
**L4 CARRIER
REPEATERS
TESTS
TRANSMITTING REPEATER J68877AM**

This section contains procedures for performance and preinstallation tests of transmitting repeater J68877AM (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 the L4 system.

This section is reissued to add reference to test set J68906C which may be provided at L4S (short L4) main stations, to correct errors, and to delete procedures for test set J68899A (Section 103-457-000) which is manufacture discontinued.

Note: Those L4 main stations using the J68899A test set should retain Issue 4 of this section for reference.

In-service adjustment procedures for main station repeaters are in Section 359-205-504. Periodic adjustment of the transmitting repeater regulator is required to compensate for cable temperature changes during the year.

Due to the general revision, arrows are not used to indicate changes. ***Equipment Test Lists are affected.***

A transmitting repeater (Fig. 1 and 2) provides

- (a) ***Gain*** to compensate for approximately half the loss of two miles of coaxial line to the first basic repeater.
- (b) ***Temperature preregulation*** to correct for approximately one-half the line loss variations caused by changes in cable temperature in the regulating section following 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 line repeaters.

Performance tests in Chart 1 include

- (a) Gain measurements at five frequencies in the L4 band.
- (b) Regulator adjustment for nominal gain, if necessary.

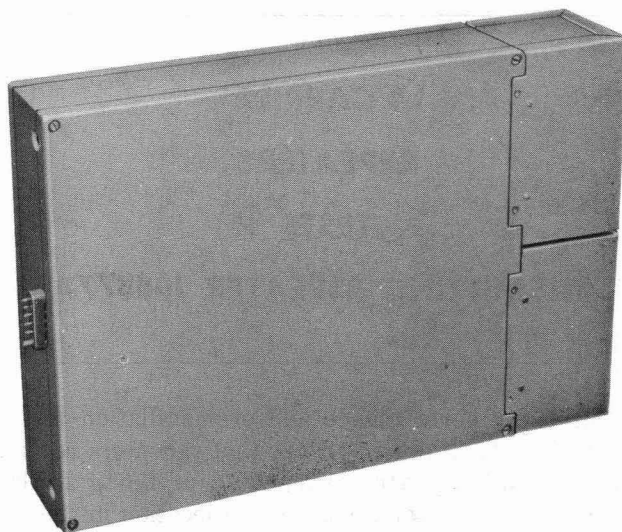
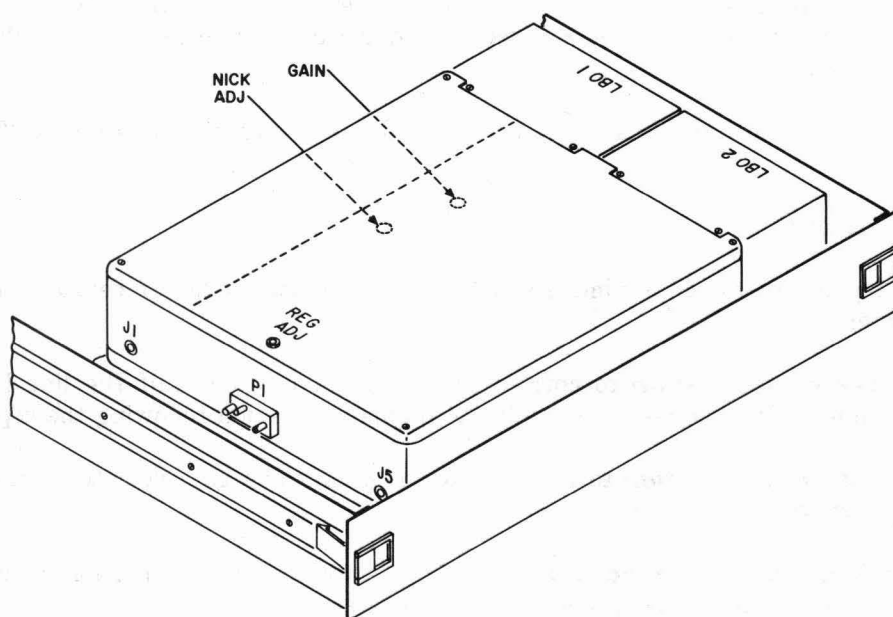


Fig. 1—Transmitting Repeater J68877AM



INSTALLATION ACCESS: FRONT OF BAY
TEST ACCESS: FRONT OF BAY
WEIGHT: APPROXIMATELY 17 POUNDS

CONNECTIONS:

TYPE	SHELF	TO	UNIT
COAXIAL	P12	TO	J5
MULTIPIN	J11	TO	P1
COAXIAL	P7	TO	J1

Fig. 2—Transmitting Repeater Controls

Preinstallation tests in Chart 2 include

- (a) Installation of required LBO networks.
- (b) Adjustment of regulator gain for the location in which the repeater is to be installed.

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

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CHART 1

PERFORMANCE TESTS

Operation of L4 line repeater test set J68906B or J68906C should be verified as prescribed in Section 103-459-000 before proceeding with these tests. Test set J68906B is shown in Fig. 3; test arrangements are shown in Fig. 4. Figure 5 is a block diagram of the transmitting repeater. For transmission measurements, sending and receiving test equipment normally provided at the L4 main station is used.

Note: To facilitate adjustment of REG ADJ, GAIN, and NICK ADJ controls, access holes should be drilled in repeater mounting slot of test set J68906B.

