

**L4 CARRIER
REPEATERS
TESTS
J68877AC REGULATING REPEATER**

PURPOSE OF TESTS

To ensure correct performance of the regulating repeater

- (a) When received from the manufacturer
- (b) When prepared for installation
- (c) When suspected of being faulty.

REASON FOR REISSUE

- (a) To include gain values and tests for the List 2 and List 3 repeaters
- (b) To include test of the post-regulation transfer feature of the List 2 and List 3 repeaters
- (c) To include 20-kHz harmonic noise test
- (d) To include information on R1 access protection
- (e) To change test procedures to improve accuracy of measurements.

Extensive changes are made in format. Change arrows are not used. *Equipment Test Lists are not affected.*

SYNOPSIS

The J68877AC regulating repeater (Fig. 1 and Fig. 14) provides

- (a) **Gain** to compensate for the loss of two miles of coaxial line.
- (b) **Fixed equalization** (deviation equalizer) to compensate for small deviations accumulated from a number of basic repeaters in tandem. These deviations accumulate because the basic repeater gain does not exactly match the loss of two miles of coaxial line.
- (c) **Temperature regulation** to compensate for cable loss variations caused by changes in cable temperature. Temperature regulation is divided into post-regulation and preregulation circuits. Post-regulation is controlled by the received 11.648-MHz pilot. Preregulation is controlled by a circuit which monitors the ground temperature via a thermistor buried with the cable.

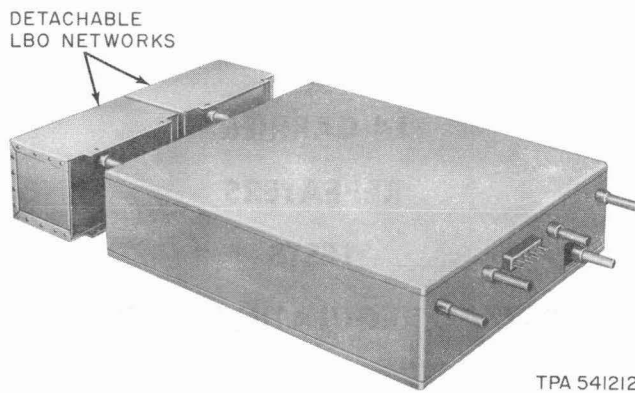


Fig. 1—J68877AC Regulating Repeater

- (d) **Line building-out connections** so that LBO networks can be inserted to build out short lengths of coaxial line to the nominal 2-mile spacing.
- (e) **Connections** for inserting the A equalizer in the transmission path between the post-regulation and preregulation circuits.

List numbers identify the differences in the J68877AC repeaters.

List 1: Original equipment. The post-regulator goes to maximum gain on loss of the temperature pilot.

List 2: Same as List 1 except the List 2 repeater is equipped with a control transfer circuit which, on loss of temperature pilot, transfers control of the post-regulator from the pilot control circuit to the buried thermistor control circuit.

List 3: Equipped with improved amplifiers and regulating circuits which provide improved gain shape and regulating range. The control transfer circuit is included which, on loss of temperature pilot, transfers control of the post-regulator from the pilot control circuit to the buried thermistor control circuit.

PERFORMANCE TESTS (CHART 1 OR 3)

- (a) **Gain** is tested at five frequencies spanning the L4 band.
- (b) The **preregulator** is adjusted for 8.63-dB gain if necessary.
- (c) **Post-regulation** is tested by varying the level of the 11.648-MHz pilot 3 dB above and below nominal and observing the effect on repeater gain.
- (d) **Preregulation** is tested by simulating, via the GROUND TEMP SELECT switch, a ground temperature change 20 degrees above and below the nominal 55°F and observing the change in repeater gain.
- (e) **Post-regulation control transfer** is tested by removing the 11.648-MHz pilot and observing the effects on repeater gain.
- (f) **Noise** is measured by terminating the repeater input in 75 ohms and measuring the signal power at 17.5 MHz over a noise bandwidth of approximately 3000 Hz.

- (g) **Test for 20-kHz harmonic tones** is performed so that the 20-kHz oscillator does not produce harmonics in the 280- to 510-kHz band when the preregulator is sensing a high cable temperature.

PREINSTALLATION TESTS (CHART 2 OR 4)

Preparation for installation is as follows:

- (a) Installing proper deviation equalizer
- (b) Adjusting the preregulator circuit to regulate at the mean temperature and spacing of the repeater location for which the unit is being prepared
- (c) Measuring repeater gain at 12 MHz

SPECIAL CONSIDERATIONS

Warm Up

Test results will not be conclusive unless the repeater has been prewarmed for at least 4 hours. A preheating rack (ED-50887-30) is available for supplying the repeater with 520-mA constant current for warm-up. (See Section 359-205-500.) After being prewarmed, the repeater should **not** be downpowered for more than 3 minutes, and then it should be powered in the test set for at least 5 minutes before any measurements are made.

R1 Access Protection Arrangements

Various arrangements for R1 access protection exist; these are:

- (a) Early List 1 repeaters have several factory-adjustment access holes and an R1 field-adjustment access hole in the repeater cover. A nylon set screw is provided in a phenolic block to protect the R1 adjustment.
- (b) In some List 2 and List 3 repeaters, the nylon set screw was omitted and a snap-in dust cap is used to seal the R1 access hole in the repeater cover.
- (c) Newer List 3 repeaters have only the R1 access hole in the repeater cover. A nylon binding-head screw is used in the phenolic block to protect the R1 adjustment, and an adhesive-backed metal decal is used to seal the R1 access hole in the repeater cover.
- (d) Newer List 2 repeaters, converted from List 1, have all factory-adjustment holes permanently sealed. A nylon binding-head screw is used to plug the R1 access hole in the phenolic block, and an adhesive-backed metal decal is used to seal the R1 access hole in the repeater cover.

When preparing a repeater for test, **see warning below** before removing the nylon set or binding-head screw from the R1 access hole. After completion of test, reinstall the nylon screw in the phenolic block and reseal the R1 access hole in the repeater cover with the snap-in dust cap or adhesive-backed metal decal if provided.

Warning: *Determine if there is a nylon set screw in the R1 access hole before attempting to remove the screw. Attempting to remove the screw when none is present could result in damage to the R1 potentiometer. When reinstalling the nylon set screw, make sure that it is not turned in far enough to disturb the R1 adjustment.*

If test requirements are not met, local procedures should be followed to return the unit to the factory or maintenance center for repair.

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CHART 1

PERFORMANCE TESTS USING THE J68906B TEST SET

Operation of the J68906B test set should be verified as prescribed in Section 103-459-000 before proceeding with these tests.

The test set is illustrated in Fig. 2; test arrangements are shown in Fig. 3. For transmission measurements, sending and receiving test equipment normally provided at the L4 main station is used.

APPARATUS

- J68906B L4 Line Repeater Test Set** (Section 103-459-000)
- Precision Attenuator* adjustable from 0.0 to 50 dB in 0.1-dB steps
- 4100A Line Build-Out (LBO) Networks* (0 loss)
- 4152A Deviation Equalizer (Test Standard) Network* (used with List 1 and 2 repeaters)
- 4152B Deviation Equalizer (Test Standard) Network* (used with List 3 repeater)

Sending Test Equipment (STE) capable of delivering, into 75-ohm circuits, signals between 0.5 and 25.0 MHz at powers from 0.0 to -30.0 dBm

Receiving Test Equipment (RTE) capable of detecting, from 75-ohm circuits, signals between 0.5 and 25 MHz at powers from 0.0 to -100.0 dBm

* Includes test adapters, patch cords, and patch plugs required for repeater test.

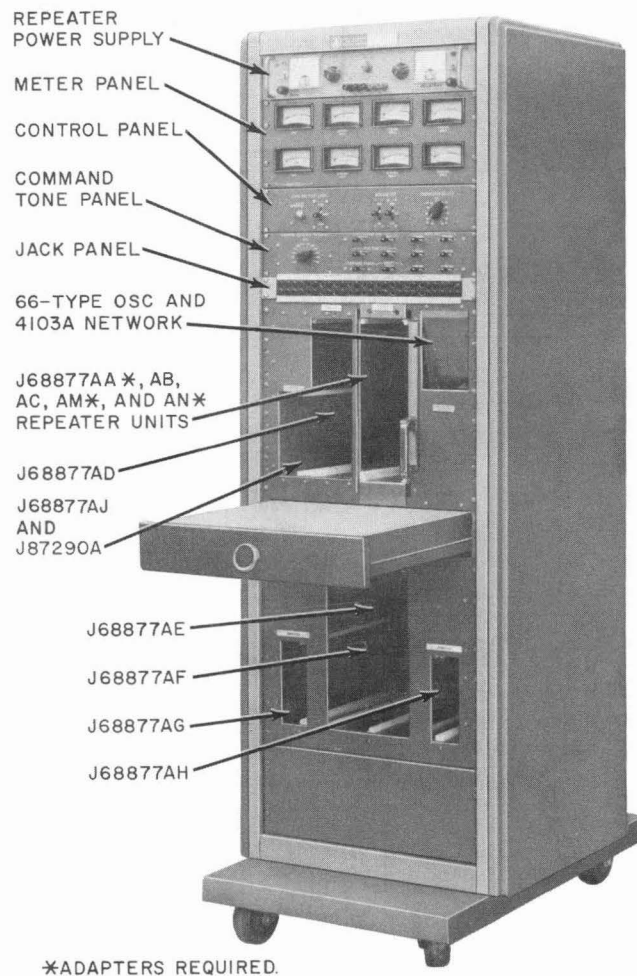


Fig. 2—J68906B L4 Line Repeater Test Set

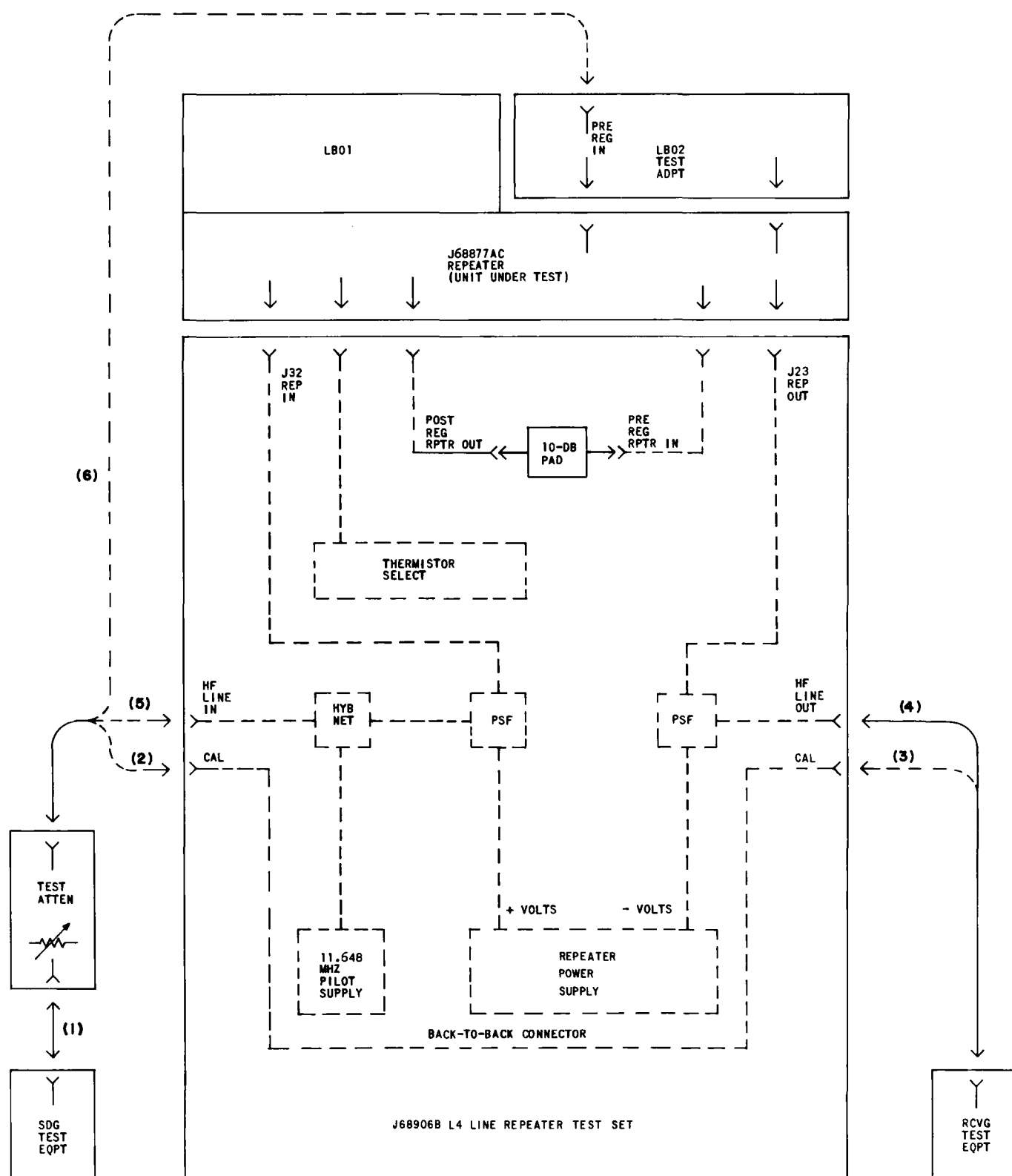


Fig. 3—Test Arrangements for Regulating Repeater (J68906B Test Set)

