4-2 WIRE REPEATERS (J99343RB, RC, RG, RJ)

2-4 WIRE INTERMEDIATE REPEATERS (J99343RD, RE, RH, RK)

SD-1C359-01

INSTALLATION AND TESTING

METALLIC FACILITY TERMINAL

CONTENTS PAGE

1. GENERAL

1.01 This section describes the manual installation and testing procedures for the Metallic Facility Terminal (MFT) 4-2 Intermediate/Terminal Repeaters (J99343RB, RC, RG and RJ) and 2-4 Intermediate Repeaters (J99343 RD, RE, RH and RK). The J99343RJ and RK plug-in units are the latest version of these 4-2 and 2-4 type repeaters. The other codes of these repeaters are manufacture discontinued (MD). The information provided in this section is applicable to all codes of 4-2 and 2-4 intermediate repeaters unless otherwise noted. Descriptive information for these repeaters is provided in Section 332-912-121. Section 332-912-222 provides prescription setting procedures and tables.

1.02 This section is being reissued to include installation and testing information on the

4-2 (J99343RJ) and 2-4 (J99343RK) repeaters. Since this reissue is a general revision, no revision arrows have been used to denote significant changes. Changes in the actual installation and testing procedures are minimal.

4-2 WIRE INTERMEDIATE/TERMINAL REPEATERS (J99343 RB, RC, RG and RJ)

1.03 The 4-2 intermediate/terminal repeaters are capable of interfacing 4-wire facility (loaded or nonloaded) or 600-ohm equipment on the A-side and 2-wire facility on the B-side. The repeaters provide selectable 4-wire impedances, 1200 ohms for loaded 4-wire facilities and 600 ohms for nonloaded cable facility or 600-ohm equipment.

1.04 The J99343RB and RG repeaters provide B-side 2-wire circuitry to interface standard gauges of 2-wire H-88 loaded facilities (Fig. 1). The J99343RB unit is MD, replaced by the J99343 RG which is additionally compatible with 25-gauge Metropolitan Area Trunk (MAT) Cable. The J99343 RC 4-2 repeater is compatible with all standard gauges (including MAT) of 2-wire nonloaded facilities (Fig. 2). The J99343RJ (Fig. 3) is the latest 4-2 repeater that is available. This repeater provides selectable circuitry for compatibility with both loaded and nonloaded cable at both the 2-wire and 4-wire interface. The J99343RJ replaces the J99343RG (loaded) and J99343RC (nonloaded) repeaters in application.

2-4 INTERMEDIATE REPEATERS (J99343RD, RF, RH, AND RK)

1.05 The 2-4 repeaters provide practically the same features as the 4-2 repeaters for the reverse arrangements. The 2-4 repeaters interface 2-wire cable facility on the A-side and 4-wire cable or equipment on the B-side.

> *Note:* For more detail on the differences between the 4-2 and 2-4 repeaters, refer to Section 332-912-121 (Description), Issue 3 or later.

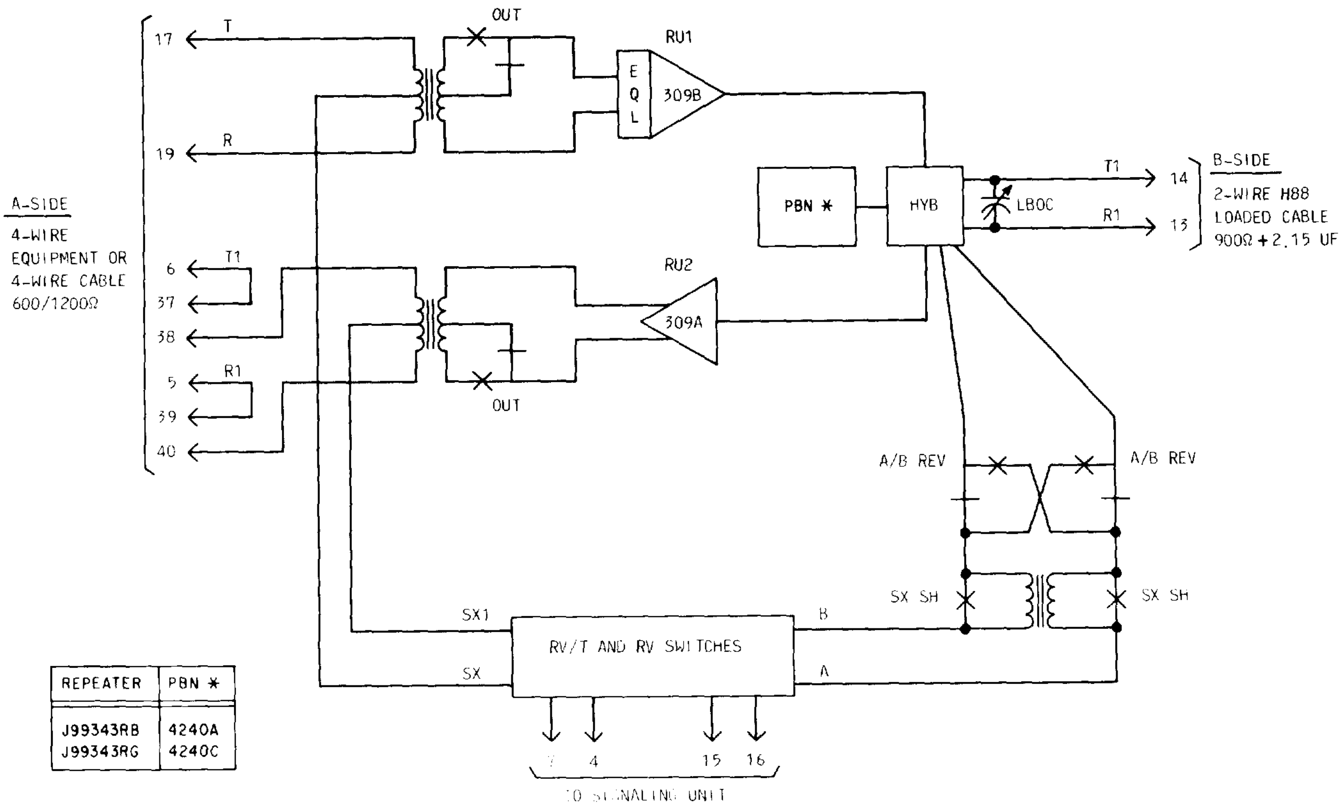


Fig. 1—Block Diagram of the 4-2 Intermediate/Terminal Repeater (L), J99343 RB (MD), RG (MD)