APPARATUS

L4 Line Repeater Test Set J68906B or J68906C (Section 103-459-000)

REPEATER POWER SUPPLY

METER PANEL

CONTROL PANEL

COMMAND TONE PANEL

JACK PANEL

66-TYPE OSC AND
4103A NETWORK

J68877AA*,
AB, AC, AM*, AND AN*
REPEATER UNITS

J68877AD

J68877AJ AND J87290A

J68877AE

J68877AF

J68877AG

J68877AH

* ADAPTERS REQUIRED

Fig. 3—L4 Line Repeater Test Set J68906B

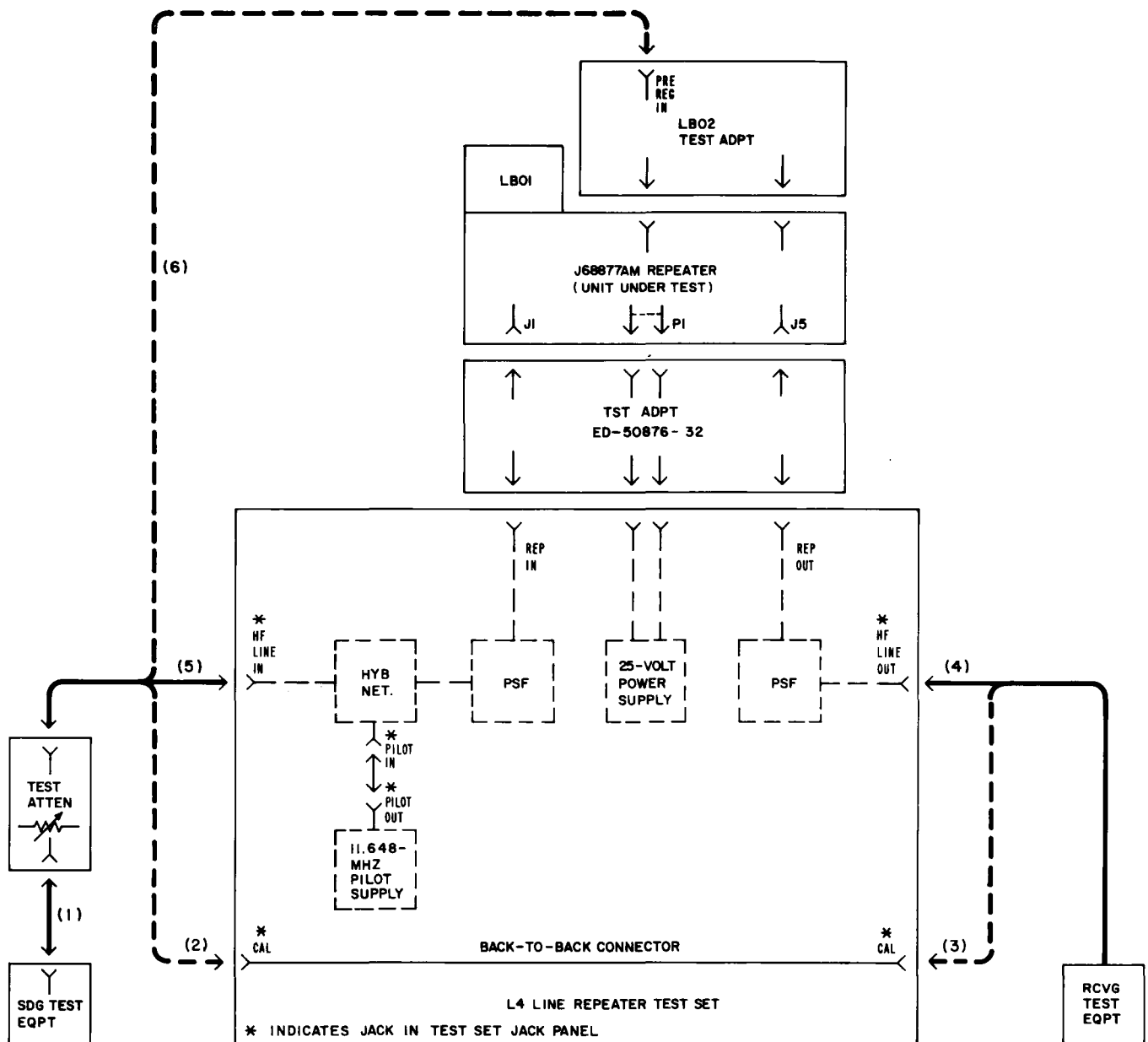


Fig. 4—Test Arrangements Using L4 Line Repeater Test Set

APPARATUS (Cont)

Precision Attenuator, adjustable from 0.0 to 50.0 dB in 0.1-dB steps

Sending and Receiving Transmission Test Equipment (provided at L4 main station)

4100A LBO Networks (2 required)

