
**L4 CARRIER
REPEATERS
TESTS
RECEIVING REPEATER J68877AN**

This section contains procedures for performance and preinstallation tests of receiving repeater J68877AN (SD-50671). Performance tests are to ensure that repeaters received from the manufacturer operate correctly and to check that repeaters suspected of being faulty are actually defective. Preinstallation tests are to prepare a repeater for a specific location in an L4 or **L4S** system. After installation, the gain of List 2 and List 3 repeaters is adjusted in the pilot-off condition.

This section is reissued to correct errors, revise Table C, and add Figure 5. Arrows are used to indicate significant changes. **Equipment Test Lists are not affected.**

Note: Those L4 main stations using repeater test set J68899A should retain Issue 3 of this section for reference.

A receiving repeater (Fig. 1) provides the following:

- (a) **Gain** to compensate for approximately one-half the loss of 2 miles of coaxial line from the preceding basic repeater
- (b) **Temperature post-regulation** to correct for approximately one-half the line loss variations caused by changes in cable temperature in the regulating section preceding the repeater
- (c) **Fixed deviation equalization** to compensate for predictable gain deviations resulting from a number of basic repeaters in tandem
- (d) **LBO (line building-out) connections** for LBO networks to build out short lengths of coaxial line to the nominal 2-mile spacing between repeaters.

Receiving repeaters are provided in three list numbers (Fig. 2) which differ as follows:

List 1: Original receiving repeater in which the gain increases upon loss of the 11.648-MHz pilot

List 2: Same as List 1, except the gain does not change upon loss of the 11.648-MHz pilot

List 3: Same as List 2, except the amplifiers more closely match the loss of the coaxial line and have an improved gain response at the low end of the L4 band.

NOTICE

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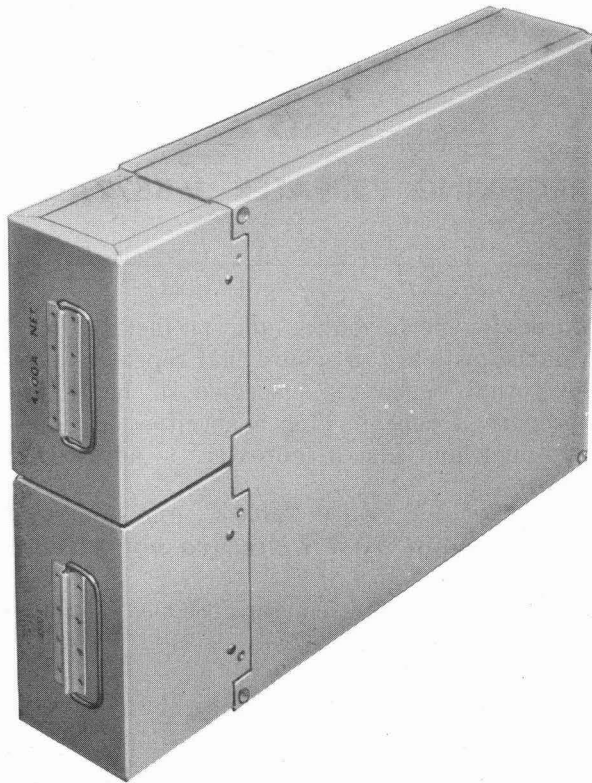


Fig. 1—Receiving Repeater J68877AN

Performance tests in Chart 1 include gain measurements at five frequencies in the L4 band, regulating range test by measuring changes in repeater gain as 11.648-MHz pilot power is changed, and pilot-off regulating test by measuring the voltage across test points on the repeater.

Note: Remove the deviation equalizer and LBO networks from repeaters to be returned for repair.

Preinstallation tests in Chart 2 include installation of appropriate LBO networks and measurement of gain at 12 MHz.

Pilot-off regulating adjustment in Chart 3 is made after the repeater is installed.

Note: The results of the tests in this section will not be conclusive unless the repeater to be tested has been allowed to warm for approximately 2 hours. After being preheated, the repeater should not be downpowered for more than 3 minutes, and then should be heated for at least 5 minutes in the test set.

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CHART 1

PERFORMANCE TESTS

Operation of the L4 line repeater test set should be verified as prescribed in Section 103-458-100 (J68906B) or Section 103-458-101 (J68906C) before proceeding with these tests. The J68906B test set is shown in Fig. 3; test arrangements are shown in Fig. 4. For transmission measurements, sending and receiving test equipment normally provided at the L4 main station is used.

Caution: *The requirements in this section assume that the test set 11.648-MHz pilot oscillator has been adjusted to supply 11.648 MHz $\pm$ 50 Hz at -55.20 dBm at the input to the repeater under test.*

APPARATUS:

L4 line repeater test set J68906B or J68906C

Precision attenuator adjustable from 0 to 50 dB in 0.1-dB steps

Sending and receiving transmission test equipment provided at L4 main station

Volt-ohm-milliammeter (VOM) capable of measuring dc voltages between 0.03 and 0.3 volt

4100A LBO network

CHART 1 (Cont)

APPARATUS(Cont):

*4100M LBO network**4152A deviation equalizer* (test standard used with List 1 and List 2 repeaters)*4152B deviation equalizer* (test standard used with List 3 repeaters)*959A equalizer* (similar to 4100M LBO network)

Note: Mark the LBO and deviation equalizer networks as **test** units and retain at the test set for use in all receiving repeater tests.