CHART 1 (Cont)	
STEP	PROCEDURE
	Note 1: The preregulator circuit is adjusted at the factory for nominal gain. On these units preregulator adjustment should not be necessary. If a repeater has been previously adjusted for installation at a particular location, the preregulator adjustment (Steps 27 through 42) should be made before the gain test (Steps 11 through 26). Note 2: After performing operations affecting regulation, it is necessary to allow the repeater to stabilize before making measurements. The repeater can be considered stable when the RTE level indication changes no more than 0.1 dB in the preceding minute. Note 3: When making gain measurements, it is recommended that the attenuator be adjusted so that the RTE expanded scale indication be in the +dB range. This will aid in computing gain values. Caution 1: <i>Do not adjust the preregulator section of the repeater until the repeater has fully warmed up. Adjustment of a cold repeater will result in misalignment.</i> Caution 2: <i>Dirt or foreign matter inside the repeater case could cause severe damage because of the high operating voltages present when the repeater is operating in the L4 line. Exercise extreme care to prevent any foreign matter from entering the opened repeater case.</i>
1	Position the repeater as shown in Fig. 1 (two coaxial plugs on left) and remove the cover which is on top. Note: Refer to Fig. 13 for helpful information in performing Steps 2 through 7.
2	Remove and retain the regular deviation equalizer unit if one is installed.
3	Install a deviation equalizer network as follows: (a) For a List 1 or 2 repeater, use a 4152A network. (b) For a List 3 repeater, use a 4152B network.
4	Check the 859C network to ensure that all the screw switches are open (turned out).
5	Remove, and retain for reinstallation, the nylon screw which is used to plug the R1 adjustment access hole. (See Special Considerations, page 3.)
6	Replace the repeater cover.
7	Install 4100A LBO networks (0 loss) in LBO positions 1 and 2.
8	Set switches and controls on the test set as follows:

CHART 1 (Cont)

STEP	PROCEDURE		
	SWITCH/CONTROL	LOCATION	SETTING
	Power switch	Back of test set	ON
	MAIN voltage control	Repeater power supply	0
	VERNIER voltage control	Repeater power supply	0
	CURRENT AMPS control	Repeater power supply	0
	DC switch	Repeater power supply	OFF
	LINE switch	Repeater power supply	ON
	11.648 MHz PILOT LEVEL	Control panel	NORM
	THERMISTOR SELECT	Control Panel	55°F
	COMMAND TONES key	Command tone panel	OFF
9	On the test set jack panel:		
	(a) Patch between PILOT IN and PILOT OUT jacks with a 372A plug.		
	(b) Patch between POST REG RPTR OUT and PRE REG RPTR IN jacks using the adapter cord and 10-dB pad assembly. (This assembly is supplied with the test set.)		
10	At the test set power supply (Fig. 4), apply power to the repeater as follows:		
	(a) Operate the DC switch to the ON position.		
	Requirement: Power on indicator lamp lights.		
	(b) Turn the MAIN voltage control to approximately 80 volts.		
	(c) Adjust the CURRENT AMPS control to obtain a 0.52-ampere indication on the DC AMPERES meter.		
	Requirement: The DC VOLTS meter indicates between 64 and 72 volts.		
	Note: The repeater power supply is providing 520-mA constant current to the repeater.		
	GAIN TEST		
11	From the test set calibration records, obtain the set loss for each of the frequencies listed in Fig. 5.		
12	Add 10 dB to the set loss value and record the result in column E of Fig. 5.		

CHART 1 (Cont)

STEP	PROCEDURE
	Fig. 4—Repeater Power Supply—Front Panel Note: This 10 dB is the loss of the impedance matching cord and pad assembly (provided with the test set) used in place of the J68877AD A equalizer unit. 13 Patch the STE through the attenuator to the CAL jack associated with the HF LINE IN jack [patches (1) and (2), Fig. 3]. (See Fig. 6.) 14 Set the attenuator for 0.00-dB loss. (See note after Step 25.) 15 Adjust the RTE to measure 20.448 MHz at -20 dBm. 16 Patch the RTE to the CAL jack associated with the HF LINE OUT jack [patch (3), Fig. 3]. 17 Adjust the STE to deliver 20.448 MHz at a level necessary to obtain an exact -20.00 dBm indication on the RTE. 18 Set the attenuator to the loss value specified in column D, Fig. 5. (25 dB for 20.448 MHz; this is approximately 5 dB above expected final attenuator setting.) 19 Patch the RTE to the HF LINE OUT jack [patch (4), Fig. 3]. 20 Patch the attenuator output to the HF LINE IN jack [patch (5), Fig. 3]. 21 Adjust the attenuator to obtain, as near as possible, a -20.00 dBm indication on the RTE. 22 Note the RTE expanded scale meter indication. Record these values in columns F and G of Fig. 5. 23 Compute the repeater gain per the following example: Column E: 14.05 dB Plus column F: 22.10 dB Plus column G: 0.02 dB Repeater gain: 36.17 dB Requirement: Within MIN and MAX values (columns B and C, Fig. 5).

CHART 1 (Cont)

STEP	PROCEDURE
24	Record the repeater gain in column H, Fig. 5.
25	Repeat Steps 14 through 24 for each of the remaining frequencies (see note) listed in Fig. 5. Requirement: As specified in Fig. 5. Note: When measuring gain at 0.512 MHz, substitute the following for Step 14: Step 14: Set the attenuator to the value in column E, Fig. 5 (set loss at 0.512 MHz plus 10 dB).
26	If the requirements of Steps 23 and 25 are met, proceed to Step 43. If they are not met, the preregulator circuit may be out of adjustment. Perform Steps 27 through 42 to adjust the preregulator. PREREGULATOR ADJUSTMENT (See Note 1 preceding Step 1.)
27	Remove the LBO network from LBO position 2. Ensure that the 4100A LBO network (installed in Step 7) is in place and that the patch between PILOT IN and PILOT OUT jacks [made in Step 9(a)] is in place.
28	Install the LBO2 test adapter (ED-51002-30) in LBO position 2 of the repeater unit.
29	Patch the STE through the attenuator to the CAL jack associated with the HF LINE IN jack [patches (1) and (2), Fig. 3].
30	Set the attenuator to equal the loss of the LBO2 test adapter (ED-51002-30). Note: This loss is approximately 10 dB. The exact loss is stamped on the LBO2 test adapter unit.
31	Set the RTE to measure 11.648 MHz at -20.00 dBm.
32	Patch the RTE to the CAL jack associated with the HF LINE OUT jack [patch (3), Fig. 3].
33	Adjust the STE to deliver 11.648 MHz at a level necessary to obtain exactly -20.00 dBm on the RTE.
34	Patch the RTE to the HF LINE OUT jack [patch (4), Fig. 3].
35	Set the attenuator for 8.63-dB loss.
36	Transfer the patch from the CAL jack associated with HF LINE IN jack to the PRE REG IN jack on the LBO2 test adapter [patch (6), Fig. 3].
37	Observe the RTE (use expanded scale meter). Requirement: -20.00 dBm $\pm$ 0.1 dB

DATE OF TEST _____ BY _____ REPEATER SERIAL NO. _____

J68877AC LIST 1 OR LIST UNIT							
A	B	C	D	E	F	G	H
TEST FREQ (MHZ)	REQUIRED GAIN (DB)		INITIAL ATTEN SET (DB)	SET LOSS +10 DB	FINAL ATTEN SET (DB)	RTE EXPANDED SCALE (DB)	RPTR GAIN (E+F+G)
	MIN	MAX					
20.448	35.14	37.14	25				
17.500	33.52	34.72	25				
12.000	27.18	27.78	15				
4.000	16.02	16.82	5				
0.512*	5.70	6.50	10				

J68877AC LIST 3 UNIT							
20.448	33.17	35.17	25				
17.500	32.07	33.27	25				
12.000	27.13	27.73	15				
4.000	16.26	17.06	5				
0.512*	5.56	6.36	10				

*See note after Step 25.

Post-regulation_____

Preregulation_____

Post-regulation transfer_____

Noise_____

Remarks_____

Fig. 5—J68877AC Regulating Repeater Test Record

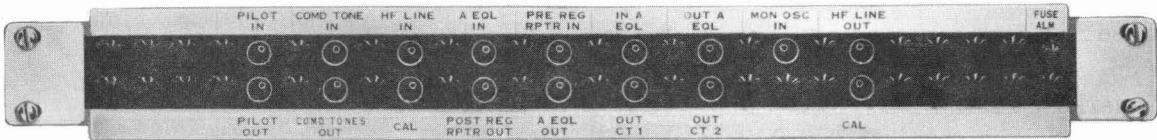
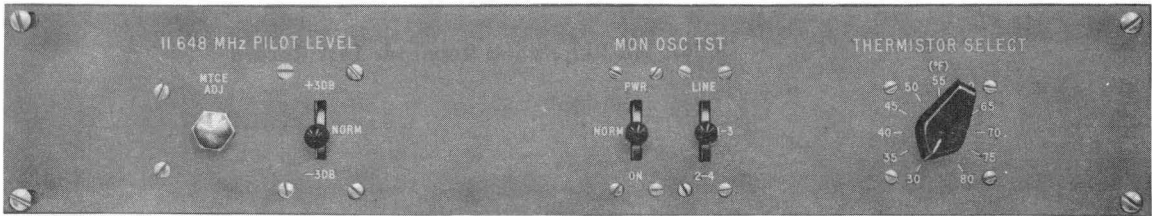
CHART 1 (Cont)	
STEP	PROCEDURE
38	If the requirement of Step 37 is met, proceed to Step 40. If it is not met, adjust the 859C network potentiometer R1 to obtain an indication of -20.00 dBm. Note: The R1 adjustment is accessible through a hole located near the front of the repeater case. See Fig. 13.
39	After adjusting R1, wait for the repeater to stabilize (minimum of 3 minutes) and, if necessary, readjust. Requirement: -20.00 dBm
40	Remove the LBO2 test adapter unit.
41	Install a 4100A LBO network (0 loss) in LBO position 2.
42	Repeat the gain test (Steps 14 through 26). POST-REGULATION
43	Remeasure the repeater gain at 12 MHz by repeating the procedures in Steps 14 through 23.
44	Record the algebraic sum of the attenuator setting and the RTE expanded scale meter indication obtained in Step 43.
45	On the test set control panel (Fig. 7), set the 11.648 MHz PILOT LEVEL key to the $+3$DB position.
	
Fig. 6—Test Set Jack Panel	
	
Fig. 7—Test Set Control Panel	

CHART 1 (Cont)	
STEP	PROCEDURE
46	Observe the RTE. Requirement: RTE indicates a decreasing level. Note: This indication verifies that the preregulator responds correctly to an increase in pilot level. Responses to a decrease in pilot level are checked in Steps 51 and 52. To check the full regulating range, perform the steps in order.
47	Allow time for the repeater to stabilize (minimum of 3 minutes).
48	Adjust the attenuator to obtain, as near as possible, a -20.00 dBm indication on the RTE.
49	Record the algebraic sum of the attenuator setting and the RTE expanded scale meter indication.
50	Compute the decrease in repeater gain per the following example: Value recorded in Step 44: 13.55 dB Minus value recorded in Step 49: <u>10.72 dB</u> Decrease in repeater gain: 2.83 dB Requirement: Between 2.65 and 3.00 dB
51	On the test set control panel, set the 11.648 MHz PILOT LEVEL key to the -3 DB position.
52	Observe the RTE. Requirement: RTE indicates an increasing level. Note: To check the full regulating range, proceed with the following steps in the order listed; otherwise, proceed to Step 57.
53	Allow the repeater to stabilize (minimum of 2 minutes).
54	Adjust the attenuator to obtain, as near as possible, a -20.00 dBm indication on the RTE.
55	Record the algebraic sum of the attenuator setting and the RTE expanded scale meter indication.
56	Compute the increase in repeater gain per the following example: Value recorded in Step 55: 16.47 dB Minus value recorded in Step 44: <u>13.55 dB</u> Increase in repeater gain: 2.92 dB Requirement: Between 2.65 and 3.00 dB

CHART 1 (Cont)