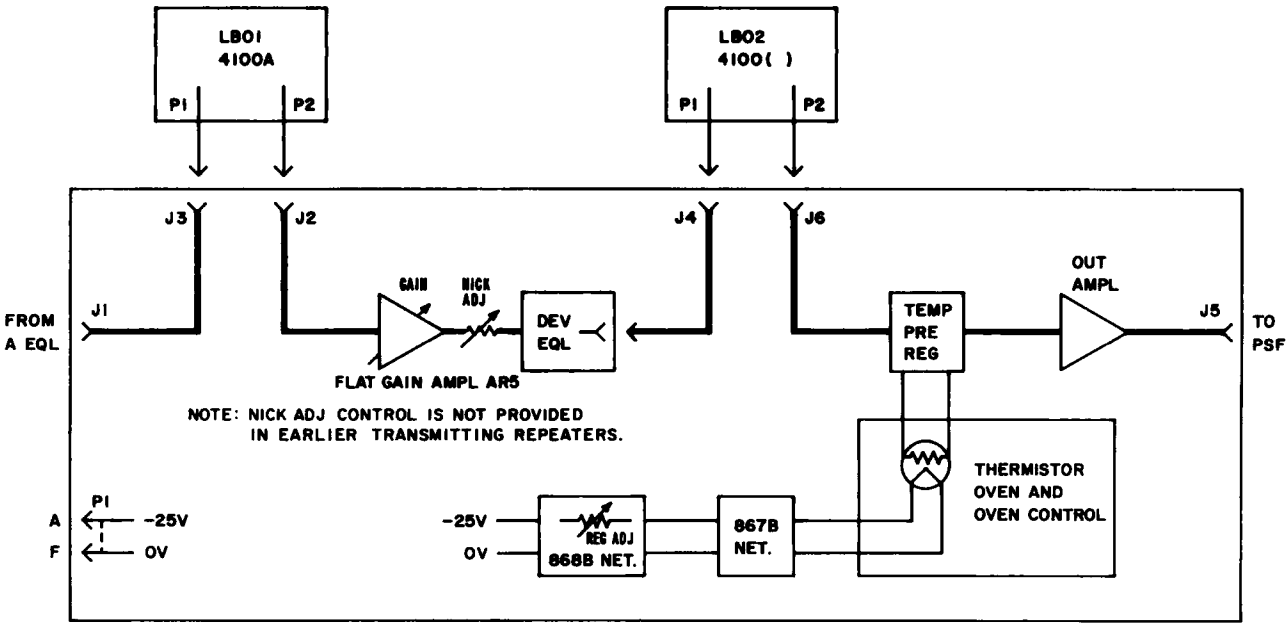


Fig. 5—Transmitting Repeater Block Diagram

APPARATUS (Cont)

4100B LBO Network

4152A Deviation Equalizer (test standard used with List 1 repeater)

4152B Deviation Equalizer (test standard used with List 2 repeater)

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

CHART 1 (Cont)

STEP	PROCEDURE
	Note 1: The results of these tests will not be conclusive unless the repeater has been powered and allowed to warm up for at least 2 hours. After being heated, the repeater should not be downpowered for more than 3 minutes, and then it should be heated for at least 5 minutes in the test stand. Note 2: 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.

 CHART 1 (Cont)

STEP

PROCEDURE

A. Preparation for Tests***Prepare repeater***

- 1 Place the repeater (Fig. 2) so that jack J1 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 J1.

- 3 Install a test standard deviation equalizer as follows:
 - (a) For a List 1 repeater, use a 4152A deviation equalizer.
 - (b) For a List 2 repeater, use a 4152B deviation equalizer.
- 4 Replace the repeater cover.
- 5 Install LBO networks as follows:
 - (a) For a List 1 repeater: use a 4100A in LBO1 position and a 4100B in LBO2 position.
 - (b) For a List 2 repeater: use a 4100A LBO in both LBO1 and LBO2 positions.
- 6 Place the repeater on its side on a flat surface and mount test adapter ED-50876-32 on the repeater.

Note: This adapter is furnished with the test set.

Prepare test set

- 7 Set the COMMAND TONES key, on command signal panel, to OFF.
- 8 Remove all patches from test set jack panel.
- 9 Set the PWR switch, at rear of test set, to ON.

Requirement: Power on indicator lamp lights.

- 10 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.*

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

CHART 1 (Cont)

STEP	PROCEDURE
12	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.
13	Proceed to Step 14 if the repeater under test has a NICK ADJ control. If the repeater under test does not have a NICK ADJ control and the regulator has not been adjusted since received from the manufacturer, proceed to Part C. If the repeater under test does not have a NICK ADJ control and the regulator has been adjusted since received from the manufacturer, proceed to Part D.

B. Alignment of Repeater With Nick Adjustment Control**Adjusting GAIN Control (4.000 MHz)**

- 14 Connect the sending test equipment (STE) through the 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 0.0 dB.
- 16 Adjust the STE to deliver a 4.000-MHz signal at the power necessary to obtain an exact -20.00 dBm indication on the RTE.
- 17 Set the test attenuator to: [(nominal gain at 4.000 MHz) - (test set loss at 4.000 MHz)].

Note: Nominal gain at 4.000 MHz is 9.89 dB in Fig. 6.

- 18 Transfer the RTE patch from the CAL jack to the HF LINE OUT jack [patch (4), Fig. 4].
- 19 Transfer the attenuator patch from the CAL jack to the HF LINE IN jack [patch (5), Fig. 4].
- 20 Adjust the GAIN control on the repeater to obtain a -20.00 dBm indication on the RTE.
- 21 Repeat Steps 14 and 15.

