. Examples of these reports are:

(a) Transmission

(1) Static or hum on the line

(2) Noisy/cross talk

(3) Hollow sounding

(4) Howling or singing

(5) Fading

(6) Can't hear—can't be heard/weak

(7) Dead line

(b) Signaling

(1) Doesn't answer

(2) Can't receive/transmit ringing

(3) No signals

(4) False rings

(5) Intermittent operation.

2.12 By obtaining as many details as possible of the trouble condition and by understanding the operation of the circuit much unnecessary testing may be eliminated. Many times, the customer will not report troubles in terms that are readily understood by telephone company forces. The report received and the trouble actually found may not agree at all, however, our obligation is to provide service. Customer dissatisfaction with our service is a valid trouble report regardless of how it is presented. The clearance of many trouble reports may be as simple as directing the user to push the signal button. Trouble reports of this type should be handled with patience and dispatched in a professional manner.

FINAL TESTS

2.13 The final tests consist of placing calls in both directions on the circuit to verify that the circuit operates to customer satisfaction prior to turning it up for service. Preferably, this test is performed by the customer under the direction of the control office. The objectives of the final test are:

(a) To determine that the circuit operates satisfactorily

(b) To determine that the customer knows how to use the circuit

(c) To verify correct designations on station sets and key functions

(d) To verify that the customer knows where to report future troubles

(e) To turn circuit up for service and to obtain the name of the person accepting the service.

3. TEST OBJECTIVES

1000-HZ LOSS DEVIATION

3.01 The overall 1000-Hz loss of a circuit is usually specified on the CLR. Normally, there will be 16 dB loss between telephone sets on a 4-wire circuit and 10 dB loss on a 2-wire circuit.

3.02 Table B gives the 1000-Hz loss deviations, ie, expected measured loss (EML) minus actual measured loss (AML) allowed on 2-point private line services.

3.03 The 1000-Hz loss deviation should be within limits before other tests are performed as all of the other tests are level sensitive.

FREQUENCY RESPONSE

3.04 The frequency response limits, also referred to as attenuation distortion, slope, and frequency attenuation, are given relative to the

TABLE B

1000-HZ LOSS DEVIATION
MAXIMUM DEVIATION FROM EML STATED ON CIRCUIT LAYOUT RECORD CARD

	CIRCUIT ORDER	ROUTINE OR TROUBLE ISOLATION
STA—STC	±0.5 dB	±2.0 dB
STC—STC	±0.5 dB	±1.0 dB
Overall (STA—STA)	±1.0 dB	±4.0 dB
Loopback (STC—STA—STC)	±0.8 dB	±2.0 dB

1000-Hz measured loss. These limits are given in Table C.

MESSAGE CIRCUIT NOISE REQUIREMENTS

3.05 Message circuit noise requirements are given in two parts:

(a) Overall message circuit noise requirements

(b) Loop message circuit noise requirements.

When overall noise requirements are met, the loop measurements may be omitted. The loop noise requirements are primarily for trouble location procedures. Table D covers message circuit noise requirements. Refer to Sections 331-850-50Z for additional information concerning message circuit noise.

SINGING RETURN LOSS REQUIREMENTS

3.06 The minimum singing return loss for a two-point private line telephone station is 10 dB.

SIGNALING TESTS

3.07 Generally, no testing of signaling functions are required other than call-through type tests. Indications of a need for "in depth" signaling tests are:

(a) Observed no signals

TABLE C

FREQUENCY	MAXIMUM ALLOWABLE DEVIATION FROM THE 1000-HZ LOSS MEASUREMENT
400 Hz	—2.0 dB to +8.0 dB
1000 Hz	0
2800 Hz	—2.0 dB to +10.0 dB

Note: (—) indicates less loss and (+) indicates more loss.

Example: When at a particular test point, the 1000 Hz loss measures —10 dB. The 400-Hz loss must measure between —8.0 and —18 dB to be within limits.