STEP	PROCEDURE
57	Set the 11.648 MHz PILOT LEVEL key to the NORM position.
58	Allow the repeater to stabilize (minimum of 2 minutes).
59	Adjust the attenuator to obtain, as near as possible, a -20.00 dBm indication on the RTE.
60	Record the algebraic sum of the attenuator setting and the expanded scale meter indication. Requirement: Within ± 0.2 dB of the value recorded in Step 44.
	PREREGULATION
61	On the test set control panel, set the THERMISTOR SELECT switch to 75°F .
62	Observe the RTE. Requirement: RTE indicates an increasing level.
	Note: To check the full regulating range, allow a minimum of 2 minutes for the repeater to stabilize and proceed to Step 63; otherwise, proceed to Step 65.
63	Adjust the attenuator to obtain, as near as possible, a -20.00 dBm indication on the RTE.
64	Record the algebraic sum of the attenuator setting and the RTE expanded scale meter indication.
65	Set the THERMISTOR SELECT switch to 35°F .
66	Observe the RTE. Requirement: RTE indicates a decreasing level.
67	Allow the repeater to stabilize (minimum of 2 minutes).
68	Adjust the attenuator to obtain, as near as possible, a -20.00 dBm indication on the RTE.
69	Record the algebraic sum of the attenuator setting and the RTE expanded scale meter indication.
70	Compute the preregulator range per the following example: Value recorded in Step 64: 13.47 dB Minus value recorded in Step 69: <u>9.03 dB</u> Preregulator range: 4.44 dB Requirement: Between 3.90 and 4.90 dB

CHART 1 (Cont)	
STEP	PROCEDURE
71	Set the THERMISTOR SELECT switch to 55°F.
	POST-REGULATOR TRANSFER
72	Allow the repeater to stabilize (minimum of 2 minutes).
73	Adjust the attenuator to obtain, as near as possible, a -20.00 dBm indication on the RTE.
74	Record the algebraic sum of the attenuator setting and the RTE expanded scale meter indication.
75	Compute the repeater gain per the following example: Value recorded in Step 74: 13.50 dB Plus value from column E (set loss + 10 dB), Fig. 5: 14.08 dB Repeater gain: 27.58 dB Requirement: <i>List 1 or 2:</i> between 27.18 and 27.78 dB <i>List 3:</i> between 27.13 and 27.73 dB
76	Remove the patch plug between the PILOT IN and PILOT OUT jacks.
77	Allow the repeater to stabilize (minimum of 3 minutes).
78	Repeat Steps 73 through 75. Requirement: <i>List 1:</i> between 29.00 and 31.50 dB <i>List 2:</i> between 26.81 and 28.21 dB <i>List 3:</i> between 26.73 and 28.13 dB
79	Reinsert the patch plug between the PILOT IN and PILOT OUT jacks.
80	Allow the repeater to stabilize (minimum of 3 minutes).
81	Repeat Steps 73 through 75. Requirement: <i>List 1 or List 2:</i> between 27.18 and 27.78 dB <i>List 3:</i> between 27.13 and 27.73
	NOISE
82	Remove the STE from the HF LINE IN jack.
83	Terminate the repeater input in 75 ohms by placing a 368A plug in the HF LINE IN jack.

CHART 1 (Cont)

STEP	PROCEDURE
84	Adjust the RTE and measure the noise at 17.5 MHz over a bandwidth of 3500 Hz. Requirement: Less than -94 dBm (-95 dBm is less than -94 dBm.) TEST FOR 20-KHZ HARMONIC TONES
85	Set the THERMISTOR SELECT switch to 75°F.
86	Allow the repeater to stabilize for at least 5 minutes.
87	Set the RTE to measure signals starting at 280 kHz in the power range of -70 to -80 dBm.
88	Starting at 280 kHz, slowly tune the RTE up in frequency to 510 kHz while monitoring the power indication and frequency of any tone higher than -80 dBm. Requirement: No 20-kHz harmonic tones higher than -75.0 dBm (-74 dBm is higher).
89	Reset the THERMISTOR SELECT switch to 55°F.
90	On the repeater power supply, turn the MAIN VOLTAGE control to 0 and set the DC switch to OFF.
91	Remove the repeater unit from the test set.
92	Remove the LBO networks.
93	Remove the repeater cover.
94	Remove the 4152() deviation equalizer network.
95	Reinstall the nylon screw in the R1 access hole, and seal the R1 access hole in the repeater cover with the snap-in dust cap or metal decal if provided.
96	Replace the repeater cover.
97	If the repeater is to be prepared for installation at a particular repeater location, proceed to Chart 2; otherwise, follow local procedures to store the unit.

CHART 2

PREINSTALLATION TESTS USING THE J68906B TEST SET

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

CHART 2 (Cont)

- (a) Installing proper deviation equalizer
- (b) Adjusting the preregulator circuit to regulate at the mean temperature and spacing of the repeater location for which the unit is being prepared
- (c) Measuring repeater gain at 12 MHz.

APPARATUS

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

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

4100A LBO Networks (two required)

Sending Test Equipment (STE) capable of delivering, into 75-ohm circuits, signals between 0.5 to 25.0 MHz at powers from 0.0 to -30.0 dBm

Receiving Test Equipment (RTE) capable of detecting, from 75-ohm circuits, signals between 0.5 to 25.0 MHz at powers from 0.0 to -100.0 dBm

* Includes adapters, patch cords, and plugs required for repeater tests.

STEP	PROCEDURE
	Caution 1: Do not adjust the preregulator section of the repeater until the repeater has fully warmed up. Adjustment of a cold repeater will result in misalignment. Caution 2: Dirt or foreign matter inside the repeater case could cause severe damage because of the high operating voltages present when the repeater is operating in the L4 line. Exercise extreme care to prevent any foreign matter from entering the opened repeater case. PREREGULATOR ADJUSTMENT 1 Position the repeater unit as shown in Fig. 1 (two coaxial plugs to left) and remove the cover which is on top. 2 Install a deviation equalizer (if not previously installed) appropriate to the location for which the repeater is being prepared. (See Fig. 13 for connections and see office records for correct deviation equalizer.) 3 Obtain the following from office records: (a) Average annual underground temperature for the repeater location (b) Distance (cable miles) to the next regulating repeater.

CHART 2 (Cont)

STEP	PROCEDURE																														
4	With the information obtained in Step 3, refer to Table A to determine which 859C screw switch should be turned in.																														
5	On the 859C network, set the screw switch determined in Step 4 fully clockwise and ensure that all other screw switches are turned out.																														
6	Remove, and retain for reinstallation, the nylon screw which is used to plug the R1 adjustment access hole. (See Special Considerations, page 3.)																														
7	Replace the repeater unit cover.																														
8	Install a 4100A LBO network in LBO position 1. (Secure with screws.)																														
9	Install an LB02 test adapter (ED-51002-30) in LBO position 2.																														
10	On the test set, set switches and controls as follows: <table><tr><th>SWITCH/CONTROL</th><th>LOCATION</th><th>SETTING</th></tr><tr><td>Power switch</td><td>Back of test set</td><td>ON</td></tr><tr><td>MAIN voltage control</td><td>Repeater power supply</td><td>0</td></tr><tr><td>VERNIER voltage control</td><td>Repeater power supply</td><td>0</td></tr><tr><td>CURRENT AMPS control</td><td>Repeater power supply</td><td>0</td></tr><tr><td>DC switch</td><td>Repeater power supply</td><td>OFF</td></tr><tr><td>LINE switch</td><td>Repeater power supply</td><td>ON</td></tr><tr><td>11.648 MHz PILOT LEVEL</td><td>Control panel</td><td>NORM</td></tr><tr><td>THERMISTOR SELECT</td><td>Control Panel</td><td>55°F</td></tr><tr><td>COMMAND TONES key</td><td>Command tone panel</td><td>OFF</td></tr></table>	SWITCH/CONTROL	LOCATION	SETTING	Power switch	Back of test set	ON	MAIN voltage control	Repeater power supply	0	VERNIER voltage control	Repeater power supply	0	CURRENT AMPS control	Repeater power supply	0	DC switch	Repeater power supply	OFF	LINE switch	Repeater power supply	ON	11.648 MHz PILOT LEVEL	Control panel	NORM	THERMISTOR SELECT	Control Panel	55°F	COMMAND TONES key	Command tone panel	OFF
SWITCH/CONTROL	LOCATION	SETTING																													
Power switch	Back of test set	ON																													
MAIN voltage control	Repeater power supply	0																													
VERNIER voltage control	Repeater power supply	0																													
CURRENT AMPS control	Repeater power supply	0																													
DC switch	Repeater power supply	OFF																													
LINE switch	Repeater power supply	ON																													
11.648 MHz PILOT LEVEL	Control panel	NORM																													
THERMISTOR SELECT	Control Panel	55°F																													
COMMAND TONES key	Command tone panel	OFF																													
11	On the test set jack panel, (a) Ensure that a patch exists between the PILOT IN and PILOT OUT jacks. (b) Patch between the POST REG RPTR OUT and the PRE REG RPTR IN jacks using the adapter cord and 10-dB pad assembly. (This assembly is supplied with the test set.)																														
12	Set the THERMISTOR SELECT switch to the mean ground temperature of the location in which the repeater is to be installed. (See office records for mean ground temperature.)																														
13	Insert the repeater in the test set mounting position marked J68877AB or AC.																														
14	On the test set repeater power supply, apply power to the repeater as follows:																														

CHART 2 (Cont)

CHART 2 (Cont)																			
STEP	PROCEDURE																		
	TABLE A 859C NETWORK SCREW SWITCH SETTINGS <table><tr><th>REG RPTR SPACING*</th><th>45° TO 62°F‡</th><th>63° TO 70°F‡</th></tr><tr><td>16 miles†</td><td>None</td><td>None</td></tr><tr><td>14 miles†</td><td>B-1</td><td>B-1</td></tr><tr><td>12 miles</td><td>A-2</td><td>A-2</td></tr><tr><td>10 miles</td><td>B-2</td><td>A-3</td></tr><tr><td>8 miles</td><td>B-3</td><td>A-1</td></tr></table> * Miles to succeeding regulating repeater † Used only in early system (Washington—Miami) ‡ Average annual underground temperature at repeater location (For this information, see office records.) (a) Operate the DC switch to the ON position. Requirement: Power on indicator lamp lights. (b) Turn the MAIN voltage control to approximately 80 volts. (c) Adjust the CURRENT AMPS control to obtain a current indication of 0.52 ampere on the DC AMPERES meter. Requirement: The DC VOLTS meter indicates between 64 and 72 volts. Note: The repeater power supply is supplying 520-mA constant current to the repeater under test. 15 Patch the STE through the attenuator and back-to-back connector to the RTE [patches (1), (2), and (3), Fig. 3]. 16 Set the attenuator to equal the loss of the LBO2 test adapter (ED-51002-30). Note: This loss is approximately 10 dB. The exact loss value is stamped on the LBO2 test adapter unit. 17 Set the RTE to measure an 11.648-MHz signal at -20.00 dBm. 18 Adjust the STE as required to deliver an 11.648-MHz signal to obtain an exact -20.00 dBm indication on the RTE.	REG RPTR SPACING*	45° TO 62°F‡	63° TO 70°F‡	16 miles†	None	None	14 miles†	B-1	B-1	12 miles	A-2	A-2	10 miles	B-2	A-3	8 miles	B-3	A-1
REG RPTR SPACING*	45° TO 62°F‡	63° TO 70°F‡																	
16 miles†	None	None																	
14 miles†	B-1	B-1																	
12 miles	A-2	A-2																	
10 miles	B-2	A-3																	
8 miles	B-3	A-1																	

CHART 2 (Cont)

STEP	PROCEDURE
19	Patch the output of the attenuator to the PRE REG IN jack on the LBO2 test adapter [patch (6), Fig. 3].
20	Patch the RTE to the HF LINE OUT jack on the test set jack panel [patch (4), Fig. 3].
21	Set the attenuator to 8.63 dB.
22	Observe the RTE. Requirement: $-20.00 \text{ dBm} \pm 0.1 \text{ dB}$
23	If the requirement of Step 22 is met, proceed to Step 24. If it is not met, adjust 859C network potentiometer R1 (see note) to obtain exactly -20.00 dBm . Note: After adjusting R1, wait for the repeater to stabilize and, if necessary, readjust. The repeater can be considered stable when the RTE indication changes no more than 0.1 dB in the preceding minute.
24	Remove the LBO2 test adapter.
25	Install 4100A LBO networks in LBO position 2. GAIN TEST
26	On the test set jack panel, remove the patch between PILOT IN and PILOT OUT jacks. Note: In this test, the gain is measured without the 11.648-MHz pilot. Without the pilot the post-regulator of: List 1 goes to maximum gain. List 2 and List 3 maintain nominal gain. Control is transferred to the preregulator control circuit.
27	Patch the STE through the attenuator and back-to-back connector to the RTE [patches (1), (2), and (3), Fig. 3].
28	Set the attenuator to 0.00 dB.
29	Set the RTE to measure 12 MHz at -20.00 dBm .
30	Adjust the STE to deliver a 12-MHz signal to obtain an indication of -20.00 dBm on the RTE.
31	Set the attenuator for 25-dB loss.
32	Patch the RTE to the HF LINE OUT jack located on the test set jack panel [patch (4), Fig. 3].

