WLR-1 AND WLR-2 WIDEBAND CUSTOMER LOOP

INITIAL LINE-UP PROCEDURE

1. GENERAL

1.01 This section covers the initial line-up procedure for 18.75, 19.2, and 40.8 kilobit per second wideband loops equipped with WLR-1 and WLR-2 wideband loop repeaters. This line-up procedure includes the following tests:

A. Preliminary Checks of the Repeaters

B. Powering the Repeaters

C. Line-Up Procedure — Direction 2

(a) Equalizer Adjustment
(b) Input Pad Adjustment
(c) Amplifier Regulation
(d) Slope and Power Adjustment at Data Auxiliary Set 803A2

D. Line-Up Procedure — Direction 1

(a) Equalizer Adjustment
(b) Input Pad Adjustment
(c) Level Adjustment at the WSB

E. Final Adjustment

1.02 This section is reissued to incorporate changes, correct references to Data Auxiliary Set 803A2, and include the remotely controlled Data Auxiliary Set 806B5. Since this is a general revision, change arrows have been omitted.

1.03 A typical wideband customer loop, designed with options to accommodate 18.75, 19.2 kbs half group services and 40.8 kbs group service, is shown in Fig. 1. The customer repeater is connected to the data set through either an 803A2 or 806B Data Auxiliary Set. To avoid repetition, these sets will be referred to in this section as the DAS. Repeaters A, C, and D are mounted in offices, and repeater B is mounted in a manhole. Repeaters A and C (WLR-1 repeaters) are powered locally using 48-volt central office battery. Repeater A provides simplex power for repeater B. Repeater C provides simplex power for repeater D and sealing current for the line sections BC and DE. The direction of current flow (+ to −) in the cable is always in the direction of transmission.

1.04 The following line-up procedure cannot be started until all cable pairs have been tested and the repeater mountings, the wideband service bay, and the DAS installed and checked.

2. GENERAL LINE-UP PROCEDURE

2.01 Starting at the terminal repeater (A in Fig. 1) and working toward the customer repeater (D in Fig. 1), perform the steps under ***A. Preliminary Checks of the Repeater.*** These checks are made to ensure that proper plug-in units are inserted, pads, amplifiers, and equalizers adjusted to initial settings, power selectors at WLR-2 repeaters adjusted for the proper option, wiring options checked, and fuses removed. For initial line-up, the amplifiers of each repeater must be set to the fixed gain mode.

2.02 After preliminary checks have been completed, apply power to the repeaters proceeding from the customer repeater toward the terminal repeater and performing the steps shown under ***B. Powering the Repeaters.*** This procedure provides for inserting the fuses and checking amplifier voltages at locally powered WLR-1 repeaters (for example, C and A on Fig. 1). The simplex current is adjusted at WLR-1 repeaters (C and A on Fig. 1) which supply power to remote WLR-2 repeaters. The WLR-1 and WLR-2 repeaters have a regulation range of ±6.0 dB from the reference setting which is established during initial line-up. Line-ups made during high ambient temperatures reduce the regulation range at cold temperatures and can result in overload during the winter months. Ideally, line-ups made when the ambient temperature is 55 to 70°F should allow regulation without overload. When it is necessary to

make initial line-ups at temperatures greater than 70°F, it may be necessary to seasonally realign the repeaters to establish a new reference point, particularly in areas where extreme low temperatures are experienced.

2.03 When power has been applied to the repeaters, perform the steps shown under ***C. Line-Up Procedure — Direction 2.*** Begin with terminal repeater A and proceed in order through each repeater to the DAS. These steps cover the application of test tones at the wideband service bay and also the adjustment of the input and output pads and the equalizers at each repeater.

2.04 The input power of the frequencies to be used for line-up to the wideband service bay (WSB) is adjusted to −10.0 dBm, 135 ohms balanced for group and half-group channels. The line output power of the intermediate repeaters is adjusted to +10.0 dBm ±0.50 dB for the group channel and +6.0 dBm ±0.50 dB for the half-group channel. The output power of the customer terminal repeater is adjusted to provide a signal power of 0.0 dBm ±0.25 dB, 135 ohms balanced at the DAS for both types of channels.

2.05 The incoming signal passes through a transformer, an adjustable pad, and an adjustable equalizer before it reaches the input of the amplifier (see Fig. 2). Both the input pad setting and the equalizer setting will affect the input level to the amplifier. After the signal is amplified, it passes through the B output pad and transformer. At the EQPT and MON jacks of the amplifier, the signal can be measured and monitored, respectively.

2.06 The procedure for adjusting the repeater is first to place the repeater in the fixed gain mode and adjust the input pads so that the 10.2 kHz power at the output of the EQPT jack of the amplifier is +11.7 ±0.50 dB for the group channel. Then the equalizer is adjusted for flat response across the band by measuring the output for a 51-kHz signal and adjusting the equalizer to obtain the same output power for 10.2- and 51-kHz signals. The input pads are readjusted so the 30.6-kHz output power of the amplifier is +11.7 dBm ±0.50 dB measured at the EQPT jack. The output transformer and associated circuitry have a loss of 1.7 dB so the power out of the repeater on the line is +10 dBm ±0.50 dB with the output pads out of the circuit. If the output is to be less than +10 dBm, the output pads must be adjusted accordingly. A similar procedure is followed for a half-group channel to provide an equalized line output of +6.0 dBm ±0.25 dB or 7.7 dBm ±0.50 dB at the EQPT jack.

2.07 The adjustable pads are a cascade of T pads that may be placed in the circuit by adjusting two screw-down connectors. For insertion of a pad in the circuit, the screw corresponding to the desired pad marked PAD IN-DN should be tightened until the terminals are shorted, while the screw corresponding to the desired pad marked PAD IN-UP should be loosened until the terminals are no longer shorted. For removal of a pad from the circuit, the procedure should be reversed. Since a pad is either in or out of the circuit, one of its screws must be up and one must be down at all times.

2.08 After the repeaters have been adjusted in the No. 2 direction of transmission, perform the steps shown under ***D. Line-Up Procedure — Direction 1.***

2.09 During the equalizer and pad adjustment part of the line-up, a craft employee with an oscillator and a VTVM (vacuum tube voltmeter) should be available on call at the wideband service bay during the line-up of the No. 2 direction. This craft employee will be needed to send −10.0 dBm at 10.2, 30.6, and 51 kHz for equalizer and pad adjustment in the No. 2 direction.

2.10 When adjusting the customer repeater, it is advisable also to have a craft employee at the DAS. The No. 2 input pad, equalizer, and output pad of the customer repeater are adjusted to provide a 0.0 dBm ±0.25 dB power input level, with flat response across the 10.2- to 51.0-kHz band at the DAS.

2.11 When adjusting the repeaters for the No. 1 direction, a craft employee with an oscillator and a VTVM should be available on call at the DAS to send 0 dBm at 10.2, 30.6, and 51 kHz for equalizer and pad adjustment in the No. 1 direction.