TABLE D

MESSAGE CIRCUIT NOISE REQUIREMENTS

OVERALL CIRCUIT

CIRCUIT LENGTH MILES	NOISE (dBrnc0)	
	OBJECTIVE	TROUBLE IF ABOVE
0—50	31	44
51—100	34	44
101—400	37	44
401—1000	41	50
1001—1500	43	50
1501—2500	45	50
2501—4000	47	50

LOOP NOISE (dBrnc0)

	NOISE MEASURED AT		
	CENTRAL OFFICE		STATION
	STATION ON-HOOK	STATION OFF-HOOK	
Objective	10	5	20
Trouble If Above		15	30

(b) Observed marginal signaling

(c) Repeated customer reports on signaling difficulties.

3.08 Signaling test points and test conditions are covered in Part 5 of this section.

4. TRANSMISSION TEST POINTS

4.01 Fig. 1, 2, and 3 are typical equipment layouts that may be used on two-point private line voice-only circuits.

4.02 The test points shown in these figures may or may not be available in all cases.

4.03 Although there are a number of points where transmission tests may be made, certain ones are not desirable for precise transmission measurements because of unknown or poorly defined impedances. They are all suitable, however, for trouble isolation.

4.04 Desirable transmission testing points are:

(a) Amplifier, equalizer, and pad inputs and outputs

(b) 4-wire terminating set inputs and outputs

(c) Carrier terminals.