STEP	PROCEDURE
A. Preparation for Tests	
<i>Prepare repeater</i>	
1	Place the repeater (Fig. 5) so that jack J3 is near your right hand and remove the cover which is on top.
2	Remove the regular deviation equalizer, if one is installed, and retain for reinstallation.
	Note: The deviation equalizer is mounted in the corner near jack J3.
3	Install a test standard deviation equalizer as follows: (a) For a List 1 or List 2 repeater, use a 4152A deviation equalizer. (b) For a List 3 repeater, use a 4152B deviation equalizer.
4	Replace the repeater cover.
5	Install LBO networks as follows: (a) In LBO1 position, use a 4100A (0-dB loss) network for all receiving repeaters. (b) In LBO2 position, use a 4100M (6-dB loss) network or use a 959A (6-dB loss) network as indicated in Table C.
	Note: A 959A network is preferred for the LBO2 position on a receiving repeater.

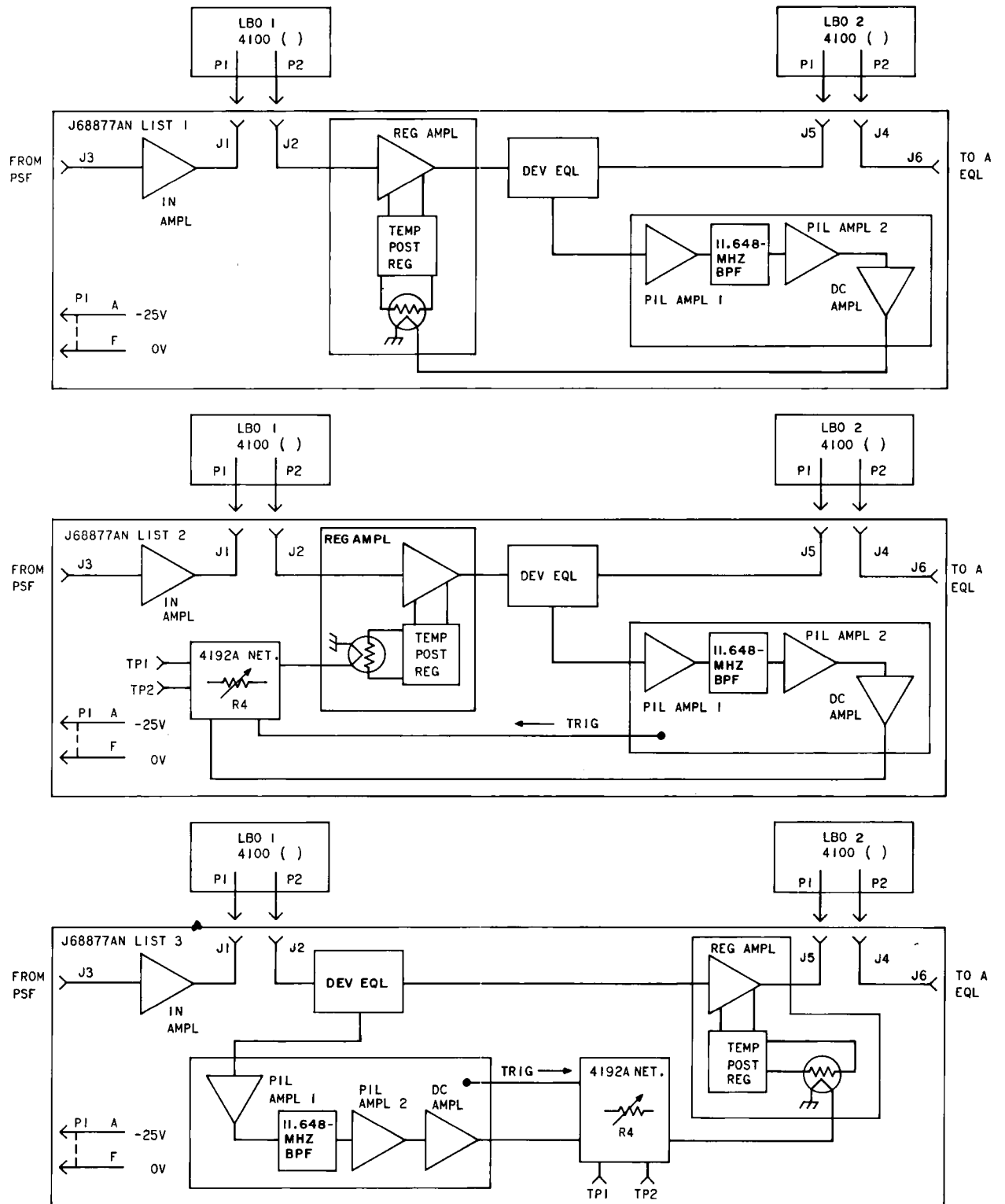


Fig. 2—Receiving Repeater Block Diagrams

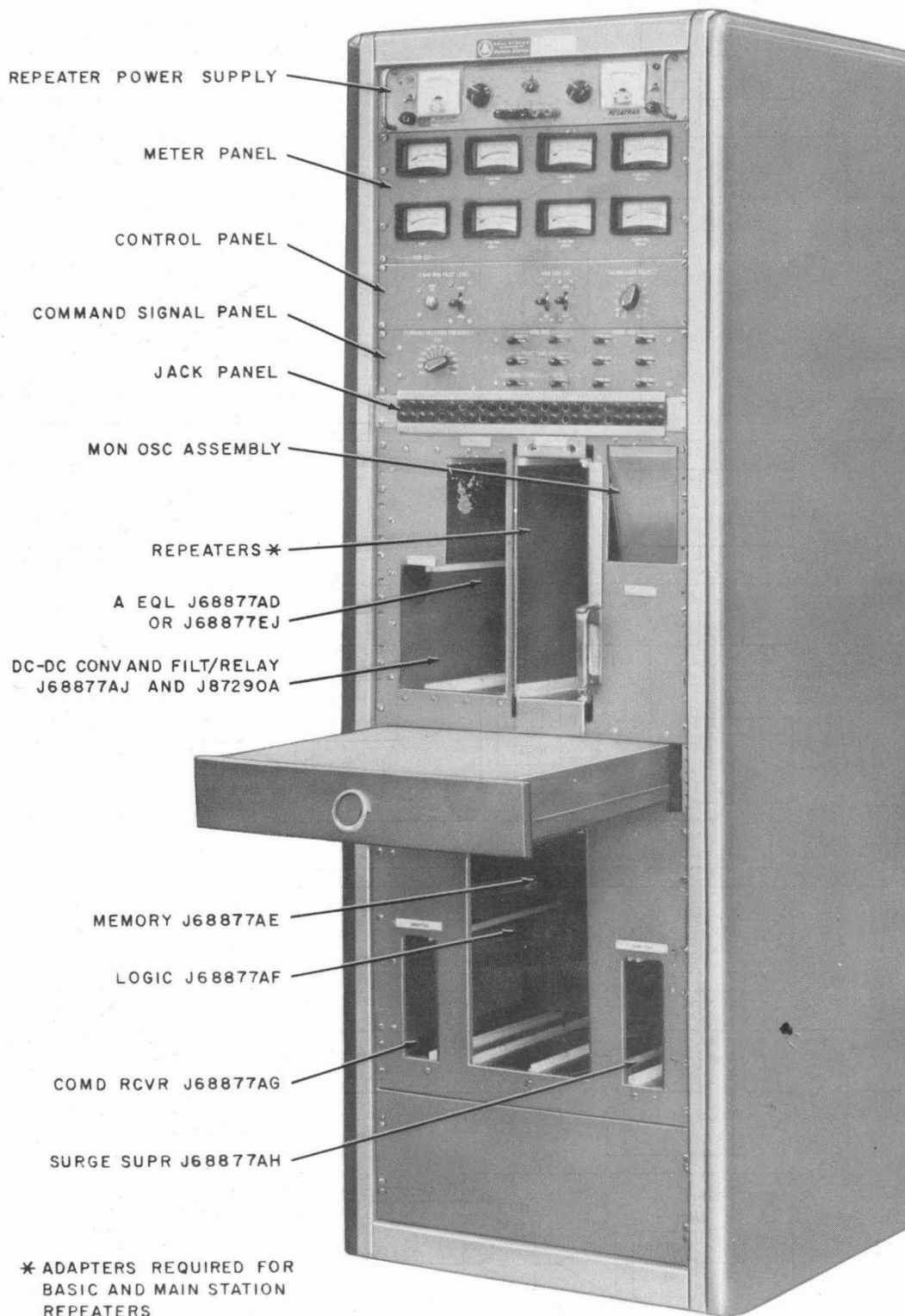


Fig. 3—L4 Line Repeater Test Set J68906B

CHART 1 (Cont)

STEP

PROCEDURE

- 6 Place the repeater on a flat surface and mount test adapter ED-50876-32 on the repeater.

Note: This adapter is furnished with the test set.

