MODEL 9041 TRANSMISSION LEVEL AND RETURN LOSS MEASURING SET OPERATION MANUAL

WILTRON

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WARRANTY

All products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation covers repairing or replacing products which prove to be defective during the warranty period and which shall be returned with transportation charges prepaid to WILTRON. Obligation is limited to the original purchaser. We are not liable for consequential damages.

MANUAL CHANGES

MODEL 9041 TRANSMISSION LEVEL AND RETURN LOSS MEASURING SET OPERATION MANUAL

Change #1

Serial Numbers Affected

All

A. On page 1-3, paragraph 1.13, change the first sentence to read as follows:

"The power required by the Model 9041 is 115 or 230 Vac, 50 to 60 Hz, at 5 watts."

B. On page 1-5, second column, under OPERATING POWER, change frequency range to read as follows: "50 to 60 Hz."

PCO 15684 June 6, 1985

INTRODUCTION

This manual provides operation instructions for the Model 9041 Transmission Level and Return Loss Measuring Set manufactured by WILTRON Company, Mtn. View, California.

The material in the manual is divided into three general sections as described below.

Section I contains an overall description of the equipment, including performance specifications.

Section II contains operation information.

Section III contains performance verification procedures.

Maintenance instructions for the Model 9041 are provided in a separate manual.

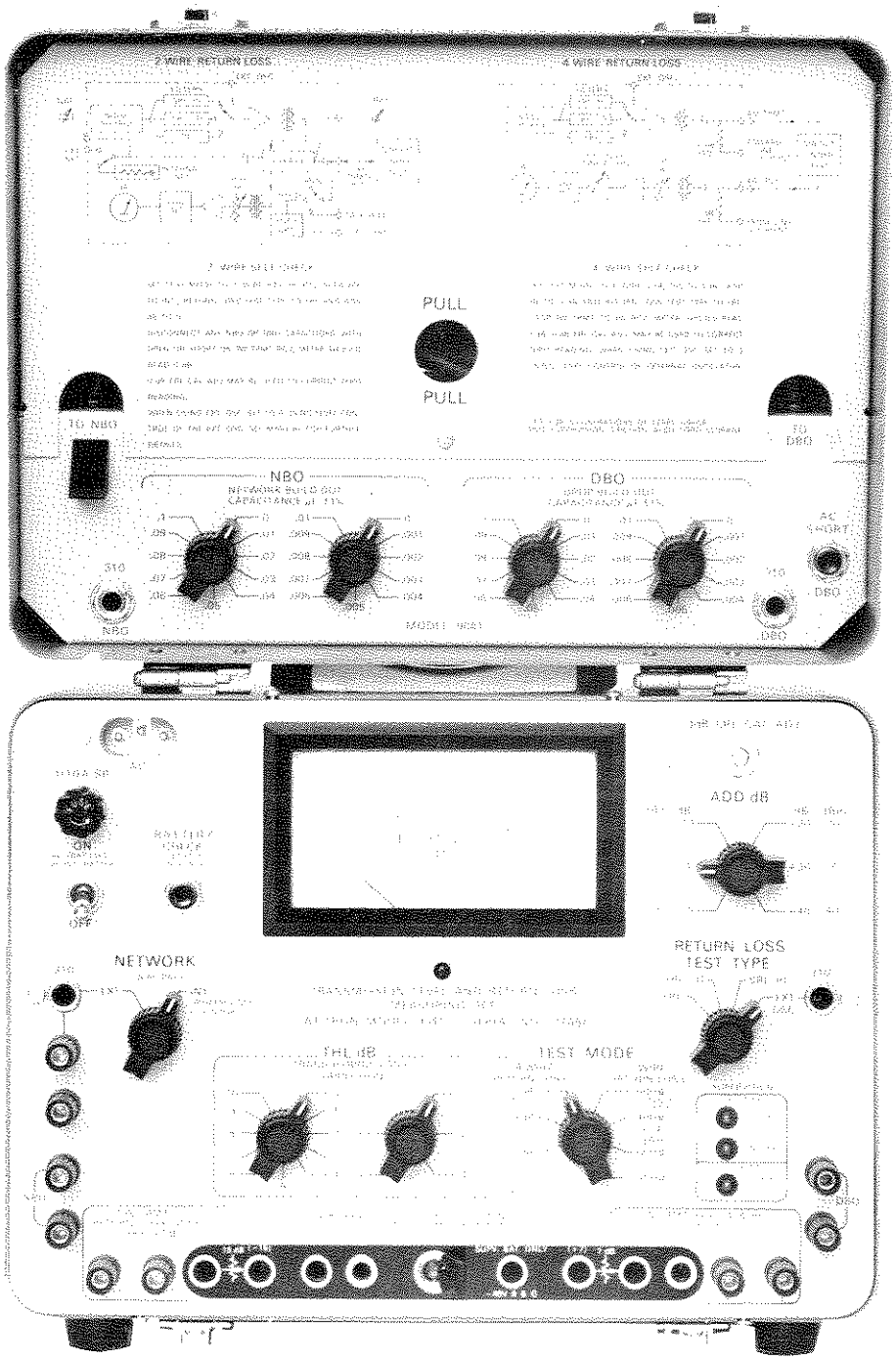


Figure 1-1. WILTRON Model 9041 Transmission Level and Return Loss Measuring Set

SECTION I

GENERAL INFORMATION

CONTENTS PAGE

1. DESCRIPTION

(A) General Description

1.01 The WILTRON Model 9041 Transmission Level and Return Loss Measuring Set (see Figure 1-1) fulfills or exceeds the requirements of Western Electric Specification KS 20501 for Through and Terminal Balance of all classes of telephone offices. The Model 9041 incorporates in one instrument the means to measure transmission level, receive frequency response, echo return loss and singing return loss on 4-wire or 2-wire, 600 ohm or 900 ohm circuits. These features permit measurements of loss and balance that meet Bell System, USITA and CCITT specifications.

(B) Measuring Features

The Model 9041 Measuring Set provides transmission level measurements from +12dBm to -48dBm on both 600 and 900 ohm incoming and outgoing trunks over a bandpass of 200Hz to 5kHz. Echo return loss (ERL) and singing return loss (SRL) (high and low) measurements from -10dB (10dB return gain) to 50dB are provided. Trans-hybrid loss correction of up to 30.8dB in 0.2dB steps is provided for 4-wire return loss measurements. Unused trans-hybrid correction ranges may also be used to correct +7 or -16dB point levels at VFPB's (voice frequency patching bays) or to extend return loss range beyond 50dB on 4-wire circuits. The meter scale and panel controls are marked in red for level measurements and black for return loss measurements.

(C) Special Features

1.03 The Model 9041 measuring set provides on/off hook reverse battery loop supervision control and supervision indicator lamps for both incoming and outgoing trunk circuits. Decade network buildout (NBO) and drop buildout (DBO) capacitors are provided in the case lid. With these capacitors, the set alone may closely simulate the Office Balance Test Hybrid circuit (Code 970) in 2-wire offices. Tests and several years of use in many offices indicate that this simulation is acceptable for practical circuit order Terminal Balance tests in offices meeting cross office resistance requirements.

1.04 A capacitive ac short circuit is available in the case lid of the Model 9041. This enables holding a working trunk being tested and at the same time checking or measuring short circuit trans-hybrid loss on the set or the external trunk hybrid without inadvertently causing release of the trunk. The case lid is detachable to allow its use as a precision decade capacitor and ac short during DBO and NBO adjustments, Through Balance measurements and office balancing operations.

1.05 Padding and interlocking are provided in the Model 9041 for use when measuring return loss from the 4-wire VF point over carrier systems. This helps protect against carrier overload.

(D) Special Capabilities

1.06 A combination of the above features permits the Model 9041 alone to control supervision and make level, frequency response and return loss measurements at many 2-wire or 4-wire access points. Measurements may also be made at outgoing trunk (OGT) test frames of both 2 and 4-wire switching offices, 17B and other toll or private line testboards, maintenance test frames, distributing frames and the test jacks of step switches, impedance compensators and repeater test stands.

The Model 9041 test set thus enables one man at a Crossbar Tandem (or 18B TTB equipped with intertoll step-by-step trunks) to perform all required circuit order overall receive net loss, receive frequency response and Terminal Balance measurements on incoming or outgoing trunks. No assistance is required from another man in his own office.

1.08 The receiving section of the Model 9041 greatly attenuates signals below 200Hz and above 5kHz. This makes possible effective use in step-by-step PBX's with rectifier power plants or other noisy environments and in the presence of "carrier leak".

1.09 The Model 9041 measuring set considerably simplifies work and reduces Central Office maintenance time (and costs) because it performs the function of the following Western Electric and other similar test sets.

MODEL	TYPE OF TEST SET
23A	Transmission Measuring Set
201A	Noise Generator
455B	Weighting Network
3C	Noise Measuring Set (return loss only)
2D	Singing Point Test Set
207G	High Pass Filter
54C	Return Loss Measuring Set
P9B	Zero Loss Test Set and other types of portable test hybrid sets
P14A	Holding and Terminating Test Set
Various	Precision Decade Capacitor Sets
Various	Switch Boxes

NOTE

For most applications, the Model 9041 can be used in place of the Office Balance Test Hybrid when making measurements to Code 970 in Crossbar Tandem Offices.

(E) Additional Capabilities

1.10 Additional measurements which can be made on cables with the Model 9041 include echo structural return loss and structural return loss (when used with an audio oscillator), and cable pair capacity and impedance. In addition, the measuring set is useful for making impedance compensator adjustments, and negative-impedance repeater adjustments.

(F) Performance Specifications

1.11 The performance specifications of the Model 9041 Transmission Level and Return Loss Measuring Set are listed in Table 1-1.

(G) Unpacking the Equipment

1.12 The measuring set is shipped in a special packing box which should be saved if re-shipment is planned. A transit bag for the measuring set is shipped in a separate package. After unpacking, the unit should be checked for damage. If any damage is noted, advise WILTRON and file a claim with the transfer company. After unpacking, a performance verification may be performed as described in Section 3. If your local supply voltage is other than 115V ac, ensure that the 115/230V switch (inside the unit) is in the proper position for the local line voltage. See Figure 1-2 for location of switch and spare fuse.

(H) Power Requirements

1.13 The power required by the Model 9041 is 115 or 230V ac, 50 to 400Hz, at 5 watts. The internal rechargeable battery provides operation up to 8 hours without recharging. Time for complete recharge is 10 hours. The 115/230V ac switch (mounted on an internal bracket) must be set for the appropriate line voltage.

WARNING

DAMAGE WILL OCCUR IF 230V AC IS APPLIED TO THE 115V AC TRANSFORMER WINDING.

(I) Function of Controls, Indicators, and Connectors

1.14 The function of the front panel and inside lid controls, indicators, and connectors is described in Table 1-2.

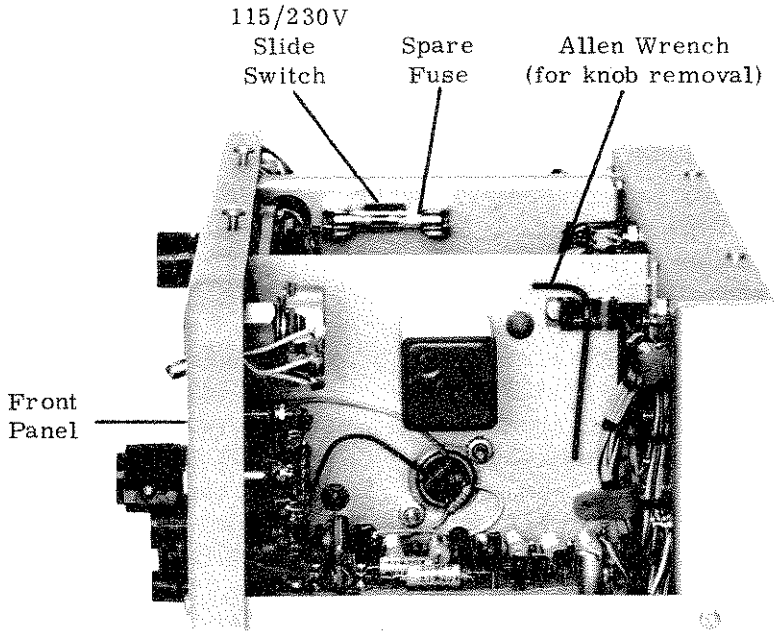


Figure 1-2. Location of 115/230V Switch, Spare Fuse, and Allen Wrench

Table 1-1. Performance Specifications

TRANSMISSION MEASUREMENTS

LEVEL MEASURING RANGE: -48dBm to +12dBm (600 or 900 ohms terminated). Meter calibrated linearly in dB from +2 to -8dBm. ADD dB control range +10 to -40dBm.

LEVEL ACCURACY AT 1KHZ: ±0.1dB from +12dBm to -28dBm. ±0.2dB from -28dBm to -48dBm.

FREQUENCY RESPONSE: ±0.05dB from 500Hz to 2500Hz. ±0.1dB from 200 to 500Hz, and 2500 to 5000Hz. >40dB down at 60Hz and 56kHz.

RETURN LOSS MEASUREMENTS

TEST SIGNALS: See Figure 2-9. White noise band limited with the following filters:

Echo Return Loss (ERL): 560 to 1965Hz (-3dB).

Singing Return Loss Low (SRL LO): 260 to 500Hz (-3dB).

Singing Return Loss High (SRL HI): 2200 to 3400Hz (-3dB).

Variation in Power Level when Switching Test Filters: < ±0.1dB.

External Oscillator (EXT OSC) Frequency Range: 200Hz to 5kHz.

RETURN LOSS MEASUREMENT: -10dB (+10dB return gain) to 50dB return loss. Meter calibrated linearly in dB from 0 to 10dB. ADD dB control range from -10 to +40dB in 10dB steps.

OVERALL ACCURACY: ±0.4dB to 40dB; ±1.2dB to 50dB return loss.

4-WIRE RETURN LOSS OPERATION:

4-Wire Transmit Levels: -2dBm ±0.2dB for normal operation, and -18dB for use at -16 points on carrier systems.

4-Wire Receive Levels: -2dBm from 0 points for normal operation and +7dBm to receive from carrier systems at +7 points.

NOTE

When a plug is inserted in the +7 (FROM LINE) jack, the -2dBm output points are disabled to insure that carrier overload does not occur because of improper connections.

4-Wire Impedance: 600 ohms balanced.

Trans-hybrid Loss Correction Range: 0 to 30.8dB in 0.2dB steps.

Return Loss Measurement Range (4-Wire): 80.8dB; 10dB on meter, +40dB (ADD dB control), +30.8dB trans-hybrid loss correction (THL dB).

Longitudinal Balance: >70dB at 100Hz; >55dB at 3kHz.

2-WIRE RETURN LOSS OPERATION:

Balance of Internal Hybrid: >>50dB.

Frequency Response of Internal Hybrid: 200Hz to 5kHz.

Internal Network Impedance: 600 or 900 ohms ±0.1% in series with a 2.16μF ±1% capacitor.

2-Wire Test Signal Level: 600 ohms, -8dBm ±0.2dB; 900 ohms, -9.8dBm ±0.2dB.

GENERAL

HOLDING COIL: 200 ohms nominal resistance. 0-120mA dc current range. Talk/Dial switch included. Type 309 and 310 input connectors provided for telephone dial set, pulse-sending MF, or SF equipment. Holding coil split center tap permits external 48V supply to be injected through front panel 310 jack (provides off-hook supervision on terminating incoming calls).

TYPE OF CONNECTORS: WE Type 310 connector provided for all input and output connections. WE Type 309 connectors also provided for 2-wire transmit/receive and Talk/Dial.

INSULATION TO GROUND: >600V dc.

RINGING SIGNALS: No damage will result if 105V rms at 20Hz is applied for 10 seconds to the transmit or receive connectors.

NBO AND DBO DECADE CAPACITORS: Contained in detachable case lid to permit separate operation. Pushbutton switch provided to apply a momentary ac short across DBO decade (used to adjust compensation for trans-hybrid loss of external 4-wire termination sets).

CAPACITANCE RANGE OF NBO AND DBO DECADES: 0 to 0.11μF in 0.001μF steps; accuracy ±1%.

OPERATING POWER: 115/230V ac, 50 to 400Hz, 5 watts; or internal rechargeable battery, up to 8 hours operation without charging.

NOTE

The internal battery is being recharged when the unit is operating from an ac supply.

SIZE AND WEIGHT: 12" x 9" x 9", 14 pounds (shipping weight 20 pounds).

Table 1-2. Function of Controls, Indicators, and Connectors

CONTROLS

POWER SWITCH: Two-position toggle switch. Power is on and battery will charge when power cord is connected to the AC socket and the power switch is in the ON position. With power cord disconnected, instrument is powered by internal batteries. Power switch is mechanically set to off position when case lid is closed.

BATTERY CHECK SWITCH: Used to determine battery condition. When pressed, a reading above 6 on black meter scale indicates that the battery has sufficient charge to operate the instrument.

ADD dB SWITCH: Extends range of front panel meter in 10dB steps to cover the total transmission level and return loss measurement ranges of the test set.

NETWORK SWITCH: Operates on 2-wire return loss positions of TEST MODE switch only. Provides internal reference network of either 600 or 900 ohms in series with a 2.16μF capacitor. An external circuit under test is compared to this reference. A WE Type 310 phone jack or GR Type 938 binding posts provide for connection of an external network, such as a precision balance network.

RETURN LOSS TEST TYPE SWITCH: Operates only on 4-wire and 2-wire return loss positions of TEST MODE switch. Selects internal filters which shape (weight) transmitter noise spectrum according to WE Specification KS 20501 (see Figure 2-9), or external oscillator input.

ERL (Echo Return Loss) is the mid-voice band (560 to 1965Hz).

SRL LO (Singing Return Loss-Low Frequency) is a selected area at the low end of the voice band (260 to 500 Hz).

SRL HI (Singing Return Loss-High Frequency) is a selected area at the high end of the voice band (2200 to 3400Hz).

EXT OSC provides a WE Type 310 phone jack to connect an external oscillator when making structural return loss measurements. As an alternative, multifrequency or single frequency supplies may be connected here for signaling purposes through the test set.

TEST MODE SWITCH: Selects either level or return loss measurements as follows:

Level measurements: 600 or 900 ohm circuits.

Return loss measurements: 2-wire, 600 or 900 ohm circuits or 4-wire, 600 ohm circuits.

In any 4-wire return loss position, the THL dB switches are connected.