4.05 Less desirable transmission test points, unless impedance matching devices are used are:

(a) Cable pair appearances

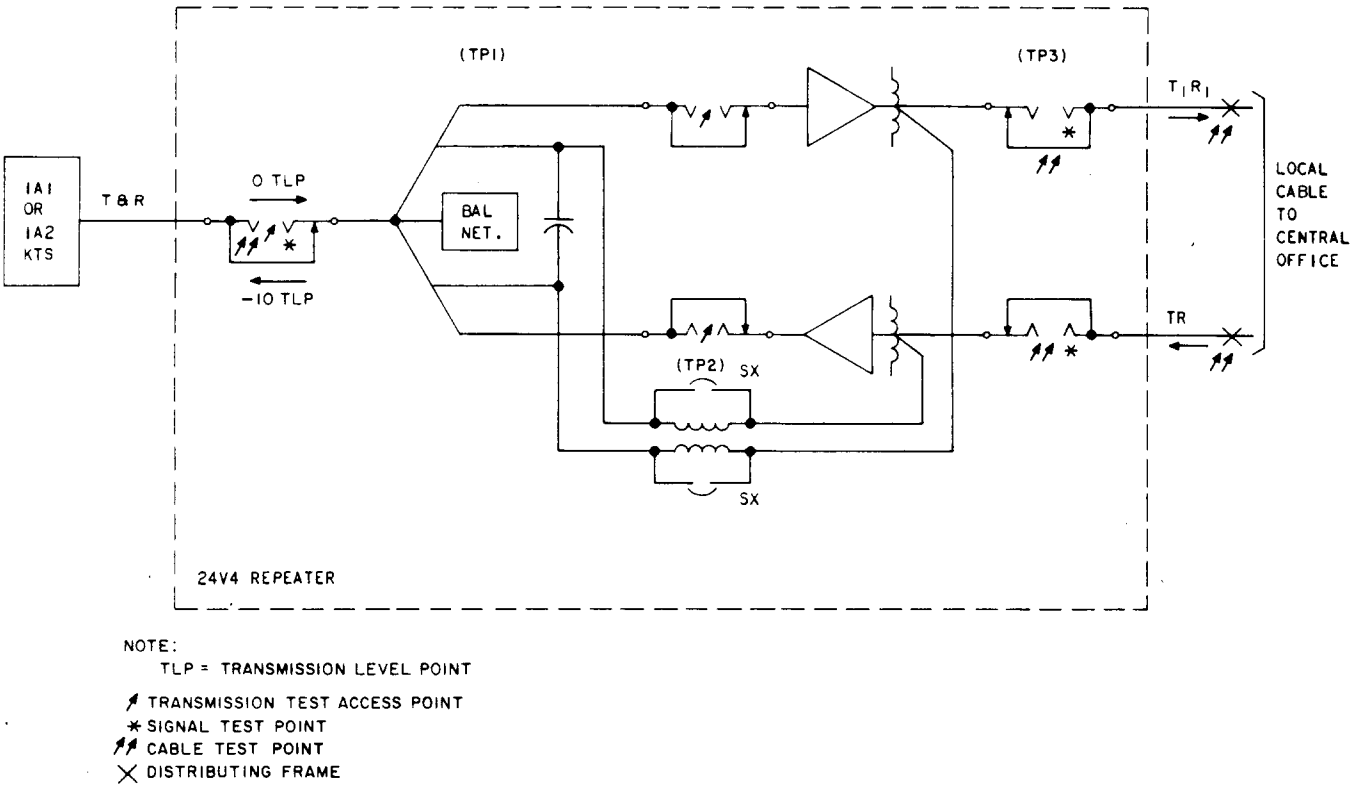


Fig. 1—Typical 2-Wire Station Termination Test Access Points

(b) Station, tel set, or KTS terminals

(c) Demarcation strips or terminals

(d) Most distributing frame appearances.

4.06 The transmission level points (TLPs) shown in Fig. 1, 2, and 3 are those commonly found on private line circuits of these types. The CLR should always be referred to for TLP levels, as engineering considerations may dictate deviations from normal levels.

4.07 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.

5. SIGNALING TEST POINTS

5.01 Many of the test points may be used for both transmission and signaling tests.

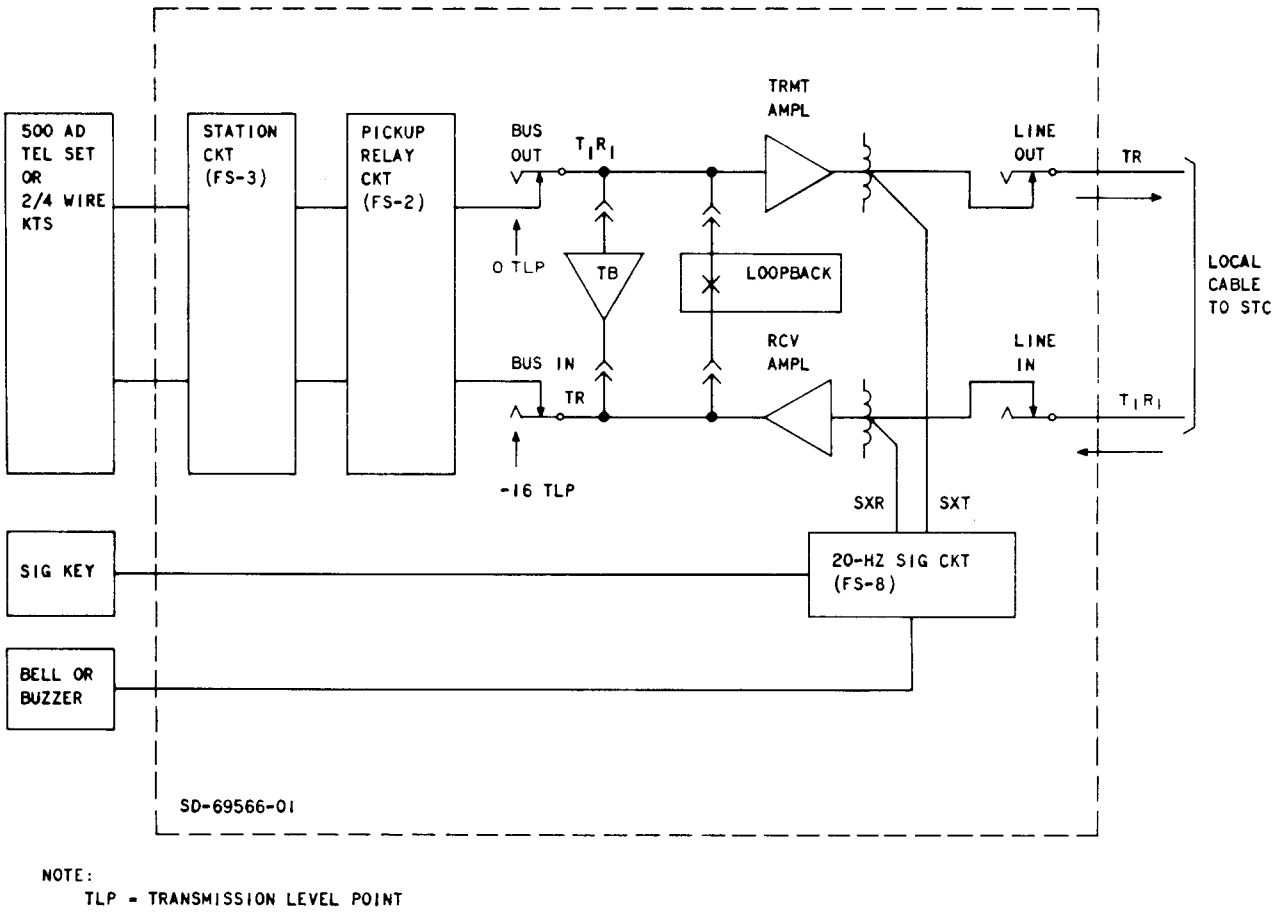
5.02 Table E shows the signaling conditions at each test point (TP-). A KS-14510 volt-ohm-milliammeter may be used for measurements unless otherwise noted.