Adjusting REG ADJ Control (15.000 MHz)

- 22 Adjust the STE to deliver a 15.000-MHz signal at a power necessary to obtain an exact -20.00 dBm indication on the RTE.
- 23 Set the test attenuator to: [(nominal gain at 15.000 MHz) - (test set loss at 15.000 MHz)].

Note: Nominal gain at 15.000 MHz is 17.55 dB in Fig. 6.

- 24 Transfer the RTE from the CAL jack [patch (3), Fig. 4] to the HF LINE OUT jack [patch (4), Fig. 4].

TRANSMITTING REPEATER J68877AM

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 2 Repeater With NICK ADJ Control</i>						
20.448	20.71	18.71				
17.500	19.26	18.46				
15.000	17.60	17.50				
11.648	15.42	15.32				
4.000	9.94	9.84				
0.512	7.15	6.55				
<i>List 2 Repeater Without NICK ADJ Control</i>						
20.448	18.75	20.75				
17.500	18.46	19.26				
11.648	15.07	15.67				
4.000	9.32	9.92				
0.512	6.25	6.85				
<i>List 1 Repeater</i>						
20.448	18.40	20.40				
17.500	17.95	18.75				
11.648	14.80	15.40				
4.000	9.05	9.65				
0.512	6.30	6.90				
Preregulator Adjusted: Remarks:						

Fig. 6—Performance Test Record

CHART 1 (Cont)

STEP	PROCEDURE
25	Transfer the attenuator from the CAL jack [patch (2), Fig. 4] to the HF LINE IN jack [patch (5), Fig. 4].
26	Adjust the REG ADJ control to obtain a -20.00 dBm indication on the RTE.
27	Repeat the GAIN adjustment (Steps 14 through 21) and the REG ADJ adjustment (Steps 22 through 26) in sequence until requirements are met with no adjustment required.
	<i>Note:</i> Usually, no repetition is necessary if the regulator has been previously adjusted, but the gains should be checked.
	Adjusting NICK ADJ Control (11.648 MHz)
28	Repeat Steps 14 and 15.
29	Set the test attenuator to: [(normal gain at 11.648 MHz) $-$ (test set loss at 11.648 MHz)].
	<i>Note:</i> Nominal gain of List 2 repeater at 11.648 MHz is shown in Fig. 6 as 15.37 dB.
30	Adjust the NICK ADJ control to obtain a -20.00 dBm indication on the RTE.
	<i>Note:</i> The repeater gain is now at nominal value.
31	Proceed to Part C to check the gain at 20.448, 17.500, and 0.512 MHz.
	C. Gain Test
	<i>Note:</i> The regulator is adjusted at the factory for nominal gain. Preregulator adjustment should not be necessary on repeaters received from the manufacturer. If a repeater without a NICK ADJ control has been previously adjusted for installation at a particular location, perform the adjustment in Part D before this gain test. For a repeater with a NICK ADJ control, perform Part B before this gain test.
32	Connect the STE through the attenuator and back-to-back connector to the RTE [patches (1), (2), and (3), Fig. 4].
33	Set the attenuator to 0.0 dB.
34	Adjust the STE to deliver 20.448 MHz at a power necessary to obtain an exact -20.00 dBm indication on the RTE.
35	Set the test attenuator to provide a loss approximately equal to the repeater maximum gain shown in column C of Fig. 6.
	<i>Note:</i> This value is approximately 4 dB above expected final attenuator setting.

CHART 1 (Cont)

STEP	PROCEDURE
36	Transfer the RTE to the HF LINE OUT jack [patch (4), Fig. 4] and transfer the attenuator output to the HF LINE IN jack [patch (5), Fig. 4].
37	Adjust the attenuator to obtain, as near as possible, a -20.00 dBm indication on the RTE.
38	Record the attenuator setting and the RTE expanded scale indication in columns E and F of Fig. 6.
39	Compute repeater gain, using values from Fig. 6, as follows: Test set loss from column D: 4.03 dB Plus final attenuator setting from column E: 16.10 dB Plus RTE expanded scale from column F: 0.02 dB Repeater gain: 20.15 dB Note: Record the repeater gain in column G of Fig. 6. Requirement: Within minimum and maximum values in columns B and C of Fig. 6.
40	Repeat Steps 32 through 39 for each of the remaining frequencies listed in Fig. 6.
41	Proceed to Step 54 if the requirement of Step 39 is met for each frequency. Otherwise, proceed to Step 42.
D. Regulator Adjustment for Repeater Without Nick Adjustment Control	
	Note: See Note preceding Step 32.
42	Remove the LBO network from LBO2 position.
43	Install the LBO test adapter ED-51002-30 in LBO2 position.
44	Patch the STE through the attenuator and back-to-back connector to the RTE [patches (1), (2), and (3), Fig. 4.].
45	Set the attenuator to equal the loss of the LBO2 test adapter.
	Note: This loss is approximately 10 dB. The exact loss is stamped on the test adapter.
46	Adjust the STE to deliver an 11.648-MHz signal at the power necessary to obtain an exact -20 dBm indication on the RTE.
47	Transfer the output of the attenuator from the CAL jack to the PRE REG IN jack on the LBO2 test adapter [patch (6), Fig. 4].