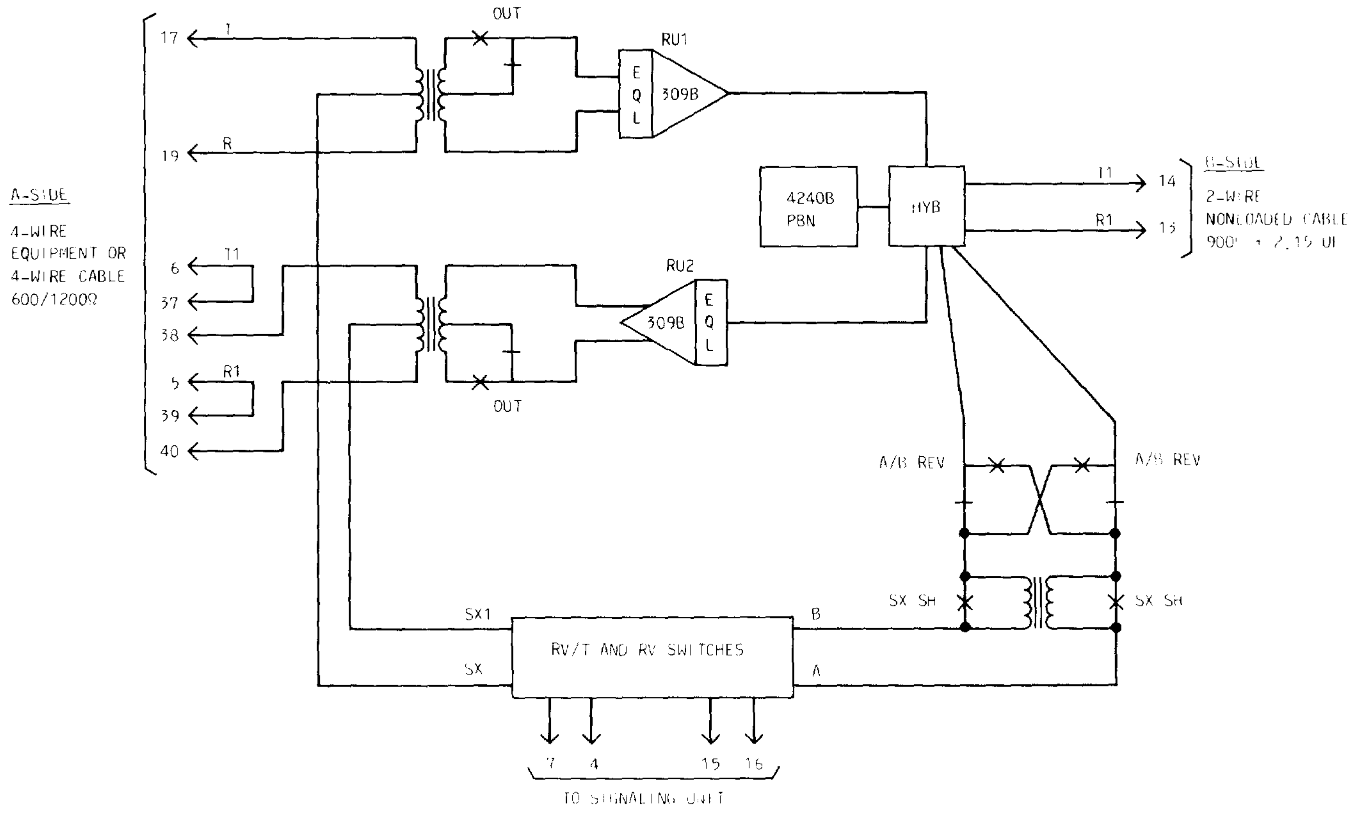


Fig. 2—Block Diagram of the 4-2 Intermediate/Terminal Repeater (NL), J99343RC

1.06 The J99343RD and RH repeaters provide A-side 2-wire circuitry to interface standard gauges of 2-wire H-88 loaded facilities (Fig. 4). The J99343RD unit is MD and replaced by J99343RH, which is also compatible with 25-gauge MAT cable. The J99343RE 2-4 repeater (Fig. 5) is compatible with all standard gauges (including MAT) of 2-wire nonloaded cable facilities. The J99343RK is the latest 2-4 repeater that is available. This repeater provides selectable circuitry for compatibility with both loaded and nonloaded cable at the 2-wire and 4-wire interface (Fig. 6). The J99343RK replaces both the J99343RH (loaded) and J99343RE (nonloaded) repeaters in application.

2. INSTALLATION SWITCH ADJUSTMENTS

2.01 All of the repeaters described in this section have independent switch controls for gain, equalization, balance and signaling. Each category of these controls is described in the following paragraphs.

A. Gain and Equalization

2.02 Gain and equalization control is provided by miniature rocker switches on all versions of the 4-2 and 2-4 repeaters. On the earlier repeater versions (J99343RB, RC, RD, RE, RG and RH), these switches are located on the 309-type amplifier unit.