APPARATUS

2 — Hewlett-Packard 3550A Portable Test Sets*
2 — Hewlett-Packard 11035A Cables (dual banana plug to BNC, 12-inch cord furnished with 3550A)
2 — 2W42A Cords (310 plug to spade tips)
1 — KS-14510 Volt-Ohm-Milliammeter
1 — Spare Amplifier J70159C

Note: The Hewlett-Packard 3550A portable test set is recommended for this line-up since it can be powered from its internal battery or from commercial ac power. A Hewlett-Packard 200CD oscillator with a 600- to 135-ohm transformer (Hewlett-Packard 11004A transformer, 146A repeating coil, or equivalent) and a Hewlett-Packard 400-type vacuum tube voltmeter with a 600- to 135-ohm transformer and a 600-ohm resistor (11004A transformer which includes a 600-ohm resistor or 146A repeating coil and a 600-ohm resistor) may be used. These test sets require ac power and external impedance matching transformers. Fig. 3(A), 3(B), and 4 show how these test sets may be used to perform the tests.

* In some cases a Hewlett-Packard E18-204B or E60-204B transmission measuring set (TMS) may be available at the DAS.

STEP	PROCEDURE
	A. Preliminary Checks of the Repeaters
	Preliminary checks are made at each repeater starting with the terminal repeater (A in Fig. 1) and working toward the customer repeater. These preliminary checks are listed for all repeaters.
1	Remove fuses from fuse receptacles +130, −130, and −48.
2	Check the strapping options and power connections on TS-1 of the WLR-1 repeaters using Table A of Circuit Note 104 on SD-73032-01.
3	Check the WLR-2 repeaters to see that the power options are as designated in Fig. 5 or 6.
4	Check to see that the plug-in amplifiers, 382B equalizers, and shorting plugs are in the proper location.
5	Adjust the input pads (A) for maximum loss (47 dB). See 2.07.
6	Adjust the output pads (B) as follows:

REPEATER	DIRECTION	OUTPUT PAD
Terminal (at WSB)	1	20 dB
	2	0 dB or as specified by engineer
Intermediate	1	0 dB or as specified by engineer
	2	
Customer	1	0 dB or as specified by engineer
	2	10 dB or as specified by engineer

7	Remove the amplifiers and set the screws for FIXED GAIN (see Fig. 7). Reinsert the amplifiers.
8	Adjust the 382B equalizers for 0-dB slope.

STEP	PROCEDURE

B. Powering the Repeaters

Power is applied to the WLR-1 repeaters starting with the customer repeater or with the WLR-1 repeater nearest the customer and working toward the terminal repeater. The general procedure is to install the 48-volt fuse, check the amplifier voltages, install the 130-volt fuses, and adjust the simplex current supplying power to the simplex loop and WLR-2 repeaters.

PWR ADJ 1 adjusts the simplex current in the simplex loop in direction 1 (toward the terminal repeater). PWR ADJ 2 adjusts the simplex current in the simplex loop in direction 2 (toward the customer). At WLR-1 repeaters, adjust PWR ADJ 1 and PWR ADJ 2, as necessary, to adjust simplex loop current to 80 milliamperes.

The detailed procedure for applying power to the repeaters is as follows. Perform the steps shown for the condition shown.

STEPS	WLR-1 REPEATERS
1 through 4, 9	No simplex current
1 through 7, 9, 10	Simplex current in direction 1
1 through 5, 8, 9, 10	Simplex current in direction 2
1 through 10	Simplex current in directions 1 and 2

1	Insert the 70H, 0.75-amp fuse in the −48 receptacle.
2	Measure the voltage between test points J2(+) and J3(−) on both amplifiers with the KS-14510 volt-ohm-milliammeter (see Fig. 8). ***Requirement:*** 19 to 25 volts dc. If the above requirement is not met, check the repeater wiring using SD-73032-01.
3	Measure the bias between test points J1(+) and J3(−) on both amplifiers with the KS-14510 volt-ohm-milliammeter (see Fig. 9). ***Requirement:*** 3.2 to 4.2 volts dc. If the above requirement is not met, replace the amplifier and repeat Steps 1 through 3.
4	Remove the dot plug buttons from PWR ADJ 1 and PWR ADJ 2 rheostats and rotate the slotted shafts fully counterclockwise.
5	Insert 70F, 0.25-amp (violet bead) fuses in +130 and −130 receptacles. (These fuses connect 130-volt battery to the simplex circuit to supply power to the simplex loop and WLR-2 repeaters.)
6	Connect the KS-14510 volt-ohm-milliammeter to the test points for direction 1 on the repeater mounting.
7	Adjust PWR ADJ 1 to obtain a reading of 8 volts on the KS-14510 volt-ohm-milliammeter. This is equivalent to 80 ma of line current. ***Note:*** No voltage reading indicates an open in the simplex loop. Check the power and simplex loop continuity using SD-73032-01. Check the cable pairs for grounds, opens, and shorts and the WLR-2 power selector boards for use of proper options. If a voltage reading is obtained but it is less than 8 volts, consult the engineer.
8	Perform Steps 5, 6, and 7 for direction 2 (PWR ADJ 2).
9	Proceed to each WLR-1 repeater, in turn, toward the terminal repeater and perform the necessary steps for the WLR-1 repeater conditions listed in Test B.

STEP	PROCEDURE
10	If there are WLR-2 repeaters mounted in offices, have Steps 2 and 3 performed by a craft employee at the office. For WLR-2 repeaters at remote locations, perform Steps 2 and 3 before any other adjustment is made.

C. Line-Up Procedure — Direction 2

After power has been applied to all repeaters adjust the equalizers and pads of each repeater in direction 2 starting with the terminal repeater and working toward the DAS.

For repeaters equipped with a shorting plug instead of an equalizer, omit the equalizer adjustment in direction 2. Line up such repeaters with a 30.6-kHz test tone. For all repeaters whether equipped with a shorting plug or an amplifier, the input pads must be adjusted in direction 2. The procedure for adjusting the input pads is described in part (b) of this test.

Set up the oscillator of the E60-204B TMS to supply −10.0 dBm with 135 ohms at 10.2 kHz as follows (see Fig. 10).

Note: To set up the oscillator for 30.6 kHz, use the same procedure except set the FREQ control to 30.6. For 51 kHz, set the FREQ control to 51.

STEP	PROCEDURE
1	

LOCATION	CONTROL	POSITION
Oscillator	AMPLITUDE RANGE FREQ	Minimum (ccw) X1K 10.2
Patch Panel	MEAS-CAL OUTPUT-IMPEDANCE INPUT-IMPEDANCE FREQ DB	CAL 135 135 >5KC 0
Voltmeter	RANGE FUNCTION	−10 DB ON

2	Connect the input of the VTVM to the VM BNC connector on the patch panel of the E60-204B TMS using the 11035A cable furnished.
3	Connect the output of the oscillator to the OSC BNC connector on the patch panel of the E60-204B TMS using the 11035A cable furnished.
4	Connect the power cords of the E60-204B TMS to ac outlets.
	Note: If a 3550A portable test set is used, it will operate on its internal batteries which are charged when the power cords are connected to an alternating source of power.
5	Adjust the oscillator AMPLITUDE control until the VTVM reads −10.0 dBm when the MEAS-CAL switch is in the CAL position.
6	Set the MEAS-CAL switch to MEAS.
7	Connect a 2W42A cord (310 plug to spade tips) to the patch panel OUTPUT terminals.