CHART 2 (Cont)

STEP	PROCEDURE								
33	Patch the output of the attenuator to the HF LINE IN jack on the test set jack panel [patch (5), Fig. 3].								
34	Allow the repeater to stabilize (minimum of 3 minutes).								
35	Adjust the attenuator to obtain, as near as possible, a -20.00 dBm indication on the RTE.								
36	Record the algebraic sum of the attenuator setting and the RTE expanded scale meter indication.								
37	Compute and record the repeater gain per the following example: <table> <tr> <td>Set loss at 12 MHz (from test set calibration records):</td><td>3.95 dB</td></tr> <tr> <td>Plus loss of pad and cord assembly:</td><td>10.00 dB</td></tr> <tr> <td>Plus value recorded in Step 36:</td><td>13.10 dB</td></tr> <tr> <td>Repeater gain:</td><td><u>27.05 dB</u></td></tr> </table> Requirement: <i>List 1:</i> between 29.00 and 31.50 dB <i>List 2:</i> between 26.81 and 28.21 dB <i>List 3:</i> between 26.73 and 28.13 dB	Set loss at 12 MHz (from test set calibration records):	3.95 dB	Plus loss of pad and cord assembly:	10.00 dB	Plus value recorded in Step 36:	13.10 dB	Repeater gain:	<u>27.05 dB</u>
Set loss at 12 MHz (from test set calibration records):	3.95 dB								
Plus loss of pad and cord assembly:	10.00 dB								
Plus value recorded in Step 36:	13.10 dB								
Repeater gain:	<u>27.05 dB</u>								
38	Remove the 4100A LBO networks (0 loss) from the repeater.								
39	Install LBO network appropriate for the location at which the repeater is to be installed. (See office records for required LBO networks.)								
40	Adjust the test attenuator to obtain, as near as possible, a -20.00 dBm indication on the RTE.								
41	Record the algebraic sum of the attenuator setting and the RTE expanded scale meter indication.								
42	Compute the overall repeater gain at 12 MHz per Example A; compute the net gain per Example B. Example A: <table> <tr> <td>Set loss at 12 MHz:</td><td>3.95 dB</td></tr> <tr> <td>Plus loss of pad and cord assembly:</td><td>10.00 dB</td></tr> <tr> <td>Plus value recorded in Step 41:</td><td>3.01 dB</td></tr> <tr> <td>Overall repeater gain at 12 MHz:</td><td><u>16.96 dB</u></td></tr> </table>	Set loss at 12 MHz:	3.95 dB	Plus loss of pad and cord assembly:	10.00 dB	Plus value recorded in Step 41:	3.01 dB	Overall repeater gain at 12 MHz:	<u>16.96 dB</u>
Set loss at 12 MHz:	3.95 dB								
Plus loss of pad and cord assembly:	10.00 dB								
Plus value recorded in Step 41:	3.01 dB								
Overall repeater gain at 12 MHz:	<u>16.96 dB</u>								

CHART 2 (Cont)

STEP	PROCEDURE																																																		
	Example B: Overall repeater gain at 12 MHz: 16.96 dB Plus combined loss of the two LBO networks*: 9.59 dB Net gain: 26.55 dB * Assume 4100AD and 4100AE networks were used; from Table B, 4.11 + 5.48 = 9.59 dB. Requirement: Net gain within ± 0.5 dB of gain value recorded in Step 37. TABLE B LINE BUILD-OUT NETWORKS <table><tr><th colspan="2">LBO NETWORK CODES</th><th rowspan="2">BUILD-OUT DISTANCE (MILES)</th><th rowspan="2">LOSS OF EACH LBO AT 12 MHZ (DB)</th></tr><tr><th>LBO NO. 1</th><th>LBO NO. 2</th></tr><tr><td>4100A</td><td>4100A</td><td>0.0</td><td>0.00</td></tr><tr><td>—</td><td>4100B</td><td>0.1</td><td>1.37</td></tr><tr><td>4100AC</td><td>4100C</td><td>0.2</td><td>2.74</td></tr><tr><td>4100AD</td><td>4100D</td><td>0.3</td><td>4.11</td></tr><tr><td>4100AE</td><td>4100E</td><td>0.4</td><td>5.48</td></tr><tr><td>4100AF</td><td>4100F</td><td>0.5</td><td>6.85</td></tr><tr><td>4100AG</td><td>4100G</td><td>0.6</td><td>8.22</td></tr><tr><td>4100AH</td><td>4100H</td><td>0.7</td><td>9.59</td></tr><tr><td>4100AJ</td><td>4100J</td><td>0.8</td><td>10.96</td></tr><tr><td>4100AK</td><td>4100K</td><td>0.9</td><td>12.33</td></tr><tr><td>4100AL</td><td>4100L</td><td>1.0</td><td>13.70</td></tr></table>	LBO NETWORK CODES		BUILD-OUT DISTANCE (MILES)	LOSS OF EACH LBO AT 12 MHZ (DB)	LBO NO. 1	LBO NO. 2	4100A	4100A	0.0	0.00	—	4100B	0.1	1.37	4100AC	4100C	0.2	2.74	4100AD	4100D	0.3	4.11	4100AE	4100E	0.4	5.48	4100AF	4100F	0.5	6.85	4100AG	4100G	0.6	8.22	4100AH	4100H	0.7	9.59	4100AJ	4100J	0.8	10.96	4100AK	4100K	0.9	12.33	4100AL	4100L	1.0	13.70
LBO NETWORK CODES		BUILD-OUT DISTANCE (MILES)	LOSS OF EACH LBO AT 12 MHZ (DB)																																																
LBO NO. 1	LBO NO. 2																																																		
4100A	4100A	0.0	0.00																																																
—	4100B	0.1	1.37																																																
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4100AK	4100K	0.9	12.33																																																
4100AL	4100L	1.0	13.70																																																
43	On the test set repeater power supply, turn the MAIN voltage control to 0 and set the DC switch to OFF.																																																		
44	Remove the repeater unit.																																																		
45	Reinstall the nylon screw in the R1 access hole, and seal the R1 access hole in the repeater cover with the snap-in dust cap or adhesive-backed metal decal if provided.																																																		
46	Record the following on a form similar to the one shown in Fig. 8:																																																		

L4 EQUALIZING REPEATER

CABLE SECTION _____

EQUALIZING MANHOLE STATION _____ AREA _____

AVERAGE ANNUAL UNDERGROUND TEMPERATURE _____ °F

L-4 LINE	AC					AD SERIAL	AE SERIAL	AH SERIAL	AJ SERIAL	DC-DC CONV	AF		AG	
	SERIAL	859C SW	LB01	LB02	DEV EQL						SERIAL	LIST	SERIAL	LIST
ODD LINES: CABLE MILES TO NEXT REG RPTR _____, MON OSC CODE 66 _____, 4103A NETWORK OUTPUT _____ DB														
L401														
L403														
L405														
L407														
L409														
L411														
L413														
L415														
L417														
L419														
EVEN LINES: CABLE MILES TO NEXT REG RPTR _____, MON OSC CODE 66 _____, 4103A NETWORK OUTPUT _____ DB														
L402														
L404														
L406														
L408														
L410														
L412														
L414														
L416														
L418														
L420														

COMMENTS _____

Fig. 8—Typical Equalizing Repeater Station Inventory Form

CHART 2 (Cont)

STEP	PROCEDURE																																
47	(a) Repeater unit serial number (b) Identification number of the deviation equalizer installed (c) Codes of the LBO networks installed in LBO positions 1 and 2 (d) Screw switch set (turned in) on the 859C network. Note: The form illustrated in Fig. 8 is recommended for use as an office record of equipment installed at an equalizing repeater location. Place a gummed label, similar to the one illustrated in Fig. 9, on LBO1 network just below the network handle and fill in the applicable portions indicated by asterisks(*) . Note: Form ST-1 may be ordered in rolls of 500 or 1000 from: Chambers, Inc. 2171 Hawkins Street Charlotte, North Carolina 28203 <table><tr><td colspan="4">FORM ST-1</td></tr><tr><td colspan="2">TYPE</td><td>SERIAL NO.</td><td>*</td></tr><tr><td colspan="2">IN SERVICE *</td><td>LOCATION</td><td>*</td></tr><tr><td colspan="2">OUT OF SERVICE</td><td>COAXIAL</td><td>*</td></tr><tr><td>Gp *</td><td>dB</td><td colspan="2">D.E. TYPE</td></tr><tr><td colspan="2">LBO #1 *</td><td>LBO #2</td><td>*</td></tr><tr><td colspan="2">STRAP</td><td>PORTS 1 & 3</td><td>2 & 4</td></tr><tr><td colspan="4">REASON OUT</td></tr></table>	FORM ST-1				TYPE		SERIAL NO.	*	IN SERVICE *		LOCATION	*	OUT OF SERVICE		COAXIAL	*	Gp *	dB	D.E. TYPE		LBO #1 *		LBO #2	*	STRAP		PORTS 1 & 3	2 & 4	REASON OUT			
FORM ST-1																																	
TYPE		SERIAL NO.	*																														
IN SERVICE *		LOCATION	*																														
OUT OF SERVICE		COAXIAL	*																														
Gp *	dB	D.E. TYPE																															
LBO #1 *		LBO #2	*																														
STRAP		PORTS 1 & 3	2 & 4																														
REASON OUT																																	

Fig. 9—Equipment Identification Tag (Stick-On Type)

Fig. 9—Equipment Identification Tag (Stick-On Type)

CHART 3

PERFORMANCE TESTS USING THE J68899A TEST SET

Operation of the J68899A main station repeater test set (Fig. 10) should be verified as prescribed in Section 103-457-000 before proceeding with these tests. Test arrangements are illustrated in Fig. 11.

CHART 3 (Cont)

APPARATUS

J68899A Main Station Repeater Test Set (Section 103-457-000)

4100A LBO Networks (0 loss), 2 required

4152A Deviation Equalizer (Test Standard) Network (used with List 1 and 2 repeaters)

4152B Deviation Equalizer (Test Standard) Network (used with List 3 repeater)

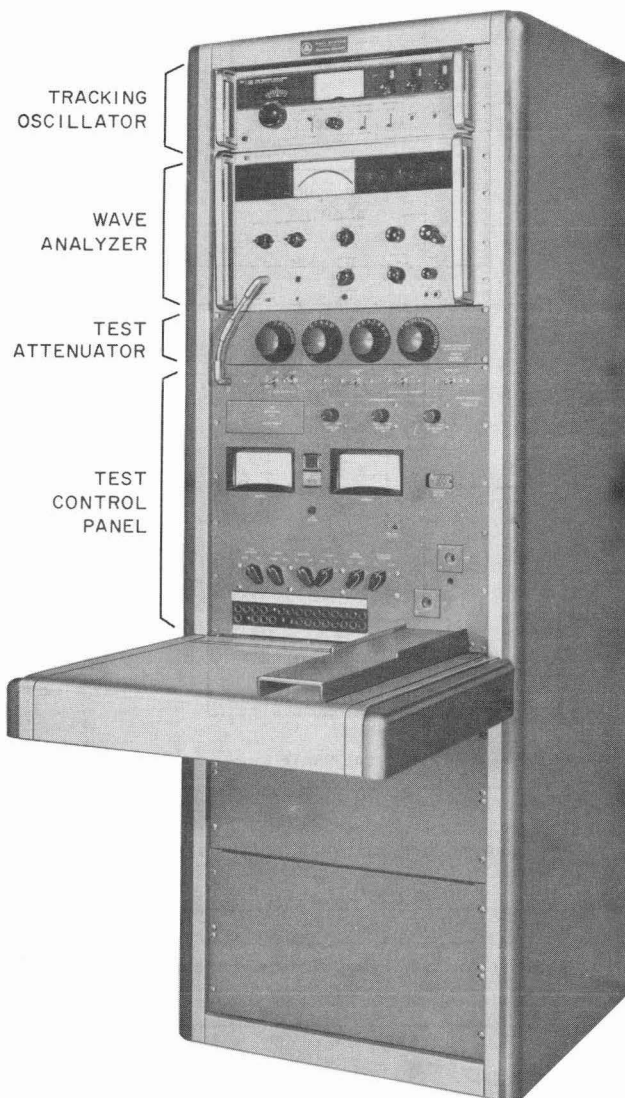


Fig. 10—J68899A Main Station Repeater Test Set

CHART 3 (Cont)