6. TEST EQUIPMENT

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

6.02 Table F is a partial listing of test equipment which may be used. Other standard equivalent test sets may be used when those listed are not available.

6.03 The application of dc voltage to the input of certain transmission measuring sets may damage the sets and affect the accuracy of measurements. To prevent accidental exposure of the test equipment to dc voltage, a voltage measurement with a KS-14510 voltmeter should



NOTE:
TLP = TRANSMISSION LEVEL POINT

Fig. 2—Typical Two-Point 4-Wire Private Line Telephone Station Termination Using SD-69566-01 Showing Test Access Points

first be made across the line pair. If 1 volt dc or greater is present, an isolation or (holding) coil arrangement must be used.

6.04 Fig. 4 shows two common methods used to provide dc isolation when required. The J94002AB (2AB) auxiliary transmission test set, Fig. 4A, should be used where it is available. To use the 2AB set for this purpose, prepare it as follows:

(a) Connect the line to be measured to the MEAS jack (selection determined by test cord available).

(b) Connect the OSC to the OSC jack or binding posts.

(c) Connect the TMS to the TMS jack or binding posts.

(d) Operate the DIAL/SLV key to the normal position.

(e) Operate the 2DB PAD IN/OUT key to the OUT position.

(f) Select mode of operation and impedance desired.

(g) Allow for .5 dB loss in the 2AB set when reading TMS and sending test tones.

6.05 An alternate dc isolation arrangement can be developed locally as shown in Fig. 4B. The loss in this arrangement at voice frequencies is negligible and no corrections are required.