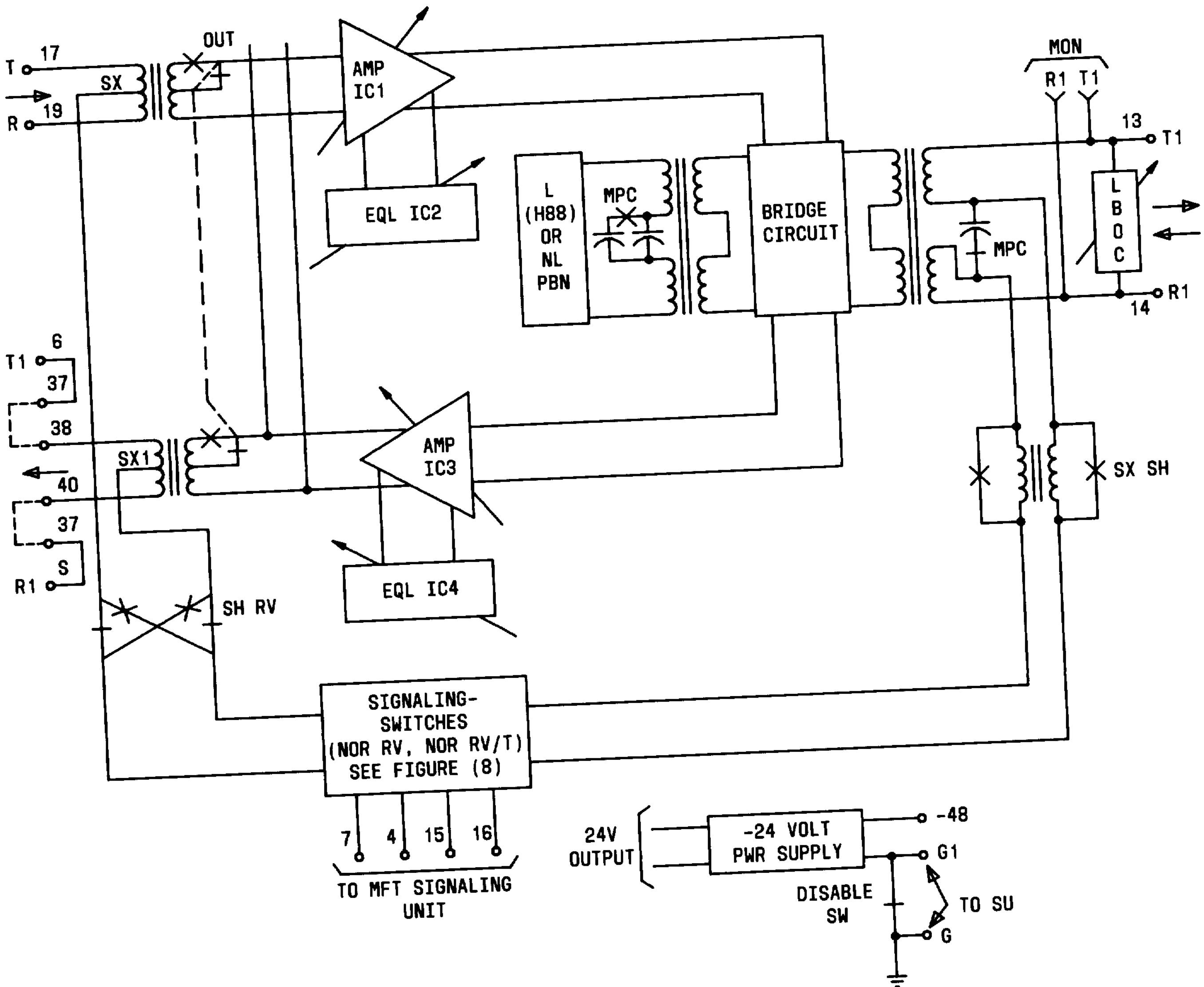
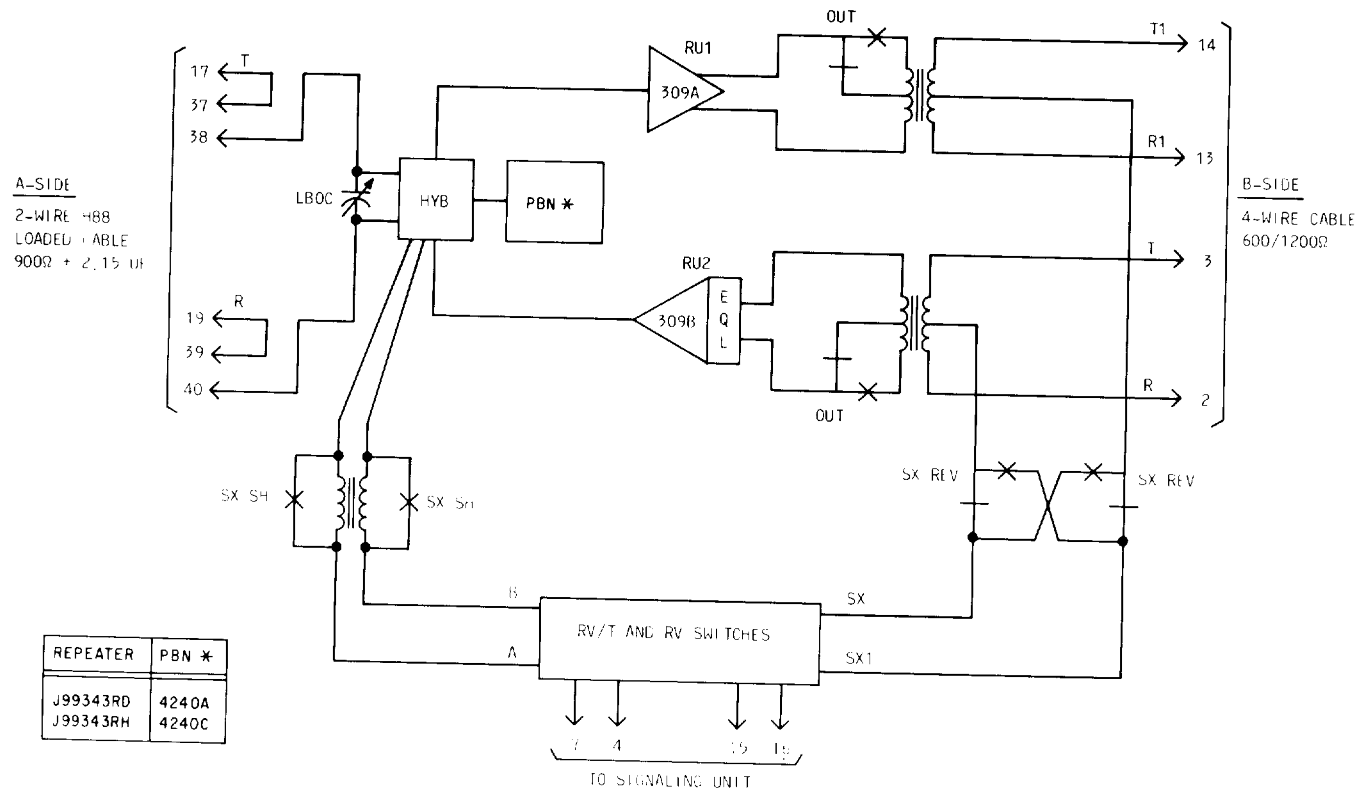