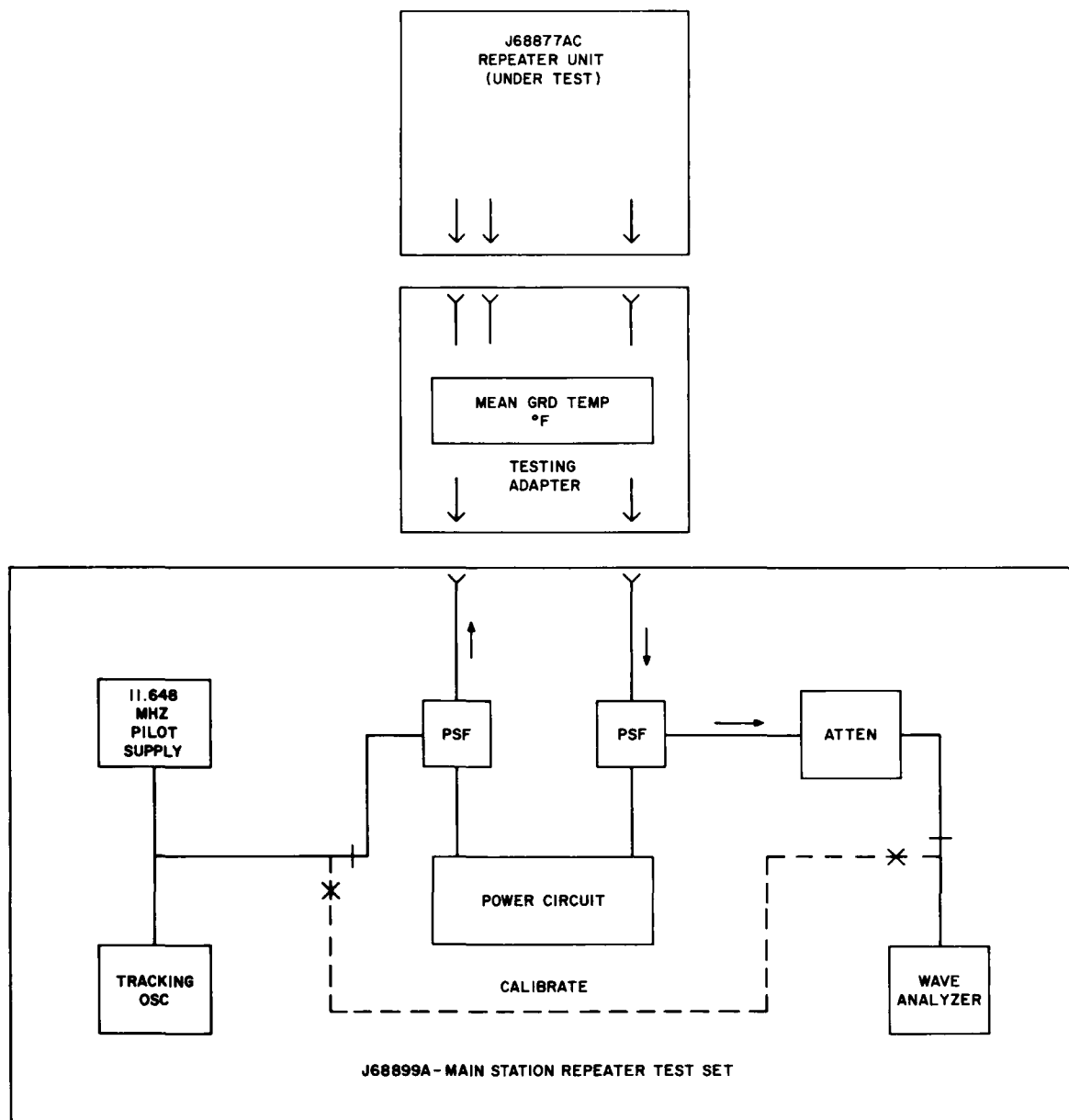


Fig. 11—Arrangement for Gain-Regulation Test of J68877AC Repeater Unit

CHART 3 (Cont)

STEP	PROCEDURE
	Note 1: The preregulator circuit is adjusted at the factory for nominal conditions. On these units preregulator adjustment should not be necessary. If the repeater has been previously adjusted for installation at a particular location, the preregulator adjustment (Steps 28 through 48) should be made before the gain test (Steps 14 through 27). Note 2: In these tests, after performing operations affecting regulation, it is necessary to allow the repeater to stabilize before making a gain measurement. The repeater can be considered stable when the tracking oscillator meter indication changes no more than 0.1 dB in the preceding minute. 1 On the test set, set switches and controls in accordance with Table C. Note: Switches and controls not listed in Table C are either set or adjusted in the test procedure or are not required for this test. 2 Position the repeater unit as shown in Fig. 1 (two coaxial plugs to the left); then remove the top cover. 3 Remove and retain the regular deviation equalizer unit if one is installed. 4 Install a deviation equalizer as follows: (a) For a List 1 or 2 repeater, use a 4152A network. (b) For a List 3 repeater, use a 4152B network. 5 Check the 859C network to ensure that all screw switches are open (turned out). 6 Remove, and retain for reinstallation, the nylon screw which is used to plug the R1 adjustment access hole. (See Special Consideration, page 3.) 7 Replace the repeater cover. 8 Install 4100A LBO networks (0 loss) in LBO positions 1 and 2. 9 Install the ED-50599-30 test adapter in the test set. 10 Install the repeater in the test adapter. 11 Set the GRD TEMP °F switch on the ED-50599-30 test adapter to 55. 12 On the test set jack panel, make the following patches: HYB OUT to SIG INT ATTEN OUT to MEAS DET INT to ATTEN IN

CHART 3 (Cont)

TABLE C
TEST SET SWITCH AND CONTROL SETTINGS

SWITCH/CONTROL	SETTING
<i>Tracking Oscillator</i> LINE OSCILLATOR MODE METER MODE MAX OUTPUT Attenuator Controls	ON (switch will light) TRACK 312A 312A EXPAND 0 DBM —30.0 DB
<i>Wave Analyzer</i> LINE-PUSH ON/OFF BANDWIDTH — HZ RECEIVER MODE BRIDGED/TERMINATED	ON (switch will light) 3000 AM 75Ω
<i>Attenuator Panel</i> All Four Controls	0
<i>Test Control Panel</i> PWR ON 3 DB-A 3 DB-B TEST REPEATER MODE DETECTOR SIGNAL BASIC REPEATER REGULATING REPEATER	OFF (switch is not lighted) IN OUT REG TRMSN INT INT MEAS CAL

CHART 3 (Cont)

STEP	PROCEDURE
13	Apply power to the repeater as follows: (a) Depress the PWR ON switch. Requirement: The lamp in the PWR ON switch lights. (b) Depress the LINE/M-STA switch (if necessary). Requirement: The lamp in the LINE portion of the switch lights. (c) Observe CURRENT and VOLTAGE meter indications. Requirements: (a) CURRENT meter: 520 ± 10 mA (b) VOLTAGE meter: between 64 and 72 volts GAIN TEST
14	Set the REFERENCE LEVEL-DBM control on the wave analyzer to -40 .
15	Set the AMPLITUDE RANGE-DB control to 0. (See Note after Step 26.)
16	Set the FREQUENCY RANGE-MHZ control to 20.
17	Adjust the FREQUENCY TUNING controls as required to obtain $20.448 \text{ MHz} \pm 50 \text{ Hz}$.
18	Adjust the SCALE OFFSET controls on the oscillator to obtain an indication of exactly 0 dB on the oscillator meter. Note: The oscillator meter acts as an expanded scale meter for the wave analyzer.
19	Set the test set attenuator to a value 10 dB less than the expected gain of the repeater at 20.448 MHz (setting approximately 26 dB, column D, Fig. 12). (See Note after Step 26.)
20	Set the REGULATING REPEATER switch on the test set control panel to MEAS.
21	Adjust the test attenuator until the oscillator meter indicates 0 dB.
22	Record the test attenuator setting under column E (MEASURED VALUE) of the test record form, Fig. 12.
23	From test set calibration records, obtain the measure path loss deviation for each of the test frequencies and record the value in column F, Fig. 12.
24	Compute repeater gain (column E plus column F) and record value (repeater gain) in column G of Fig. 12. Requirement: Within the range specified in columns B and C of Fig. 12.

DATE OF TEST _____ BY _____ REPEATER SERIAL NO. _____

J68877AC LIST 1 OR LIST 2 UNIT						
A	B	C	D	E	F	G
TEST FREQ (MHZ)	REQUIRED GAIN (DB)		INITIAL ATTEN SET (DB)	FINAL ATTEN SET (DB)	MEAS PATH DEVIATION (DB)	RPTR GAIN (E + F) (DB)
	MIN	MAX				
20.448	35.14	37.14	26			
17.500	33.52	34.77	24			
12.000	27.18	27.78	17			
4.000	16.02	16.82	6			
0.512*	5.70	6.50	6.5			
J68877AC LIST 3 UNIT						
20.448	33.17	35.17	26			
17.500	32.07	33.27	24			
12.000	27.13	27.73	17			
4.000	16.26	17.06	6			
0.512*	5.56	6.36	6.5			
*See note after Step 26. Post-regulation _____ Preregulation _____ Post-regulation Transfer _____ Noise _____ Remarks _____ _____						

Fig. 12—J68877AC Regulating Repeater Test Record

CHART 3 (Cont)

CHART 3 (Cont)															
STEP	PROCEDURE														
25	Reset the REGULATING REPEATER switch to the CAL position.														
26	Repeat Steps 15 through 25 (see note) at the remaining frequencies listed in Fig. 12. Note: When measuring gain at 0.512 MHz, substitute the following for Steps 15 and 19: Step 15: Set the AMPLITUDE RANGE-DB control to -10. Step 19: Set the test attenuator to the expected gain of the repeater.														
27	If the requirement of Step 24 is met, proceed to Step 49. If it is not met, the preregulator may be out of adjustment. Perform Steps 28 through 48. PREREGULATOR ADJUSTMENT														
28	Remove the LBO network from LBO position 2.														
29	Set switches on the test set control panel as follows: <table><tr><th>SWITCH DESIGNATION</th><th>SWITCH POSITION</th></tr><tr><td>TEST REPEATER</td><td>BASIC</td></tr><tr><td>MODE</td><td>TRMSN</td></tr><tr><td>DETECTOR</td><td>INT</td></tr><tr><td>SIGNAL</td><td>EXT</td></tr><tr><td>BASIC REPEATER</td><td>MEAS</td></tr><tr><td>REGULATING REPEATER</td><td>MEAS</td></tr></table>	SWITCH DESIGNATION	SWITCH POSITION	TEST REPEATER	BASIC	MODE	TRMSN	DETECTOR	INT	SIGNAL	EXT	BASIC REPEATER	MEAS	REGULATING REPEATER	MEAS
SWITCH DESIGNATION	SWITCH POSITION														
TEST REPEATER	BASIC														
MODE	TRMSN														
DETECTOR	INT														
SIGNAL	EXT														
BASIC REPEATER	MEAS														
REGULATING REPEATER	MEAS														
30	Make patches on the control panel jack field as follows: ATTEN OUT to SIG INT OSC OUT to ATTEN IN SIG EXT to 10-dB pad (via patch cord) 10-dB pad to MEAS (directly) Note: It is important that the SIG EXT jack be connected to the 10-dB pad via a patch cord and that the 10-dB pad be inserted directly into the MEAS jack.														
31	At the rear of test set remove the normal cable connections and patch from the (variable pad) attenuator 5 OUT jack to the SIG IN jack on the input side of the power separation filter. This patch is necessary to provide 11.648-MHz pilot to the repeater during preregulator adjustment.														
32	Set the FREQUENCY RANGE-MHZ control to 11.														

CHART 3 (Cont)

STEP	PROCEDURE														
33	Adjust the FREQUENCY TUNING controls to obtain 11.648 MHz ± 50 Hz.														
34	Set the REFERENCE LEVEL-DBM control to -40.														
35	Set the AMPLITUDE RANGE-DB control to 0.														
36	Set the attenuator panel controls to 00.00 dB.														
37	Adjust the SCALE OFFSET controls on the oscillator to obtain exactly 0 dB on the oscillator meter.														
38	Set the test set attenuator to 8.63 dB.														
39	Remove the 10-dB pad from the MEAS jack and connect it directly to jack J6 on the repeater.														
40	Patch the DET INT jack to the MEAS jack.														
41	Observe the oscillator meter. Requirement: 0 ± 0.1 dB														
42	If the requirement of Step 41 is met, proceed to Step 44. If it is not met, adjust the R1 potentiometer to meet the requirement. Note: R1 adjustment is accessible through a hole in the cover.														
43	Wait for the repeater to stabilize and, if necessary, readjust R1. (The repeater can be considered stable when the oscillator meter indication changes no more than 0.1 dB in the preceding minute.)														
44	Remove the patch from between attenuator 5 OUT jack and SIG IN of the power separation filter, and restore cables to normal.														
45	Set the switches on the test set control panel as follows:														
	<table> <tr> <th>SWITCH DESIGNATION</th><th>SWITCH POSITION</th></tr> <tr> <td>TEST REPEATER</td><td>REG</td></tr> <tr> <td>MODE</td><td>TRMSN</td></tr> <tr> <td>DETECTOR</td><td>INT</td></tr> <tr> <td>SIGNAL</td><td>INT</td></tr> <tr> <td>BASIC REPEATER</td><td>MEAS</td></tr> <tr> <td>REGULATING REPEATER</td><td>CAL</td></tr> </table>	SWITCH DESIGNATION	SWITCH POSITION	TEST REPEATER	REG	MODE	TRMSN	DETECTOR	INT	SIGNAL	INT	BASIC REPEATER	MEAS	REGULATING REPEATER	CAL
SWITCH DESIGNATION	SWITCH POSITION														
TEST REPEATER	REG														
MODE	TRMSN														
DETECTOR	INT														
SIGNAL	INT														
BASIC REPEATER	MEAS														
REGULATING REPEATER	CAL														

CHART 3 (Cont)

STEP	PROCEDURE
46	Make patches on the control panel jack field as follows: HYB OUT to SIG INT ATTEN OUT to MEAS DET INT to ATTEN IN
47	Replace the LBO network in LBO position 2.
48	Measure the repeater gain by repeating Steps 14 through 27. POST-REGULATION
49	Remeasure the repeater gain at 12 MHz (Steps 14 through 27). Record the measured gain.
50	Operate the 3DB-A switch on the test set control panel to OUT. (The 3DB-B switch should already have been set to OUT.) This increases the input power level of the 11.648-MHz pilot signal applied to the repeater by 3 dB. Requirement: The gain decreases toward a level 3 dB below the level measured in Step 49.
51	To check the full regulating range, allow time for the regulating action to stop (minimum of 3 minutes) and again measure the gain at 12 MHz. Requirement: Between 2.65 and 3.00 dB below the value recorded in Step 49.
52	Set both 3DB switches to the IN positions. (This decreases the level of the 11.648-MHz pilot 6 dB, ie, 3 dB below the original level.) Requirement: The gain increases toward a level 3 dB above the level measured in Step 49.
53	To check the full regulating range, allow time for the regulating action to stop (minimum of 2 minutes) and again measure the gain at 12 MHz. Requirement: Between 2.65 and 3.00 dB above the value measured in Step 49.
54	Reset the 11.648-MHz pilot to its original power level by operating the 3DB-B switch to OUT.
55	Allow time for the regulating action to stop (minimum of 2 minutes) and measure the repeater gain at 12 MHz. Requirement: Within ± 0.2 dB of the value measured in Step 49. Record the gain value for use in the preregulation test.