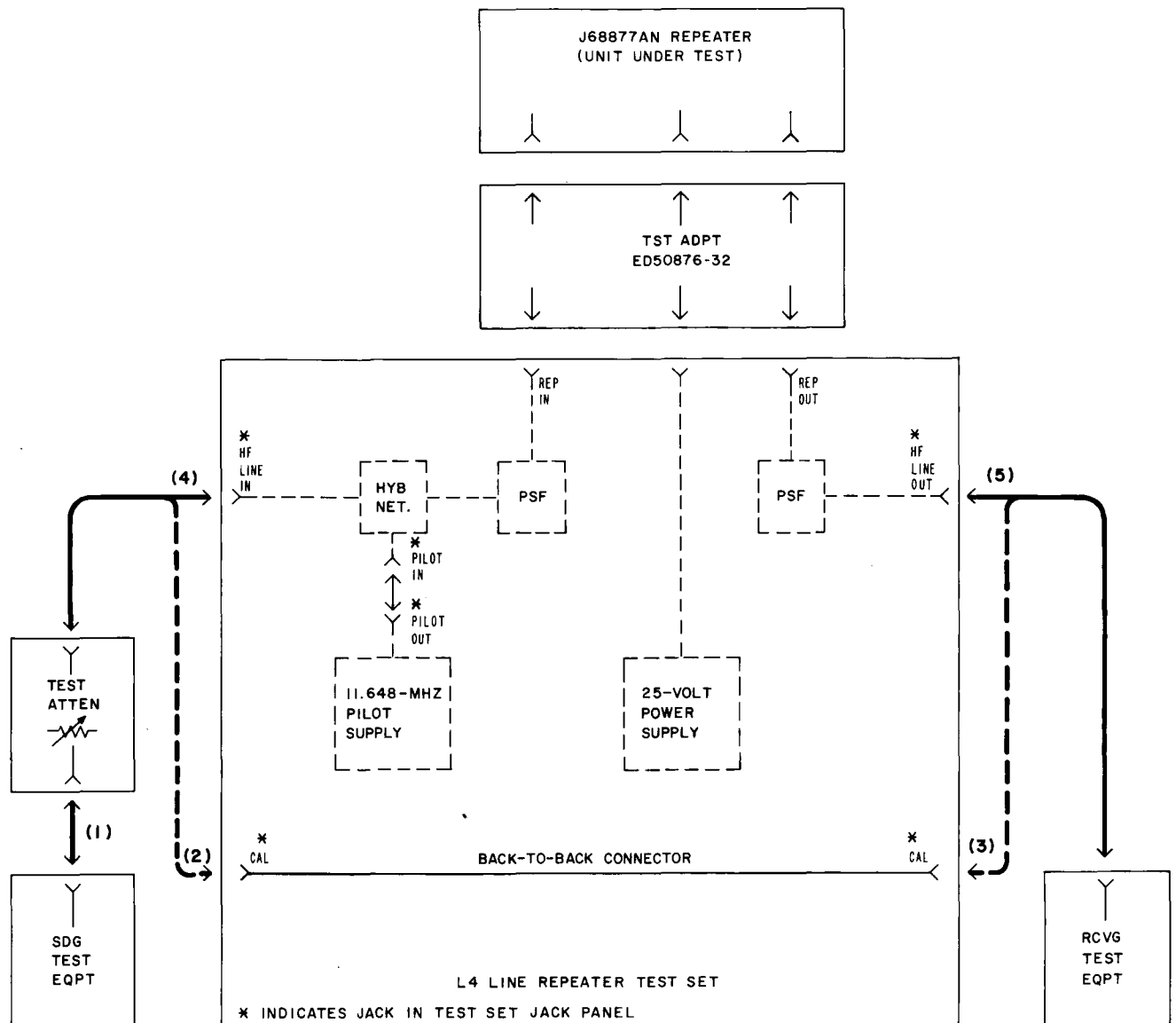


Fig. 4—Test Arrangements Using L4 Line Repeater Test Set

CHART 1 (Cont)

STEP

PROCEDURE

Prepare test set

- 7 Set the COMMAND TONES key on the command signal panel to OFF.
- 8 Set the 11.648-MHz PILOT LEVEL key on the control panel to NORM.
- 9 Insert a patch plug between the PILOT OUT and PILOT IN jacks on test set jack panel.
- 10 Set the PWR switch at rear of test set to ON.

Requirement: Power-on indicator lamp lights.

- 11 Set the DC switch and the LINE switch on repeater power supply panel to OFF.

Warning: The line repeater power supply must be OFF or the repeater will be damaged.

- 12 Install receiving repeater J68877AN with test adapter in the test set mounting position marked J68877AB or AC.