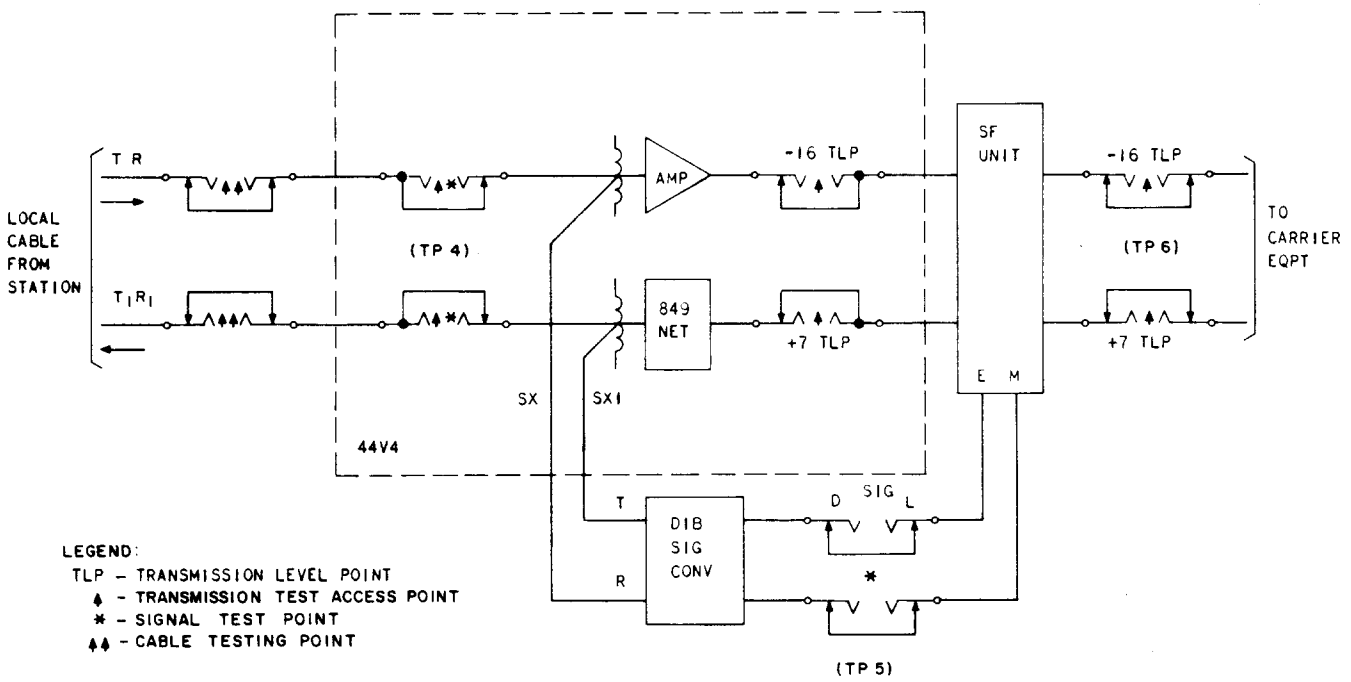


Fig. 3—Typical Central Office Arrangement for Two-Point Private Line Telephone Service and Test Access Points

7. REFERENCES

7.01 The following documents contain additional information applicable to private line telephone service.

SD-, CD-	TITLE
SD-, CD-1C359-01	Metallic Facility Terminal Circuit
SD-, CD-69203-01	Station Systems—Key Telephone System No. 1A1 Line and Signaling CKT
SD-, CD-69559-01	Station Systems—Key Telephone System No. 1A2 Tie Line and Station Line Circuits
SD-, CD-69566-01	4-Wire Private Line Terminating and Station Circuit
SD-, CD-96147-01	Private Line Automatic Ringdown Circuit
SD-, CD-1C475	Customer Premises Facility Terminal for F Type Signaling

SECTION	TITLE
103-106-105	2D and 2E Singing Point Test Set—Description
103-106-110	54C Return Loss Measuring Set—Description
103-106-115	KS-20501 Return Loss Measuring Set—Description and Operation
310-300-100	Two-Point Private Line Voice-Only Telephone Circuits Description
310-300-500	Two-Point Private Line Voice-Only Telephone Circuits Maintenance Procedures
311-100-552	Special Service Link Line-up-CO to CO-2-wire Link Using E6 Repeaters
311-100-553	Special Service Link Line-up-CO to Station-2-wire Link Using E6 Repeaters
331-100-100	Message Circuit Noise—General Information

TABLE E

SIGNALING CONDITIONS FOR FIG. 1, 2, 3

TEST POINT	RINGING/SIGNALING TOWARD STATION	RINGING/SIGNALING FROM STATION
1	20-Hz ac measured between tip and ring on cord in monitor jack (Min. 50 v ac).	20-Hz ac measured between tip and ring on cord in monitor jack (75—105 v ac).
2	20-Hz ac measured between screw switches "SX Short Ind" on 1-type term. set (Min. 50 v ac).	20-Hz ac measured between screw switches "SX Short Ind" on 1-type term. set (75—105 v).
3	20-Hz ac measured between tip of receive pair and tip of transmit pair. The same measurement should be obtained on the ring pairs (Min. 50 v ac).	20-Hz ac measured between tip of receive pair and tip of transmit pair. The same measurement should be obtained on the ring pairs (75—105 v ac).
4	Same as 3 above (75—105 v ac).	Same as 3 above (Min. 15 v ac).
5	Lighted line and dark drop lamps on 2B signaling test set or equivalent signal monitoring arrangement.	Lighted drop and dark line lamps on 2B set or equivalent signal monitoring arrangement.
6	SF tone (2600 Hz) receiving at —13 dBm (20 dB below TLP). No SF tone transmitting (see Note).	SF tone (2600 Hz) transmitting at —36 dBm (20 dB below TLP). No SF tone receiving (see Note).

Note: There will be an initial burst of SF tone 12 dB higher than that shown.