THL dB SWITCHES: Used for 4-wire return loss operation only. Provides correction for internal loss of hybrid under test when making 4-wire measurements. Up to 30.8dB (in 0.2dB steps) can be corrected for when used in conjunction with the TEST MODE switch. Also used to correct for +7 and -16 point levels on the drop side at voice frequency patching bays.

0dB ERL CAL ADJ CONTROL: Used to adjust meter to zero when calibration is performed as outlined in the instrument lid.

MECHANICAL METER ZERO ADJUST CONTROL (through the hole in the meter bezel): Used to mechanically adjust the meter zero with power turned off, and with test set in horizontal or vertical position as per office practice.

NBO CONTROLS (in case lid): Provides decade capacitance steps from 0.001 to 0.11μF for use when selecting network buildout (NBO) capacitors in 4-wire termination sets and Central Office balancing etc.

DBO CONTROLS (in case lid): Provides decade capacitance steps from 0.001 to 0.11μF for use when selecting drop buildout (DBO) capacitors for Central Office balancing etc.

AC SHORT DBO SWITCH (in case lid): Places ac short (8μF) across DBO jack and captive cable in case lid. Used to measure trans-hybrid loss (THL) when connected to 2-wire side of external hybrid (used with THL dB switches).

TALK/DIAL, HOLD, OPEN (NORMAL) SWITCH (used on 2-wire return loss and level receive operation only): Provides a means of dialing connections to various circuits or terminations for making level or return loss measurements. Dialing jacks provide a WE 309 or 310 phone jack for connection to a handset or test frame. On/off hook supervision on outgoing trunks is provided in the HOLD and OPEN (NORMAL) positions. In the HOLD position, a holding coil is placed across the trunk to permit holding current to flow. For incoming trunk measurements made at the OGT test frame, a -48V battery can be applied through the split holding coil (with the switch in the HOLD position) to maintain an off-hook condition.

INDICATORS

FRONT PANEL METER: Indicates dB of return loss from 0 to 10dB or dBm level from +2 to -8dBm; range for both scales is extended by ADD dB switch.

SUPERVISION INDICATORS:

OUTGOING TRUNKS

TIP BAT INDICATOR: Lights when supervision battery from the line on test is connected to the connector tip (ring ground) to show on/off hook status.

RING BAT. INDICATOR: Lights when supervision battery from the line on test is connected to the connector ring (tip ground) to show on/off hook status.

INCOMING TRUNKS

SLEEVE GRD. INDICATOR (needs -48V dc applied to SUPV. BAT. ONLY jack): Indicates that the sleeve has been grounded on 2W TRMT/RCV or LEVEL RCV jacks. Lights when a calling incoming trunk circuit is completed to the test set at the outgoing trunk test frame (OGT) of a crossbar tandem office providing that -48V dc has been applied to the SUPV. BAT. ONLY jack.

CONNECTORS

2W TRMT/RCV, 4W RCV, LEVEL RCV CONNECTORS: Provides a WE Type 309 and 310 phone jack and GR Type 938 binding posts for connection to the circuit under test (no other connection necessary for 2-wire return loss measurements).

4W TRMT CONNECTORS (RETURN LOSS ONLY): Provides a WE Type 310 phone jack and GR 938 binding posts to send a white noise test signal to external circuits when making 4-wire return loss measurements.

NOTE

The -2dBm output is disabled when a plug is inserted in the +7 (FROM LINE) jack to prevent carrier overload.

TWD LINE JACK (-16): Provides a transmit output level attenuated 16dB (to a -18dBm level) for 4-wire return loss tests towards the line when measuring on carrier channels.

SUPV. BAT. ONLY JACK -48 B AND G WE type 310 jack accepts 48V battery input for supervision to present off-hook condition (ring to battery, tip to ground on 2W TRMT/RCV and LEVEL RCV jacks) to the trunk under test. Off-hook condition is independent of the sense of the battery input on tip and sleeve or sleeve and tip. This jack is used only when battery and ground is needed from the test set to provide off-hook supervision on incoming trunks for 2-wire return loss or level receive measurements, or to supply power for supervision SLEEVE GRD. indicator.

FROM LINE JACK (+7) (used for 4-wire return loss measurements only): Attenuates receive signal by 7dB for making measurements over carrier channels.

NOTE

With a plug inserted in the +7 (FROM LINE) jack, the -2dBm 4-wire transmit output is disabled to prevent overload on carrier systems.

NBO CONNECTORS: Connect to NBO decade capacitors in the case lid. Connection made through captive cable under instruction panel in the case lid.

DBO CONNECTORS: Connect to DBO decade capacitors in the case lid. Connection made through captive cable under instruction panel in the case lid.

310 NBO JACK (in case lid): Used when the NBO decade capacitors in the case lid are being used remotely from the instrument as test capacitors. A plug inserted in the 310 NBO jack cuts out the captive cable (in the case lid) from the circuit.

310 DBO JACK (in case lid): Used when the NBO decade capacitors in the case lid are being used remotely from the instrument as test capacitors. A plug inserted in the 310 DBO jack cuts off the captive cable (in the case lid) from the circuit).

MISCELLANEOUS

1/10 A SB (Fuse): Provides circuit protection when line cord is connected to 115/230V ac lines. A spare fuse is mounted inside case. See Figure 1-2.

AC RECEPTACLE: Provides connection for ac line cord (stored in case lid).

SECTION II

OPERATION

CONTENTS PAGE

2. OPERATING THE MODEL 9041

2.01 INTRODUCTION

This section contains operating procedures for using the Model 9041 Measuring Set to make level, through and terminal balance, and other useful measurements in Central Offices.

NOTE

Bell System Practice 660-471-504, entitled "Crossbar Tandem Offices Test Equipment, Test Circuits, and Terminations used in Through and Terminal Balance Testing" (dated Nov. 1973), uses the same test method for Echo Return Loss and Singing Point measurements as is used in the Model 9041.

2.02 PERFORMANCE CHECK

The following procedure may be used if the operator wishes to check the measuring set for proper operation. Detailed performance verification procedures are contained in Section III.

2.03 OPERATING PROCEDURES

(A) Supervision Circuit and Indicators

2.04 The supervision circuit of the Model 9041 measuring set enables one man to make return loss and level measurements on 2-wire Incoming and Outgoing trunks. A TALK/DIAL and HOLD feature provides a means of calling up and holding (when necessary) the desired circuit or termination to be measured.

PERFORMANCE CHECK

STEP	PROCEDURE	
1	Ensure that the ac power cord is disconnected from the measuring set. Switch the test set power ON.	
2	Momentarily press the BATTERY CHECK switch. The meter should indicate above 6 on the black scale if the battery is sufficiently charged to operate the measuring set.	
3	Set the controls as follows:	
	NETWORK	INT
	RETURN LOSS TEST TYPE	ERL
	TEST MODE	2-WIRE RETURN LOSS, 600 ohms
	THL dB	0.0
	ADD dB	0
	NBO DECADE	0.00μF
	DBO DECADE	0.00μF
	TALK/DIAL, HOLD, OPEN	OPEN
4	Check that the meter indicates 0 ±0.1dB. If necessary, adjust the 0dB ERL CAL ADJ control to bring the meter indication to within ±0.1dB of zero on the black scale.	
5	Short-circuit the 2W TRMT/RCV terminals. The meter should indicate 0 ±0.1dB. Remove the short.	
6	Patch the 4W TRMT terminals to the 4W RCV terminals. Set the TEST MODE switch to 4-Wire RETURN LOSS 0dB. Check that the meter indicates 0 ±0.1dB. Adjust the 0dB ERL CAL ADJ if necessary. Remove the patch.	
7	Patch the Central Office Milliwatt Supply (0dBm, 1kHz signal) to the LEVEL RCV jacks. Set the TEST MODE switch to LEVEL dBm, 600 ohms or 900 ohms depending on the output impedance of the Milliwatt Supply. Check that the meter indicates 0dBm (±0.1dBm ± level accuracy of the Milliwatt Supply used) on the red scale. Disconnect the Milliwatt Supply from the measuring set. See paragraph 3.04 of Section III if an acceptable level accuracy reading cannot be obtained.	

2.05 A simplified diagram of the Outgoing trunk supervision circuit is shown in Figure 2-1. For 2-wire Outgoing trunk measurements, the desired circuit is dialed with the TALK/DIAL, HOLD, OPEN switch in the TALK/DIAL position. The TALK/DIAL switch is then set to the HOLD position to provide a path for the dc loop current through the holding coil.

2.06 Figure 2-2 is a simplified diagram of the Incoming trunk supervision circuit. For 2-wire Incoming trunk measurements, the tests may be made at various 2-wire access points such as the Outgoing trunk (OGT) test frame. For this purpose a -48V battery (signal battery) is applied to the Model 9041 through an internal diode matrix and holding coil to the 2W TRMT/RCV or LEVEL RCV jacks. The diode matrix is used to ensure that an off-hook condition is applied to the line regardless of the sense of the battery input.

NOTE

An off-hook condition is presented as -48V on the ring and ground on the tip. Some offices require the reverse conditions for off-hook supervision. When supplying supervision, use the banana jacks (binding posts) on the Model 9041, since the battery sense can be easily reversed by reversing the banana plug connections.

2.07 The RING. BAT. and TIP BAT. indicators are status indicators used to determine "on" or "off" hook trunk conditions by checking the lead polarity of the tip and ring of the 2-wire connected trunk. The sleeve indicator lights when a sleeve ground is present from the connected trunk equipment. This indicator is most useful in crossbar tandem offices when the Model 9041 is connected at the CGT to the Outgoing link appearance (OLS test jack) of the transmission test code.

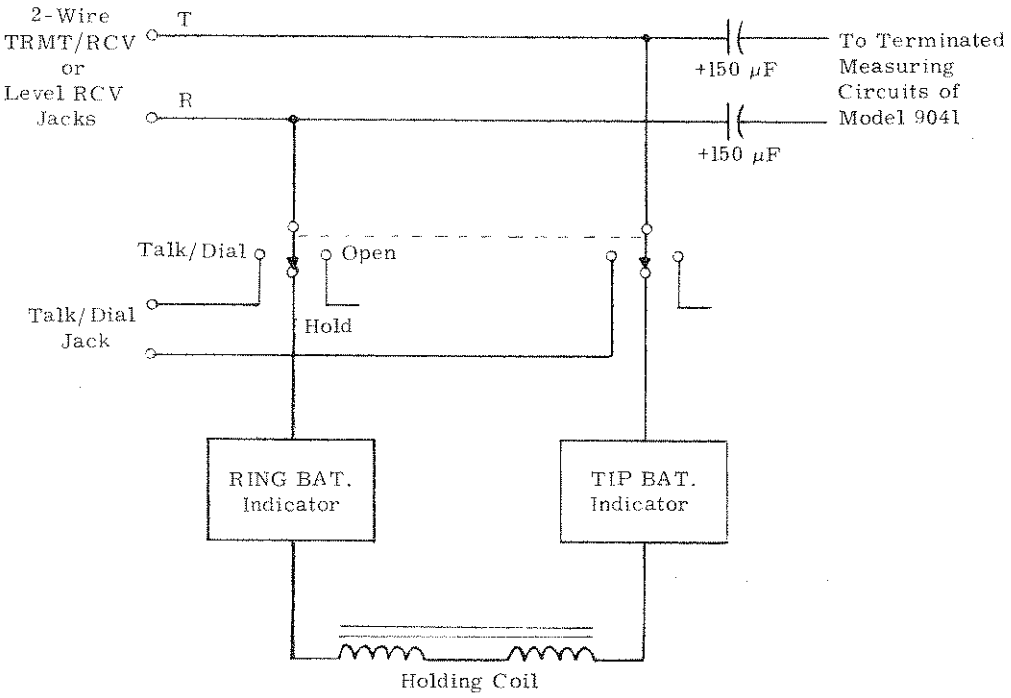


Figure 2-1. Outgoing Trunk Supervision Circuit, Simplified Diagram

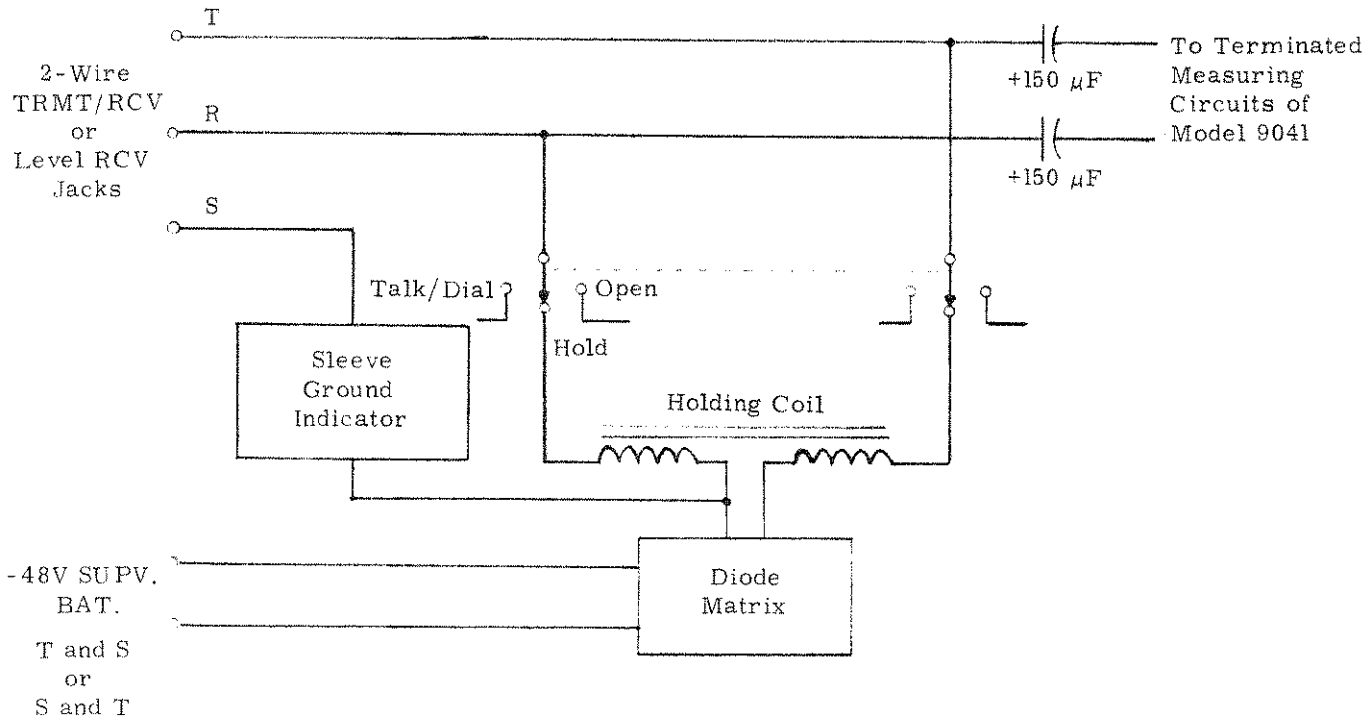


Figure 2-2. Incoming Trunk Supervision Circuit, Simplified Diagram

USE OF 2-WIRE SUPERVISION CIRCUITS AND INDICATORS (INCLUDING TALK/DIAL)

STEP	PROCEDURE
	2-WIRE OUTGOING TRUNKS (In all offices using reverse battery answering supervision)
1	Connect a dial handset (or suitable pulse-sending equipment) to the TALK/DIAL jack.
2	Set the TALK/DIAL, HOLD, OPEN switch to TALK/DIAL.
3	Establish a connection to the circuit under test then set the switch to HOLD (off-hook condition). NOTE On/Off hook status is shown by the TIP BAT. and RING BAT. indicators. Either indicator may light for on/off hook status depending on the Central Office convention for off-hook conditions.
4	Perform the desired measurements (level or return loss) at the outgoing trunk.
5	Return the TALK/DIAL switch from HOLD to OPEN or TALK/DIAL as necessary to release the switched connection.

USE OF 2-WIRE SUPERVISION CIRCUITS AND INDICATORS (INCLUDING TALK/DIAL)

STEP	PROCEDURE
	2-WIRE INCOMING TRUNKS (In common control offices)
1	Connect a -48V signal battery to the SUPV. BAT. CNLY jack (tip and sleeve, or sleeve and tip). Sense of the battery is optional. (See paragraph 2.06).
2	Establish a connection from the originating (far) end of the circuit being tested to the access jack where the Model 9041 is connected. After the connection is completed, set the TALK/DIAL switch to HOLD to provide off-hook or answer supervision. NOTE The 48V input to the SUPV. BAT. ONLY jack is required only if answer supervision (-48V and ground on tip and ring) must be supplied at the test access jack.
3	Perform the desired measurements (level or return loss) at the incoming trunk. NOTE The SLEEVE (ground) indicator lights when the sleeve of the 2W TRMT/RCV jack has been grounded by the machine to indicate a completed connection. This occurs when the Model 9041 is used in crossbar tandem offices for making 2-wire measurements at the OGT test frame.

(B) Level Measurements

2.08 For level measurements, a 0dBm, 1kHz test signal is applied to the sending end of the circuit to be checked. The receive end of the circuit is connected to the LEVEL RCV input jacks of the Model 9041. The internal circuitry of the measuring set used for level tests is shown in Figure 2-3. The bandpass filter prevents noise and extraneous signals from affecting level and return loss readings. As shown in Figure 2-4, the sharp dropoff in response outside the 200 to 5000Hz bandpass also prevents the measurement of signals outside of this frequency range (such as 60Hz hum or channel carrier leak above 5KHz).

2.09 Figures 2-5 through 2-8 show how typical level measurements can be made with the Model 9041, on 2-wire or 4-wire circuits (with and without supervision). Each figure is followed by a procedure which describes the method of making the measurement.

NOTE

When making measurements with the Model 9041 operating on internal battery, check the battery voltage every 2 hours. This is done by pressing the BATTERY CHECK switch and checking that the meter reading is above 6 on the black scale. Always check that test cords are in good condition and test plugs and jacks are polished clean to ensure good connections.