Fig. 3—Block Diagram of the 4-2 Intermediate/Terminal Repeater (NL), J99343RJ



REPEATER	PBN *
J99343RD	4240A
J99343RH	4240C

Fig. 4—Block Diagram of the 2-4 Intermediate Repeater (L), J99343RD (MD), RH (MD)

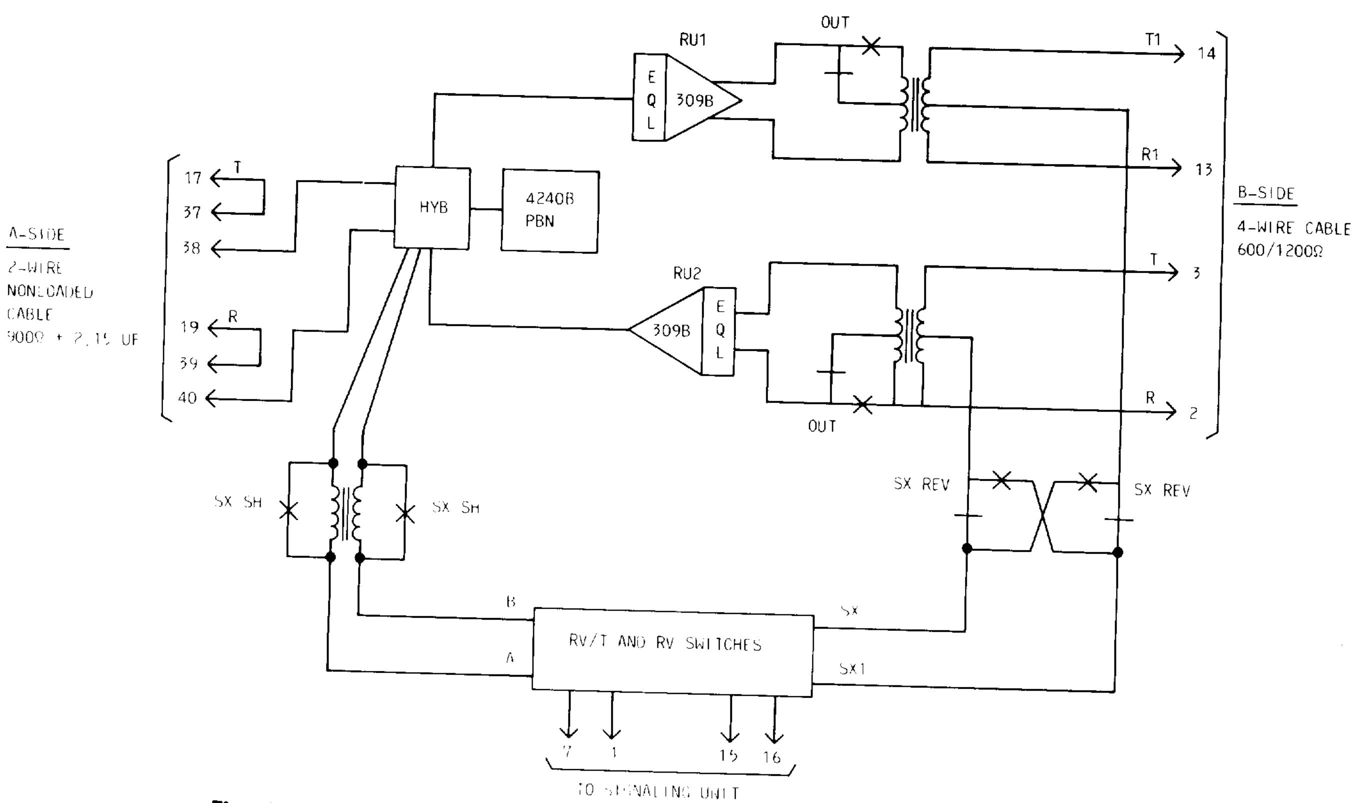


Fig. 5—Block Diagram of the 2-4 Intermediate Repeater (NL), J99343RE

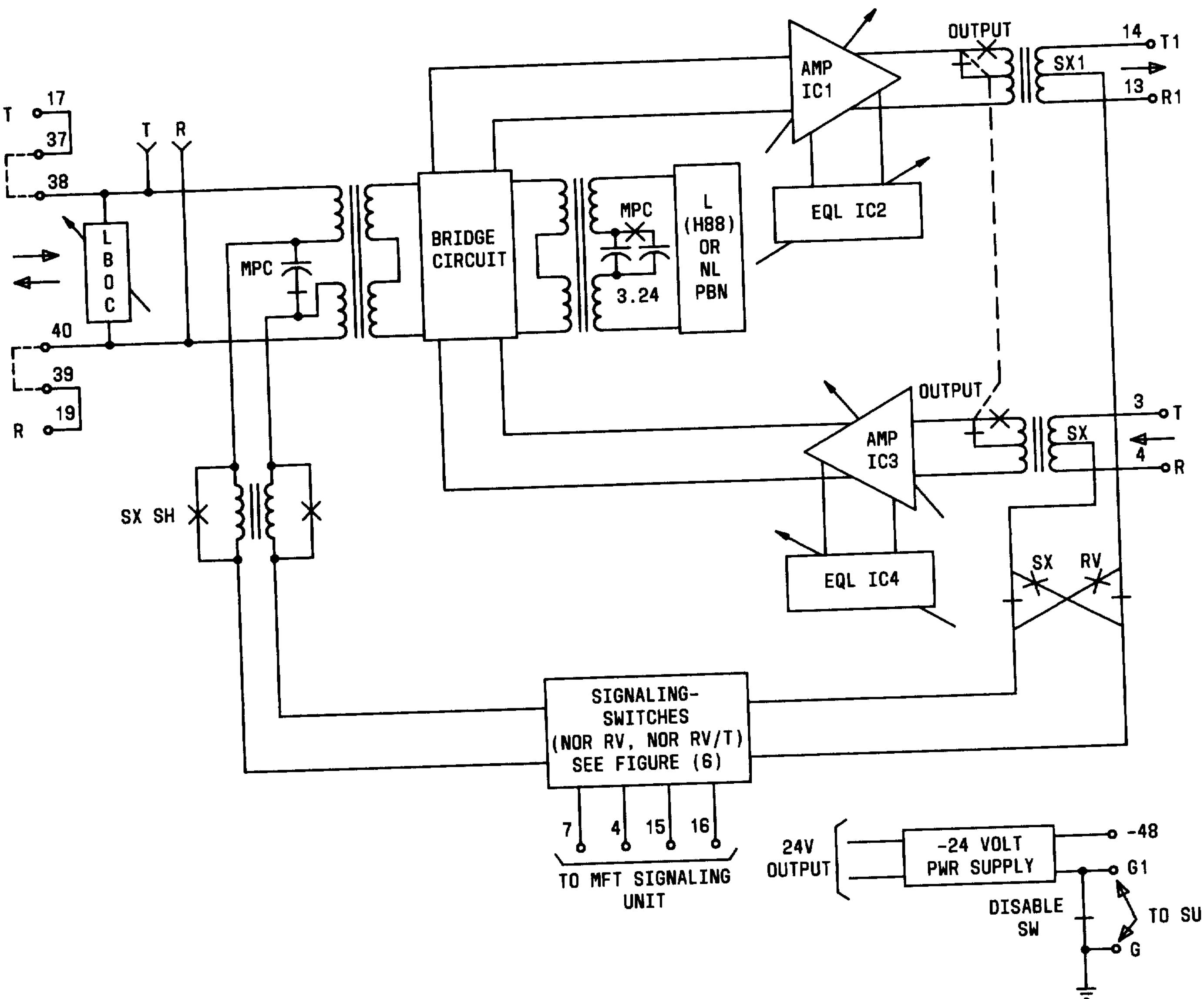


Fig. 6—Block Diagram of the 2-4 Intermediate Repeater (NL), J99343RK

309A Amplifier Unit

2.03 The 309A unit provides gain only and is used in one transmission direction on the J99343RB, RH 4-2 and J99343RD, RG 2-4 loaded repeaters. Figure 7 shows the controls associated with the 309A unit.

309B Amplifier Unit

2.04 The 309B amplifier unit provides both gain and equalization. It is used in the opposite direction of transmission to the 309A unit in the J99343RB, RG and J99343RD, RH loaded repeater and in both directions of transmission in the J99343RC 4-2 and J99343RE 24 nonloaded repeaters. Figure 8 illustrates the 309B amplifier unit controls.