CHART 1 (Cont)

STEP	PROCEDURE
48	Transfer the RTE from the CAL jack to the HF LINE OUT jack on the test set jack panel [patch (4), Fig. 4].
49	Set the attenuator to 8.63 dB, and observe the RTE for an 11.648-MHz signal power indication. Requirement: $-20.00 \text{ dBm} \pm 0.1 \text{ dB}$
50	Adjust the REG ADJ control, if required, to obtain a -20.00 dBm indication on the RTE. Note: After adjusting, wait for the repeater gain to stabilize and, if necessary, adjust again. The repeater gain can be considered stable when the power of the 11.648-MHz signal changes no more than 0.1 dB in one minute.
51	Remove the test adapter from LBO2 position.
52	Install appropriate LBO network in LBO2 position. (a) For a List 1 unit, use a 4100B LBO network. (b) For a List 2 unit, use a 4100A LBO network.
53	Perform the gain test in Part C. E. Restoring Repeater to Normal
54	Remove the repeater from the test set and remove the test adapter.
55	Remove the LBO networks.
56	Proceed to Chart 2 if the repeater is to be prepared for installation at a particular location. Otherwise, proceed to Step 57.
57	Remove the repeater cover.
58	Remove the test standard deviation equalizer.
59	Install the regular deviation equalizer removed in Step 2.
60	Replace the repeater cover.
61	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 transmitting repeater for installation at a particular location includes:

- (a) Installation of required LBO networks.
- (b) Adjustment of repeater gain for the location in which the repeater is to be installed.

The transmitting repeater regulator is manually adjusted periodically as the temperature changes (Section 359-205-504). Included are procedures for adjusting the repeater gain to the required value for a particular time of installation.

The required repeater gain is controlled by three factors:

- (a) Code of the LBO2 network required
- (b) Mean annual ground temperature of the buried cable and the time of year
- (c) Cable length in miles to the first regulating repeater.

The variations in required repeater gain due to factors (b) and (c) above are shown in curves 1 through 6 of Fig. 8.

STEP
PROCEDURE

Note: Repeaters with a NICK ADJ control must be set for nominal gain at 11.648 MHz before proceeding. Perform the nick adjustment in Part B of Chart 1.

A. Preparation for Tests

Determine required gain

- 1 Determine the ***required*** repeater gain at the 11.648-MHz pilot frequency for the particular time and location in accordance with the following example.

Note: Required repeater gain equals nominal repeater gain minus loss of LBO2 plus/minus seasonal gain deviation from nominal.

Example:

Assume a location where a 4100F LBO network is required, the mean annual ground temperature is 40° to 45°F, the time for installation is August, and the distance to the next regulating repeater is 10 miles. Then, required repeater gain = 16.45 dB* - 6.78 dB† + 1.3 dB‡ = 10.97 dB.

CHART 2 (Cont)

STEP

PROCEDURE

* Repeater gain when equipped with 0-dB loss LBO networks is:

For a List 1 repeater: 16.45 dB

For a List 2 repeater: 15.37 dB

† The required LBO2 network depends on the required build-out distance. See office records for network required and Table A for network loss.

‡ Seasonal gain deviation from nominal is obtained from the appropriate seasonal gain curve in Fig. 8, which depends on the mean annual ground temperature and the cable distance to the next regulating repeater. See office records for mean annual ground temperature and cable distance to next regulating repeater.

TABLE A
LINE BUILDING – OUT NETWORKS

LBO NETWORK CODES		BUILD-OUT DISTANCE (MILES)	LOSS AT 11.648 MHZ (DB)
LB01	LB02		
4100A	4100A	0.0	0.00
—	4100B	0.1	1.35
4100AC	4100C	0.2	2.71
4100AD	4100D	0.3	4.07
4100AE	4100E	0.4	5.42
4100AF	4100F	0.5	6.78
4100AG	4100G	0.6	8.14
4100AH	4100H	0.7	9.49
4100AJ	4100J	0.8	10.85
4100AK	4100K	0.9	12.20
4100AL	4100L	1.0	13.56

CHART 2 (Cont)

STEP	PROCEDURE
2	Compute the test attenuator setting for use in Step 13 as follows: Test attenuator setting equals required repeater gain determined in Step 1 minus the test set loss at 11.648 MHz. Obtain from test set calibration records the test set loss at 11.648 MHz. <i>Example:</i> Assume that the required repeater gain is 10.97 dB and the test set loss is 4.2 dB. set the test attenuator for 10.97 dB minus 4.2 dB = 6.77 dB. <i>Prepare repeater</i>
3	Install a 4100A LBO network in LBO1 position and the required 4100-type LBO network in LBO2 position.
4	Place the repeater on its side on a flat surface, and mount test adapter ED-50876-32 on the repeater. <i>Prepare test set</i>
5	Set the COMMAND TONES key, on command signal panel, to OFF.
6	Remove all patches from the test set jack field.
7	Set PWR switch, at rear of test set, to ON. <i>Requirement:</i> Power on indicator lamp lights.
8	Set the DC switch and the LINE switch, on repeater power supply panel, to OFF. <i>Warning: The line repeater power supply must be OFF or the repeater will be damaged.</i>
9	Install the repeater with test adapter in the test set mounting position marked J68877AB or AC. B. Regulator Adjustment
10	Connect the output of the STE through the test attenuator and back-to-back connector to the RTE [patches (1), (2), and (3), Fig. 4].
11	Set the test attenuator to 0.0 dB.
12	Adjust the STE to deliver an 11.648-MHz signal at the power necessary to obtain an exact -20.0 dBm indication on the RTE.