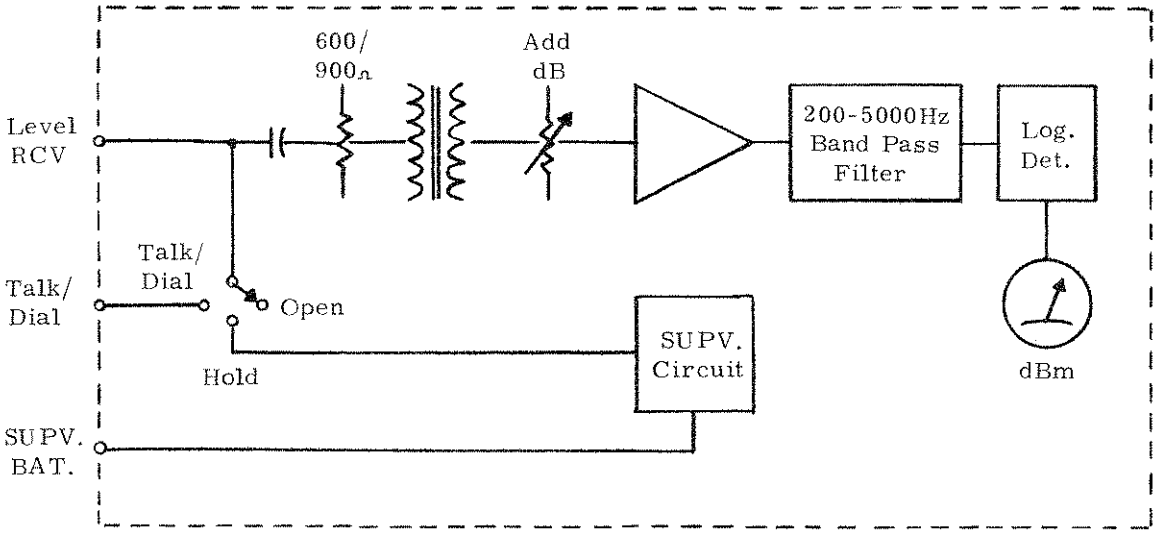


Figure 2-3. Level Measurement, Simplified Diagram

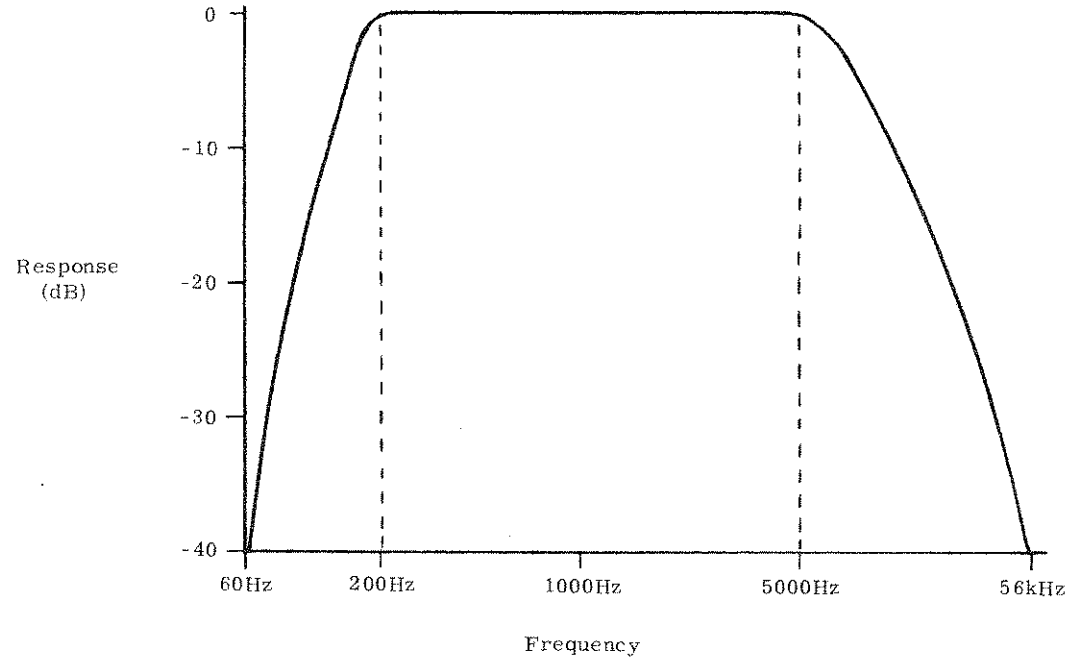


Figure 2-4. Receiver Bandpass Filter Response

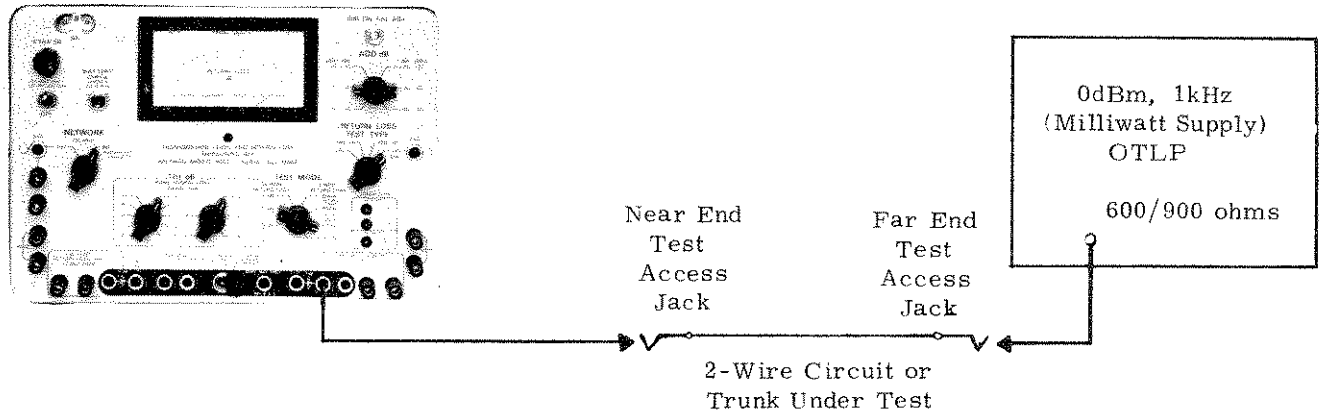


Figure 2-5. 2-Wire Level Measurement (Without Supervision) Test Setup

2-WIRE LEVEL MEASUREMENT (WITHOUT SUPERVISION)

STEP	PROCEDURE
1	Connect the signal source and the Model 9041 to the circuit or device under test as shown in Figure 2-5.
2	Set the controls on the Model 9041 as follows: TEST MODE — LEVEL dBm (600 or 900 ohms as applicable) NETWORK — INT THL dB — 0.0 ADD dB — 0 TALK/DIAL, HOLD, OPEN — OPEN (NORMAL)
3	Measure the receive level on the LEVEL dBm scale (red), setting the ADD dB switch as necessary to bring the meter reading on scale. NOTE The level in dBm = meter reading + ADD dBm setting. It is valid with circuits presenting 600 or 900 ohm impedance. If a level measurement versus frequency is desired, refer to paragraph 2.26 for attenuation distortion (frequency response) measurements.

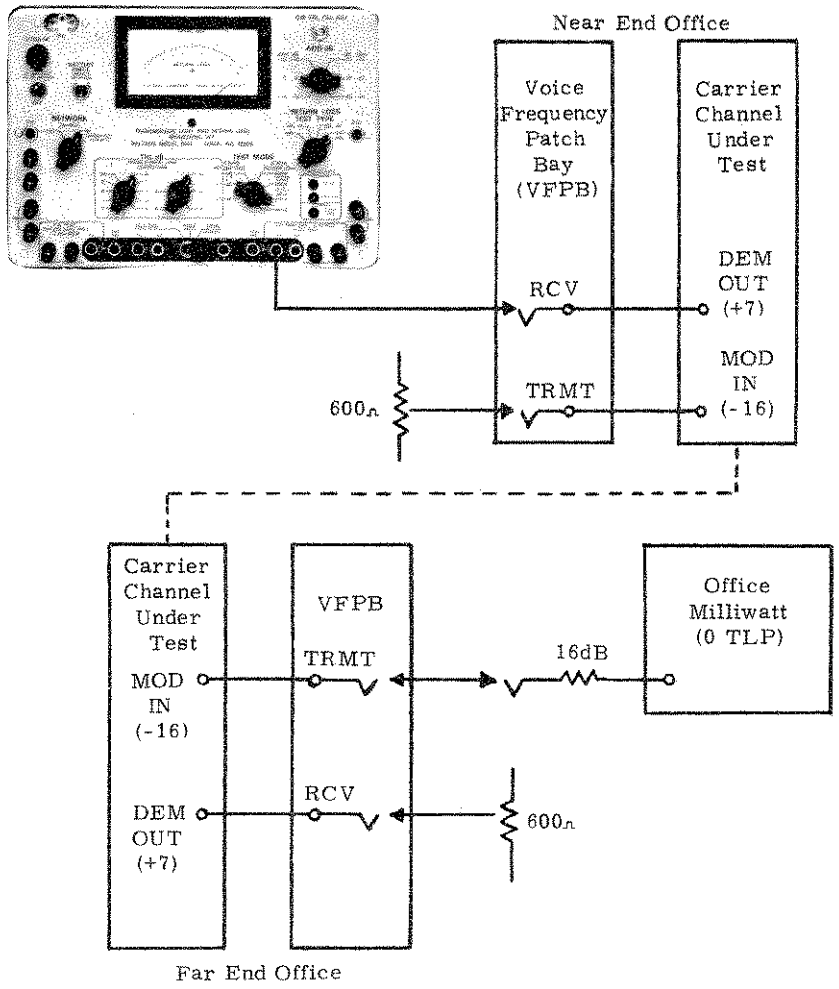


Figure 2-6. 4-Wire Level Measurement, Test Setup

4-WIRE LEVEL MEASUREMENT

STEP	PROCEDURE	
1	Connect the test equipment as shown in Figure 2-6.	
2	Set the controls on the Model 9041 as follows:	
	TEST MODE	LEVEL dBm 600 ohms
	NETWORK	INT
	THL dB	0.0
	ADD dB	0
	TALK/DIAL, HOLD, OPEN	OPEN (NORMAL)
3	Measure the level (red scale), setting the ADD dBm switch as required to bring the meter reading on scale.	
4	Level (dBm) = meter reading + ADD dB switch setting.	

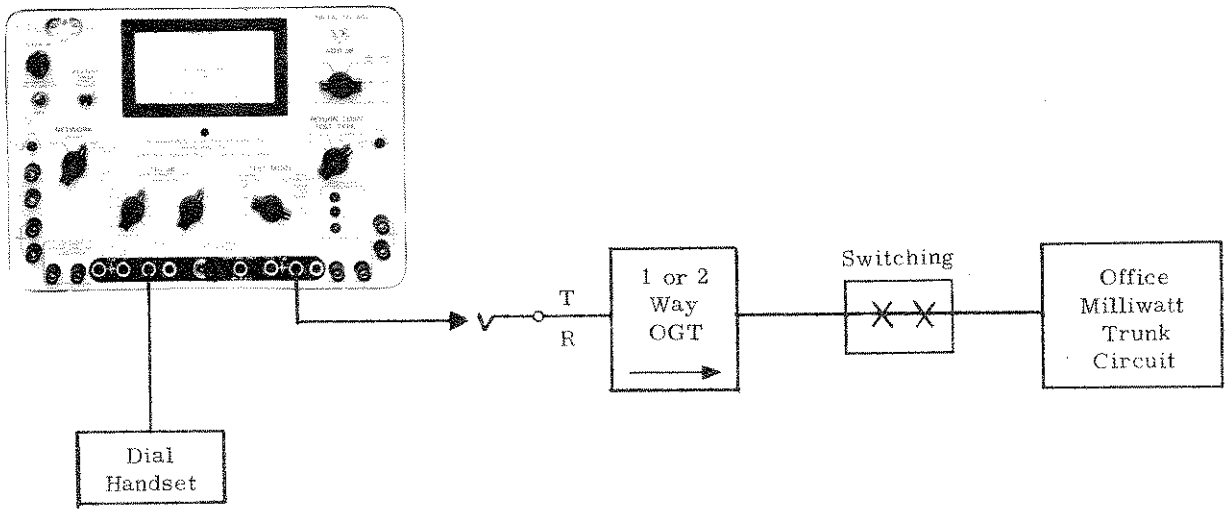


Figure 2-7. 2-Wire Level Measurement (With Supervision) on Outgoing Trunks, Test Setup

2-WIRE LEVEL MEASUREMENT (WITH SUPERVISION) ON OUTGOING TRUNKS

STEP	PROCEDURE
1	Connect the test equipment as shown in Figure 2-7.
2	Set the controls on the Model 9041 as follows: TEST MODE — LEVEL dBm (600 or 900 ohms as applicable) NETWORK — INT ADD dB — 0 THL dB — 0.0 TALK/DIAL, HOLD, OPEN — TALK/DIAL
3	Set up a call (through the Model 9041) on the circuit to be tested to the office milliwatt 1kHz test number. To measure the 1kHz test signal, set the TALK/DIAL, HOLD, OPEN switch to HOLD. NOTE Either the TIP BAT. or RING BAT. indicator may light for on/off hook status depending on the office convention for supervision battery sense (see paragraph 2.06).
4	Measure the level (red scale), setting the ADD dB switch as required to bring the meter reading on scale. Level = meter reading + ADD dB switch setting.
5	Set the TALK/DIAL switch to OPEN or TALK/DIAL as necessary to release connections to the circuit under test. Some connections may not release with the TALK/DIAL switch at OPEN because of the large input capacitance of the measuring set.

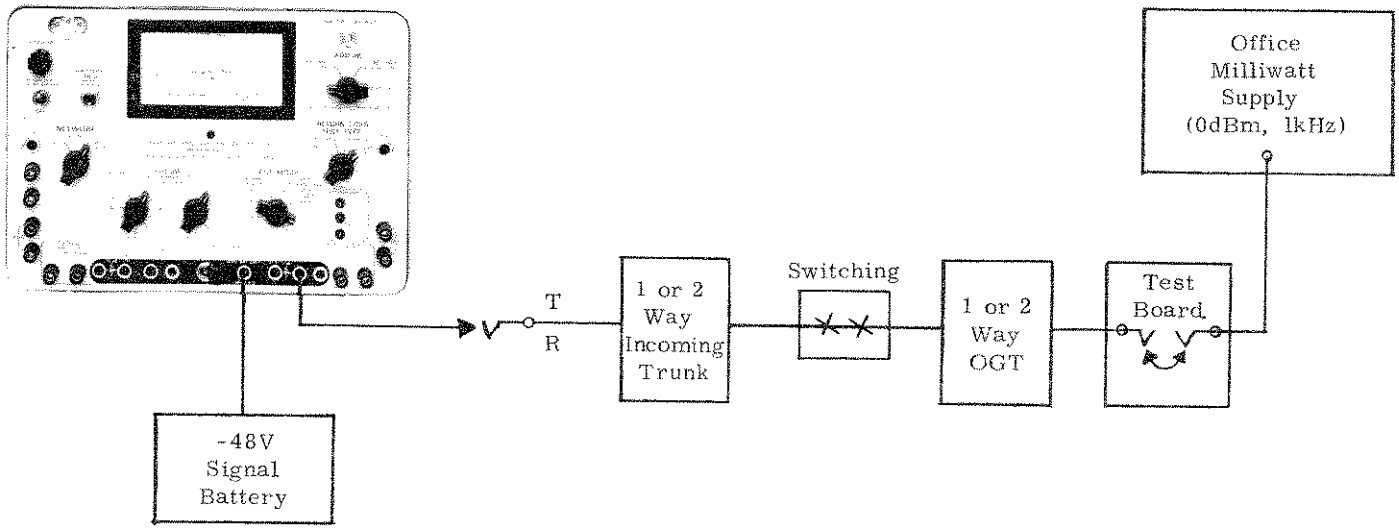


Figure 2-8. 2-Wire Level Measurement (With Supervision) on Incoming Trunks, Test Setup

2-WIRE LEVEL MEASUREMENT (WITH SUPERVISION) ON INCOMING TRUNKS

STEP	PROCEDURE
1	Connect the test equipment as shown in Figure 2-8.
2	Set the controls on the Model 9041 as follows: TEST MODE — LEVEL dBm (600 or 900 ohms as applicable) NETWORK — INT ADD dB — 0 THL dB — 0.0 TALK/DIAL, HOLD, OPEN — OPEN
3	Establish an connection from the originating (far) end of the circuit being tested to the access jack where the Model 9041 is connected. After the connection is completed, set the TALK/DIAL switch to HOLD to provide off-hook or answer supervision. NOTE The 48V input to the SUPV. BAT. ONLY jack is required only if answer supervision (-48V and ground) must be supplied at the test access jack.
4	Measure the level (red scale), setting the ADD dB switch as necessary to bring the meter reading on scale. Level (dBm) = meter reading + ADD dB switch setting.
5	Set the TALK/DIAL switch to OPEN or TALK/DIAL as necessary to release the connection.

(C) Echo Return Loss and Singing Point Measurements

2.10 The WILTRON Model 9041 Measuring Set provides Echo Return Loss (ERL) and Singing Point (SP) measurements over a range of -10dB (+10dB return gain) to 50dB return loss on both 4-wire and 2-wire circuits. The measurement results are compatible with Western Electric Specification KS#20501.

2.11 To make these measurements, the measuring set produces a white-noise (noise covering a wide band of frequencies) test signal extending over three selectable bandwidths (see Figure 2-9). The bands are defined as Echo Return Loss (ERL), Singing Return Loss Low (SRL LO), and Singing Return Loss High (SRL HI). The ERL test signal compares with that of the combined weighting (shaping) provided by a WE Type 201 Noise Generator and WE Type 455B and 497A "C" message weighting filters. The test signals for the SRL LO and SRL HI bands give measurements that are equivalent to the singing point measurements obtained using test equipment such as a WE Type 2D Singing Point Test Set.

2.12 When making Singing Return Loss measurements, the loss in dB is measured for the SRL LO and SRL HI bands. The band which provides the lowest return loss reading is the frequency range in which singing is most likely to occur. Some typical causes of low ERL and SRL LO readings in Central Offices are:

1. Defective 4-wire terminating sets (Hybrid Transformers).
2. Impedance compensators improperly adjusted.
3. Repeat coils incorrectly wired.
4. Excessive circuit noise.

Typical causes of a low SRL HI reading are:

1. Incorrect value of NBO or DBO capacitors (see procedures in this section).
2. Central Office wiring incorrect.
3. Improper circuit terminations.
4. Excessive circuit noise.
5. A and B leads on 4-wire terminating sets improperly connected.