<table>
<tr><th>STEP</th><th>PROCEDURE</th></tr>
<tr><td>8</td><td>At the wideband service bay, insert the 310 plug of this 2W42A cord into the appropriate jack toward the customer loop. Leave this connection established until direction 2 has been lined up.</td></tr>
<tr><td colspan="2">(a) Adjust the 382B Equalizer as Follows:</td></tr>
<tr><td>9</td><td>Set up the voltmeter and patch panel of the 3550A portable test set as follows:
<table>
<tr><th>LOCATION</th><th>CONTROL</th><th>POSITION</th></tr>
<tr><td>Patch Panel</td><td>INPUT-IMPEDANCE
FREQ
DB
MEAS-CAL</td><td>135
>5KC
0
MEAS</td></tr>
<tr><td>Voltmeter</td><td>RANGE
FUNCTION</td><td>+10 DB
ON</td></tr>
</table></td></tr>
<tr><td>10</td><td>Connect the input of the voltmeter to the VM BNC connector on the patch panel of the 3550A portable test set using the 11035A cable furnished.</td></tr>
<tr><td>11</td><td>Connect the power cord of the voltmeter to an ac outlet if in an office. If at a remote location, use the internal batteries.</td></tr>
<tr><td>12</td><td>Connect the INPUT terminals of the patch panel to the EQPT jack of amplifier 2 using a 2W42A cord.</td></tr>
<tr><td>13</td><td>Adjust the loss of PAD A (input pad) of amplifier 2 on a group channel to obtain a voltmeter reading of +10.0 dBm ±0.5 dB at 10.2 kHz. For a half-group channel obtain a reading of +6.0 dBm ±1.0 dB. Record this value (example: +10.3).

Note: To insert the loss of a section of a pad, loosen the top screw and tighten the bottom screw. For example, to insert loss of 23 dB (1 + 2 + 4 + 16 = 23) loosen the top screws (turn them counterclockwise) of 1, 2, 4, and 16 until the screwhead does not touch the metal contacts. All other top screws of PAD A should be tight and bottom screws loose.</td></tr>
<tr><td>14</td><td>Have the craft employee at the wideband service bay adjust the oscillator of the E60-204B TMS for 51 kHz and the level to −10.0 dBm as in Steps 5 and 6 of this test.</td></tr>
<tr><td>15</td><td>At the repeater, record the 51-kHz output reading on the voltmeter (example: −2.4 dBm group or −6.4 dBm half-group).</td></tr>
<tr><td>16</td><td>Calculate the required 382B equalizer setting as follows: value from Step 13 − value from step 15 = slope setting (round off to nearest dB).

Example 1:

<table>
<tr><th></th><th>GROUP</th><th>HALF-GROUP</th></tr>
<tr><td>Step 13 value</td><td>+10.3</td><td>+6.3</td></tr>
<tr><td>Step 15 value</td><td>−(−2.4)</td><td>−(−6.4)</td></tr>
<tr><td>Slope</td><td>12.7 dB, use 13 dB</td><td>+12.7 dB, use 13 dB</td></tr>
</table>
Example 2:

<table>
<tr><th></th><th>GROUP</th><th>HALF-GROUP</th></tr>
<tr><td>Step 13 value</td><td>+10.3</td><td>+6.3</td></tr>
<tr><td>Step 15 value</td><td>−(+1.0)</td><td>−(−3.0)</td></tr>
<tr><td>Slope</td><td>9.3 dB, use 9 dB</td><td>9.3 dB, use 9 dB</td></tr>
</table>
Note: Slope is the same for both channels.</td></tr>
</table>

STEP	PROCEDURE
17	Adjust the 382B equalizer to the slope determined in Step 16. ***Note:*** To adjust the 382B equalizer for 13 dB, loosen the center screw and tighten the left and right screws for 1, 4, and 8 dB. All other center screws should be tight and left and right screws loose.
18	At the repeater, record the new 51-kHz output reading on the VTVM.
19	Have the craft employee at the wideband service bay adjust the oscillator of the E60-204B TMS for 10.2 kHz and the level to −10.0 dBm as in Steps 5 and 6.
20	At the repeater, record the 10.2-kHz reading on the VTVM.
21	If the difference in the reading of Steps 18 and 19 is greater than 1.0 dB, repeat Steps 13, 14, 15, 16, and 17.
(b) Adjust the Input Pad as Follows:	
22	Have the central office craft employee at the wideband service bay adjust the oscillator of E60-204B TMS for 30.6 kHz and the level to −10.0 dBm as in Steps 5 and 6.
23	At the repeater, record the 30.6-kHz output reading on the voltmeter (example: −3.2 dBm group or −7.2 dBm, half-group).
24	Calculate the input pad (PAD A) loss to be removed as follows: **GROUP** +11.7 −Step 23 value PAD A loss to be removed ***Example:*** +11.7 −(−3.2) Remove 14.9 dB, use 15 dB **HALF-GROUP** +7.7 −Step 23 value PAD A loss to be removed ***Example:*** +7.7 −(−7.2) Remove 14.9 dB, use 15 dB ***Caution: Always add additional pad values before removing pad values to avoid too much signal power on the line and possible interference into other circuits.*** ***Note 1:*** For example, if PAD A has 23-dB loss, the loss of PAD A should be adjusted to 23 − 15 = 8 dB. Add 8 dB by loosening the top screw and tightening the bottom screw of the 8-dB section of PAD A and remove 23-dB loss by tightening the top screws and loosening the bottom screw of all other values (1, 2, 4, 16). ***Note 2:*** When the input pads are finally adjusted, the output power reading shall be +11.7 dBm ±0.5 dB for group or +7.7 dBm ±0.5 dB for half-group.
(c) Regulate the Amplifiers as Follows:	
After the input level has been adjusted, the regulation of the amplifiers must be checked by performing the following steps:	
25	Remove the No. 2 direction amplifier and adjust it to the REG GAIN condition on group channel with the three screws located inside the amplifier (see Fig. 7). Because of overload from transmission of restored polar signal on half-group channel, the repeater must remain in the ***fixed gain mode.***

STEP	PROCEDURE
26	Reinsert the amplifier and wait 20 seconds for the regulator to stabilize. ***Requirement:*** VTVM reading +11.7 dBm ±0.5 dB (group only). If the requirement is not met, consult the control office. If the requirement is met, proceed to Step 27.
27	Remove the No. 2 direction amplifier and adjust it back to the FIXED GAIN condition with the three screws located inside the amplifier.
28	Remove the No. 1 direction amplifier and adjust it to the REG GAIN condition.
29	Insert this amplifier in the slot normally reserved for the No. 2 direction amplifier and wait 20 seconds for the regulator to stabilize. ***Requirement:*** VTVM reading +11.7 dBm ±0.5 dB. If the requirement is not met, consult the control office. If the requirement is met, proceed to Step 30.
30	Remove the amplifier and adjust it back to the FIXED GAIN condition.
31	Return this amplifier to its original position in the No. 1 direction slot.
32	Reinsert the No. 2 direction amplifier in its slot.
33	Remove the 310 plug from the EQPT jack and proceed in turn to the other repeaters toward the DAS. Adjust the equalizers and amplifiers in direction 2 following the procedures of parts (a) (b), and (c) of this test.