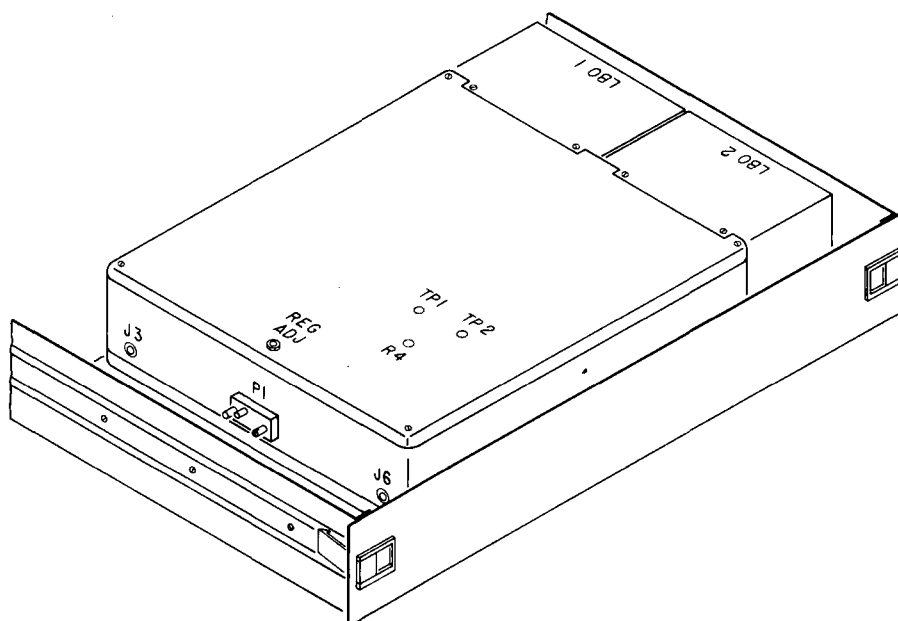


Fig. 5—Receiving Repeater

CHART 1 (Cont)

STEP	PROCEDURE
B. Gain Test	
13	Obtain from the test set calibration records the test set loss at each of the frequencies listed in Fig. 6. Record these values in column D of Fig. 6.
14	Patch the sending test equipment (STE) output through the test attenuator and back-to-back connector to the receiving test equipment (RTE) [patches (1), (2), and (3), Fig. 4]. Note: The CAL jacks on the test set jack panel are connected to form a back-to-back connector.
15	Set the attenuator to 0.00 dB. Note: For 0.512 MHz, use 10.00 dB.
16	Adjust the STE to deliver 20.448 MHz at the power necessary to obtain a -20.00 dBm indication on the RTE.
17	Set the test attenuator to provide a loss approximately equal to the repeater maximum gain shown in column C of Fig. 6.
18	Transfer the attenuator output from the CAL jack to the HF LINE IN jack [patch (4), Fig. 4].
19	Transfer the RTE from the CAL jack to the HF LINE OUT jack [patch (5), Fig. 4].
20	Adjust the attenuator to obtain, as near as possible, a -20.00 dBm indication on the RTE. Note: When making gain measurements, the attenuator should be adjusted so that the receiving test equipment expanded scale indication is in the +dB range. This will aid in computing gain values.
21	Record the attenuator setting and RTE expanded scale indication in columns E and F of Fig. 6.
22	Compute the repeater gain, using values from Fig. 6, as shown in Example 1 .

Example 1:

Test set loss from column D	= 3.97 dB
Plus attenuator setting from column E	= 12.10 dB
Plus RTE expanded scale indication from column F	= <u>0.08 dB</u>
Repeater gain	= 16.15 dB

RECEIVING REPEATER J68877AN

DATE OF TEST _____			BY _____		REPEATER SERIAL NO. _____	
A	B	C	D	E	F	G
TEST FREQ (MHZ)	REQUIRED GAIN (DB)		TEST SET LOSS (DB)	FINAL ATTEN SETTING (DB)	RTE EXPANDED SCALE (DB)	REPEATER GAIN (D+E+F)
	MIN	MAX				
<i>List 1 or List 2 Repeater</i>						
20.448	15.70	17.30				
17.500	15.00	16.00				
12.000	12.00	12.40				
4.000	6.85	7.45				
0.512	-0.34	+0.26				
<i>List 3 Repeater</i>						
20.448	14.35	15.95				
17.500	13.84	14.84				
12.000	12.02	12.42				
4.000	7.28	7.98				
0.512	-0.43	+0.17				
Remarks:						

Fig. 6—Performance Test Record

 CHART 1 (Cont)

STEP

PROCEDURE

Note: Record the repeater gain in column G of Fig. 6.

Requirement: Gain is within minimum and maximum values in columns B and C of Fig. 6.

23 Repeat Steps 14 through 22 for each of the other frequencies listed in Fig. 6.

Note: When measuring gain at 0.512 MHz, substitute the following for Steps 15 and 22:

Step 15: Set the test attenuator for 10-dB loss.

Step 22: To determine repeater gain, add -10 dB to the value computed.

Example 2:

Repeater gain at 0.512 MHz computed in Step 22 = 9.90 dB

Plus -10.00 dB attenuator gain = -10.00 dB

Repeater gain = -0.10 dB

C. Regulating Range Test

24 Measure the repeater gain at 12 MHz as in Steps 14 through 22 and **record** the test attenuator setting.

25 Set the 11.648 MHz PILOT LEVEL key on test set control panel to +3DB.

Requirement: RTE indicates a decreasing power.

26 Allow a minimum of 2 minutes for the regulating action to stabilize and then adjust the attenuator to obtain an exact -20.0 dBm indication on the RTE.