CHART 3 (Cont)

STEP	PROCEDURE
	PREREGULATION
56	Set the MEAN GRD TEMP °F switch on the test set adapter to 75.
	Requirement: The repeater gain increases toward a level approximately 2 dB above the level measured in Step 55.
57	To check the full regulating range, allow time for the repeater to stabilize (minimum of 2 minutes) and measure the repeater gain at 12 MHz. Record the measured gain.
58	Set the MEAN GRD TEMP °F switch to 35.
	Requirement: The repeater gain decreases toward a level approximately 2 dB below the level measured in Step 55.
59	To check the full regulating range, allow time for the repeater to stabilize (minimum of 5 minutes) and again measure the repeater gain at 12 MHz. Record the measured gain.
60	Compute preregulator gain range as follows: Gain value obtained in Step 57 minus gain value obtained in Step 59. Requirement: 4.4 ± 0.5 dB
61	Reset the MEAN GRD TEMP °F switch to 55.
	POST-REGULATOR TRANSFER
62	Allow 5 minutes for the repeater to stabilize.
63	Measure and record the repeater gain as in Step 26.
	Requirement: Within ± 0.2 dB of value recorded in Step 49.
64	At the rear of the test set, on the oscillator shelf, remove pilot to the repeater by removing the coaxial plug from the OSC 4 11.648 MHz jack.
65	Allow 5 minutes for the repeater to stabilize.
66	Measure the repeater gain at 12 MHz as in Step 26.
	Requirement: Repeater gain List 1: between 29.0 and 31.5 dB List 2: between 26.81 and 28.21 dB List 3: between 26.73 and 28.13 dB

CHART 3 (Cont)									
STEP	PROCEDURE								
67	At the rear of the test set, reconnect the coaxial cable plug (removed in Step 64) in the OSC 4 11.648 MHz jack.								
	TEST FOR 20-KHZ HARMONIC TONES								
68	On the control panel, set switches as follows:								
	<table> <tr> <th>SWITCH DESIGNATION</th><th>SWITCH POSITION</th></tr> <tr> <td>TEST REPEATER</td><td>BASIC</td></tr> <tr> <td>BASIC REPEATER</td><td>MEAS</td></tr> <tr> <td>REGULATING REPEATER</td><td>MEAS</td></tr> </table>	SWITCH DESIGNATION	SWITCH POSITION	TEST REPEATER	BASIC	BASIC REPEATER	MEAS	REGULATING REPEATER	MEAS
SWITCH DESIGNATION	SWITCH POSITION								
TEST REPEATER	BASIC								
BASIC REPEATER	MEAS								
REGULATING REPEATER	MEAS								
69	Set the attenuator panel controls to 0.00 dB.								
70	On the test adapter, set the MEAN GRD TEMP °F switch to 75°F.								
71	On the wave analyzer, set the REFERENCE LEVEL-DBM control to -40 and the AMPLITUDE RANGE-DB control to -30 such that the lighted annunciator indicates -70 dBm.								
72	On the wave analyzer, set the FREQUENCY RANGE-MHZ control to 0.								
73	Using the FREQUENCY TUNING COARSE and FINE controls, sweep frequency from 280 to 510 kHz while monitoring the power indication and frequency of any tone higher than -80 dBm.								
	Requirement: No 20-kHz harmonic tone higher than -75 dBm (-74 dBm is higher).								
	NOISE								
74	On the test set jack panel, remove all patches.								
75	Patch between the DET INT and MEAS jacks.								
76	Place a 75-ohm termination in the SIG INT jack on the test set control panel.								
77	Adjust the FREQUENCY RANGE-MHZ control on the wave analyzer to 17.								
78	Adjust the FREQUENCY TUNING controls to detect approximately 17.5 MHz.								
79	Set the REFERENCE LEVEL-DBM control to -40.								
80	Set the AMPLITUDE RANGE-DB control as required to measure the noise (-50 or -60).								
	Requirement: Noise power less than -94 dBm. (-95 dBm is less than -94 dBm.)								
81	Remove the repeater unit from the test set and then remove the LBO networks, the repeater cover, and the 4152() deviation equalizer.								

CHART 3 (Cont)

STEP	PROCEDURE
82	If the regular deviation equalizer was removed, reinstall the unit.
83	Reinstall the nylon screw in the R1 adjustment access hole, and seal the R1 access hole in the repeater cover with the snap-in dust cap or adhesive-backed metal decal, if provided.
84	Replace the repeater cover.
85	If the repeater is to be prepared for installation at a particular repeater location, proceed to Chart 4; otherwise, follow local procedures to store the unit.

CHART 4**PREINSTALLATION TEST USING THE J68899A TEST SET**

As a prerequisite to preparing a repeater unit for installation at a specific repeater location in the L4 system, the unit must have met the requirements of the tests in Chart 3 of this section. Preparation for installation is as follows:

- (a) Installing the proper deviation equalizer
- (b) Adjusting the preregulator circuit to regulate at the mean temperature and spacing of the repeater location for which the unit is being prepared
- (c) Measuring repeater gain at 12 MHz.

APPARATUS

J68899A Main Station Repeater Test Set (Section 103-457-000)

4100A LBO Networks (0 loss)

STEP	PROCEDURE
1	<i>Caution: Do not adjust the preregulator section of the repeater until the repeater has fully warmed up. Adjustment of a cold repeater will result in misalignment.</i>
	PREREGULATOR ADJUSTMENT Position the repeater unit as shown in Fig. 1 (two coaxial plugs on left); then remove the cover.

CHART 4 (Cont)

CHART 4 (Cont)

STEP	PROCEDURE																		
2	Install a deviation equalizer (if not previously installed) appropriate to the location for which the repeater is being prepared.																		
3	Obtain the following from office records: (a) Average annual underground temperature for the repeater location (b) Distance (cable miles) to the next regulating repeater.																		
4	With the information obtained in Step 3, refer to Table D to determine which 859C screw switch should be turned in. TABLE D 859C NETWORK SCREW SWITCH SETTINGS <table><tr><th>REG RPTR SPACING*</th><th>45°F TO 62°F‡</th><th>63°F TO 70°F‡</th></tr><tr><td>16 miles†</td><td>None</td><td>None</td></tr><tr><td>14 miles†</td><td>B-1</td><td>B-1</td></tr><tr><td>12 miles</td><td>A-2</td><td>A-2</td></tr><tr><td>10 miles</td><td>B-2</td><td>A-3</td></tr><tr><td>8 miles</td><td>B-3</td><td>A-1</td></tr></table> * Miles to succeeding regulating repeater † Used only in early system (Washington-Miami) ‡ Average annual underground temperature at repeater location (For this information, see office records.)	REG RPTR SPACING*	45°F TO 62°F‡	63°F TO 70°F‡	16 miles†	None	None	14 miles†	B-1	B-1	12 miles	A-2	A-2	10 miles	B-2	A-3	8 miles	B-3	A-1
REG RPTR SPACING*	45°F TO 62°F‡	63°F TO 70°F‡																	
16 miles†	None	None																	
14 miles†	B-1	B-1																	
12 miles	A-2	A-2																	
10 miles	B-2	A-3																	
8 miles	B-3	A-1																	
5	On the 859C network, set the screw switch determined in Step 4 fully clockwise and ensure that all other screw switches are open (turned out).																		
6	Remove, and retain for reinstallation, the nylon screw used to plug the R1 adjustment access hole. (See Special Considerations, page 3.)																		
7	Replace the repeater cover.																		
8	Ensure that the test set switches and controls are set in accordance with Table E.																		
9	Make the following patches on the test set jack panel: ATTEN OUT to SIG INT OSC OUT to ATTEN IN																		

CHART 4 (Cont)

STEP	PROCEDURE										
	SIG EXT to 10-dB pad (via patch cord) 10-dB pad to MEAS (directly) Note: It is important that the SIG EXT jack be connected to the 10-dB pad via a patch cord and that the 10-dB pad be inserted directly in the MEAS jack. TABLE E TEST SET SWITCH AND CONTROL SETTINGS <table> <tr> <th>SWITCH/CONTROL</th><th>SETTING</th></tr> <tr> <td> Tracking Oscillator LINE OSCILLATOR MODE METER MODE MAX OUTPUT Attenuator Controls </td><td> ON (switch will light) TRACK 312A 312A EXPAND 0 DBM —30.0 DB </td></tr> <tr> <td> Wave Analyzer LINE-PUSH ON/OFF BANDWIDTH — HZ RECEIVER MODE BRIDGED/TERMINATED </td><td> ON (switch will light) 3000 AM 75Ω </td></tr> <tr> <td> Attenuator Panel All Four Controls </td><td> 0 </td></tr> <tr> <td> Test Control Panel PWR ON 3 DB-A 3 DB-B TEST REPEATER MODE DETECTOR SIGNAL BASIC REPEATER REGULATING REPEATER </td><td> OFF (switch is not lighted) IN OUT BASIC TRMSN INT EXT MEAS MEAS </td></tr> </table>	SWITCH/CONTROL	SETTING	Tracking Oscillator LINE OSCILLATOR MODE METER MODE MAX OUTPUT Attenuator Controls	ON (switch will light) TRACK 312A 312A EXPAND 0 DBM —30.0 DB	Wave Analyzer LINE-PUSH ON/OFF BANDWIDTH — HZ RECEIVER MODE BRIDGED/TERMINATED	ON (switch will light) 3000 AM 75Ω	Attenuator Panel All Four Controls	0	Test Control Panel PWR ON 3 DB-A 3 DB-B TEST REPEATER MODE DETECTOR SIGNAL BASIC REPEATER REGULATING REPEATER	OFF (switch is not lighted) IN OUT BASIC TRMSN INT EXT MEAS MEAS
SWITCH/CONTROL	SETTING										
Tracking Oscillator LINE OSCILLATOR MODE METER MODE MAX OUTPUT Attenuator Controls	ON (switch will light) TRACK 312A 312A EXPAND 0 DBM —30.0 DB										
Wave Analyzer LINE-PUSH ON/OFF BANDWIDTH — HZ RECEIVER MODE BRIDGED/TERMINATED	ON (switch will light) 3000 AM 75Ω										
Attenuator Panel All Four Controls	0										
Test Control Panel PWR ON 3 DB-A 3 DB-B TEST REPEATER MODE DETECTOR SIGNAL BASIC REPEATER REGULATING REPEATER	OFF (switch is not lighted) IN OUT BASIC TRMSN INT EXT MEAS MEAS										

CHART 4 (Cont)

STEP	PROCEDURE
10	At the rear of the test set remove the normal cables and patch from the attenuator 5 OUT jack to the SIG IN jack on the input side of the power separation filter. This patch is necessary to provide 11.648-MHz pilot to the repeater during preregulator adjustment.
11	Install the ED-50599-30 test adapter in the test set and install the repeater unit in the adapter. Ensure that a 4100A LBO network is installed in position 1.
12	Set the MEAN GRD TEMP °F switch on the test adapter to the mean ground temperature of the location in which the repeater is to be installed. (See office records.)
13	Apply power to the repeater as follows: (a) Depress the PWR ON switch. Requirement: The lamp in the PWR ON switch lights. (b) Depress the LINE/M-STA switch (if necessary). Requirement: The lamp in the LINE portion of the switch lights. (c) Observe CURRENT and VOLTAGE meter indications. Requirement: (a) CURRENT meter: $520 \pm \text{mA}$ (b) VOLTAGE meter: between 64 and 72 volts
14	Set the REFERENCE LEVEL-DBM control on the wave analyzer to -40 .
15	Set the AMPLITUDE RANGE-DB control to 0.
16	Set the FREQUENCY RANGE-MHZ control to 11.
17	Adjust the FREQUENCY TUNING controls to obtain 11.648 MHz ± 50 Hz.
18	Set the attenuator panel controls to 0.00 dB.
19	Adjust the SCALE OFFSET controls to obtain an indication of exactly 0 dB on the oscillator meter.
20	Set the test set attenuator to 8.63 dB.
21	Remove the 10-dB pad from the MEAS jack and connect it directly to jack J6 on the repeater.
22	Patch between the DET INT and MEAS jacks.
23	Observe the oscillator meter indication.
	Requirement: 0 ± 0.1 dB