(d) Adjust the Slope and Power at Data Auxiliary Set as Follows:

After the customer repeater has been adjusted, the slope and power at the DAS must be adjusted. This requires voltmeter measurements at the DAS and may require additional equalizer, input pad, and output pad adjustment at the customer repeater. It is desirable to use two craft employees each with test equipment for these adjustments, however, it is possible for one craft employee to make the measurements and adjustments. Steps 34 through 44 are common to both group and half-group channels.

34 At the DAS, set up the voltmeter and patch panel of the 3550A portable test set as follows:

LOCATION	CONTROL	POSITION
Patch Panel	INPUT-IMPEDANCE FREQ DB MEAS-CAL	135 >5KC 0 MEAS
Voltmeter	RANGE FUNCTION	+10 DB ON

35 Connect the input of the voltmeter to the VM BNC connector on the patch panel of the 3550A portable test set using the 11035A cable furnished.

STEP	PROCEDURE
36	Connect the power cord of the voltmeter to an ac outlet.
37	Connect the INPUT terminals of the patch panel to the REC LINE jack of the DAS using a 2W42A cord.
38	Have the craft employee at the wideband service bay adjust the oscillator of the E60-204B TMS for 10.2 kHz and the level to −10.0 dBm as in Steps 5 and 6.
39	Adjust the RANGE control of the voltmeter to obtain a voltmeter reading. Record the sum of the RANGE control setting and the meter reading. ***Example:*** RANGE Setting 0 Meter Reading −2 Corrected Reading −2
40	Have the craft employee at the wideband service bay adjust his oscillator for 51 kHz and the level to −10 dBm as in Steps 5 and 6.
41	Adjust the RANGE control of the voltmeter to obtain a voltmeter reading. Record the sum of the RANGE control setting and the meter reading. ***Example:*** RANGE Setting 0 Meter Reading −4.2 Corrected Reading −4.2
42	Calculate the additional 382B equalizer slope required by determining the difference between the values obtained in Steps 39 and 41. ***Example:*** Step 39 −2 Step 41 −(−4.2) Slope 2.2 db, use 2 db
43	At the customer repeater, adjust the 382B equalizer for the additional slope determined in Step 42.
44	Repeat Steps 38 through 43 as a check on the equalization of the line.
45	At the customer repeater, readjust the input pad (PAD A) as in part (b) to obtain a value of +11.7 dBm ±0.5 dB output level at the EQPT jack of the No. 2 amplifier, for a group channel. On a half-group channel, the input pad (PAD A) is adjusted to obtain a value of +7.7 dBm ±0.5 dB output level.
46	Measure the 30.6-kHz power at the REC LINE jack of the DAS using the voltmeter as in Steps 25 through 28. Record the sum of the RANGE control and the meter reading. ***Example:*** RANGE Setting — GROUP 0 — HALF-GROUP 0 Meter Reading — GROUP −5.8 — HALF-GROUP −9.8 Corrected Reading — GROUP −5.8 — HALF-GROUP −9.8
47	Calculate the change required in the customer repeater output pad (PAD B direction 2) as follows: Desired value — GROUP 0 — HALF-GROUP 0 Step 46 value — GROUP −5.8 — HALF-GROUP −9.8 Pad change — GROUP −5.8 dB, use 5.5 dB — HALF-GROUP −9.8 use 9.5 dB ***Note:*** + indicates additional pad required, − indicates pad value to be removed.

STEP	PROCEDURE
48	At the customer repeater, adjust the output pad (PAD B direction 2) by the value determined in Step 47.
49	Repeat the procedure of Step 46. ***Requirement:*** 0 dBm ±0.25 dB (group and half-group). If requirement is not met, repeat Steps 46 through 49.

D. Line-Up Procedure — Direction 1

After the pad and equalizers of each repeater in direction 2 have been adjusted, adjust the equalizers and pads of each repeater in direction 1 starting with the customer repeater and working toward the WSB.

For repeaters equipped with a shorting plug instead of an equalizer, omit the equalizer adjustment in direction 1. Line-up such repeaters with a 30.6-kHz test tone. For all repeaters whether equipped with a shorting plug or an amplifier, the pads must be adjusted in direction 1. The procedure for adjusting the input pads is described in part (b) of this Test D.

A Hewlett-Packard 3550A portable test set will be needed at the DAS. If a 3550A was used at the WSB to line up direction 2, it is no longer needed at that location and may be used at the DAS if an extra 3550A is not available.

Set up the oscillator of the 3550A portable test set to supply 0.0 dBm with 135 ohms at 10.2 kHz as follows (see Fig. 10).

Note: To set up the oscillator for 30.6 kHz, use the same procedure except set the FREQ control to 30.6. For 51 kHz set the FREQ control to 51.

1

LOCATION	CONTROL	POSITION
Oscillator	AMPLITUDE RANGE FREQ	Minimum (ccw) X1K 10.2
Patch Panel	MEAS-CAL OUTPUT-IMPEDANCE INPUT-IMPEDANCE FREQ DB	CAL 135 135 >5KC 0
Voltmeter	RANGE FUNCTION	0 DB ON

2 Connect the input of the VTVM to the VM BNC connector on the patch panel of the 3550A portable test set using the 11035A cable furnished.

3 Connect the output of the oscillator to the OSC BNC connector on the patch panel of the 3550A portable test set using the 11035A cable furnished.

4 Connect the power cords of the 3550A to ac outlets.

Note: The 3550A portable test set will operate on its internal batteries which are charged when the power cords are connected to an ac source of power.

5 Adjust the oscillator AMPLITUDE control until the VTVM reads 0.0 dBm when the MEAS-CAL switch is in the CAL position.

STEP	PROCEDURE
6	Set the MEAS-CAL switch to MEAS.
7	Connect a 2W42A cord (310 plug to spade tips) to the patch panel OUTPUT terminals.
8	At the DAS, insert the 310 plug of this 2W42A cord into the TRANS LINE jack toward the WSB. Leave this connection established until direction 1 has been lined up.
(a)	**Adjust the 382B Equalizer as Follows:**
9	Set up the voltmeter and patch panel of the other 3550A portable test set as follows:

LOCATION	CONTROL	POSITION
Patch Panel	INPUT-IMPEDANCE FREQ DB MEAS-CAL	135 >5KC 0 MEAS
Voltmeter	RANGE FUNCTION	+10 DB ON

10	Connect the input of the voltmeter to the VM BNC connector on the patch panel of the 3550A portable test set using the 11035A cable furnished.
11	Connect the power cord of the voltmeter to an ac outlet if in an office. If at a remote location, use the internal batteries.
12	Connect the INPUT terminals of the patch panel to the EQPT jack of amplifier 1 using a 2W42A cord.
13	Adjust the loss of PAD A (input pad) of amplifier 1 on a group channel to obtain a voltmeter reading of +10.0 ±0.5 dBm. For a half-group channel, obtain a reading of +6.0 dBm ±1.0 dB. Record this value (example: +10.3). ***Note:*** To insert the loss of a section of a pad, loosen the top screw and tighten the bottom screw. For example, to insert loss of 23 dB (1 + 2 + 4 + 16 = 23) loosen the top screws (turn them counterclockwise) of 1, 2, 4, and 16 until the screwhead does not touch the metal contacts, and tighten (turn clockwise) the bottom screws of 1, 2, 4, and 16 until the screwhead touches the metal contacts. All other top screws of PAD A should be tight and bottom screws loose.
14	Have the craft employee at the DAS location adjust the oscillator of the 3550A portable test set for 51 kHz and the level to 0.0 dBm as in Steps 5 and 6 of this test.
15	At the repeater record the 51-kHz output reading on the voltmeter (example: −2.4 dBm group or −6.4 dBm half-group).
16	Calculate the required 382B equalizer setting as follows: value from Step 13 − value from Step 15 = slope setting (round off to nearest dB). ***Example 1:***