Requirement: Attenuator setting is between 2.65 and 3.00 dB below the value recorded in Step 24.

27 Set the 11.648 MHz PILOT LEVEL key to -3DB.

Requirement: RTE indicates an increasing power.

28 Allow a minimum of 2 minutes for the regulating action to stabilize and then adjust the attenuator to obtain an exact -20.0 dBm indication on the RTE.

Requirement: Attenuator setting is between 2.65 and 3.00 dB above the value recorded in Step 24.

CHART 1 (Cont)

STEP	PROCEDURE
29	Set the 11.648 MHz PILOT LEVEL key to NORM.
30	Allow time for the regulating action to stabilize and then adjust the attenuator to obtain an exact -20.0 dBm indication on the RTE. Requirement: Attenuator setting is within ± 0.2 dB of the setting recorded in Step 24.
	D. Pilot-Off Regulating Test (List 2 and List 3 Repeaters)
31	Prepare the VOM to measure DC volts in a range between 0.0 and 0.3 volt.
32	Measure and record the voltage between test points TP1 (-) and TP2 (+) on the repeater. Note: TP1 and TP2 are accessible through holes in the repeater cover.
33	Remove the patch plug between the PILOT OUT and PILOT IN jacks in the test set jack panel.
34	Measure the voltage between test points TP1 and TP2. Requirement: Same as the voltage recorded in Step 32.
35	Adjust control R4, if required, to meet the requirement. Note: Control R4 is accessible via a hole in the repeater cover near TP1 and TP2.
36	Insert a patch plug between the PILOT OUT and PILOT IN jacks. Requirement: No change in voltage across TP1 and TP2.
37	Remove VOM. E. Restoring Repeater to Normal
38	Remove repeater from test set and remove the test adapter.
39	Remove the LBO networks.
40	Proceed to Chart 2 if the repeater is to be prepared for installation at a particular location. Otherwise, proceed to Step 41.
41	Remove the repeater cover.
42	Remove the test standard deviation equalizer.
43	Install the regular deviation equalizer removed in Step 2.

CHART 1 (Cont)

STEP	PROCEDURE
44	Replace the repeater cover.
45	Store the repeater in accordance with local procedures.

CHART 2

PREINSTALLATION TESTS

As a prerequisite to preparing a repeater for installation at a specific location in the L4 system, the repeater must have met the requirements of the tests in Chart 1 of this section.

Preparation of a receiving repeater for installation at a particular location includes the following:

- (a) Installation of required LBO networks
 - (b) Measurement of repeater gain at 12 MHz.
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APPARATUS:

L4 line repeater test set J68906B or J68906C

Sending and receiving transmission test equipment provided at L4 main station

Precision attenuator adjustable from 0 to 50 dB in 0.1-dB steps

4100A LBO network

4100M LBO network

959A equalizer (similar to 4100M LBO network).

STEP	PROCEDURE
A. Preparation for Tests	
<i>Prepare repeater</i>	
1	Ensure that the repeater is equipped with the correct deviation equalizer.
Note: See Table A for correct deviation equalizer.	

CHART 2 (Cont)

STEP

PROCEDURE

- 2 Install a 4100A LBO network in LBO1 position and a 4100M LBO network in LBO2 position.
- 3 Place the repeater on a flat surface and mount test adapter ED-50876-32 on the repeater.

Prepare test set

- 4 Set the COMMAND TONES key on command signal panel to OFF.
- 5 Set the 11.648 MHz PILOT LEVEL key on control panel to NORM.
- 6 Remove the patch plug between the PILOT OUT and PILOT IN jacks on the test set jack panel.
- 7 Set the PWR switch at rear of test set to ON.

Requirement: Power-on indicating lamp lights.

- 8 Set the DC switch and the LINE switch on repeater power supply panel to OFF.

Warning: The line repeater power supply must be OFF or the repeater will be damaged.

- 9 Install receiving repeater J68877AN with test adapter in the test set mounting position marked J68877AB or AC.

B. Regulator Adjustment

- 10 Connect the STE output through the test attenuator and back-to-back connector to the RTE [patches (1), (2), and (3), Fig. 4].

TABLE A

DEVIATION EQUALIZERS FOR RECEIVING REPEATERS

SYSTEM	REPEATER	DEVIATION EQUALIZER	SEE SD-50671-01
L4	List 1 and List 2	F57825 or 963A	Note 113
	List 3	943F	
L4S	List 3	943F, 943H, or 943J	Note 112

CHART 2 (Cont)