CHART 4 (Cont)

STEP	PROCEDURE														
24	If the requirement of Step 23 is met, proceed to Step 25. If it is not met, adjust the R1 potentiometer to meet the requirement. (This adjustment is accessible through a hole in the case near the rear of the repeater.) Note: Wait for the repeater to stabilize and, if necessary, readjust. The repeater can be considered stable when the oscillator meter changes no more than 0.1 dB in the preceding minute.														
25	Remove the patch from between the attenuator 5 OUT jack and the SIG IN jack on the power separation filter and restore cables to normal.														
26	Remove the 10-dB pad from jack J6 on the repeater.														
	GAIN TEST														
27	Install 4100A LBO networks (0 loss) in LBO positions 1 and 2.														
28	Set the REFERENCE LEVEL-DBM control on the wave analyzer to -30.														
29	Set the switches on the test set control panel as follows:														
	<table> <tr> <th>SWITCH DESIGNATION</th><th>SWITCH POSITION</th></tr> <tr> <td>TEST REPEATER</td><td>BASIC</td></tr> <tr> <td>MODE</td><td>TRMSN</td></tr> <tr> <td>DETECTOR</td><td>INT</td></tr> <tr> <td>SIGNAL</td><td>INT</td></tr> <tr> <td>BASIC REPEATER</td><td>CAL</td></tr> <tr> <td>REGULATING REPEATER</td><td>MEAS</td></tr> </table>	SWITCH DESIGNATION	SWITCH POSITION	TEST REPEATER	BASIC	MODE	TRMSN	DETECTOR	INT	SIGNAL	INT	BASIC REPEATER	CAL	REGULATING REPEATER	MEAS
SWITCH DESIGNATION	SWITCH POSITION														
TEST REPEATER	BASIC														
MODE	TRMSN														
DETECTOR	INT														
SIGNAL	INT														
BASIC REPEATER	CAL														
REGULATING REPEATER	MEAS														
30	Make patches on the jack panel as follows: ATTEN OUT to SIG INT OSC OUT to ATTEN IN DET INT to MEAS														
31	Set the FREQUENCY RANGE-MHZ control to 12.														
32	Adjust the FREQUENCY TUNING controls as required to obtain 12 MHz $\pm$ 50 Hz.														
33	Adjust the SCALE OFFSET controls to obtain an indication of 0 dB on the oscillator meter.														
34	Set the test attenuator as follows: List 1: 20 dB List 2: 17 dB List 3: 17 dB														

CHART 4 (Cont)

STEP	PROCEDURE								
35	Set the BASIC REPEATER switch to MEAS.								
36	Allow 5 minutes for the repeater gain to stabilize.								
37	Adjust the test attenuator until the oscillator meter indicates 0 dB.								
38	Compute repeater gain in accordance with the following example: <table> <tr> <td>Attenuator setting (Step 37):</td><td>16.95 dB</td></tr> <tr> <td>Plus loss of impedance matching cord and pad assembly:</td><td>10.00 dB</td></tr> <tr> <td>Plus basic repeater measure path deviation:</td><td>0.08 dB</td></tr> <tr> <td>Repeater gain:</td><td>27.03 dB</td></tr> </table> Requirement: <i>List 1:</i> between 29.00 and 31.50 dB <i>List 2:</i> between 26.81 and 28.21 dB <i>List 3:</i> between 26.73 and 28.13 dB	Attenuator setting (Step 37):	16.95 dB	Plus loss of impedance matching cord and pad assembly:	10.00 dB	Plus basic repeater measure path deviation:	0.08 dB	Repeater gain:	27.03 dB
Attenuator setting (Step 37):	16.95 dB								
Plus loss of impedance matching cord and pad assembly:	10.00 dB								
Plus basic repeater measure path deviation:	0.08 dB								
Repeater gain:	27.03 dB								
39	Remove the 4100A LBO networks (0 loss) from the repeater and install networks appropriate for the location in which the repeater is to be installed.								
40	Adjust the test attenuator until the oscillator meter indicates 0 dB.								
41	Compute the overall repeater gain per the following example: <table> <tr> <td>Attenuator setting in Step 40:</td><td>10.10 dB</td></tr> <tr> <td>Plus loss of impedance matching cord and pad assembly:</td><td>10.00 dB</td></tr> <tr> <td>Plus basic repeater measure path deviation:</td><td>0.08 dB</td></tr> <tr> <td>Overall repeater gain:</td><td>20.18 dB</td></tr> </table>	Attenuator setting in Step 40:	10.10 dB	Plus loss of impedance matching cord and pad assembly:	10.00 dB	Plus basic repeater measure path deviation:	0.08 dB	Overall repeater gain:	20.18 dB
Attenuator setting in Step 40:	10.10 dB								
Plus loss of impedance matching cord and pad assembly:	10.00 dB								
Plus basic repeater measure path deviation:	0.08 dB								
Overall repeater gain:	20.18 dB								
42	Add the combined loss of 12 MHz of the two LBO networks to the value obtained in Step 41. Example: Assume a 4100AD LBO was used in LBO 1 position and a 4100C LBO was used in LBO 2 position. See Table F for LBO network loss at 12 MHz. $4.11 \text{ dB} + 2.74 \text{ dB} + 20.18 \text{ dB} = 27.03 \text{ dB}$ Requirement: Within ± 0.5 dB of gain recorded in Step 38.								
43	Remove the repeater unit from the test set.								

CHART 4 (Cont)

STEP	PROCEDURE
44	Reinstall the nylon screw in the R1 access hole, and seal the R1 access hole in the repeater cover with the snap-in dust cap or adhesive-backed metal decal if provided.
45	On a form similar to the one shown in Fig. 8, record the following: (a) Repeater unit serial number (b) Identification number of the deviation equalizer installed (c) Codes of the LBO networks installed in LBO positions 1 and 2 (d) Screw switch set (turned in) on the 859C network. Note: The form illustrated in Fig. 8 (Chart 2) is recommended for use as an office record of the equipment installed at a regulating repeater location.
46	Place a gummed label, similar to the one illustrated in Fig. 9, on LBO1 network just below the network handle and fill in applicable portions indicated by asterisks (*). Note: Form ST-1 may be ordered in rolls of 500 or 1000 from: Chambers, Inc. 2171 Hawkins Street Charlotte, North Carolina 28203

TABLE F

LINE BUILD-OUT NETWORKS

LBO NETWORK CODES		BUILD-OUT DISTANCE (MILES)	LOSS OF EACH LBO AT 12 MHZ (DB)
LBO NO. 1	LBO NO. 2		
4100A	4100A	0.0	0.00
—	4100B	0.1	1.37
4100AC	4100C	0.2	2.74
4100AD	4100D	0.3	4.11
4100AE	4100E	0.4	5.48
4100AF	4100F	0.5	6.85
4100AG	4100G	0.6	8.22
4100AH	4100H	0.7	9.59
4100AJ	4100J	0.8	10.96
4100AK	4100K	0.9	12.33
4100AL	4100L	1.0	13.70

- NOTES:
1. ACCESS TO R1 IS THROUGH THE HOLE IN THE REPEATER COVER. A NYLON SCREW MUST BE REMOVED WHILE THE REPEATER COVER IS OFF TO GAIN ACCESS TO THE R1 ADJUSTMENT.
 2. FOR ACCESS TO THE DEVIATION EQUALIZER, 859C NETWORK SCREW SWITCHES AND NYLON SCREW IN THE R1 ACCESS HOLE, LOCATE THE TWO COAXIAL JACKS THAT ARE CLOSEST TOGETHER ON THE LEFT, AS VIEWED FROM POINT A, AND THEN REMOVE THE COVER WHICH IS ON TOP.