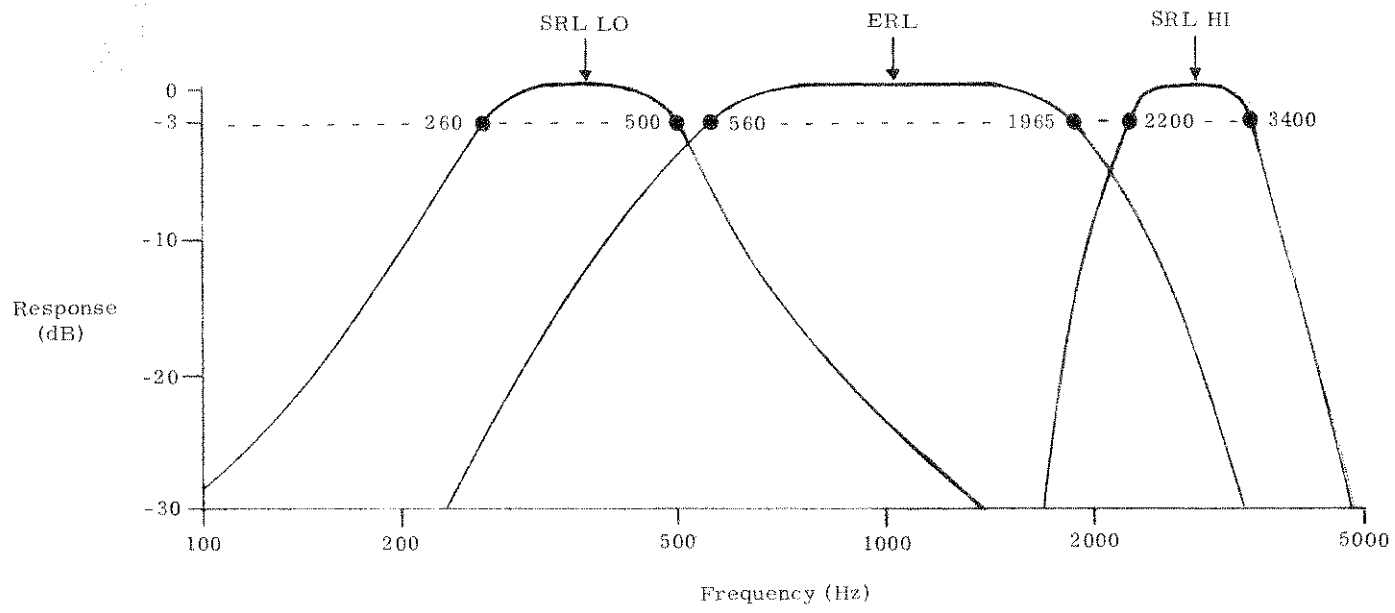


Figure 2-9. Bandwidths of ERL, SRL LO, and SRL HI Test Signals

(D) 4-Wire Return Loss

2.13 Figure 2-10 is a simplified diagram showing the Model 9041 being used for 4-wire return loss measurements. The noise signal is applied to the circuit under test through the selected noise weighting filter. Alternatively, an external oscillator signal can be applied to make structural return loss measurements. The receive signal is applied through the ADD dB switch, a trans-hybrid loss correction circuit, a band-pass filter, and a logarithmic detector to indicate the return loss level on a linear dB scale. The 16dB and 7dB pads are included for circuits requiring transmit signals at a -16dB point and receive signals at a +7dB point.

(E) 2-Wire Return Loss

2.14 The Model 9041 measuring set is used for 2-wire return loss measurements as shown in Figure 2-11. The transmit and receive signals are applied through an internal precision hybrid. The circuit under test is checked against an internal compromise balance network (600 or 900 ohms in series with 2.16μF). An external network such as a precision balancing network (PBN) can be connected if desired for structural return loss measurements, etc.

2.15 NBO and DBO Decade Capacitors. Network buildout (NBO) and drop buildout (DBO) decade capacitors (in the case lid) are used for measurement and adjustment of Central Office Through and Terminal balance or cable completion tests.

2.16 On/Off Hook Supervision and Indicators - On/Off hook supervision is provided and supervision indicators included for both Outgoing and Incoming 2-wire trunks. This is applicable to both level and 2-wire return loss measurements. A TALK/DIAL switch is also provided to simplify circuit setups (see paragraph 2.04).

(F) Central Office Through Balance Measurements (Class 3 and higher offices only)

2.17 Through balance is the process of averaging the echo return loss and singing return loss measurements made at the 4-wire arms of the terminating sets for all combinations of intertoll through paths in the office. These measurements involve the office equipment and 4-wire to 4-wire paths only. The objective of through balancing is to match the 2-wire impedance of the 4-wire terminating sets of Incoming trunks to that of the 2-wire impedance of the 4-wire terminating sets of the Outgoing trunks on a uniform basis regardless of the path used through the office.

2.18 For through balancing, the first step is the selection of the network buildout (NBO) capacitor value. Usually this is done by making return loss readings on many different paths through the office, and adjusting the NBO capacitor value for the highest return loss reading. The average of the NBO readings is usually considered to be the office NBO value that is strapped in on all of the 4-wire terminating sets in the office. The NBO decades in the Model 9041 case lid can be used to facilitate the selection of the NBO value.

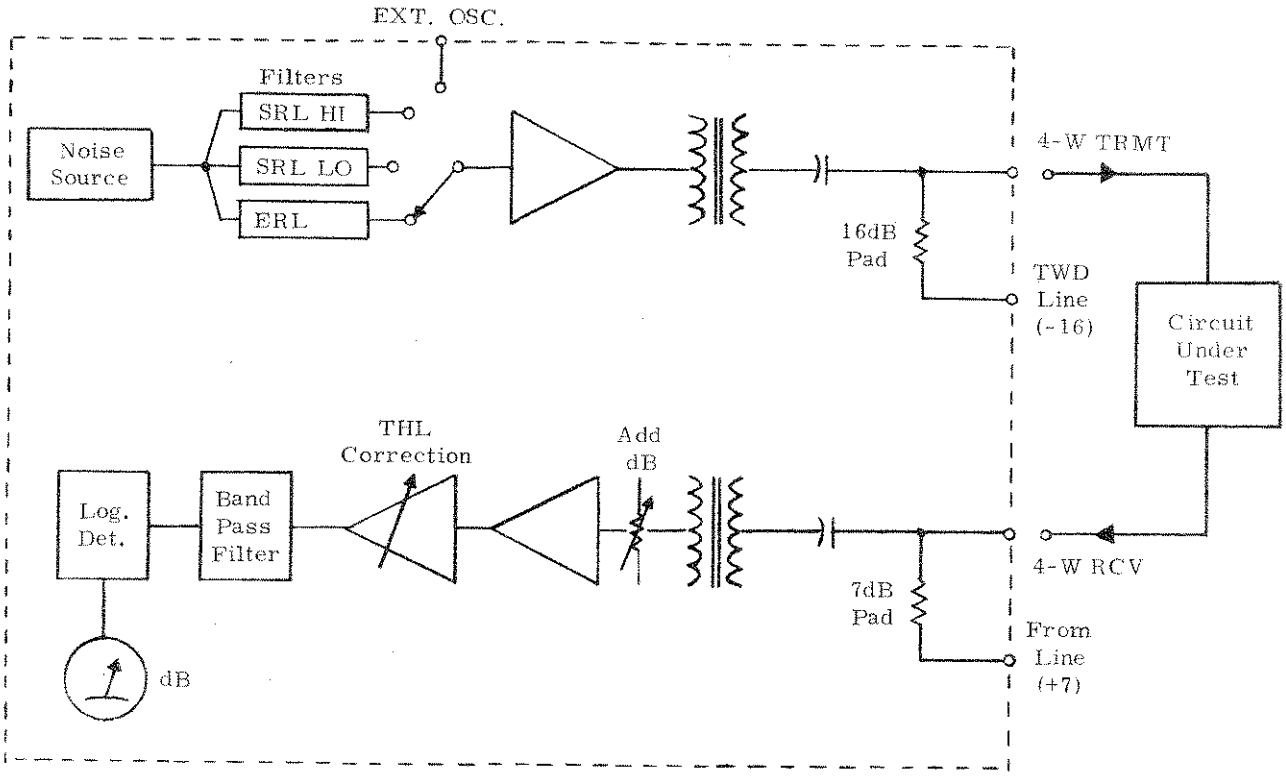


Figure 2-10. 4-Wire Return Loss Measurement, Simplified Diagram

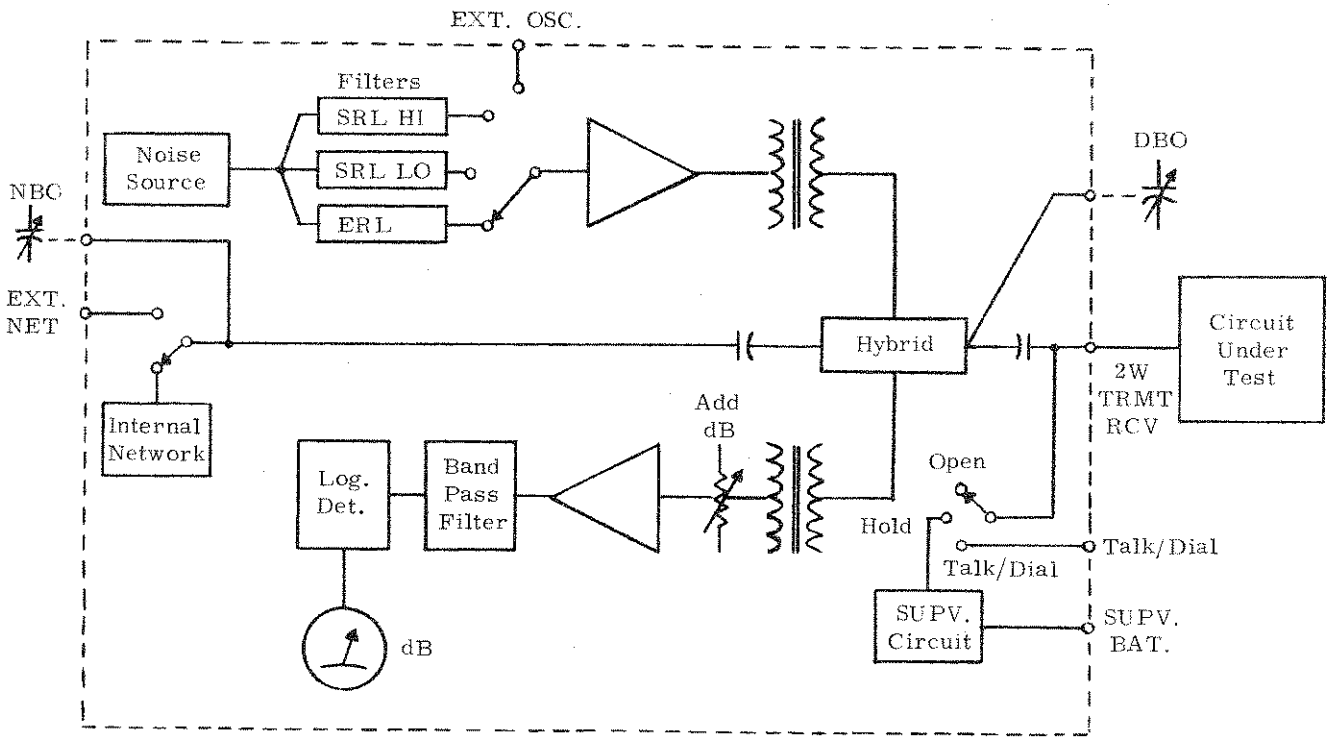


Figure 2-11. 2-Wire Return Loss Measurement, Simplified Diagram

2.19 When the return loss and singing point objectives cannot be met by averaging and selecting an NBO compromise value, it will be necessary to use drop buildout (DBO) capacitors. The trunk DBO capacitors make the shorter through paths appear electrically longer so that all of the paths have approximately the same capacitance. In general, the optimum value of the DBO capacitors is found by measuring the Singing Return Loss High (SRL HI) and adjusting the value of the DBO capacitor (using the DBO decade capacitors in the case lid) for maximum return loss reading. This optimum value of DBO capacitance is then strapped into the circuit under test. Individual Plant Practices contain detailed information and should always be adhered to before making these adjustments.

2.20 Through balance may be performed using an office test hybrid (one typical of those used in the Central Office) with the Model 9041 measuring set.

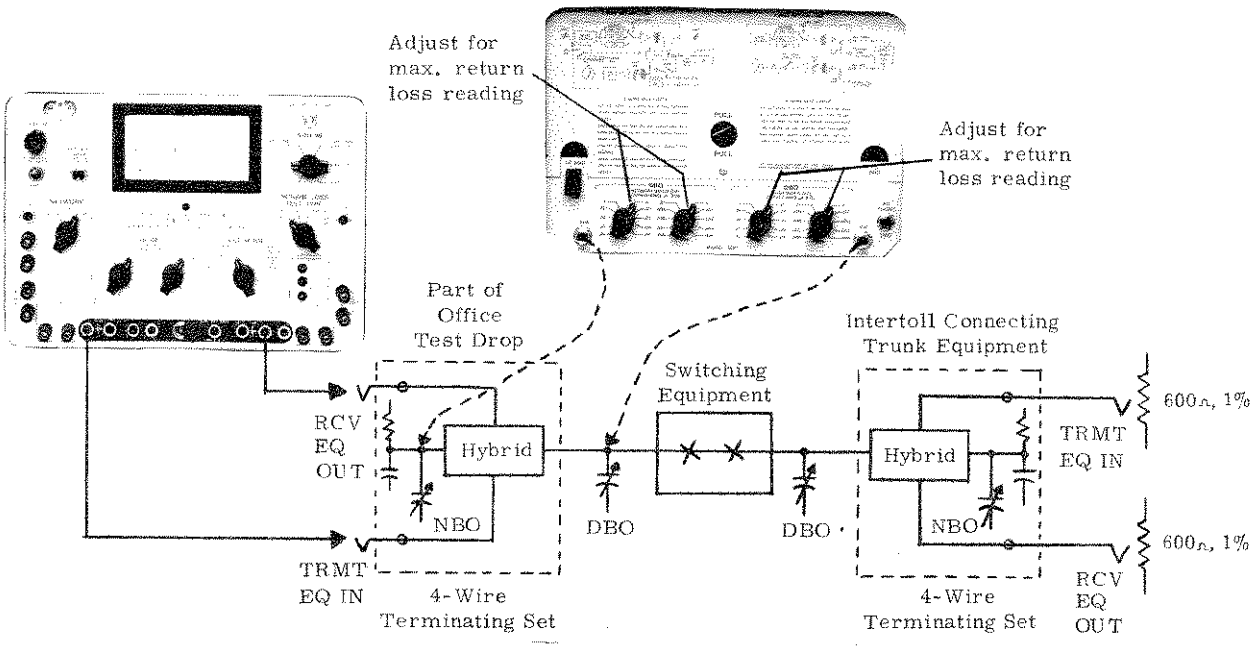


Figure 2-12. Through Balance Typical Test Setup, 4-Wire Operation

THROUGH BALANCE, ECHO RETURN LOSS, AND SINGING POINT MEASUREMENTS, 4-WIRE OPERATION

STEP	PROCEDURE
1	Check that the NBO capacitor in the representative hybrid used for testing is the correct value for the Central Office convention (see paragraph 2.18).
2	Establish a connection (drop dial) through the office to an intertoll connecting trunk under test, using the office test hybrid and associated drop equipment.
3	After the outgoing trunk has been identified, terminate the drop side of the 4-wire hybrid arms of the trunk under test with 600 ohm (1% or better) terminating plugs.
4	Patch from the TRMT and RCV jacks on the Model 9041 to the office test hybrid TRMT EQ IN and RCV EQ OUT jacks (4-wire arms). See Figure 2-12.

THROUGH BALANCE, ECHO RETURN LOSS, AND SINGING POINT MEASUREMENTS, 4-WIRE OPERATION (CONT.)

STEP	PROCEDURE
5	Patch the DBO decades (in Model 9041 case lid) to the 2-wire drop side of the office test hybrid.
6	Set the controls on the Model 9041 as follows: NETWORK — INT ADD dB — 0 RETURN LOSS TEST TYPE — ERL TEST MODE — 4-WIRE RETURN LOSS, 0dB THL dB — 0.0 TALK/DIAL, HOLD, OPEN — OPEN NBO DECADE — 0.00μF DBO DECADE — 0.00μF
7	Adjust the THL dB decades for the amount of trans-hybrid loss through the office test hybrid. If this value is unknown, press and hold the AC SHORT switch (in Model 9041 case lid) while adjusting the THL dB controls for a 0dB reading. Release the AC SHORT switch.
8	Measure the Echo Return Loss (ERL), setting the ADD dB switch to bring the meter reading on scale. The reading obtained is the echo return loss of the office through measurement to the intertoll connecting trunk. Note the reading.
9	Measure the Singing Return Loss High (SRL HI) and Singing Return Loss Low (SRL LO), setting the RETURN LOSS TEST TYPE switch as necessary. Note the readings. The lowest of the two readings is considered to be the singing return loss (singing point) of the connection under test.
10	Repeat steps 1 through 9 for all combinations of intertoll through paths in the office to obtain average office balance readings. NOTE If any one of the three measurements does not meet specifications for the particular class of office, refer to paragraph 2.12 for typical causes of low readings. Relative noise level can be checked by setting the RETURN LOSS TEST TYPE switch to EXT OSC and noting the meter reading. The noise reading must be at least 10dB lower than the return loss reading.
11	To optimize the readings obtained in steps 8 through 10, refer to individual Plant Practices on Through Balance describing NBO and DBO adjustments and compromises. The NBO and DBO decades in the case lid can be used to facilitate these adjustments.

(G) Central Office Terminal Balance Measurements

2.21 Terminal balance consists of matching the 2-wire impedance of the 4-wire terminating sets of the intertoll trunks to the 2-wire impedance of the toll connecting trunks (usually 2-wire). Terminal balance involves various combinations of office equipment and wiring in toll offices connecting to test terminations in end offices. The objective of terminal balance is to obtain a transmission quality for the toll office that permits it to switch intertoll trunks at Via Net Loss (VNL) level to toll connecting trunks at VNL +2dB which represents the overall objective of the Direct Distance Dialing Network.

2.22 For terminal balancing, the NBO capacitors are normally adjusted with the trunk at the end office terminated in a standard impedance such as 900 ohms and 2.16μF. When ERL and SRL objectives for terminal balance cannot be met by averaging and reaching a compromise NBO value, it may be necessary to provide some of the shorter trunk paths with DBO capacitors. Figure 2-13 shows a typical test setup for terminal balance measurements.

2.23 Following are separate test setup diagrams and procedures for performing 4-wire and 2-wire terminal balance measurements.