STEP	PROCEDURE								
11	Set the test attenuator to 0.0 dB and adjust the STE to deliver a 12.0-MHz signal at the power necessary to obtain an exact -20.0 dBm indication on the receiving test equipment.								
12	Set the test attenuator to 11.5 dB.								
13	Transfer the test attenuator from the CAL jack to the HF LINE IN jack [patch (4), Fig. 4].								
14	Transfer the receiving test equipment from the CAL jack to the HF LINE OUT jack [patch (5), Fig. 4].								
15	Adjust the attenuator to obtain, as near as possible, a -20.00 dBm indication on the RTE; then record the attenuator setting and the RTE expanded scale indication.								
	Note: When making gain measurements, the attenuator should be adjusted so that the receiving test equipment expanded scale indication is in the +dB range. This will aid in computing gain values.								
16	Compute the repeater gain with test LBO networks as shown in Example 3 .								
	Example 3:								
	<table> <tr> <td>Test set loss at 12 MHz</td><td>= 3.95 dB</td></tr> <tr> <td>Plus attenuator setting in Step 15</td><td>= 11.00 dB</td></tr> <tr> <td>Plus RTE expanded scale indication in Step 15</td><td>= <u>0.03 dB</u></td></tr> <tr> <td>Repeater gain with test LBO networks</td><td>= 14.98 dB</td></tr> </table>	Test set loss at 12 MHz	= 3.95 dB	Plus attenuator setting in Step 15	= 11.00 dB	Plus RTE expanded scale indication in Step 15	= <u>0.03 dB</u>	Repeater gain with test LBO networks	= 14.98 dB
Test set loss at 12 MHz	= 3.95 dB								
Plus attenuator setting in Step 15	= 11.00 dB								
Plus RTE expanded scale indication in Step 15	= <u>0.03 dB</u>								
Repeater gain with test LBO networks	= 14.98 dB								
	Note: The combined loss of the 4100A and 4100M test LBO networks is 6 dB.								
	Requirement: Repeater gain is 15.4 $\pm$ 1.0 dB for List 1 repeater and 12.40 $\pm$ 0.25 dB for List 2 and List 3 repeaters.								
17	Adjust control R4 on List 2 or List 3 repeater to meet the requirement.								
18	Install the required LBO networks in LBO1 and LBO2 positions.								
	Note: Refer to office records for the required LBO networks for the location in which the repeater is to be installed.								
19	Adjust the attenuator to obtain, as near as possible, a -20.00 dBm indication on the RTE; then record the attenuator setting and RTE expanded scale indication.								
20	Compute the overall repeater gain with required LBO networks as shown in Example 4 .								

CHART 2 (Cont)

STEP	PROCEDURE
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Example 4:

Test set loss at 12 MHz from Fig. 6 = 3.95 dB

Plus attenuator setting in Step 19 = +8.68 dB

Plus expanded scale indication in Step 19 = +0.03 dB

Overall repeater gain at 12 MHz = 12.66 dB

- 21 Compute the **total** repeater gain with required LBO networks as shown in **Example 5**.

Example 5:

Overall repeater gain at 12 MHz from Step 20 = 12.66 dB

Plus combined loss of required LBO networks (see **Note**) = 8.74 dB

Total repeater gain with required LBO networks = 21.40 dB

Note: This example assumes a 4100AC network with 2.74-dB loss in position LBO1 and a 4100M network with 6-dB loss in position LBO2. Refer to Tables B and C for loss values of required LBO networks at 12 MHz.

- 22 Compute the **net** repeater gain with required LBO networks as shown in **Example 6**.

Example 6:

Total repeater gain with required LBO networks from Step 21 = 21.40 dB

Minus combined loss of test LBO networks used in Step 16 = -6.00 dB

Net repeater gain at 12 MHz = 15.40 dB

Requirement: Net repeater gain is within ± 0.5 dB of the repeater gain computed in Step 16.

Note: In the examples given, the net repeater gain with required LBO networks in Step 22 (15.40 dB) is within ± 0.5 dB of the repeater gain with test LBO networks computed in Step 16 (14.98 dB).♦

C. Preparing Repeater for Installation

- 23 Remove the repeater from the test set and remove the test adapter.

TABLE B

NETWORKS FOR LBO1 POSITION

NETWORK	LOSS AT 12 MHZ (DB)	BUILD-OUT DISTANCE (MILES)
4100A	0.00	0.0
4100AC	2.74	0.2
4100AD	4.11	0.3
4100AE	5.48	0.4
4100AF	6.85	0.5
4100AG	8.22	0.6
4100AH	9.59	0.7
4100AJ	10.96	0.8
4100AK	12.33	0.9
4100AL	13.70	1.0

◆TABLE C◆

NETWORKS FOR LBO2 POSITION

RECEIVING REPEATER	SYSTEM	OPTION R (MD)	OPTION S (STD)	NO. OF REGULATING AND EQUALIZING REPEATERS IN MAIN SECTION	NETWORK LOSS AT 12 MHZ (DB)
List 1 and List 2	L4	4100M	4100M	2 or less	6.0
		F-57557	F-57957	3 to 5	5.6
		F-57556	F-57956	6 to 8	5.2
		F-57539	F-57949	9 or more	4.8
List 3			959A		6.0
				MAIN SECTION LENGTH IN MILES	
List 3	L4S		4100M	Up to 28	6.0
			959A	28 to 48	

CHART 2 (Cont)

STEP	PROCEDURE
24	Place a gummed label, similar to the one shown in Fig. 7, on the repeater.
	Note: Form ST-1 may be ordered in rolls of 500 or 1000 from: Chambers, Inc. 2171 Hawkins Street Charlotte, North Carolina 28203.
25	Enter the applicable information for the items marked by an asterisk (*) on the form.