TABLE F

TEST EQUIPMENT REQUIRED

MEASUREMENT/TEST	TEST EQUIPMENT REQUIRED
1000-Hz Loss & Slope	Hewlett-Packard 3550B Portable Test Set
	Hewlett-Packard 4940A Transmission Impairment Test Set
	Northeast Electronics TTS 4 BNH
	Northeast Electronics TTS 4 BNH-N
	Northeast Electronics TTS 15B
	Northeast Electronics TTS 35B
	TTI 1103A, 1103B Digital Transmission Test Sets
Message Circuit Noise	Hewlett-Packard 4940A Transmission Impairment Test Set
	Northeast Electronics TTS 4 BNH-N
	TTI 1105 Level/Noise Digital Test Set
	WECo 3A, 3B, 3C Noise Measuring Sets
DC Voltage and Ringing Voltage	KS-14510 Volt-Ohm-Milliammeter
Signaling	Northeast Electronics TTS 26B Signaling Test Set
	WECo 1A, 2B or 4A Signaling Test Set
Return Loss (Echo and Singing)	KS-20501 Return Loss Measuring Set
	WECo 2D Or 2E Singing Point Test Set
	WECo 54C Return Loss Measuring Set
	Wiltron Model 9031 Return Loss Measuring Set

331-850-501	Noise Measurements on 2-wire Subscriber Loops—Methods and Requirements-At Stations	332-104-100	V4 Telephone Repeater
		332-104-500	Initial Line-up
331-850-502 (to be issued)	Methods for Identifying and Correcting Inductive Noise	332-104-501	227-Type Amplifiers—Tests and Adjustments
332-015-100	Simplified Theory of Singing Point Tests	332-105-10Z	24V4 Repeaters—Description

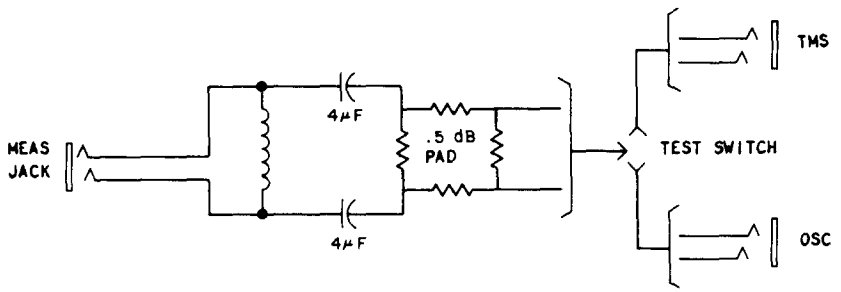


FIG. 4A 2AB SET USED FOR DC ISOLATION

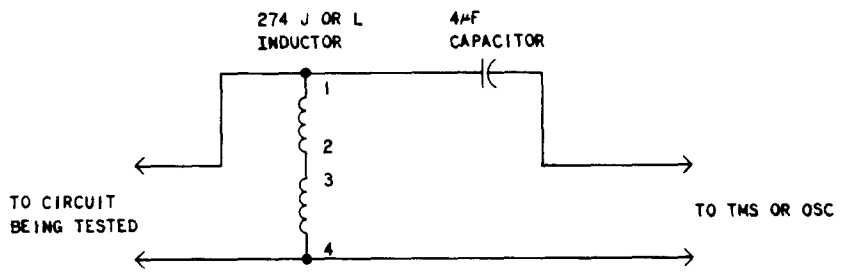


FIG. 4B LOCALLY PREPARED HOLDING ARRANGEMENT

Fig. 4—DC Isolation and Holding Coil Arrangements

332-115-10Z	849-Type Networks—Description	332-910-100	Metallic Facility Terminal—General Description
332-116-10Z	359-Type Equalizers—Description	332-910-180 (to be issued)	Metallic Facility Terminal—Application Information
332-116-20Z	Strapping Charts for 359-Type Equalizers	332-911-ZZZ	Metallic Facility Terminal—Signaling Units
332-206-100	E6 Repeater—Description	332-912-ZZZ	Metallic Facility Terminal—Transmission Units
332-206-200	E6 Repeater—Alignment Procedure	480-615-100	4-wire Private Line Terminating Circuit—SD-69566-01 Identification, Installation, Connections, and Line-up Procedures
332-206-500	E6 Repeater—Tests and Adjustments	518-YYY-ZZZ	Key Telephone Systems
332-601-ZZZ	Customer Premises Facility Terminal for Type F Signaling System		