	GROUP	HALF-GROUP
Step 13 value	+10.3	+6.3
Step 15 value	−(−2.4)	−(−6.4)
Slope	12.7 dB, use 13 dB	12.7 dB, use 13 dB

STEP	PROCEDURE
	Example 2: Step 13 value +10.3 +6.3 Step 15 value −(+1.0) −(−3.0) Slope 9.3 dB, use 9 dB 9.3 dB, use 9 dB
	Note: Slope is the same for both channels.
17	Adjust the 382B equalizer to the slope determined in Step 8.
	Note: To adjust the 382B equalizer for 13 dB, loosen the center screw and tighten the left and right screws for 1, 4, and 8 dB. All other center screws should be tight and the left and right screws loose.
18	At the repeater, record the new 51-kHz reading on the VTVM.
19	Have the craft employee at the DAS adjust the oscillator of the 3550A portable test set for 10.2 kHz and the level to 0.0 dBm as in Steps 5 and 6 of this test.
20	At the repeater, record the 10.2-kHz reading on the VTVM.
21	If the difference in the readings of Steps 18 and 20 is greater than 1.0 dB, repeat Steps 13, 14, 15, 16, and 17.
(b) Adjust the Input Pad as Follows:	
22	Have the craft employee at the DAS adjust the oscillator of the 3550A portable test set for 30.6 kHz and the level to 0.0 dBm as in Steps 5 and 6 of this test.
23	At the repeater, record the 30.6 output reading on the voltmeter (example: −3.2 dBm group or −7.2 dBm half-group).
24	Calculate the input pad (PAD A) loss to be removed as follows: +11.7 −Step 23 value PAD A loss to be removed ***Example:*** GROUP HALF-GROUP +11.7 +7.7 −(−3.2) −(−7.2) Remove 14.9 dB, use 15 dB 14.9 dB, use 15 dB ***Caution: Always add additional pad values before removing pad values to prevent too much signal power on the line and possible interference into other circuits.*** ***Note 1:*** For example, if PAD A has 23-dB loss, the loss of PAD A should be adjusted to 23 − 15 = 8 dB. Add 8 dB by loosening the top screw and tightening the bottom screw of the 8-dB section of PAD A and remove 23-dB loss by tightening the top screws and loosening the bottom screw of all other values (1, 2, 4, 16). ***Note 2:*** When the input pads are finally adjusted, the output power reading at the EQPT jack shall be +11.7 ±0.5 dBm group or +7.7 ±0.5 dBm half-group.
25	Remove the 310 plug from the EQPT jack and in turn proceed to the other repeaters toward the wideband service bay. Adjust the equalizers and amplifiers in direction 1 following the procedures of parts (a) and (b) of this Test D.

STEP	PROCEDURE
(c) Make Level Adjustment at the WSB as Follows:	
After the WSB terminal repeater has been adjusted, the power level at the wideband service bay must be adjusted. This requires voltmeter measurements at the WSB and may require additional output pad adjustment at the terminal repeater to meet the −10.0 dBm ±0.25 dB requirement.	
26	At the wideband service bay, set up the voltmeter and patch panel of the 3550A portable test set as follows:

LOCATION	CONTROL	POSITION
Patch Panel	INPUT-IMPEDANCE FREQ DB MEAS-CAL	135 >5KC 0 MEAS
Voltmeter	RANGE FUNCTION	−10 DB ON

27	Connect the input of the VTVM to the VM BNC connector on the patch panel of the 3550A portable test set using the 11035A cable furnished.
28	Connect the power cord of the VTVM to an ac outlet.
29	Connect the INPUT terminals of the patch panel to the appropriate jack of the WSB using the 2W42A cord.
30	Have the craft employee at the DAS adjust his oscillator to 30.6 kHz and the level to 0.0 dBm as in Steps 5 and 6 of this test.
31	Measure the power at the WSB and record it. Determine the amount of output padding to be removed or inserted to bring the level at the WSB to −10.0 ±0.25 dBm group or half-group. ***Example:*** Step 31 value −11.6 dBm Desired value −(−10.0) Pad Change − 1.6 dBm, use 1.5 dBm ***Note:*** + indicates additional pads required, − indicates value to be removed. Since we must remove 1.5 dB from the output pad which has been set to 20 dB (16 + 4), we need 18.5 dB when we are finished. Hence, we will first add 2.5 dB (2.0 + 0.5) and then remove 4.0-dB pad.
32	At the terminal repeater, adjust the output pad (PAD B direction 1) by the value determined in Step 31. The output power at the WSB should now be −10.0 ±0.25 dBm. If the requirement is not met, repeat Step 31. This completes the line-up of direction 1 of the customer loop. The local loop is now lined up and ready for the over-all system checks. The WLR repeaters on group channel ***must remain*** in the FIXED GAIN condition until: (a) Noise and impulse noise measurements are completed on each local loop and the over-all wideband channel in each direction of transmission. (b) Local loops for group channels are terminated in Data Sets 301B at both ends of the wideband channel. These sets continuously supply either the idle signal or the random data signal which are required for regulation.

STEP	PROCEDURE
32 (cont)	(c) Non-regulated local loops for half-group data service terminate in a Data Set 303B equipped with a Data Auxiliary Set 809A which derives a 28- to 44-kHz channel. An idle signal may or may not be transmitted. (d) A 30.6-kHz tone is injected at −10.0 dBm ±0.25 dB at the WSB toward the customer, the Data Auxiliary Set 803A2 is in the TEST position, and the No. 1 direction of transmission is terminated in 135 ohms at the WSB. If the customer location is equipped with a DAS 806B5, the DAS must be placed in the local test mode. The procedure for doing this will be described in Test E.
	E. Final Adjustment Group Channel Only
	When both direction 2 and direction 1 have been lined up, the amplifiers in each repeater must be set in the regulated gain condition. This requires transmitting a 30.6-kHz signal at the WSB and looping it at the Data Auxiliary Set 803A2 (The reason the amplifiers were not set to REG GAIN when each repeater was adjusted is that the regulation feature would have interfered with the equalizer adjustment of the complete line section). To set the amplifiers to REG GAIN, perform the following steps:
1	Set up the oscillator of the E60-204B TMS at the WSB according to Test C, Steps 1 through 8, using a 30.6-kHz signal instead of 10.2 kHz.
2	Terminate the No. 1 direction of the local loop in 135 ohms by performing part (c) of Test D, Steps 26, 27, 28, and 29.
3	Loop the Data Auxiliary Set 803A2 by manually putting the key to the TEST position, or place Data Auxiliary Set 806B5 in the RT-1 mode, remotely or locally.
4	Set the amplifiers for both the No. 1 and No. 2 directions in each repeater to REG GAIN, starting at the WSB terminal repeater and proceeding in turn down the line to the customer repeater. *Note:* To set an amplifier to REG GAIN, remove the amplifier and turn the screw marked REG-UP counterclockwise until it is no longer shorting its connections. Turn the two screws marked REG-DN clockwise until the screws make a firm contact with their connections (see Fig. 7).
5	Readjust the received power level at the WSB, if necessary, by performing Steps 31 and 32 of part (c), Test D.
6	When the last step is completed, notify the control office. Leave the line looped at the data auxiliary set and maintain the 30.6-kHz signal at the WSB to prevent the regulators from increasing the gain of the amplifiers excessively.