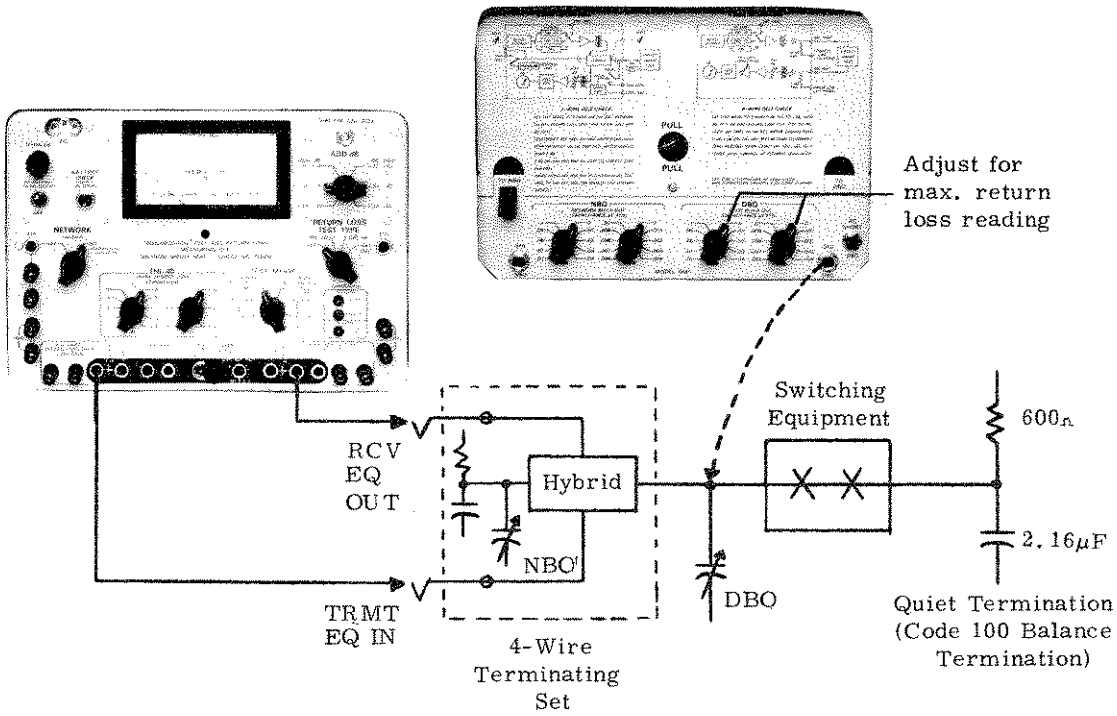


Figure 2-13. Terminal Balance Typical Test Setup, 4-Wire Cperation

TERMINAL BALANCE, ECHO RETURN LOSS, AND SINGING POINT MEASUREMENTS, 4-WIRE OPERATION

STEP	PROCEDURE
1	Check that the NBO capacitor in the representative hybrid used for testing is the correct value for the Central Office convention (see paragraph 2.18).
2	Using the office test hybrid and associated drop equipment, establish a connection through the office (drop dial) to the office termination number or to a toll connecting trunk capable of accessing a balance termination number (see Figure 2-13). NOTE The office test termination is also referred to as a quiet termination number, and is assigned as Code 100 in many common control offices.
3	Connect the test equipment as shown in Figure 2-13, with the DBO decades (case lid) patched to the 2-wire drop side of the office test hybrid. Set the controls on the Model 9041 as follows: NETWORK — INT ADD dB — 0 RETURN LOSS TEST TYPE — ERL TEST MODE — 4-WIRE RETURN LOSS, 0dB THL dB — 0.0 TALK/DIAL, HOLD, OPEN — OPEN NBO DECADE — 0.00μF DBO DECADE — 0.00μF
4	Adjust the THL dB decades for the amount of trans-hybrid loss through the office test hybrid. If this value is not known, press and hold the AC SHORT switch (case lid) while adjusting the THL dB decades for a 0dB reading. Release the AC SHORT switch.
5	Measure the Echo Return Loss (ERL), setting the ADD dB control as required. Note the reading.
6	Measure the Singing Return Loss High (SRL HI) and Singing Return Loss Low (SRL LO), setting the RETURN LOSS TEST TYPE switch as necessary. Note the two readings. The lowest of these readings is the Singing Point of the circuit.
7	Repeat steps 5 and 6 for all remaining combinations of toll connecting trunk paths in the office. NOTE If any one of the three measurements does not meet specifications for the particular class of office, refer to paragraph 2.12 for typical causes of low readings.
8	To optimize the return loss readings obtained in steps 5 through 7, refer to Individual Plant Practices on Terminal Balance. The NBO and DBO decades in the case lid may be used to facilitate the adjustments.

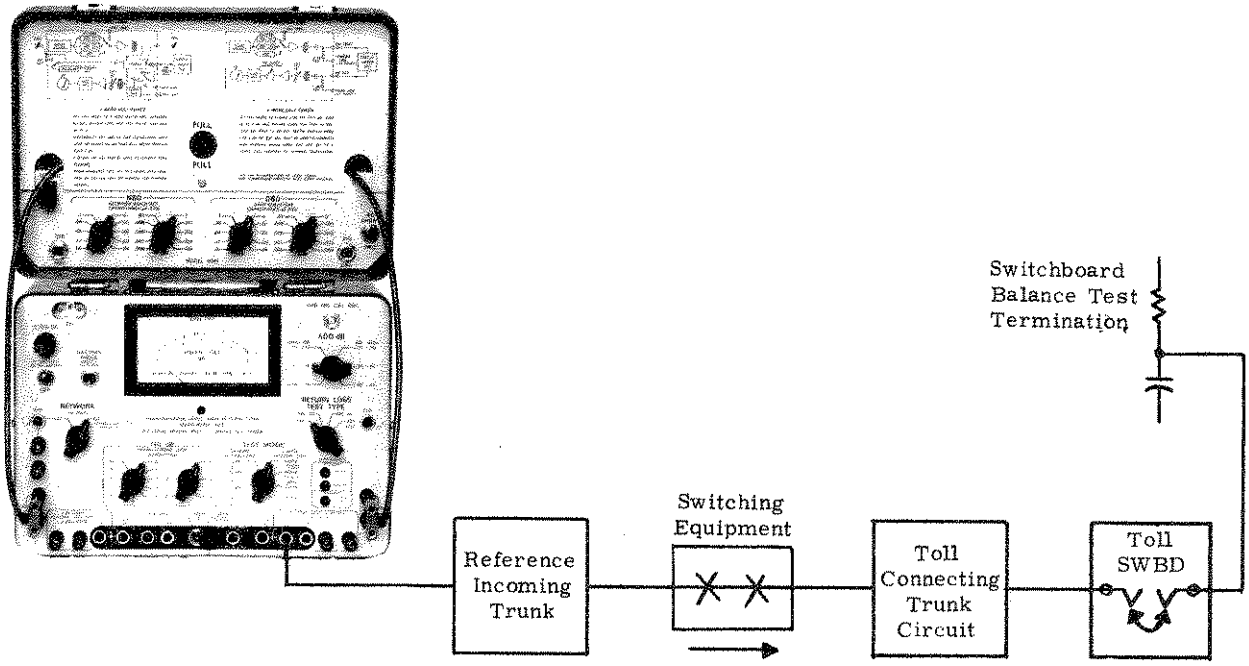


Figure 2-14. Terminal Balance Typical Test Setup, 2-Wire Operation

TERMINAL BALANCE, ECHO RETURN LOSS, AND SINGING POINT MEASUREMENTS, 2-WIRE OPERATION

STEP	PROCEDURE
	NOTE This is an alternate procedure that can be used in 2-wire switching offices to enable measurements to be made by only one craftsman. In this case the internal hybrid of the Model 9041 is used in place of the office test hybrid. Therefore, the measured values do not include the effects of the near end office test hybrid and associated drop equipment cabling. This measurement method should be used only if allowance is made for these effects. The readings obtained using this method should be compared with those of the preceding 4-wire procedure. If the results closely agree (within 1dB), this procedure can be used to simplify office terminal balance.
1	Set the NBO decade in the case lid to the NBO capacitor value for the Central Office being tested.
2	Connect the test equipment as shown in Figure 2-14, with the NBO decades (case lid) patched to the test set.

TERMINAL BALANCE, ECHO RETURN LOSS, AND SINGING RETURN LOSS MEASUREMENTS, 2-WIRE OPERATION (CONT.)

STEP	PROCEDURE
3	Set the controls on the Model 9041 as follows: NETWORK — INT ADD dB — 0 TEST MODE — 2-WIRE RETURN LOSS (600 or 900 ohms as applicable) RETURN LOSS TEST TYPE — ERL TALK/DIAL, HOLD, OPEN — As required (See paragraph 2.04) NBO DECADE — Office NBO value
4	Establish a connection through the reference intertoll trunk and switching equipment to a toll connecting trunk (see Figure 2-14).
5	After the connection has been established, terminate the office side of the toll connecting trunk with a proper balance test termination (600/900 ohms, 2.16μF).
6	Measure the Echo Return Loss (ERL), setting the ADD dB control as required. Note the reading.
7	Measure the Singing Return Loss High (SRL HI) and Singing Return Loss Low (SRL LO), setting the RETURN LOSS TEST TYPE switch as necessary. Note the two readings. The lower of the two readings is considered to be the Singing Point of the circuit.
8	Repeat steps 5 through 7 for all intertoll to toll connecting paths in the office to obtain average office balance readings. NOTE If any one of the three measurements does not meet specifications for the particular class of office, refer to paragraph 2.12 for typical causes of low readings. Relative noise level can be checked by setting the RETURN LOSS TEST TYPE switch to EXT OSC and noting the level (should be at least 10dB below the return loss reading).
9	To optimize the readings obtained in steps 6 through 8, refer to individual Plant Practices for Terminal Balance. The NBO and DBO decades in the case lid may be used to facilitate these adjustments.

(H) Carrier Channel Return Loss and Singing Return Loss Measurements

2.24 The Model 9041 provides two padded jacks to introduce 23dB of loss for making return loss measurements over carrier channels. The transmit jack, marked TWD LINE (-16) provides a test signal to the carrier voice channel input (MOD INPUT) that is attenuated by 16dB (to a -18dBm level). The receive jack, marked FROM LINE (+7) attenuates the voice output (DEMOD OUT) of the carrier channel by 7dB (to a -2dBm level). This feature facilitates making a measurement toward a distant office to determine the quality of the connected channel, trunk, and office equipment for ERL and singing point objectives. In practice, a connection is established to another office over a carrier channel and return loss readings taken. The readings should comply with ERL and Singing Point objectives for the distant office. If the readings are below specifications, the far end Mod and Demod channel voice access points can be split (terminated) to determine whether the carrier channel is at fault or the far office has balance problems. A typical test setup for carrier channel return loss measurements is shown in Figure 2-15.

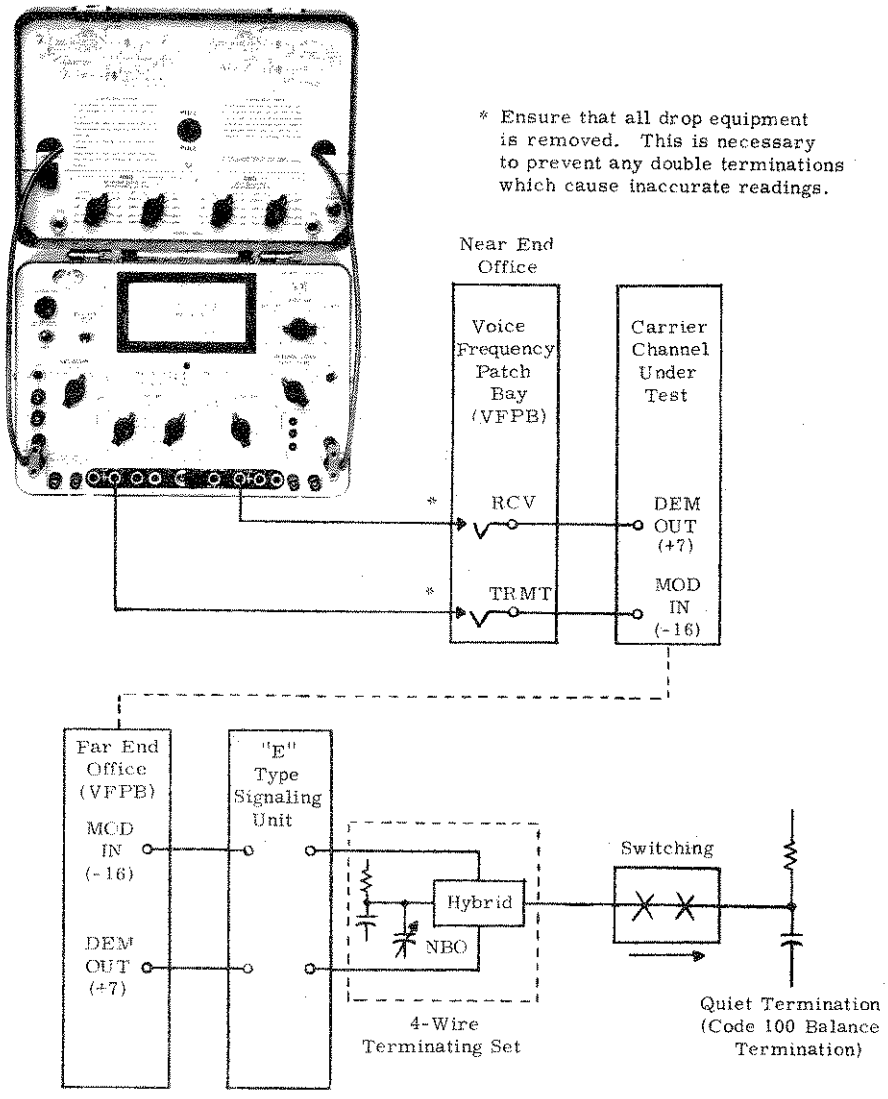


Figure 2-15. Carrier Channel Return Loss Measurements, Typical Test Setup

CARRIER CHANNEL ECHO RETURN LOSS AND SINGING RETURN LOSS MEASUREMENTS

STEP	PROCEDURE
1	Line dial the circuit under test to the balance termination in the distant office. NOTE The balance termination is also referred to as a quiet termination number, and is assigned as Code 100 in many common control offices.
2	Connect the Model 9041 as shown in Figure 2-15.
3	Set the Model 9041 controls as follows: NETWORK — INT RETURN LOSS TEST TYPE — ERL TEST MODE — 4-WIRE RETURN LOSS, 0dB TALK/DIAL, HOLD, OPEN — OPEN ADD dB — 0 THL dB — 0dB
4	Have the distant office place a short on the 2-wire side of the hybrid for the circuit under test. While the short is applied, adjust the THL dB decades for a 0dB reading on the Model 9041. Remove the short.
5	Measure the Echo Return Loss (ERL), setting the ADD dB switch as necessary to bring the meter reading on scale. Note the ERL reading. (ERL = meter reading + ADD dB setting.)
6	Measure the Singing Return Loss High (SRL HI) and Singing Return Loss Low (SRL LO), setting the RETURN LOSS TEST TYPE switch as necessary. Note the two readings. The lowest of these readings is the Singing Point of the circuit.
7	Compare the readings obtained in steps 5 and 6 with the Terminal balance measurements previously made in the distant office to determine if the associated carrier channel degrades the ERL, SRL HI, or SRL LO readings (see paragraph 2.24).
8	Repeat steps 1 through 7 for the remaining carrier channels in the office.

(I) Other Measurement Applications

2.25 The Model 9041 measuring set can also be used to make other measurements such as:

1. Attenuation distortion (frequency response) checks.
2. Cable capacitance (terminated or unterminated cables) measurements.
3. Impedance measurements of cable pairs and networks.
4. Echo Structural Return Loss and Structural Return Loss Measurements for cable completion tests.
5. Impedance Compensator Adjustments.

2.26 For attenuation distortion (frequency response) measurements, the Model 9041 measures the output level of the circuit under test while the frequency of the test signal is varied over the desired range (within 200 to 5000Hz). The output level versus frequency can then be plotted on a graph if desired to obtain a frequency response curve for the circuit under test.

2.27 Cable capacitance measurements are made with the Model 9041 by using the NBO decades in the case lid as a precision capacitance reference. The capacitance of the cable under test and the NBO decade capacitance are connected to opposite arms of the internal precision hybrid. When the NBO decades are adjusted to balance the hybrid, the NBO capacitance value selected is equal to the cable capacitance. The internal precision reference (900Ω +2.16μF) is switched in for terminated cable measurements and is not required for unterminated cable capacitance measurements.

2.28 The Model 9041 can be used to measure the impedance of a circuit or device at three frequency ranges described as ERL, SRL LO, and SRL HI. The frequency ranges covered by the three bands are as follows:

ERL - 560 to 1965Hz
SRL LO - 260 to 500Hz
SRL HI - 2200 to 3400Hz

To make the impedance measurement, the Model 9041 is operated with the 4-wire transmit output patched to the 4-wire receive input. This establishes a 0dB return loss reference (100% reflected signal). When the impedance to be measured is connected to the 4-wire receive terminals, it absorbs some of the reflected signal. The amount of signal absorbed is inversely proportional to the impedance value and produces a return loss reading between 0 and 12dB for impedances from 100 ohms to approximately 18 kilohms (see Figure 2-21).

2.29 Echo structural return loss measurements are made using the Model 9041 in conjunction with two precision balancing networks. One network is connected to the reference arm of the internal precision hybrid. The second network is used to terminate the cable pair under test. The Echo Return Loss of the cable pair is measured to determine how closely the cable pair impedance matches the impedance curve of the PBN over the ERL frequency range. The NBO and DBO decades are connected across the reference and measuring arms of the internal precision hybrid to balance out any reactance of the cable pair in order to obtain an accurate return loss reading. The method used for making a Structural Return Loss measurement is similar to that described for Echo Structural Return Loss, except an external oscillator is used for the test signal instead of the ERL signal. The oscillator frequency is varied over the range appropriate for the cable loading used and the return loss readings noted.

2.30 The Model 9041 can also be used for making adjustments of the frequency corrector networks in impedance compensators. The return loss of the properly terminated impedance compensator is measured using the ERL, SRL LO, and SRL HI test signals. Usually the frequency corrector networks are adjusted using the test signals as follows:

ERL - mid frequency network.
SRL LO - low frequency network.
SRL HI - high frequency network.

Each network is adjusted to obtain maximum return loss reading.