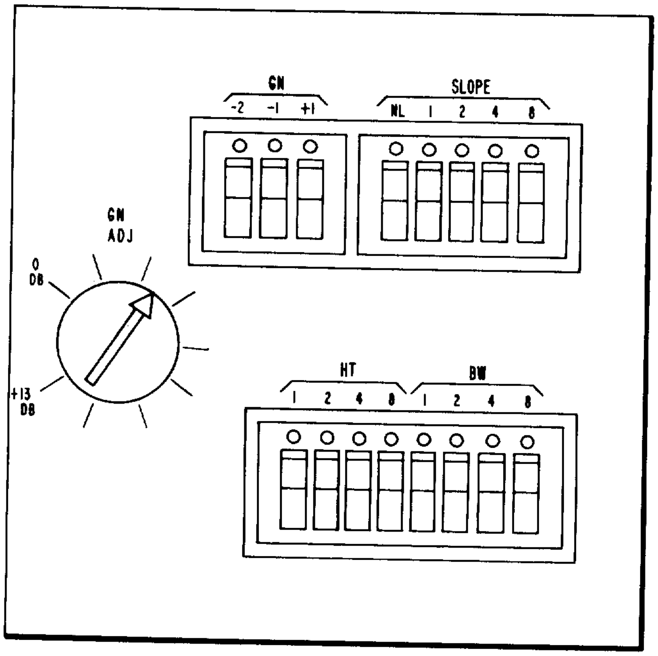


Fig. 7—309A Amplifier Unit Controls

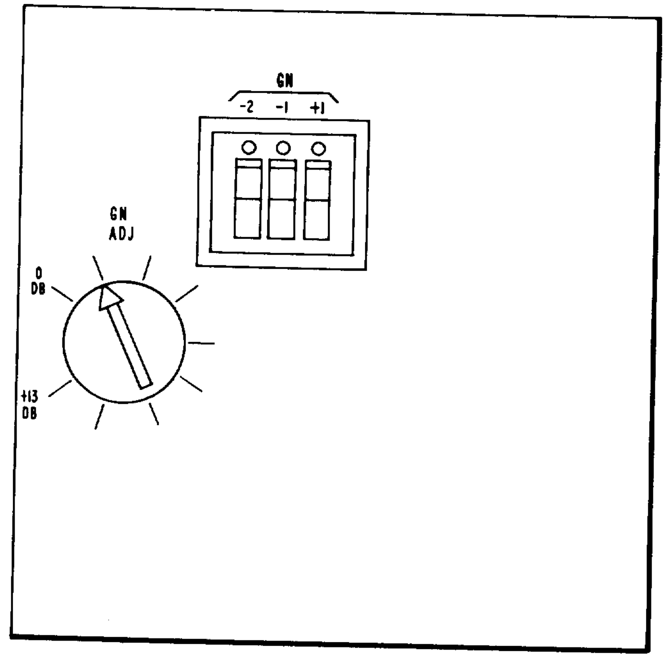


Fig. 8—309B Amplifier Unit Controls

Integrated Circuit Amplifiers

2.05 The latest 4-2 and 2-4 repeaters (J99343RJ, RK) provide gain and equalization by new integrated circuits (IC). The gain adjustment for each amplifier is controlled by a set of ten miniature rocker switches located on the printed wiring board of the repeater (Fig. 9). These switches are designated in decibels .1, .2, .4 and .8 (fine adjust), 1, 2, 4, and 8 (course adjust) and +1 × 10 and -2 × 10 (range (selection). These switch values are additive. The -20 range should be selected when the repeater is to provide loss instead of gain.

Note: The sum of the 1, 2, 4, 8 gain switches should not exceed +12 dB. Use the +10 range when providing gain in excess of +12 dB.

B. Precision Balance Network (PBN)

2.06 The 4-2 and 2-4 repeaters contain 3 basic types of PBN. The older repeaters use the 4240A or 4240C PBN for loaded cable applications and the 4240B for nonloaded cable. Switch settings for the PBNs are shown in Fig. 10, 11 and 12.