CHART 2 (Cont)

STEP	PROCEDURE
13	Set the attenuator to the loss value determined in Step 2.
14	Transfer the RTE patch from the CAL jack to the HF LINE OUT jack [patch (4), Fig. 4].
15	Transfer the test attenuator patch from the CAL jack to the HF LINE IN jack [patch (5), Fig. 4].
16	Observe the 11.648-MHz power indication. Requirement: -20.0 dBm
17	Adjust the REG ADJ control, if required, to obtain an exact -20.0 dBm indication. Note: Wait for the repeater gain to stabilize and, if necessary, adjust again. The repeater gain can be considered stable when the power of the 11.648-MHz signal changes no more than 0.1 dB in one minute. C. Preparing Repeater for Installation
18	Remove the repeater from the test set and remove the test adapter.
19	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.

FORM ST1 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 2 (Cont)

STEP**PROCEDURE**

20 Enter the applicable information for the items marked by an asterisk (*) on the form.

D. Nick Adjustment

Note: When the repeater is installed, the NICK ADJ control must be adjusted per Section 359-205-301.

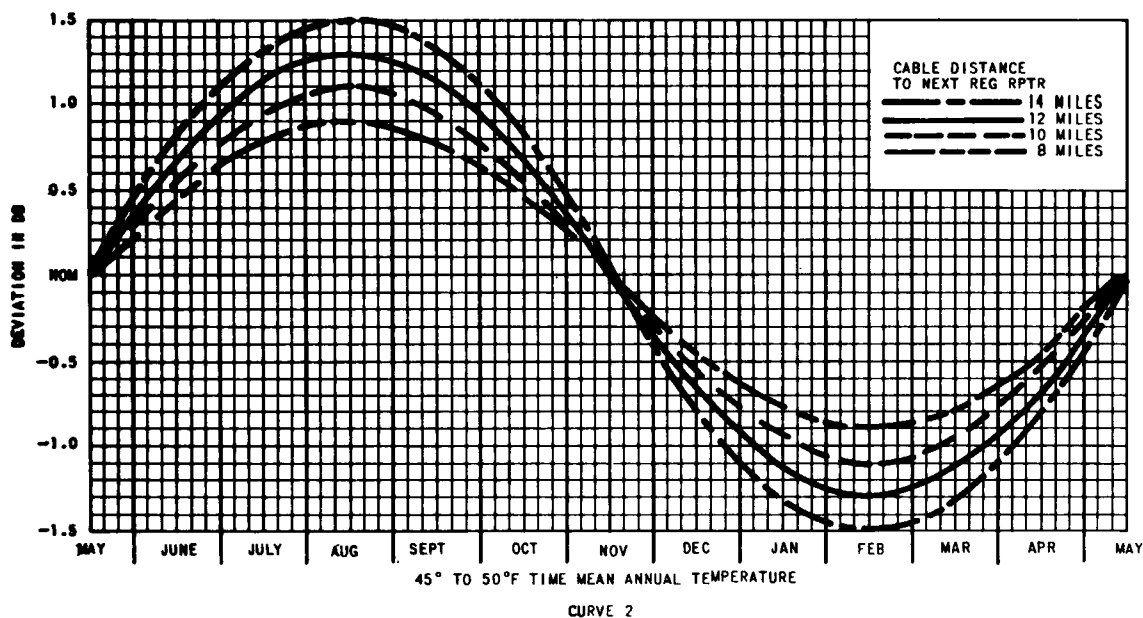
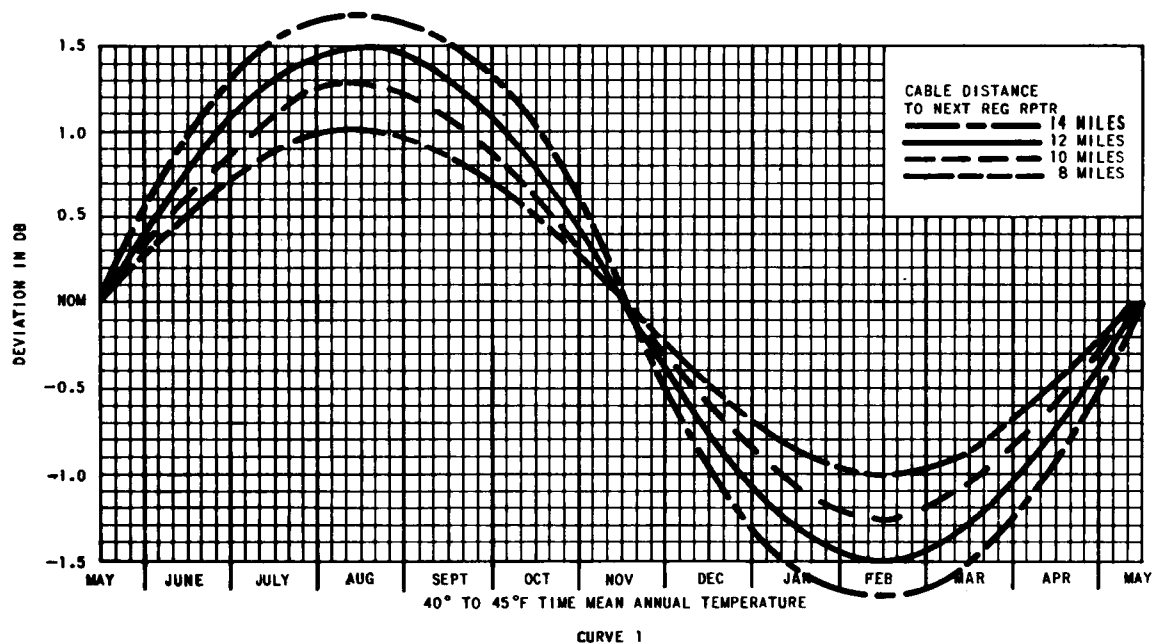