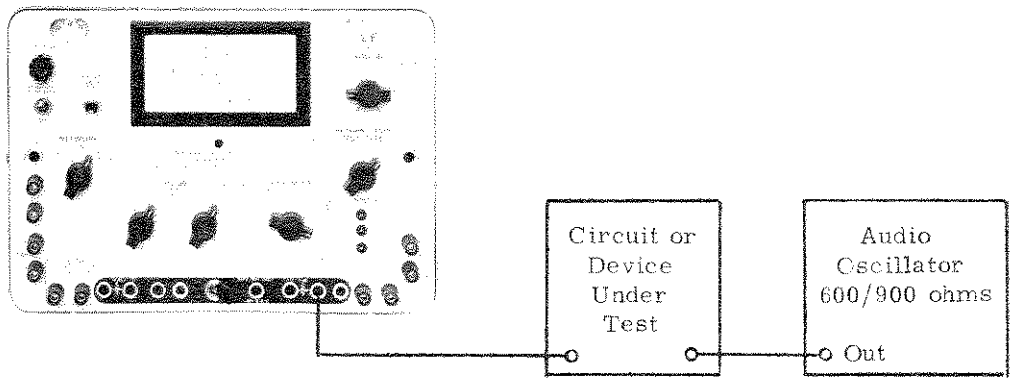


Figure 2-16. Attenuation Distortion (Frequency Response) Measurement, Test Setup

ATTENUATION DISTORTION (FREQUENCY RESPONSE) MEASUREMENT

STEP	PROCEDURE	
1	Connect the test equipment as shown in Figure 2-16.	
2	Set the controls on the Model 9041 as follows:	
	NETWORK	INT
	TEST MODE	LEVEL dBm, 600 or 900 ohms, as applicable
	ADD dB	0
	TALK/DIAL, HOLD, OPEN	OPEN
3	Set the audio oscillator to 1kHz, and adjust the output level to 0dBm. Note the reading on the Model 9041 meter red scale. This reading will serve as the reference level.	
4	Slowly tune the audio oscillator over the desired frequency range (within 200 to 5000Hz), noting the minimum and maximum meter indications (or a step-frequency oscillator may be used). Frequency response is the reference level + maximum and - minimum values + ADD dB switch setting referred to the response at 1kHz.	

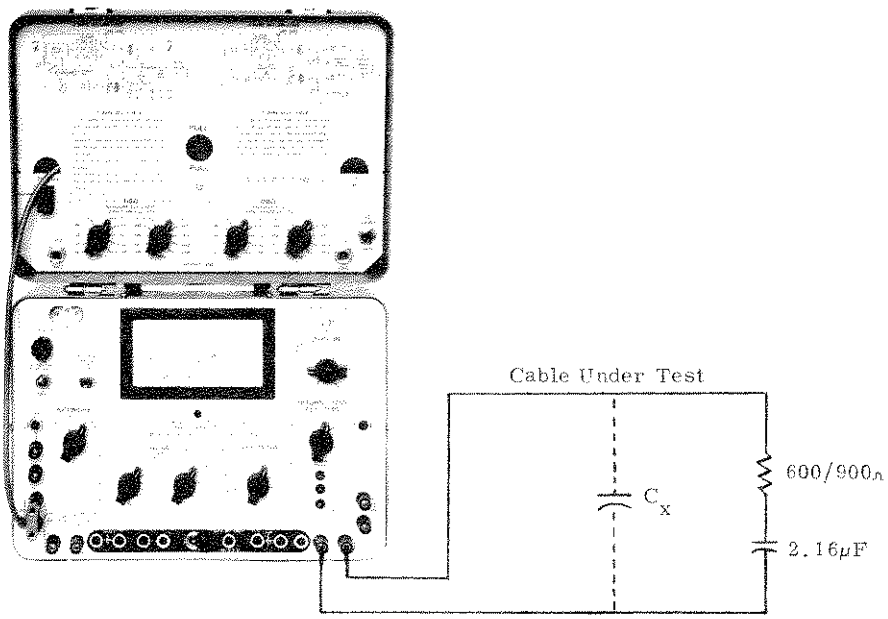


Figure 2-17. Cable Capacitance Measurement (Terminated Cable Pair), Test Setup

CABLE CAPACITANCE MEASUREMENT (TERMINATED CABLE PAIR)

STEP	PROCEDURE	
1	Set up the test connections as shown in Figure 2-17.	
2	Set the controls on the Model 9041 as follows:	
	NETWORK	INT
	RETURN LOSS TEST TYPE	SRL HI
	TEST MODE	2-WIRE RETURN LOSS (600 or 900 ohms to match the cable pair terminating impedance).
	TALK/DIAL, HOLD, OPEN	OPEN
	ADD dB	0
	NBO DECADE	0.00μF
3	Adjust the NBO decade (case lid) for maximum return loss reading, setting the ADD dB switch as necessary to bring the reading on scale. The capacitance to be measured, C_X = NBO setting in μF.	
	NOTE The maximum return loss reading should exceed 20dB. If not, the Model 9041 or the cable under test may be terminated with an incorrect impedance. Repeat (or loading) coils may be in the cable under test as long as correct impedance terminations are used.	

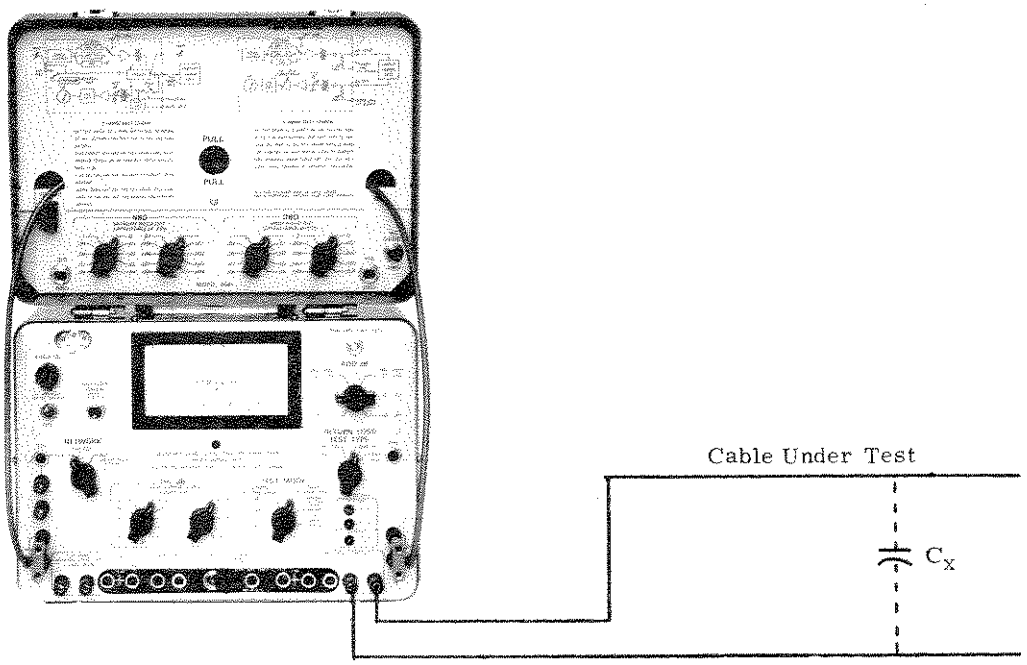


Figure 2-18. Cable Capacitance Measurement (Unterminated Cable Pair), Test Setup

CABLE CAPACITANCE MEASUREMENT (UNTERMINATED CABLE PAIR)

STEP	PROCEDURE	
1	Set up the connections as shown in Figure 2-18. No repeat coils should be in the cable under test.	
2	Set the controls on the Model 9041 as follows:	
	NETWORK	EXT
	RETURN LOSS TEST TYPE	SRL HI
	TEST MODE	2-WIRE RETURN LOSS (600 or 900 ohms, as applicable)
	TALK/DIAL, HOLD, OPEN	OPEN
	ADD dB	0
	NBO DECADE	0.00μF
3	Adjust the NBO decade (case lid) for maximum return loss reading, setting the ADD dB switch as necessary to bring the reading on scale. The capacitance to be measured, C_X = NBO setting in μF.	
	NOTE The maximum return loss reading should exceed 20dB. If not, the Model 9041 may be incorrectly set to INT NET or the cable pair has something connected across it.	

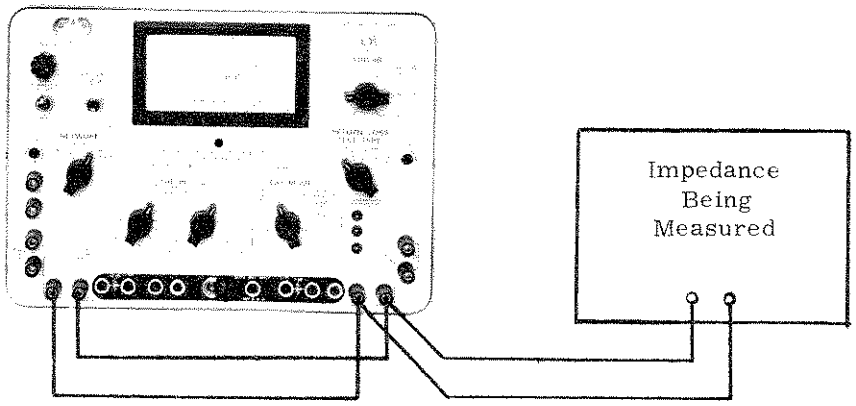


Figure 2-19. Impedance Measurements, Test Setup

IMPEDANCE MEASUREMENTS OF CABLE PAIRS AND NETWORKS

STEP	PROCEDURE
1	Make test connections as shown in Figure 2-19.
2	Set the controls on the Model 9041 as follows:
	NETWORK — INT
	TEST MODE — 4-WIRE RETURN LOSS
	RETURN LOSS TEST TYPE — ERL
	ADD dB — 0
	THL dB — 0.0
	TALK/DIAL, HOLD, OPEN — OPEN
3	Measure the return loss reading, setting the ADD dB switch as required to bring the meter on scale.
4	Use the conversion chart (Figure 2-20) to convert the return loss reading to impedance in ohms. See paragraph 2.28 for a description of this measurement.
	NOTE This test measures impedance of the ERL frequency range of 560 to 1965Hz. Switch to SRL LO or SRL HI to measure the impedance of the circuit on test at frequency ranges of 260 to 500Hz, or 2200 to 3400Hz, respectively. An audio oscillator (EXT OSC) can also be used for measurements at a desired frequency.

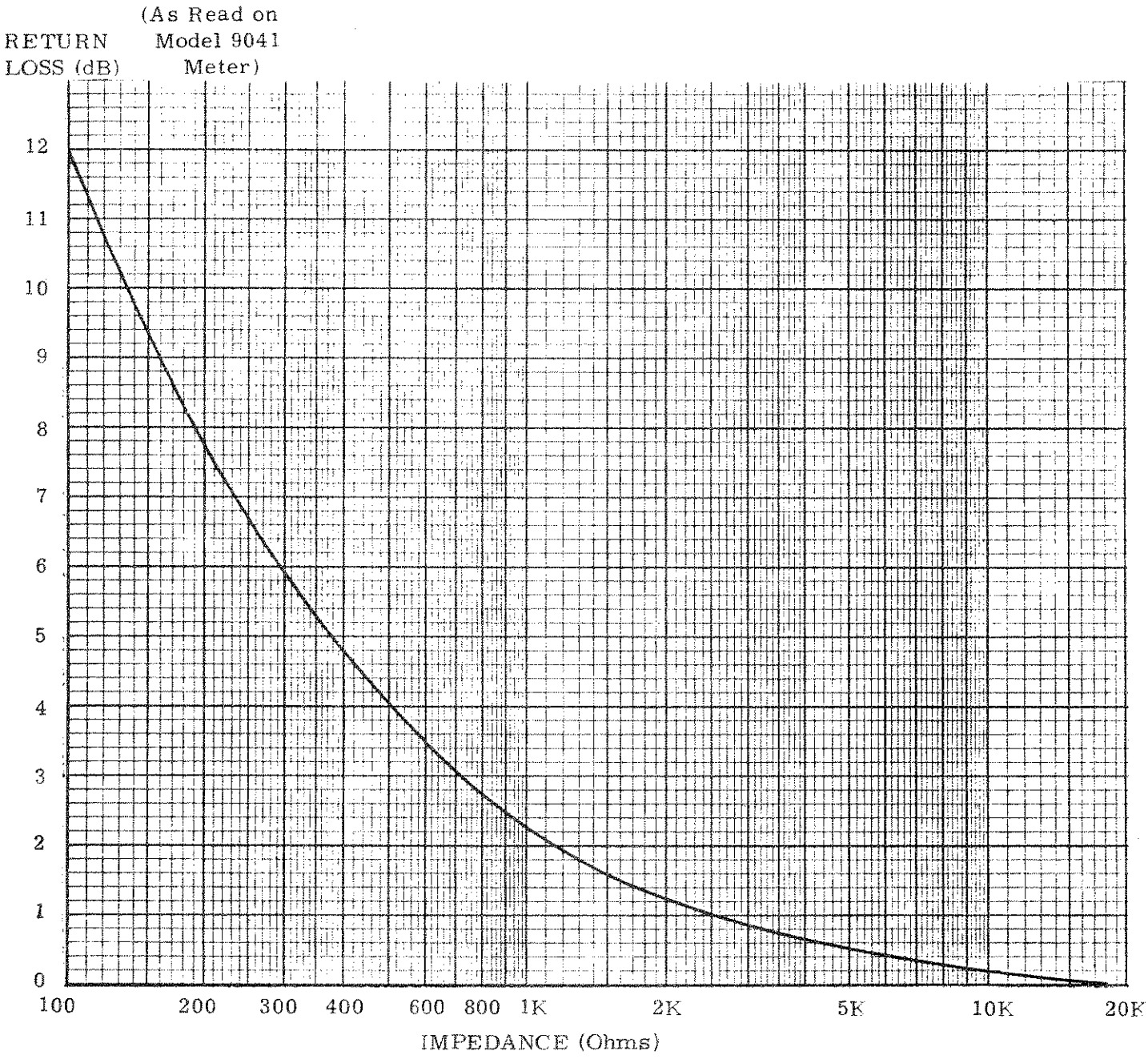


Figure 2-20. Conversion Chart, Return Loss (dB) Reading on WILTRON 9041 to Impedance

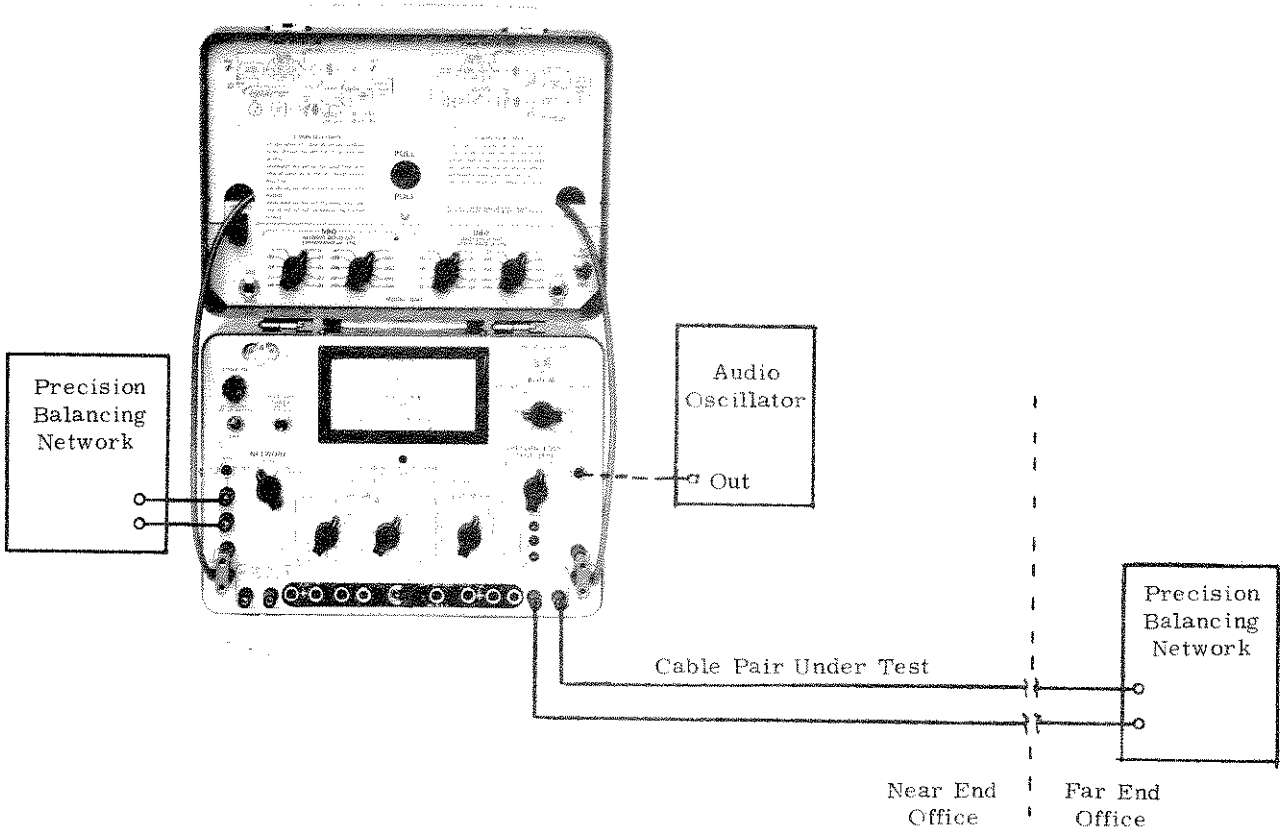


Figure 2-21. Echo Structural Return Loss Measurements, Typical Test Setup

ECHO STRUCTURAL RETURN LOSS (ESRL) MEASUREMENTS

STEP	PROCEDURE	
1	Connect the test equipment as shown in Figure 2-21, using PBN's having the same characteristics as the cable pair on test.	
2	Set the controls on the Model 9041 as follows:	
	NETWORK	EXT
	TEST MODE	2-WIRE RETURN LOSS (600 or 900 ohms)
	RETURN LOSS TEST TYPE	SRL HI
	TALK/DIAL, HOLD, OPEN	OPEN
	ADD dB	0
	NBO DECADE	0.00μF
	DBO DECADE	0.00μF
3	Measure the return loss, setting the ADD dB switch as necessary to bring the meter indication on scale.	

ECHO STRUCTURAL RETURN LOSS (ESRL) MEASUREMENTS (CONT.)