FORM ST-1 8 67	
TYPE *	SER. NO. *
IN SERVICE *	LOCATION *
OUT SERVICE	TUBE *
GP	db D.E. TYPE
LBO #1 *	LBO #2 *
STRAP	PORTS 1 & 3 2 & 4
REASON OUT	

Fig. 7—Equipment Identification Tag

CHART 3

PILOT-OFF REGULATING ADJUSTMENT

Note: This procedure is applicable to the List 2 and List 3 receiving repeaters. List 2 and List 3 repeaters are equipped with a gain adjustment which permits the repeater gain to be adjusted in the pilot-off condition. This adjustment is made to minimize transmission level changes which otherwise could occur with the loss of the 11.648-MHz pilot. This adjustment is made at the time of installation and again during May or November when the cable is at the mean annual temperature. Once the adjustment is made at the mean annual cable temperature, no further adjustment should be necessary.

This procedure assumes that the repeater has been installed and powered and that the L4 line is stabilized and normal.

A 12-MHz signal is inserted at the far main station LOOP SIG IN jack. The 12-MHz signal power is measured at the near main station RCVG LINE TST jack. Then the 11.648-MHz pilot is removed at the far main station. The repeater gain is adjusted to obtain a 12-MHz signal power which is the same as the value measured when the 11.648-MHz pilot was on the line.

CHART 3 (Cont)

If the repeater gain cannot be adjusted to the required value, the line section has defective equipment or an excessive gain deviation. The trouble can be isolated by comparing measured 11.648-MHz pilot power at line repeater locations to expected power. Gain deviations can usually be reduced or eliminated by changing LBO networks in the regulating sections affected.

STEP**PROCEDURE**

Caution: *The line must be manually switched out of service before performing this test.*

- 1 Check that the repeater and the line have been powered at least 30 minutes before proceeding with this test.

Note: *Near* main station refers to the main station at which the receiving repeater is to be tested. *Far* main station refers to the adjacent main station which is transmitting signals to the receiving repeater to be tested.

At near main station,

- 2 Record the indication of the 11.648-MHz pilot meter in the line receiving bay.

At far main station,

- 3 Remove the patch between the LOOP BACK OUT and LOOP SIG IN jacks in the line transmitting bay jack field.
- 4 ♦Apply a 12-MHz test signal at approximately -33.8 dBm to the LOOP SIG IN jack and measure the 12-MHz power at the TRMTG LINE TST jack.

Note: Adjust the 12-MHz test signal power until the signal power at the TRMTG LINE TST jack is -52.9 dBm.

At near main station,

- 5 Measure and record the power of the 12-MHz signal at the RCVG LINE TST jack in the line receiving bay jack field.

Note: Nominal power of the 12-MHz test signal at this jack is -40.0 dBm.♦

At far main station,

- 6 Remove the 11.648-MHz pilot by removing the patch plug between the HYB OUT A and LINE AMPL IN jacks in the line transmitting bay jack field.

CHART 3 (Cont)

STEP	PROCEDURE
	Note: These jacks are not provided in earlier bays. Remove the coaxial plug from the IN jack or from the OUT jack on the 266L amplifier in the hybrid panel. Take care that the coaxial plug does not short the power terminals on the amplifier.
7	Allow 15 minutes for the line gain to stabilize in the pilot-off condition. Note: With the pilot removed from the line, the receiving repeater and each regulating and equalizing repeater in the main section will regulate to the pilot-off gain value. At near main station,
8	Measure and record the power of the 12-MHz signal at the RCVG LINE TST jack. Requirement: Power is within ± 5.0 dB of the value recorded in Step 5.
9	Adjust control R4 on the receiving repeater, if required, to meet the requirement. Note: Since R4 is a multiturn control, several turns may be required. Allow the signal power to stabilize between adjustments. If the requirement cannot be met, excessive misalignment in the line section is indicated. Investigate and correct this misalignment. At far main station,
10	Restore the 11.648-MHz pilot by reinserting the patch plug between the HYB OUT A and LINE AMPL IN jacks or by replacing the plug removed from the amplifier jack.
11	Remove the test equipment at the near and far main stations.
12	Restore the patch plug between the LOOP BACK OUT and LOOP SIG IN jacks in the line transmitting bay jack field. At near main station,
13	Note in office records, if the adjustment is made at a time when the cable is not at mean annual temperature, that this adjustment must be repeated during May or November when the cable is at mean annual temperature.
14	Observe the 11.648-MHz pilot meter. Requirement: Meter indication is within ± 0.3 dB of the indication recorded in Step 2.
15	Restore the line to service in accordance with established procedures.