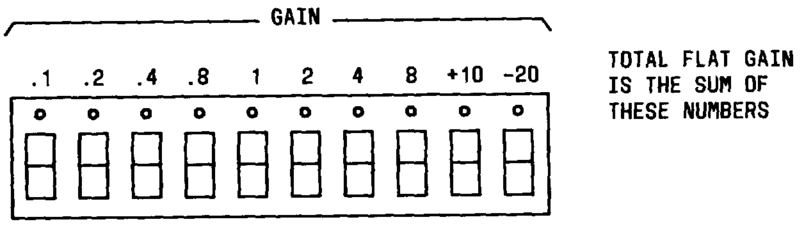


Fig. 9—Integrated Circuit Amplifier Unit Controls

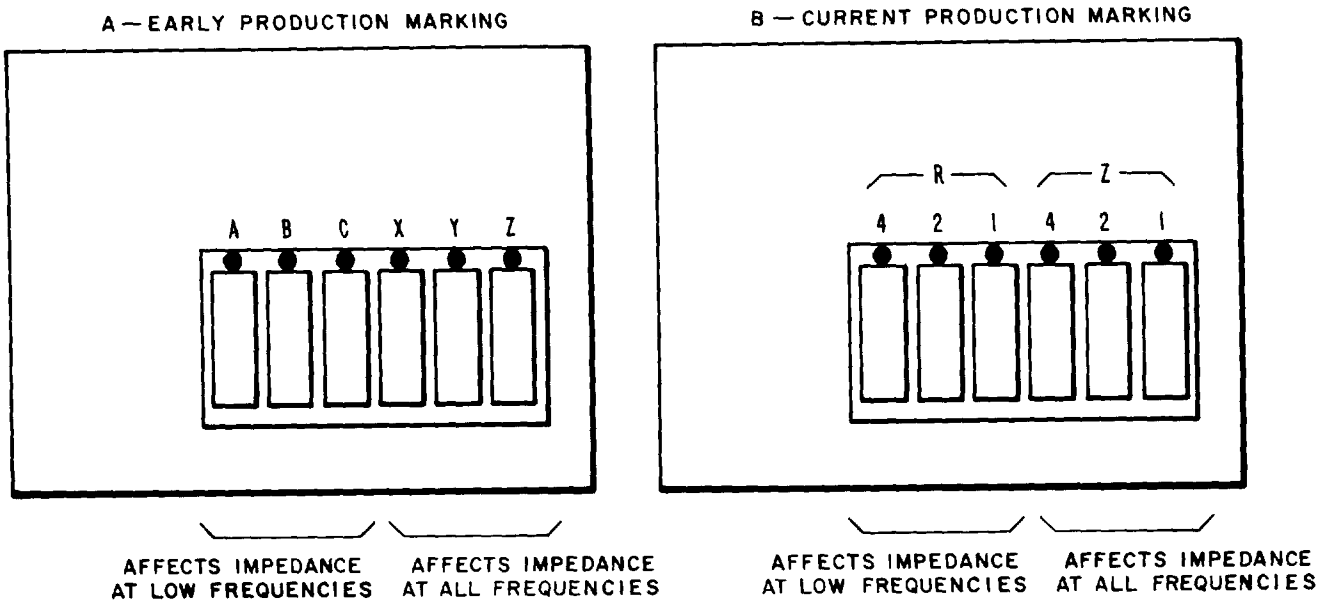
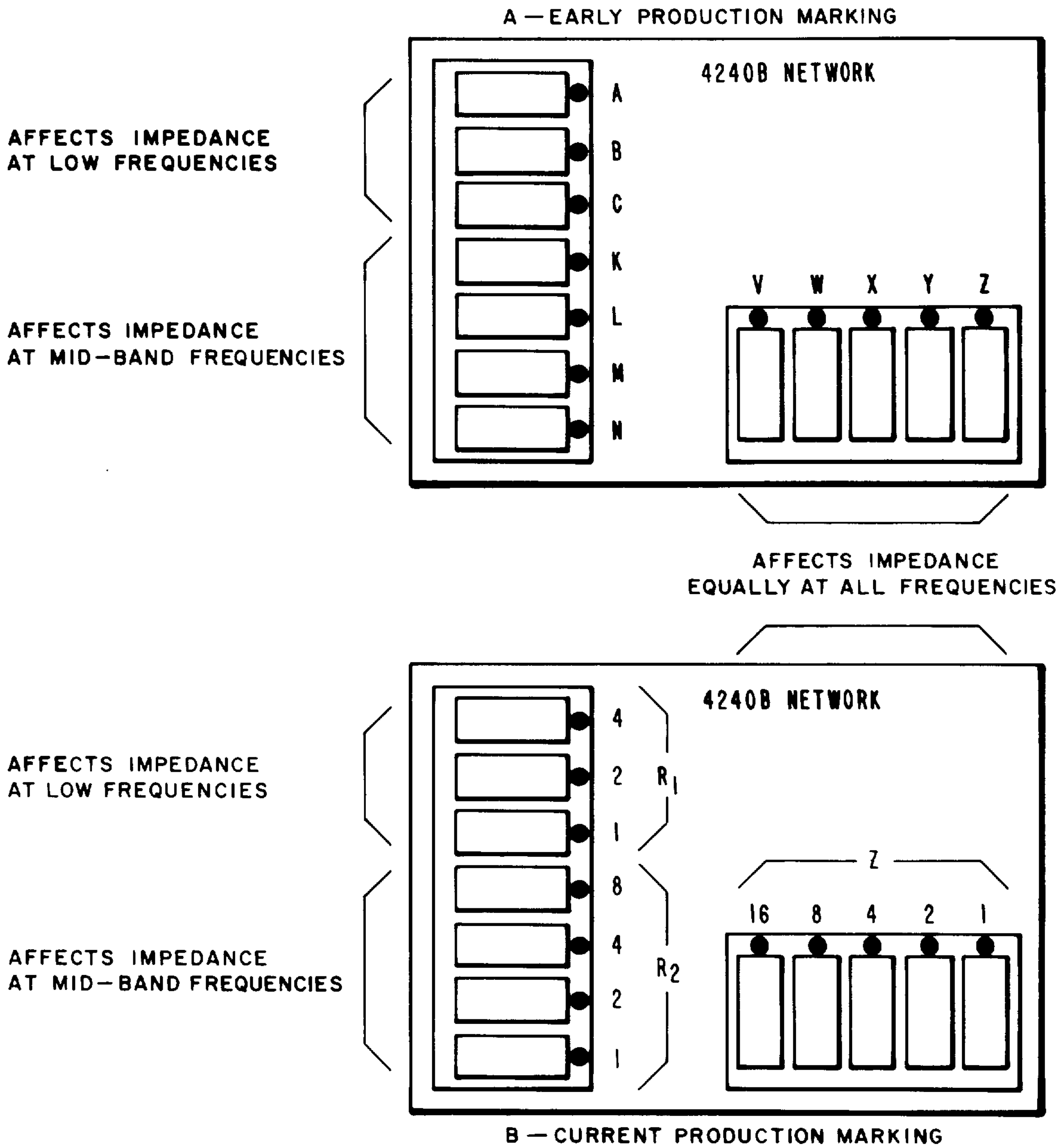


Fig. 10—4240A Precision Balancing Network Switch Functions



NOTE:
FUNCTIONS ARE ENERGIZED WHEN SWITCH(S) ARE PRESSED TOWARD THE DESIGNATIONS.