STEP	PROCEDURE
4	Adjust the NBO decade in steps and note any change in the return loss reading. If the reading increases, adjust the NBO decade for a maximum meter indication. If the reading decreases, set the NBO decade to 0.00μF and adjust the DBO decade instead for maximum meter reading. NOTE This step balances out any line reactance so that a true return loss reading can be obtained.
5	Switch the RETURN LOSS TEST TYPE switch to ERL.
6	Note the Echo Structural Return Loss reading. ESRL = meter reading + ADD dB switch setting. If the ESRL reading is below requirements, it is recommended that structural return loss measurements be made to uncover any cable irregularities.

STRUCTURAL RETURN LOSS MEASUREMENTS

STEP	PROCEDURE
1	Perform steps 1 through 2 of the previous procedure, except connect the audio oscillator (set to 1kHz) to the EXT OSC jack of the Model 9041. Set the RETURN LOSS TEST TYPE switch to EXT OSC, the ADD dB switch to 0 and the NBO and DBO decades to 0.00μF.
2	Disconnect the cable pair on test from the 2W TRMT/RCV jacks. Adjust the audio oscillator output level for a 0dB reading on the Model 9041.
3	Reconnect the cable pair on test to the 2W TRMT/RCV jacks, then set the NBO and DBO decades to the values used in step 4 of the previous ESRL procedure.
4	Tune the audio oscillator over the frequency range of 200 to 3500Hz (for cable using H88 loading) while noting the variation in return loss readings. This is the structural return loss of the cable pair on test. NOTE The structural return loss readings can be used to plot a chart which shows the effect of irregularities in loading of the cable pair.

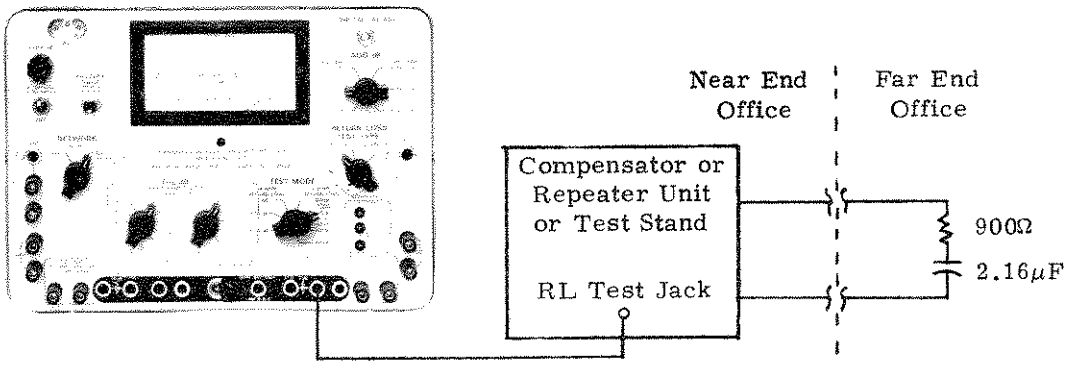


Figure 2-22. Impedance Compensator or Negative Impedance Repeater RL Adjustments, Test Set-up

IMPEDANCE COMPENSATOR & NEGATIVE IMPEDANCE REPEATER RL ADJUSTMENTS

STEP	PROCEDURE
1	Connect the test equipment as shown in Figure 2-22.
2	Set the controls on the Model 9041 as follows: NETWORK — INT TEST MODE — 2-WIRE RETURN LOSS, 900Ω RETURN LOSS TEST TYPE — ERL ADD dB — 0 TALK/DIAL, HOLD, OPEN — OPEN
3	Measure the return loss, setting the ADD dB switch as necessary to bring the reading on scale.
4	Adjust the mid-frequency, low frequency, and high frequency corrector networks on the repeater or compensator as described in the individual Plant Practice for these adjustments. NOTE Generally, the corrector networks are adjusted using the following test signal control settings: ERL - Mid frequency corrector network SRL HI - High frequency corrector network SRL LO - Low frequency corrector network If loaded cable is used between the Near End and Far End Offices, the SRL-HI reading will show the effect of high frequency roll-off as a lower return loss than would be the case with a flat or unloaded line. However, the resulting High Frequency corrector network setting is still optimum when the return loss reading is maximum.

SECTION III

PERFORMANCE VERIFICATION

CONTENTS PAGE

3. PERFORMANCE VERIFICATION PROCEDURES

3.01 The performance checks in the following paragraphs enable the user to verify that the Model 9041 Measuring Set meets the design specifications. These checks may be performed upon receipt of the measuring set (prior to use) or when the unit has been repaired or failure is suspected.

3.02 The performance checks are made with the set in its case and with the front panel meter face in a horizontal position.

NOTE

The meter indication may vary up to 0.1dB between the vertical and horizontal positions. The meter should be zeroed in the position in which it will be used by setting the mechanical adjustment screw through the hole in the meter bezel (with power turned off).

3.03 The test equipment required to make the performance verification checks is listed in Table 3-1. Standard patch cords and test leads are not listed. Equivalent test instruments may be used if the accuracy equals or exceeds that of the test instruments listed.

Table 3-1. Test Equipment Required

TEST EQUIPMENT

TRUE RMS VOLTMETER: Fluke 931B.

AUDIO OSCILLATOR: HP236A.

DECADE ATTENUATOR: General Radio 1450.

DECADE RESISTOR: General Radio 1433.

DECADE CAPACITORS: General Radio 1423A. Two required.

48V SUPPLY: Office Signal Battery.

1kHz SOURCE: Office Milliwatt Supply at 0 TLP (transmission level point).

ADAPTER: Binding posts (or double banana jacks) to BNC plug. Pomona Electronics Model 1296 or equivalent.

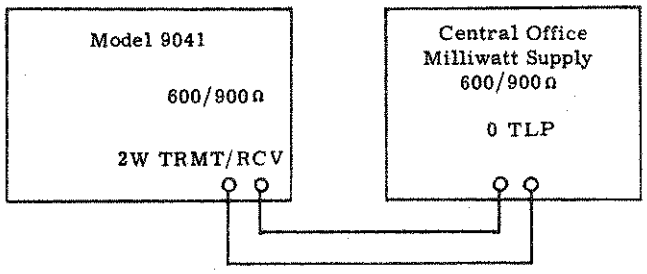
TEST CABLE: Type 310 Plug to double banana plug.

(A) Level Measurement Accuracy Check

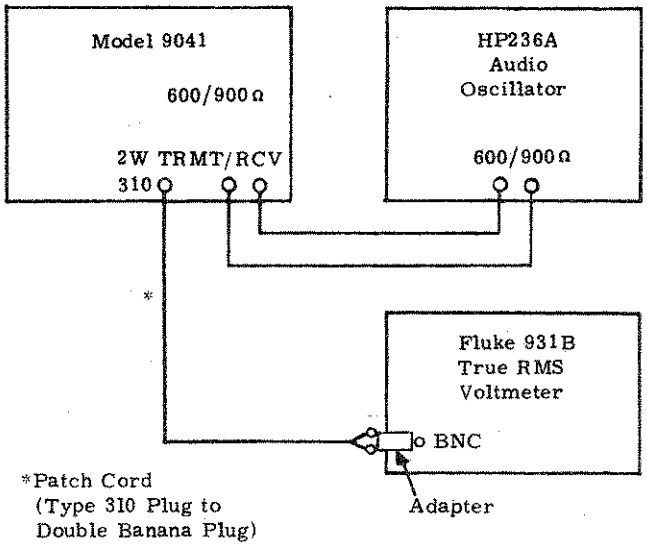
3.04 The following procedure checks the level meter accuracy of the Model 9041 using either of two methods. Method 1 checks the meter against the Central Office milliwatt supply (0dBm at 1kHz). Method 2 uses an audio oscillator as a 1kHz source, and a true rms voltmeter as a reference standard. The test setup for each method is shown in Figure 3-1.

CAUTION

If the Model 9041 level measurement accuracy is checked using the Office Milliwatt Supply or a Wilcom T-105 Test Set, the measured level accuracy requirement of the Model 9041 becomes ±0.2dB. If this accuracy is not obtained, and the performance check has been carried out (para 2.02), check the Model 9041 using an alternate accurate test set (such as a WE Type 22A Level Measuring Set). The level accuracy of the Model 9041 has been calibrated at the factory to be within ±0.1dB using a test standard accurate to within ±0.02dB. Therefore, if the measured accuracy is still not within ±0.2dB, contact WILTRON for advice. Do not attempt to adjust the level calibration unless Standards Laboratory type equipment (such as a Fluke 931B) is available.



METHOD 1



METHOD 2

Figure 3-1. Level Measuring Accuracy Check Test Setup

LEVEL MEASUREMENT ACCURACY CHECK

STEP	PROCEDURE
	METHOD 1: Use this method if an accurate office milliwatt is available. See CAUTION in paragraph 3.03.
1	Patch the output of the Central Office milliwatt supply to the 2W/TRMT/RCV input on the Model 9041 (see Figure 3-1, Method 1).
2	Set the TEST MODE switch to the 600Ω or 900Ω LEVEL dBm position as applicable to the outlet impedance of the supply.
3	Set the ADD dBm switch to 0.
4	Check that the Model 9041 level indication is 0 ±0.1dBm, ±accuracy of the milliwatt supply.
5	Repeat steps 1 through 4 using a supply outlet of the alternate impedance (600Ω or 900Ω) if available.
	METHOD 2:
1	Connect the true rms voltmeter and the audio oscillator to the 2W TRMT/RCV inputs of the Model 9041 Measuring Set (see Figure 3-1, Method 2).
2	Set the TEST MODE switch on the Model 9041 to the 600Ω LEVEL dBm position.
3	Set the ADD dBm switch to 0.
4	Set the true rms voltmeter to the 1V scale and to read a null within 1%.
5	Set the true rms voltmeter digits at .77459V rms (equal to 0dBm at 600 ohms).
6	Set the audio oscillator frequency to 1kHz, and adjust the output level for a null on the true rms voltmeter.
7	Check that the Model 9041 level indication is 0 ±0.1dBm. Proceed with step 8 if an audio oscillator output impedance of 900Ω is available.
8	Repeat steps 3 through 7 with the TEST MODE switch on the Model 9041 set to the 900Ω LEVEL position. Select the audio oscillator 900Ω output impedance. Set the true rms voltmeter digits at .94868V rms (equal to 0dBm at 900Ω) for this test.

(B) 4-Wire Return Loss Accuracy Check

3.05 The following procedure checks the meter accuracy at 0dB return loss when used in 4-wire functions. This is a self-check and does not require external test equipment (other than standard patch cords). The 16dB and 7dB attenuators are also checked for accuracy.

4-WIRE RETURN LOSS ACCURACY CHECK

STEP	PROCEDURE
1	Set the front panel controls as follows: NETWORK — INT RETURN LOSS TEST TYPE — ERL TEST MODE — 4-WIRE 0dB THL dB — 0.0 ADD dB — 0 TALK/DIAL HOLD OPEN — OPEN (NORMAL)
2	Patch the transmitter (4W TRMT) output to the receiver (4W RCV) input.
3	The average value of the meter reading should be 0dB. If necessary, set the 0dB ERL CAL ADJ control for this reading. NOTE It is normal for the meter to have ±0.2 to ±0.5dB of fluctuation during a reading. This occurs because narrow band noise is being measured. The SRL LO position of the return loss TEST TYPE switch gives the biggest fluctuation in meter readings.
4	Select the ERL, SRL LO, and SRL HI positions of the return loss TEST TYPE switch in turn. The average meter reading should be 0dB ±0.4dB in each position. It is necessary to average out by eye the effect of meter reading fluctuations for this test.
5	Patch from the 4W RCV input to the TWD LINE (-16) jack.
6	Set the TEST MODE switch to the +10dB position.
7	Check that the meter indicates 6dB ±0.4dB (16dB return loss).
8	Transfer the patch cord from the 4W RCV input to the FROM LINE (+7) jack.
9	Set the TEST MODE switch to the +20dB position.
10	Check that the meter indicates 3dB ±0.4dB (23dB return loss).

(C) 2-Wire Return Loss Accuracy Check

3.06 The following procedure checks the meter accuracy at 0dB return loss when used in 2-wire functions. No external test equipment is required for this check (other than standard patch cords).

(D) Return Loss Range Accuracy Check (4-Wire and 2-Wire)

3.07 For this procedure, the calibrated ADD dB gain control is checked against an external reference attenuator. The General Radio Model 1450 Decade Attenuator and the HP236A Audio Oscillator are used. See Figure 3-2 for test setup.

(E) Overall Accuracy Check (2-Wire Return Loss)

3.08 This check is an actual return loss measurement using a termination of known return loss. When measuring 2-wire return loss, the Model 9041 Measuring Set solves the equation:

$$\text{RETURN LOSS} = 20 \log_{10} \frac{Z + Z_x}{Z - Z_x}$$

where Z = Reference value impedance (internal network)

Z_x = Unknown impedance

Solving the equation for Z_x:

$$Z_x = \frac{10^{\text{R. L. }/20}+1}{10^{\text{R. L. }/20}-1} \; Z$$

The return loss value for this check is 40dB. Setting return loss to 40dB and Z=600 ohms, a test resistor of 612.1 ohms is computed. The Model 9041 should measure this value within ±0.4dB, ± the inaccuracy due to the resistor representing Z_x.

For this test, an HP236A Audio Oscillator and two GR1433 Decade Resistors are used. The test setup is shown in Figure 3-3.

2-WIRE RETURN LOSS ACCURACY CHECK

STEP	PROCEDURE
1	Set the front panel controls as follows: NETWORK — INT RETURN LOSS TEST TYPE — ERL TEST MODE — 2-WIRE 600 ohms THL dB — 0.0 ADD dB — 0 TALK/DIAL HOLD OPEN — OPEN (NORMAL)
2	With the transmit (4W TRMT) terminals open circuited (a complete reflection), the front panel meter should read 0dB ±0.4dB. If it does not, use the calibration adjust (0dB ERL CAL ADJ) potentiometer to set the meter on 0dB ±0.1dB.
3	Short circuit the 2W TRMT/RCV output terminals. The meter reading should remain on 0dB (±0.4dB). Proceed with step 4 if an audio oscillator output impedance of 900Ω is available.
4	Select the 2-Wire Return Loss 900 ohm position of the TEST MODE switch. Select the audio oscillator 900Ω output impedance. Repeat steps 2 and 3.

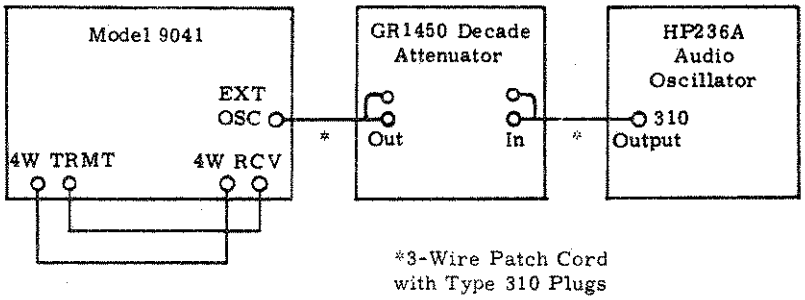


Figure 3-2. Return Loss Range Accuracy Check Test Setup

RETURN LOSS RANGE ACCURACY CHECK

STEP	PROCEDURE	
1	NETWORK	INT
	RETURN LOSS TEST TYPE	EXT OSC
	TEST MODE	4-WIRE 0dB
	THL dB	0.0
	ADD dB	-10
	TALK/DIAL HOLD OPEN	OPEN (NORMAL)
2	Connect the 4W TRMT and the 4W RCV terminals together. Connect the Audio Oscillator to the EXT OSC input through the decade attenuator. See Figure 3-2. Set the attenuator to 0.0dB, and set the oscillator output so that the Model 9041 meter reads 0dB.	
3	Increase ADD dB setting from -10dB to 0dB, then add 10.0 dB attenuation to the external attenuator. The front panel meter should read 0dB ±0.2dB.	
4	Repeat the previous step, increasing the ADD dB setting 10.0dB each time while tracking with the external attenuator. In each case, the front panel meter reading should return to 0dB ±0.2dB.	

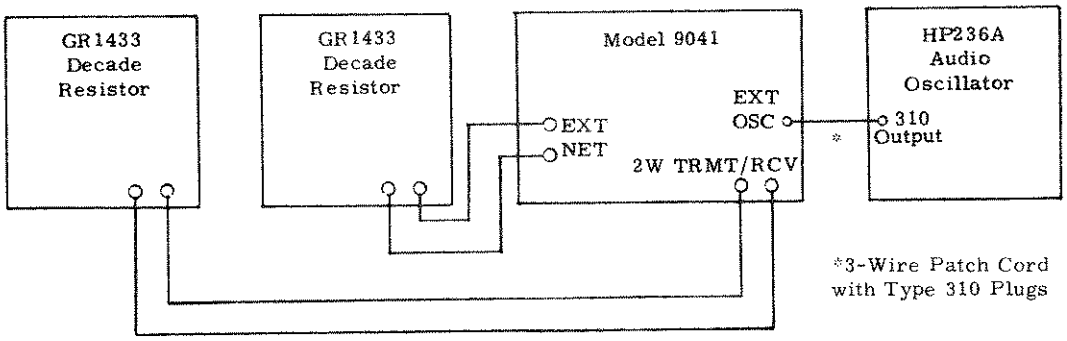


Figure 3-3. Overall Accuracy Check Test Setup

OVERALL ACCURACY CHECK

STEP	PROCEDURE
1	Set the front panel controls as follows: NETWORK — EXT RETURN LOSS TEST TYPE — EXT OSC TEST MODE — 2-WIRE 600 ohms ADD dB — 0 THL dB — 0.0 TALK/DIAL HOLD OPEN — OPEN (NORMAL)
2	Connect one GR1433 Decade Resistor (set to 600.0 ohms) to the EXT NETWORK terminals.
3	Apply a 1kHz input to the EXT OSC jack, with the 2W TRMT/RCV connector open circuited. Adjust output power of the HP236A for exactly 0dB reading on the front panel meter of the Model 9041.
4	Connect the second GR1433 (set to 612.1 ohms) to the 2W TRMT/RCV terminals and change the ADD dB setting to 30dB. The front panel meter should read 10.0dB ±0.4dB. Proceed with step 5 if an audio oscillator output impedance of 900Ω is available.
5	Switch the decade resistor connected to the EXT NETWORK terminals to 900.0 ohms. Set the TEST MODE switch to 900 ohms RETURN LOSS. Select the audio oscillator 900Ω output impedance. Set the decade resistor connected to the 2W TRMT/RCV terminals to 918.2 ohms. With the ADD dB control on 30dB, the front panel meter should resettle on 10.0dB ±0.4dB.