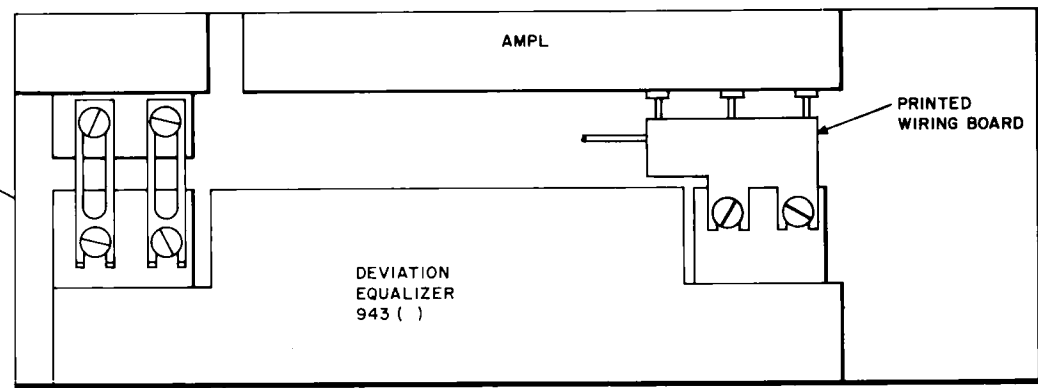
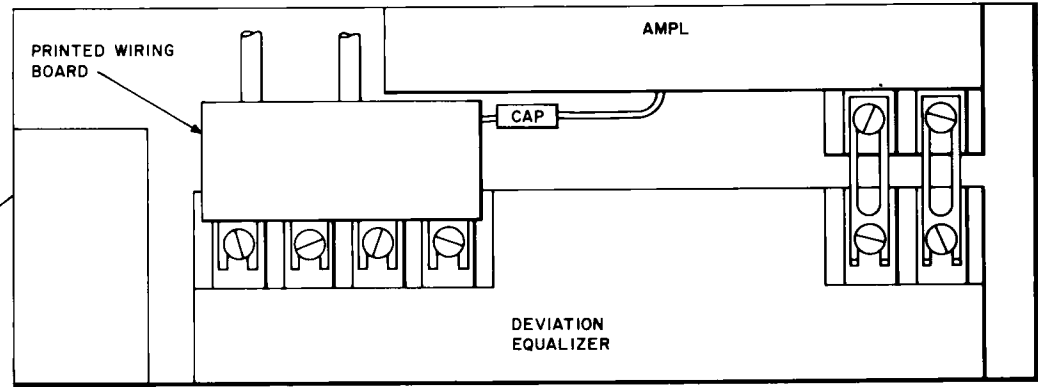
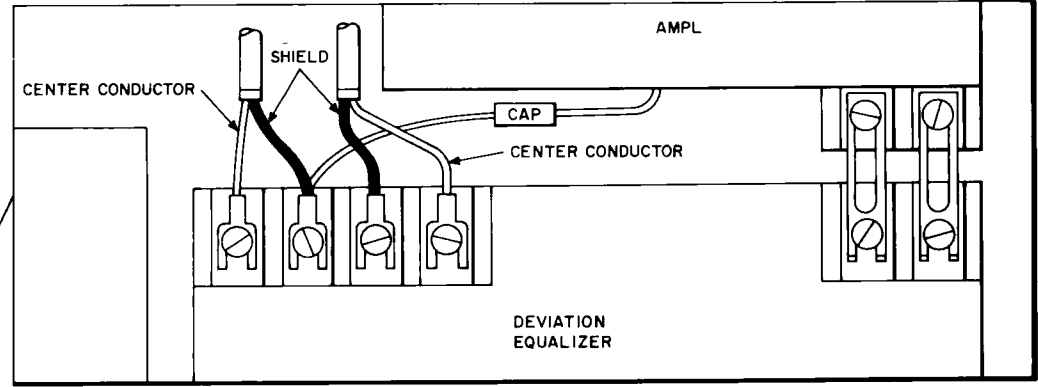
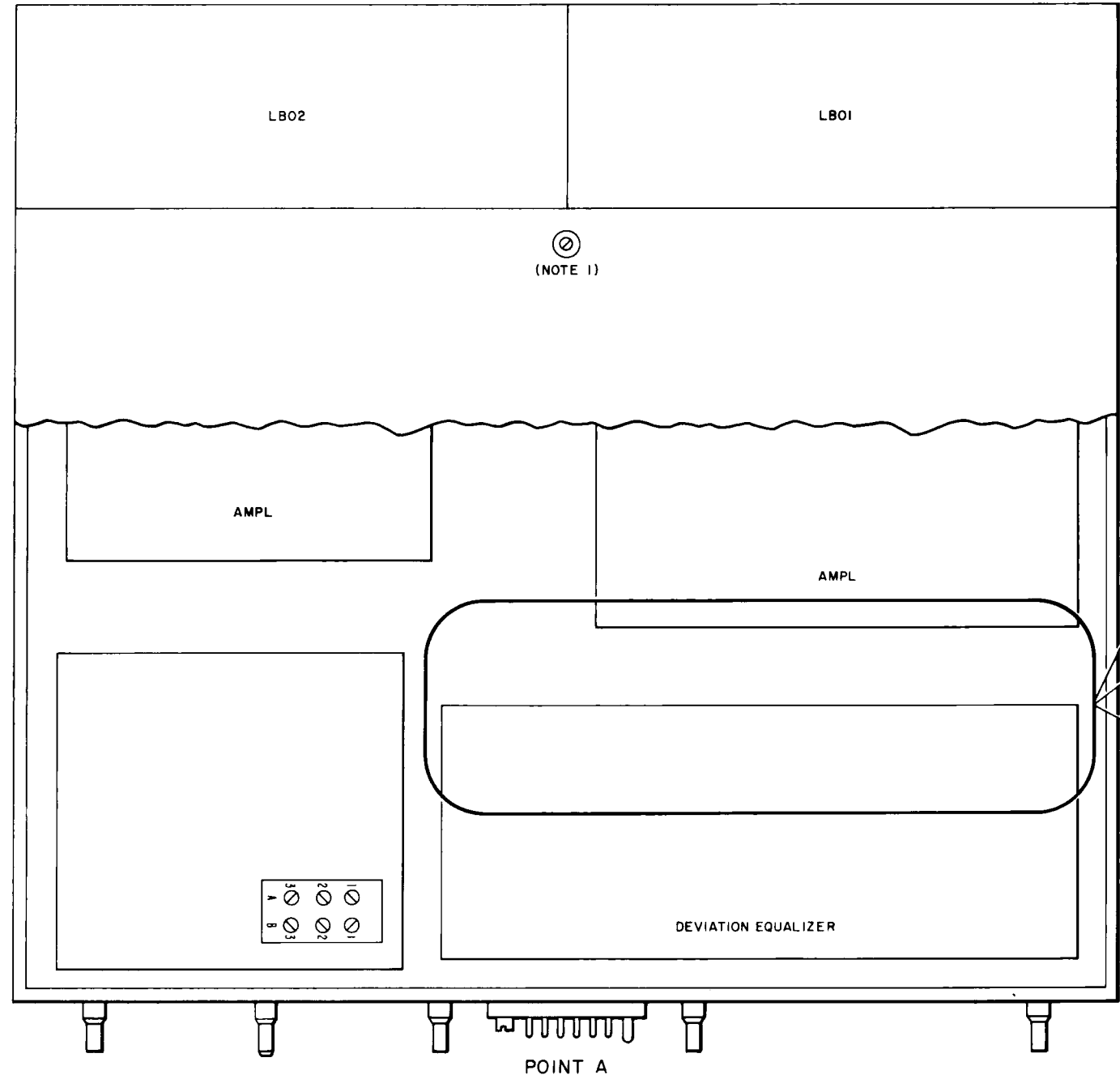
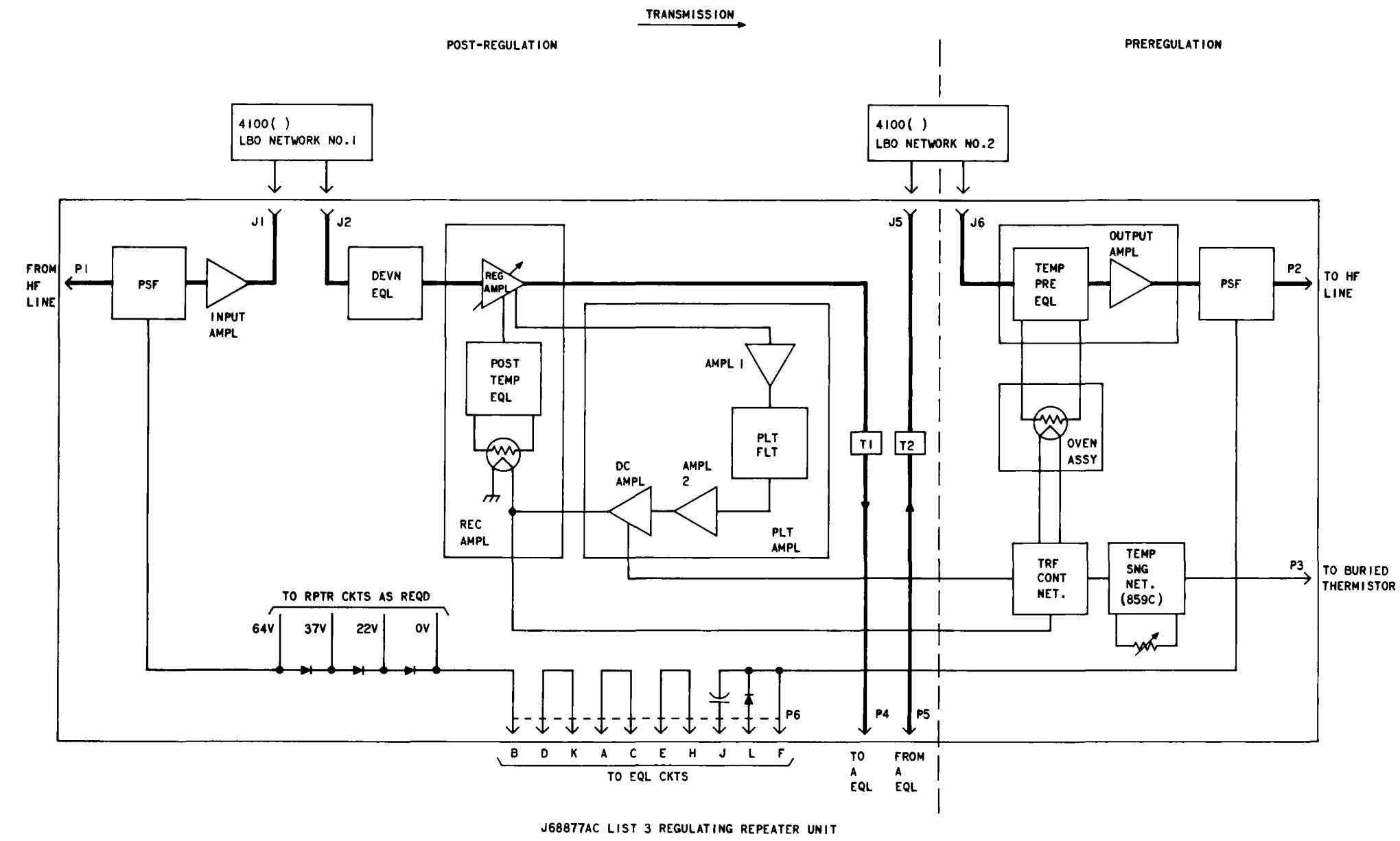
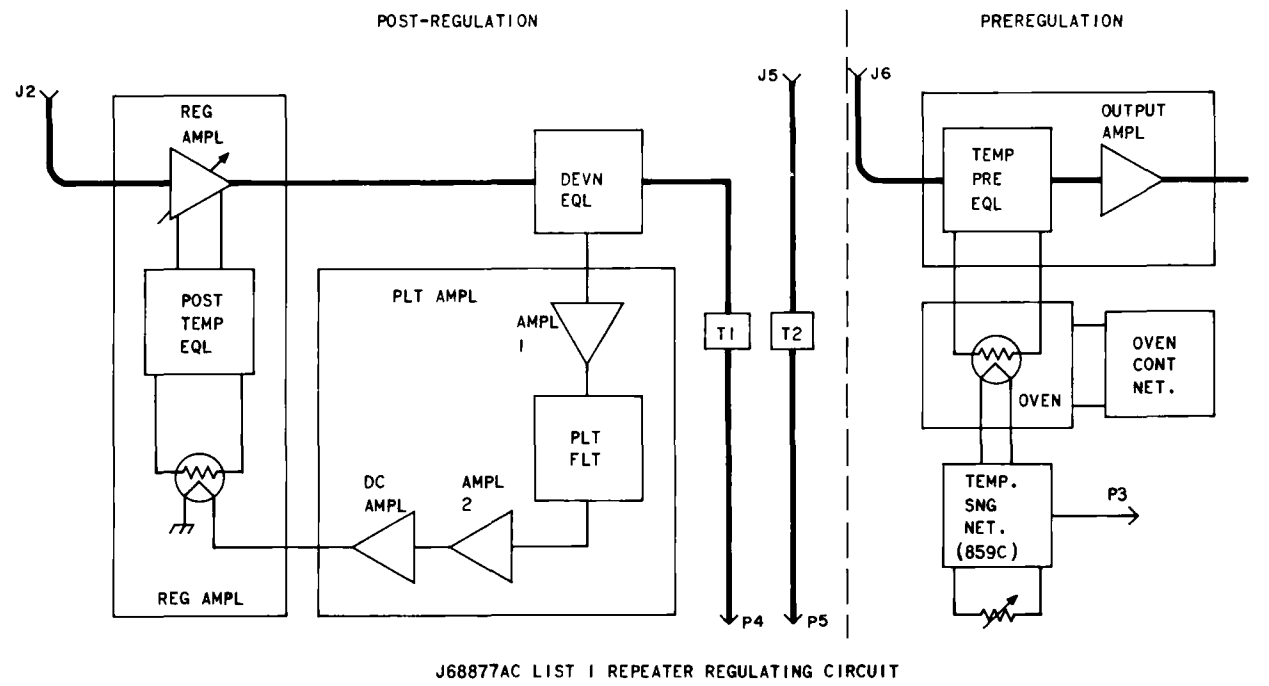


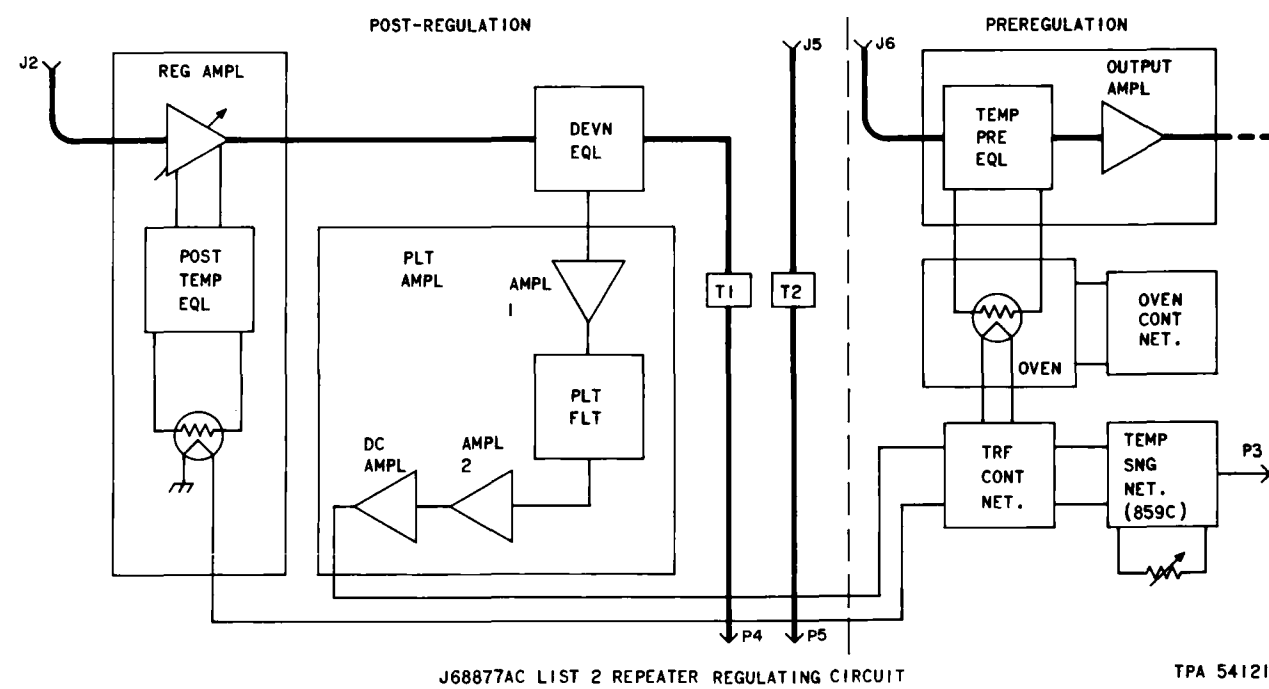
Fig. 13—J68877AC Regulating Repeater—Pictorial Showing Location of Deviation Equalizer, 859C Network, and R1 Adjustment



J68877AC LIST 3 REGULATING REPEATER UNIT



J68877AC LIST 1 REPEATER REGULATING CIRCUIT



J68877AC LIST 2 REPEATER REGULATING CIRCUIT

TPA 541210

Fig. 14—J68877AC Regulating Repeater Configurations for List 1, List 2, and List 3