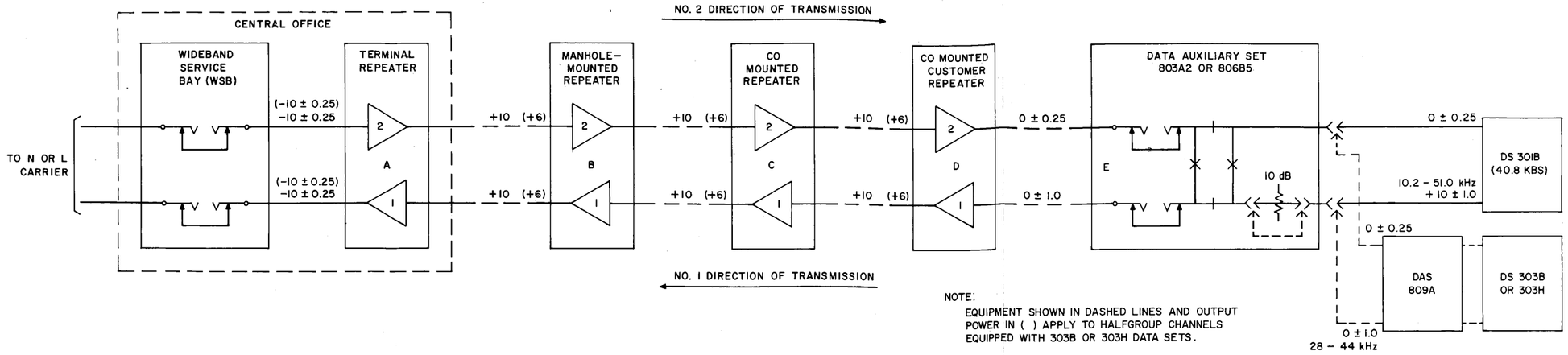


Fig. 1 — A Typical Customer Loop

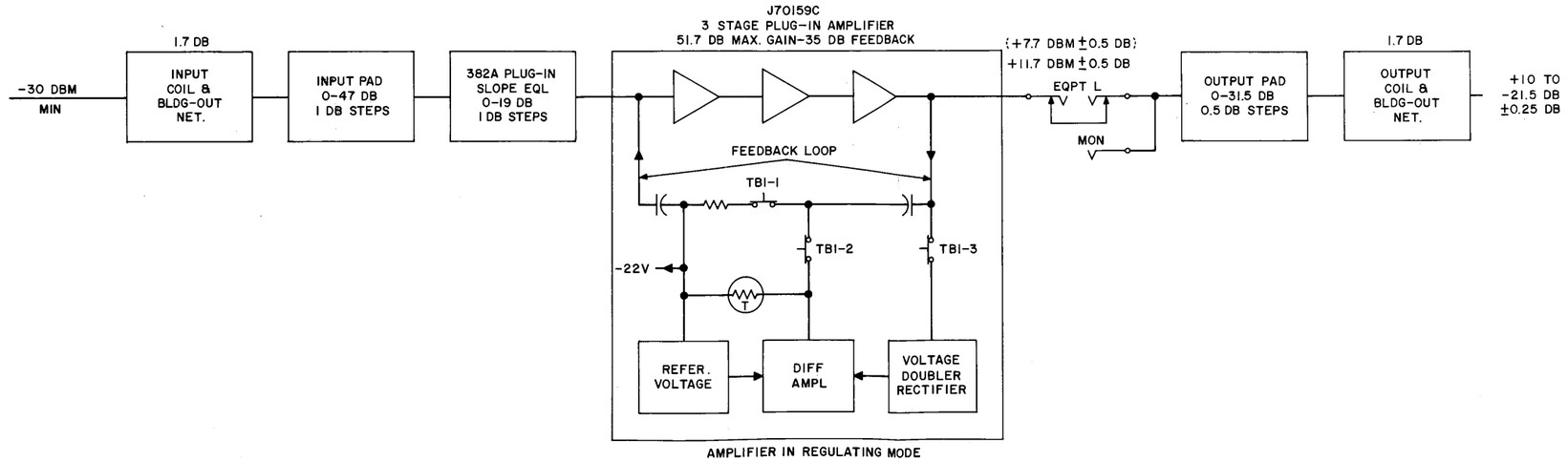


Fig. 2 — Simplified Schematic of Signal Path Through One Direction of Transmission of WLR-1 or WLR-2 Repeater for 40.8 and 19.2 Kilobit Data Channel

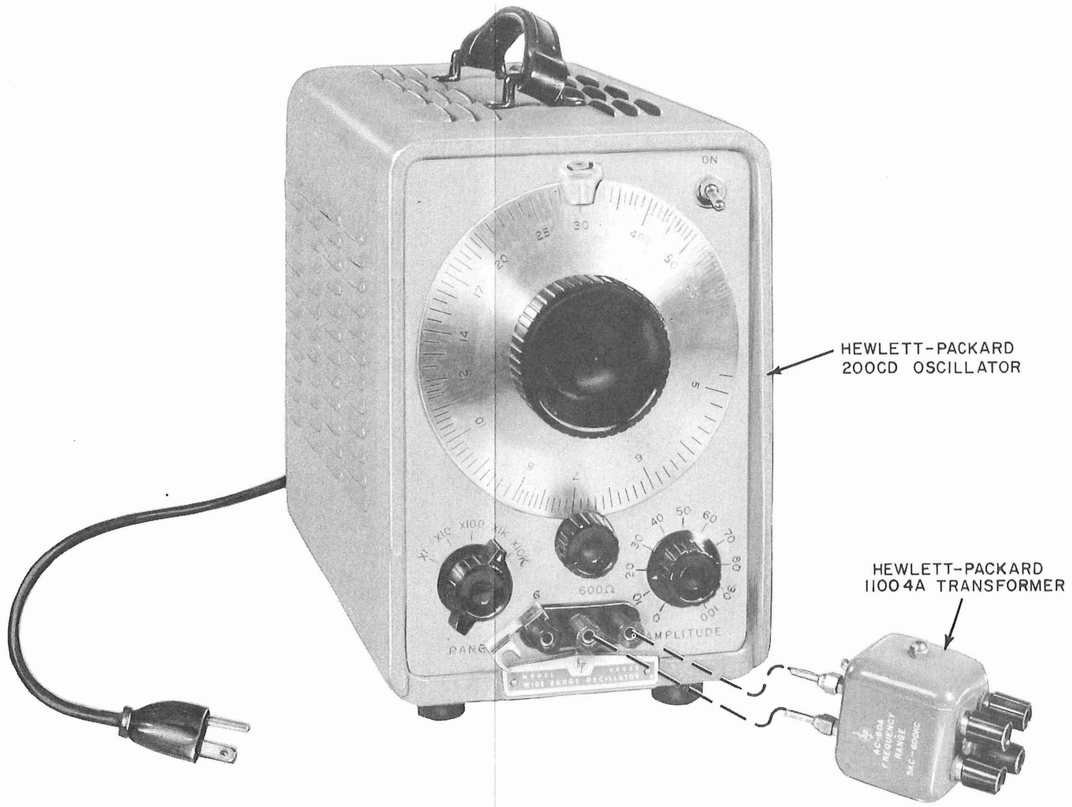


Fig. 3A — Equivalent Test Set to Simulate Output Side of Hewlett-Packard 3550A Test Set