Fig. 8—Repeater Gain Deviations Versus Temperature Changes (Sheet 1 of 3)

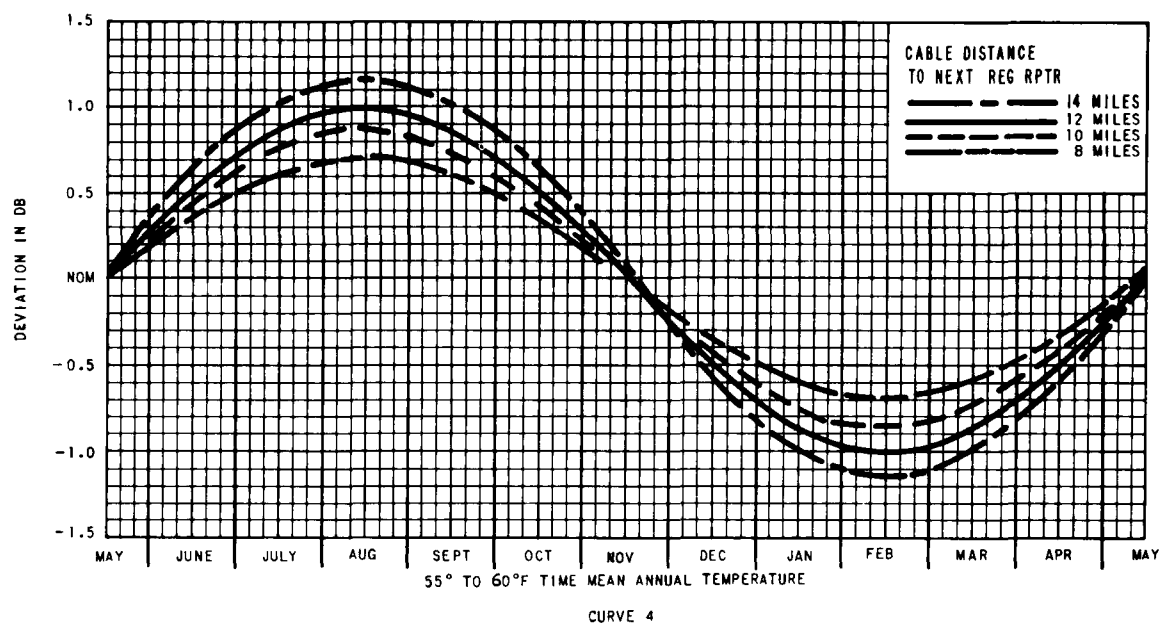
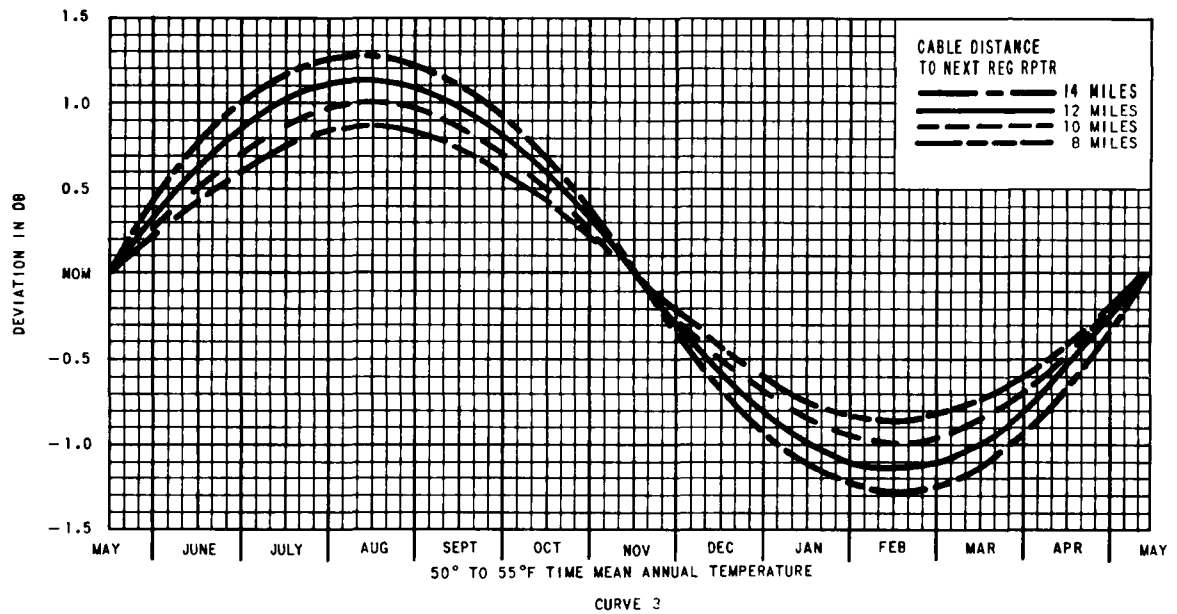