(F) 4-Wire Output Level Check

3.09 In this test, the output power of the measuring set is measured as a voltage across a 600-ohm load (GR1433 decade resistor). This measurement is complicated by the fact that the output signal is band-limited (weighted) white noise (noise covering all frequencies within the bandwidth) and is non-sinusoidal in shape. Thus, an average reading rms indicating voltmeter will read less than actually is present at the output terminals. At the -2dBm output power level, such a meter (the HP400D is typical) will read -3.05dBm. An alternative is to use a true rms (heat sensing) voltmeter, such as the Fluke 931B.

The test setup for this check is shown in Figure 3-4.

(G) Trans-Hybrid Loss Correction Accuracy

3.10 For this check, the THL dB gain control is checked against an external reference attenuator. The HP236A Audio Oscillator is used as a test signal. Figure 3-5 shows the test connections.

(H) Internal Hybrid Balance Check

3.11 This procedure checks the balance of the internal resistive hybrid (used as a return loss bridge). An HP236A Audio Oscillator is used as an external signal source. Two GR1433 Decade Resistors are also used for this check. Figure 3-6 shows the test setup.

(I) Internal Hybrid Frequency Response Check

3.12 For this check, the frequency response of the internal hybrid is verified over the range of 200Hz to 5kHz. The frequency response should be within ±0.2dB over this range. Only the HP236A Audio Oscillator is required for this check. The test setup is shown in Figure 3-7.

(J) Internal Network Impedance Check

3.13 This procedure verifies the accuracy of the internal reference network. The network consists of a 2.16μF capacitor in series with either a 900 ohm or 600 ohm resistance. The network is used as the reference arm of the internal hybrid. The network accuracy is checked using an HP236A Audio Oscillator, a GR1433 Decade Resistor, and two GR1423A Decade Capacitors. The test setup for this check is shown in Figure 3-8.

(K) Test Signal Level Check, 2-Wire

3.14 This procedure checks the test signal noise power output in 2-wire 600 ohm and 900 ohm return loss use. The test signal level should be -8dBm ±0.2dB for 2-wire, 600 ohm use, and -9.8dBm ±0.2dB for 2-wire, 900 ohm use. A true rms voltmeter (such as the Fluke 931B or equivalent) and a GR1433 Decade Resistor are required for this check.

NOTE

If an average responding voltmeter (such as a HP400D) is used instead of the rms voltmeter, apply a -1.05dBm compensation to the reading. Figure 3-9 shows the test setup for this check.

(L) Supervision Indicator Checks

3.15 The signaling supervision indicator lights are checked for proper operation in this procedure. This check requires a 48V supply (Central Office Signal battery is suitable), and a patch cord with the battery wired between the tip and sleeve. The test setup is shown in Figure 3-10.

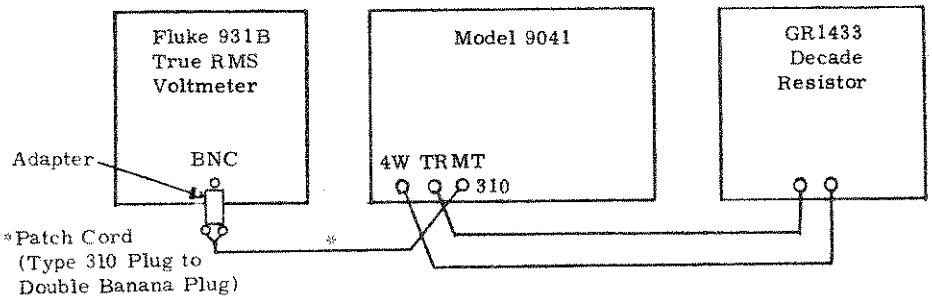


Figure 3-4. 4-Wire Output Level Check Test Setup

4-WIRE OUTPUT LEVEL CHECK

STEP	PROCEDURE
1	Set the front panel controls as follows: NETWORK — INT RETURN LOSS TEST TYPE — SRL HI TEST MODE — 4-WIRE 0dB THL dB — 0.0 ADD dB — 0 TALK/DIAL HOLD OPEN — OPEN (NORMAL)
2	Connect the decade resistor (set to 600.0 ohms) and the true rms voltmeter to the transmit terminals. Set the true rms voltmeter to the 1V scale and to read a null within 1%. The true rms voltmeter should null between 0.6002V and 0.6296V (equal to -2dBm ±0.2dB).
3	Rotate the RETURN LOSS TEST TYPE switch through SRL LO and ERL. The rms voltmeter should null within ±0.0080V (equal to ±0.1dB) of the null obtained in step 2. NOTE Since noise is being measured, it is necessary to average out fluctuations of the meter reading by eye.

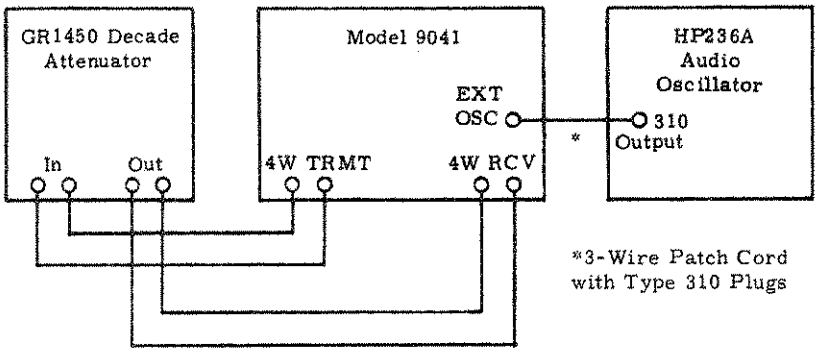


Figure 3-5. Trans-Hybrid Loss Correction Accuracy Check, Test Setup

TRANS-HYBRID LOSS CORRECTION ACCURACY CHECK

STEP	PROCEDURE
1	Set the front panel controls as follows: NETWORK — INT RETURN LOSS TEST TYPE — EXT OSC TEST MODE — 4-WIRE 0dB THL dB — 0.0 ADD dB — 0 TALK/DIAL HOLD OPEN — OPEN (NORMAL)
2	Patch the 4W TRMT to the 4W RCV jacksthrough the external attenuator. Connect the HP236A audio oscillator to the EXT OSC input. Set the attenuator to 0.0dB then adjust the output level of the oscillator for 0dB reading on the front panel meter.
3	Increase the THL dB setting from 0dB to 1dB, then add 1.0dB attenuation to the external attenuator. The front panel meter should return to 0dB ±0.2dB.
4	Repeat the above step for each 1dB setting of the THL dB control. In each case, the front panel meter reading should return to 0dB ±0.2dB.
5	Return the THL dB control to 0.2dB. Add 0.2dB attenuation to the external attenuator. The front panel meter reading should return to 0dB. If the external attenuator is of a type that has no 0.1dB step decade, this procedure can be done by interpolation on the front panel meter.
6	Repeat the previous step, increasing the THL dB control setting 0.2dB each time. The front panel meter reading should return to 0dB ±0.1dB each time.

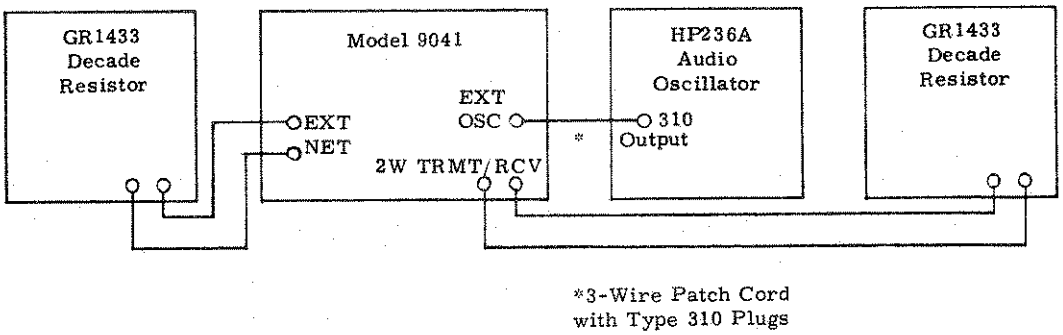


Figure 3-6. Internal Hybrid Balance Check, Test Setup

INTERNAL HYBRID BALANCE CHECK

STEP	PROCEDURE
1	Set front panel control functions as follows: NETWORK — EXT RETURN LOSS TEST TYPE — EXT OSC TEST MODE — 2-WIRE 900 ohms THL dB — 0.0 ADD dB — 0 TALK/DIAL HOLD OPEN — OPEN (NORMAL)
2	Connect one of the GR1433 decade resistors to the EXT NETWORK terminals of the Test Set. Set both resistors to 900.0 ohms. Connect the audio oscillator (set to 1kHz) to the EXT OSC terminals.
3	Adjust the oscillator level for an 0dB reading on the front panel meter.
4	Connect the second GR1433 decade resistor set to 900.0 ohms to the terminals.
5	Advance the position of the ADD dB control to the +40dB position. The reading should be greater than 10dB on the meter.

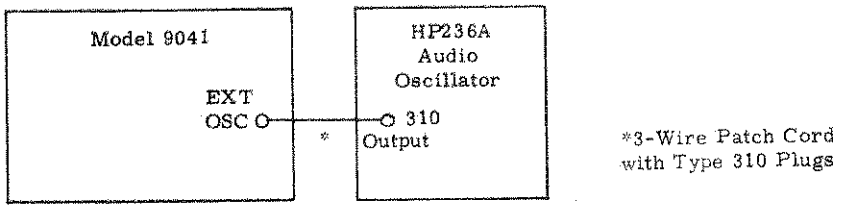


Figure 3-7. Internal Hybrid Frequency Response Check, Test Setup

INTERNAL HYBRID FREQUENCY RESPONSE CHECK

STEP	PROCEDURE
1	Set the front panel controls as follows: NETWORK — INT RETURN LOSS TEST TYPE — EXT OSC TEST MODE — 2-WIRE 600 ohms THL dB — 0.0 ADD dB — 0 TALK/DIAL HOLD OPEN — OPEN (NORMAL)
2	Connect the HP236A Audio Oscillator (set to 1kHz) to the EXT OSC terminals.
3	Adjust the oscillator output for an 0dB reading on the Model 9041 meter.
4	Slowly tune the oscillator up to 5kHz, noting the front panel meter reading. It should not vary more than ±0.4dB.
5	Slowly tune the oscillator down from 1kHz to 200Hz, noting the meter reading. It should not vary more than ±0.4 dB. NOTE If the tolerance is exceeded, the power output variation of the oscillator should be checked. Any variation in its output power level should be allowed for. If the power output variation is not within the oscillator specifications, a more suitable oscillator should be used.

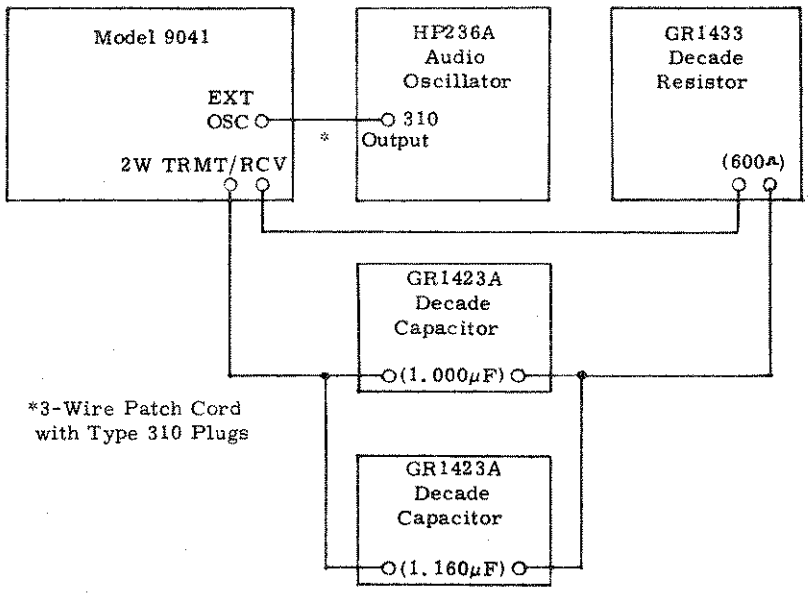


Figure 3-8. Internal Network Impedance Check, Test Setup

INTERNAL NETWORK IMPEDANCE CHECK

STEP	PROCEDURE
1	Select the front panel control as follows: NETWORK — INT RETURN LOSS TEST TYPE — EXT OSC TEST MODE — 2-WIRE 600 ohms THL dB — 0.0 ADD dB — 0 TALK/DIAL HOLD OPEN — OPEN (NORMAL)
2	Connect the audio oscillator (set at 1kHz) to the EXT OSC terminals. Set the oscillator output level for a 0dB meter reading on the Model 9041, with no connections to the 2W TRMT/RCV terminals
3	Connect the GR1423A capacitors and the GR1433 resistor as shown in Figure 3-8. Set the GR1433 decade resistor to 600.0 ohms.
4	Set one capacitor for 1.000μF, and the second capacitor for 1.160μF. Adjust the ADD dB switch to bring the meter reading on scale, if possible. The ADD dB setting plus meter indication should exceed 40dB.
5	Set the TEST MODE switch to 2-WIRE 900 ohms. Set the GR1433 decade resistor to 900.0 ohms. Repeat step 4.

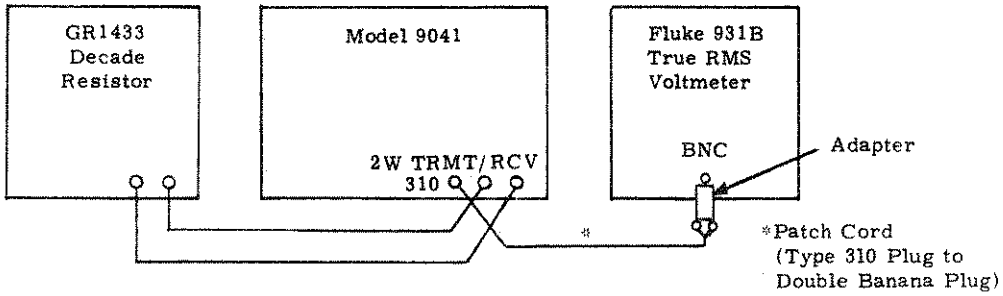
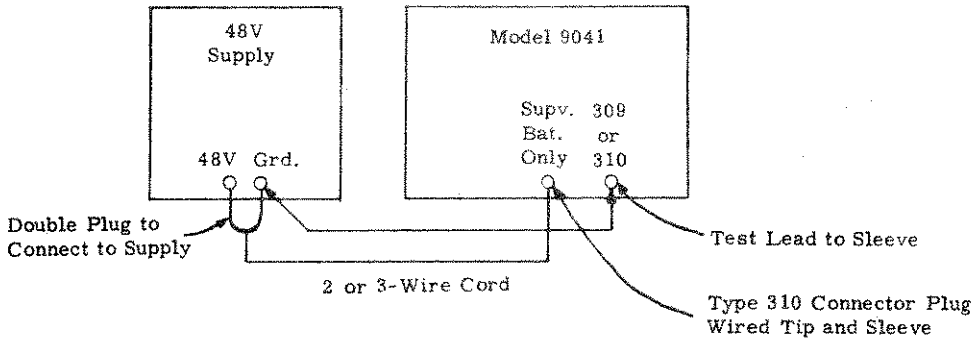


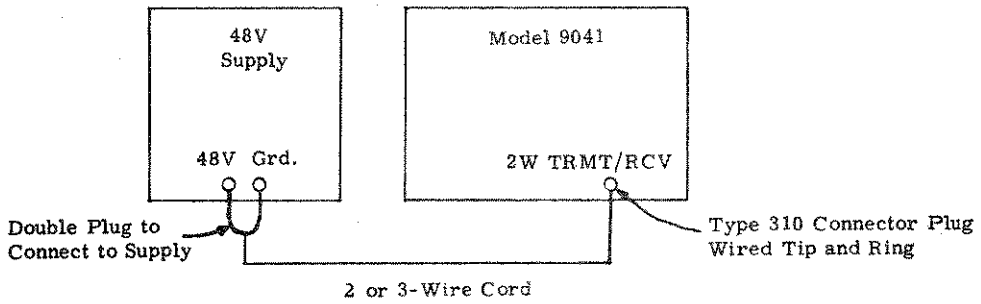
Figure 3-9. Test Signal Level Check (2-Wire), Test Setup

TEST SIGNAL LEVEL CHECK (2-WIRE)

STEP	PROCEDURE
1	Select front panel control functions as follows: NETWORK — INT RETURN LOSS TEST TYPE — ERL TEST MODE — 2-WIRE 600 ohms THL dB — 0.0 ADD dB — 0 TALK/DIAL HOLD OPEN — OPEN (NORMAL)
2	Connect the true rms voltmeter and the decade resistor (set to 600.0 ohms) as shown in Figure 3-9. Set the true rms voltmeter to the 1V scale and to read a null within 1%. The voltmeter should null between 0.3013V and 0.3154V (equal to -8dBm ±0.2dB).
3	Select 2-WIRE 900 ohms on the TEST MODE control. Set the decade resistor to 900.0 ohms. The voltmeter should null between 0.3000V and 0.3139 (equal to -9.8dBm ±0.2dB at 900 ohms). NOTE Since noise signals are being measured, it is necessary to average out the fluctuations of the meter reading by eye.



A. SLEEVE GRD. Indicator Check



B. TIP BAT and RING BAT. Indicator Check

Figure 3-10. Supervision Indicator Check Test Setup

SUPERVISION INDICATOR CHECKS

STEP	PROCEDURE
	A. SLEEVE GRD. Indicator Check
1	Connect the 48V supply to the SUPV. BAT. ONLY jack as shown in Figure 3-10A. Either tip or sleeve may be grounded.
2	Connect one end of a test lead to the ground terminal of the 48V supply, and touch the other end of the test lead to the sleeve of the 2W TRMT/RCV jack. Check that the SLEEVE GRD. indicator lights.
	B. TIP BAT. and RING BAT. Indicator Checks
1	Connect the 48V supply to the 2W TRMT/RCV jack as shown in Figure 3-10B (tip connected to battery).
2	Set the TALK/DIAL switch to HOLD. Check that the TIP BAT. indicator lights.
3	Reverse the connections to the 48V supply (ring to battery) and check that the RING BAT. indicator lights.

MAINTENANCE NOTE

If the Model 9041 does not operate properly and the power supply voltages are abnormal, try disconnecting the battery connector from the battery pack. While operating the set from AC line power, check the power supply voltages again. A defective battery pack can cause an apparent power supply problem.

If the set is to be operated only from AC power, the battery pack is not required. In such a case, the set should be labeled "AC POWER ONLY."