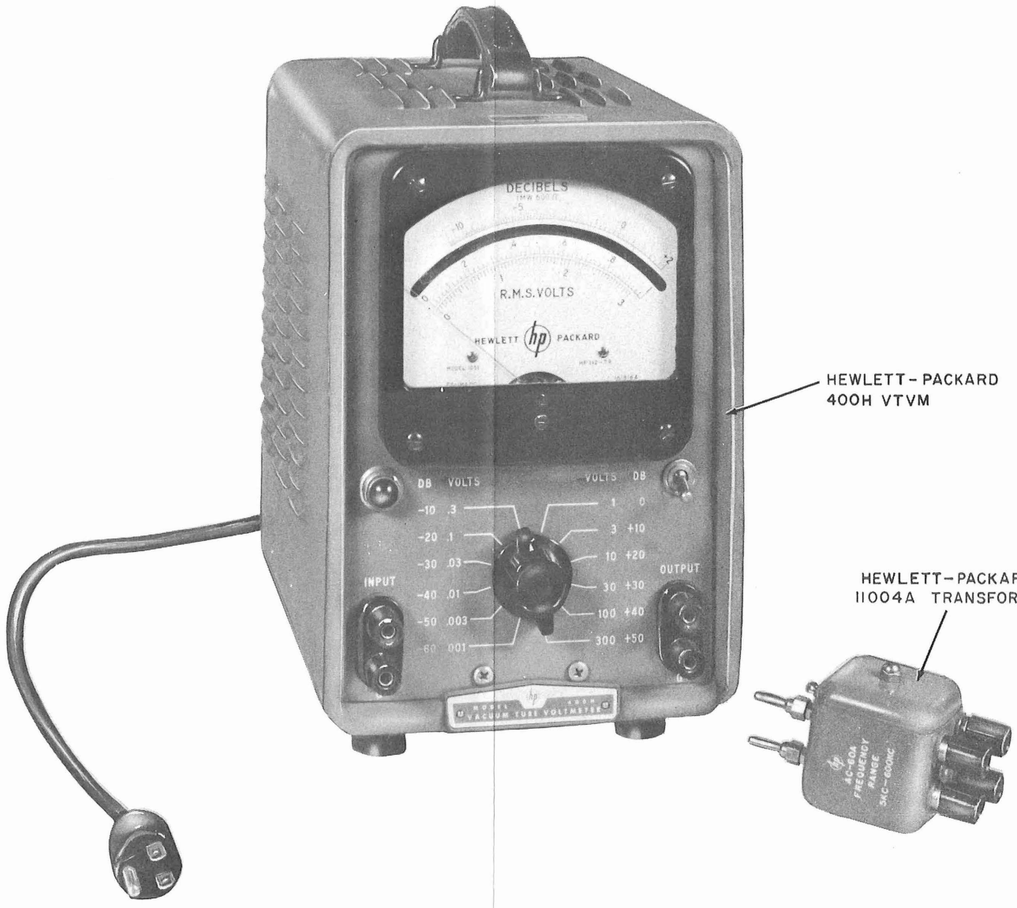
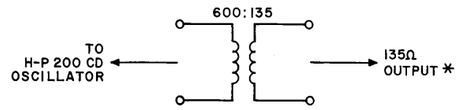
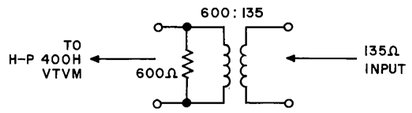


Fig. 3B — Equivalent Test Set to Simulate Input Side of Hewlett-Packard 3550A Test Set



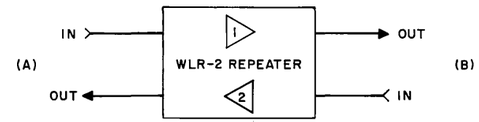
* SET LEVELS WITH A 135-OHM RESISTOR ACROSS THE TRANSFORMER, NOT THE IMPEDANCE OF THE CABLE.

(A) USE OF TRANSFORMER WITH OSCILLATOR



(B) USE OF TRANSFORMER WITH VTVM

Fig. 4 — Method of Using 135:600 OHM Transformer

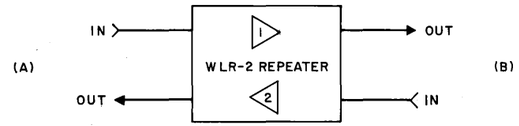


NOTE:
THE DIRECTION OF CURRENT FLOW [PLUS (+) TO MINUS (−)] IS ALWAYS IN THE DIRECTION OF TRANSMISSION.

TABLE A

POWERING OPTIONS	POWER SELECTOR SCREWS
POWER THROUGH REPEATER IN BOTH DIRECTIONS (A TO B) AND (B TO A)	CLOSE - S1, S3, S5, S7 OPEN - S2, S4, S6, S8
RECEIVE POWER FROM (A) SEAL TOWARD (B)	CLOSE - S1, S3, S6, S8 OPEN - S2, S4, S5, S7
RECEIVE POWER FROM (B) SEAL TOWARD (A)	CLOSE - S2, S4, S5, S7 OPEN - S1, S3, S6, S8

Fig. 5 — Powering Arrangement When Power is Supplied Over Line to WLR-2 Repeater



NOTE:
THE DIRECTION OF SEALING CURRENT FLOW [PLUS(+) TO MINUS(-)] IS ALWAYS IN THE DIRECTION OF TRANSMISSION.

TABLE B

WIRE -22 VOLT (CONNECTOR BLOCK E1) TO (TSI TERM. 49)
WIRE +22 VOLT (CONNECTOR BLOCK E2) TO (TSI TERM. 29)
ON TSI - CUT STRAPS BETWEEN 40 TO 44 AND 37 TO 41
ON TSI - STRAP TERM. 44 TO 47, 41 TO 45, 32 TO 36, AND 29 TO 33

POWERING OPTIONS	TERMINAL STRIP (TSI)	POWER SELECTOR SCREWS
SEND SEALING CURRENT TOWARD (A)	STRAP 30 TO 34 AND 50 TO 54	ALL OPEN
SEND SEALING CURRENT TOWARD (B)	STRAP 31 TO 35 AND 51 TO 55	ALL OPEN
RECEIVE SEALING CURRENT FROM (A)		CLOSE S2 ALL OTHERS OPEN
RECEIVE SEALING CURRENT FROM (B)		CLOSE S6 ALL OTHERS OPEN

Fig. 6 — Powering Arrangement When WLR-2 is Powered by the 22-Volt Pole-Mounted Power Plant J86463A