Fig. 8—Repeater Gain Deviations Versus Temperature Changes (Sheet 2 of 3)

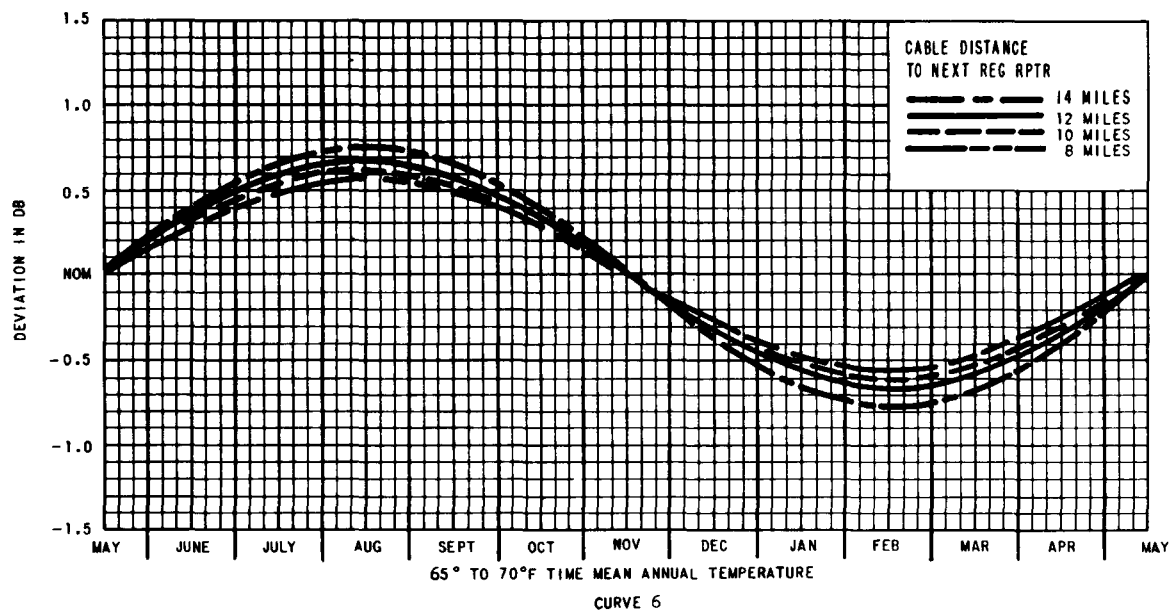
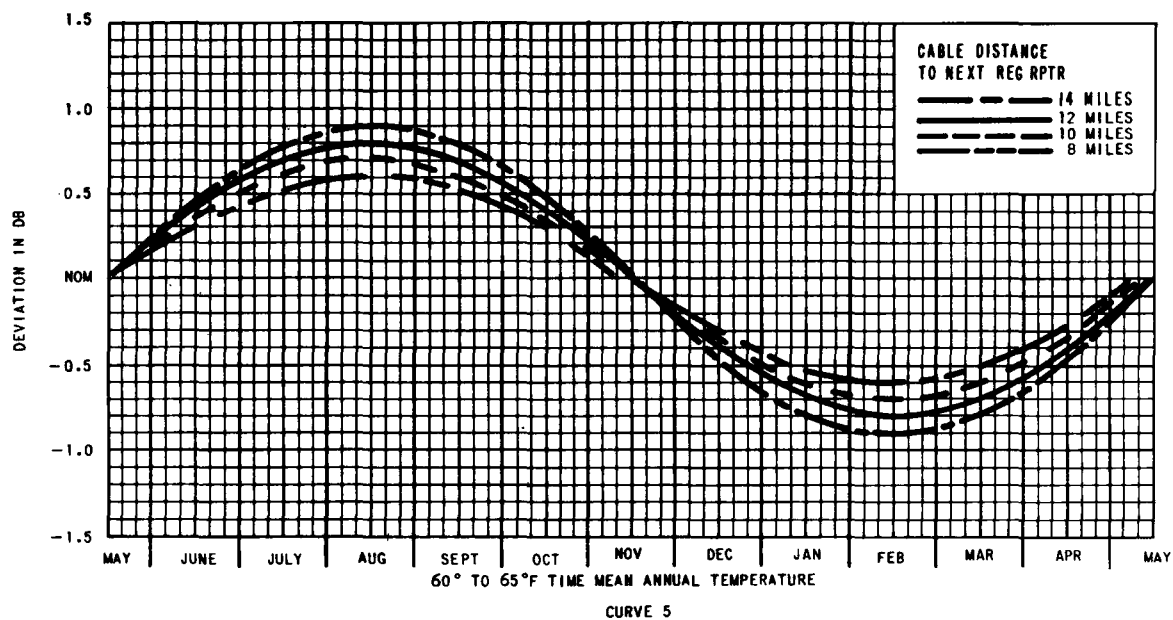


Fig. 8—Repeater Gain Deviations Versus Temperature Changes (Sheet 3 of 3)