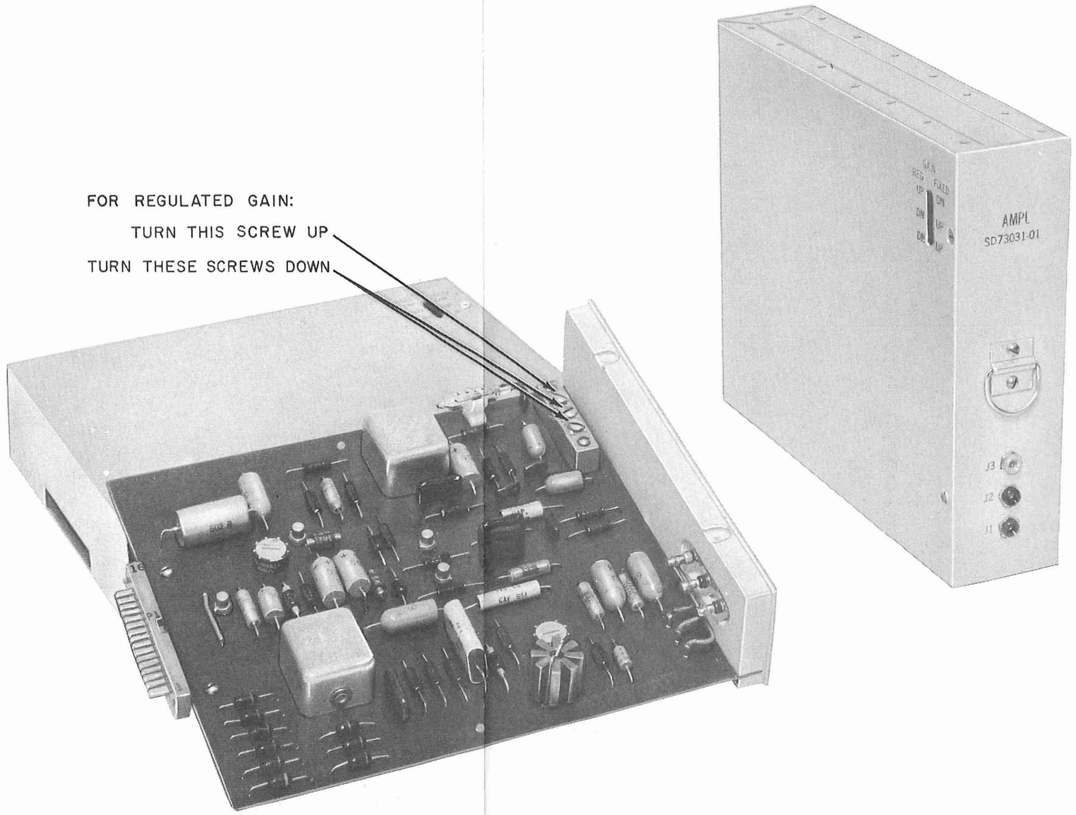
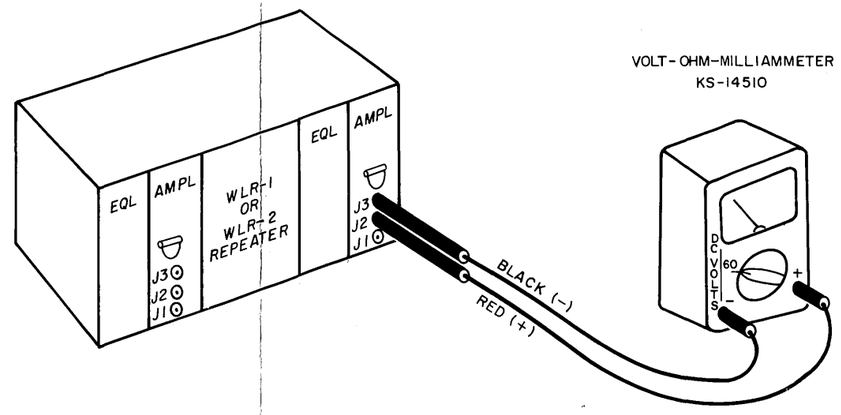
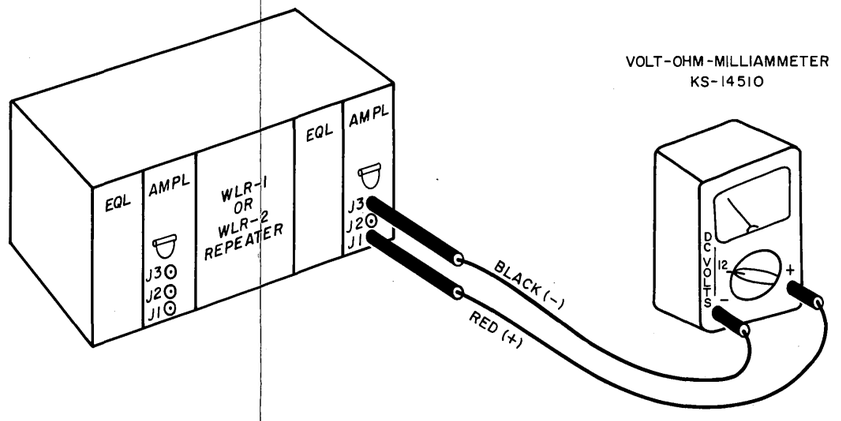


Fig. 7 — Regulating Amplifier J70159C



AMPLIFIER SUPPLY VOLTAGE MEASUREMENT

Fig. 8 — Amplifier Supply Voltage Measurement



AMPLIFIER BIAS VOLTAGE MEASUREMENT

Fig. 9 — Amplifier Bias Voltage Measurement

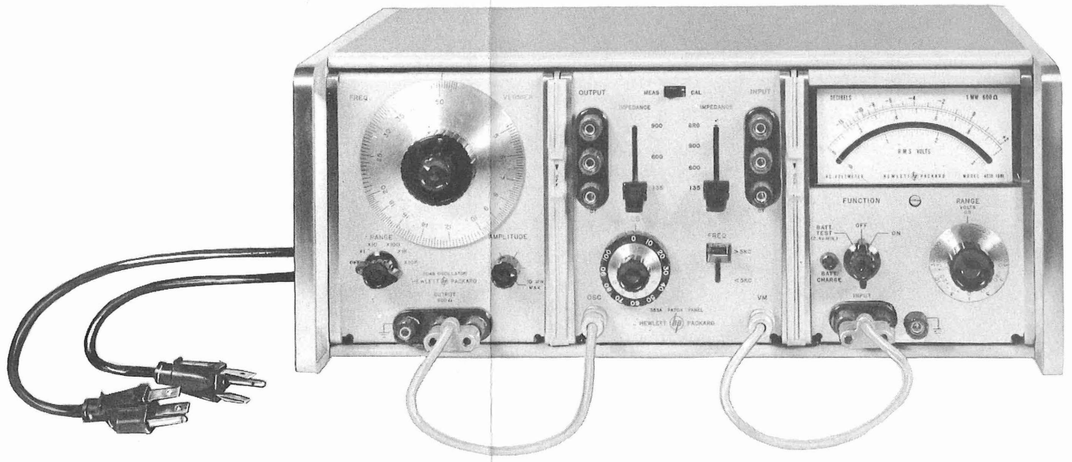


Fig. 10 — Hewlett-Packard 3550A Portable Test Set