Fig. 11—4240B Precision Balancing Network Switch Functions

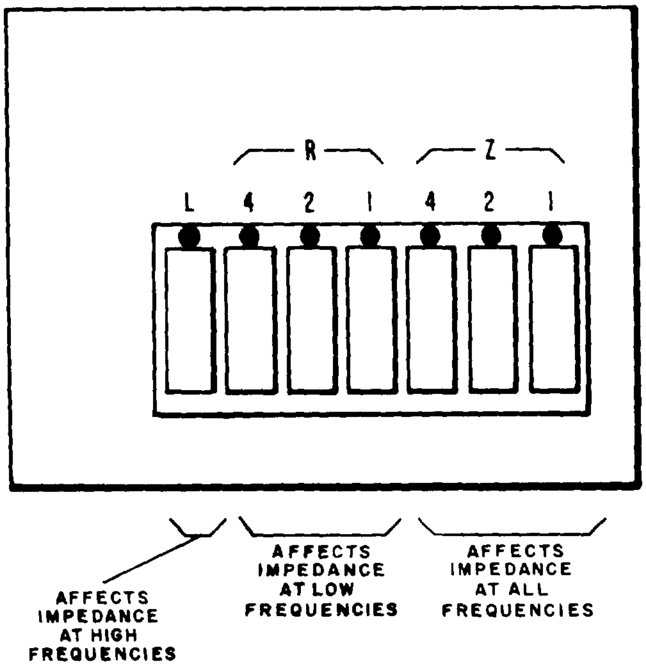


Fig. 12—4240C Precision Balancing Network Switch Functions

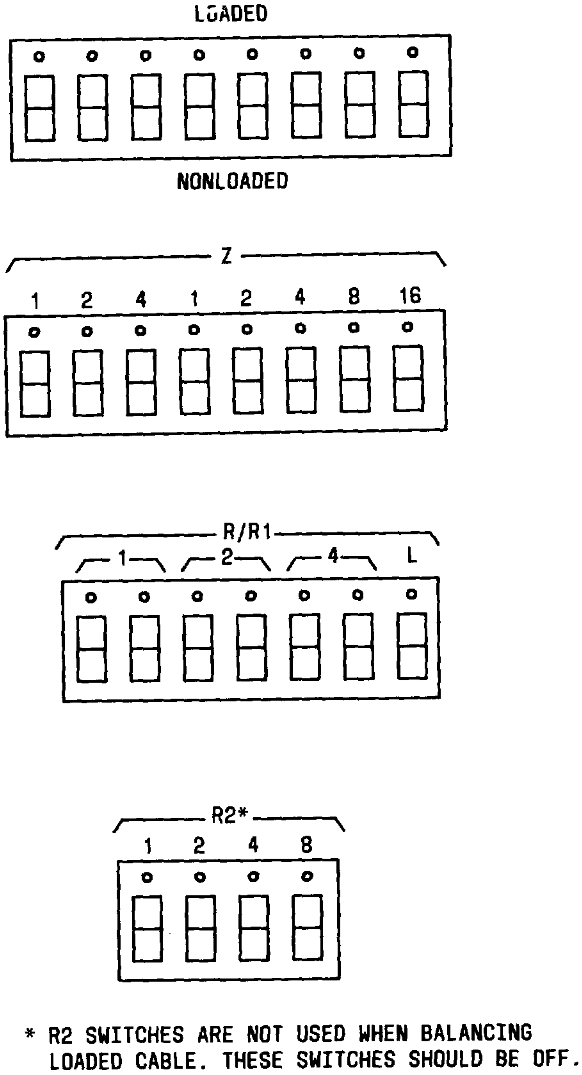


Fig. 13—J99343RJ, RK Precision Balancing Network Switch Functions

2.07 The latest repeaters (J99343RJ and RK) provide a new type PBN which combines circuitry for both loaded and nonloaded applications. Figure 13 shows the selection switches located on the PBN. The cable type selection switch should be set to the cable type to be used (loaded or nonloaded). Once this switch is set, the balance setting should be selected. For loaded applications, the R/R1 and Z (1, 2 and 4) switches should be set (all other switches set to zero). For nonloaded applications, the R/R1, R2, and Z (1, 2, 4, 8 and 16) switches should be used.

2.08 Charts 2 through 4 provide the manual step procedures for obtaining the proper PBN settings for all of the PBNs described in this section.

C. Line Buildout Capacitor

2.09 A line buildout capacitor (LBOC) network is provided on each repeater that operates with 2-wire loaded cable. This network is used to buildout the cable end section to an equivalent length of 6000 feet.

2.10 Proper LBOC setttings can be obtained from either Table A or from the following formula:

- High-Capacitance cable (.083 μf/mile)

  LBOC (μF) = .008 + .016 (6-N)

- Low-capacitance cable (.064 μF/mile)

  LBOC (μF) = .008 + .0122 (6-N)

  where N = the length of the near end section in kilo feet.

Table A covers end section lengths from 1450 to 4549 feet. To determine the LBOC for lengths not covered in Table A, the previously mentioned formulas should be used.

2.11 The proper LBOC setting should be installed in the repeater before attempting to obtain the PBN settings by the manual methods described in this section.

2.12 The LBOC switches are designated in the following manner:

A = .002

B = .004

C = .008

D = .016

E = .032

F = .064

Note: To select the value desired, the switch should be operated toward the value (newer repeaters J99343RJ, RK) or the screw switch should be turned down (earlier repeaters).

D. Midpoint Capacitors

2.13 The 4-2 wire repeaters are generally specified for the terminal 4-wire applications. These repeaters contain a selectable midpoint capacitor to allow use with the terminal and intermediate applications. The two midpoint values available are:

- 1.06 μF for all standard transmission applications (switch S_2 operated, S_1 open)

- 4μF for terminal applications with duplex signaling (switch S_2 open, S_1 operated)

TABLE A

LBOC SETTINGS (H88 LOADED CABLE)

END-SECTION LENGTH (FEET)	CAPACITANCE VALUE HI-CAP.	SCREWS DOWN	CAPACITANCE VALUE LOW-CAP. (MAT CABLE)	SCREWS DOWN
1450 — 1549	.080	DF	.064	F
1550 — 1649	.078	ABCF	.062	ABCDE
1650 — 1749	.076	BCF	.060	BCDE
1750 — 1849	.076	BCF	.060	BCDE
1850 — 1949	.074	ACF	.058	ACDE
1950 — 2049	.072	CF	.058	ACDE
2050 — 2149	.070	ABF	.056	CDE
2150 — 2249	.068	BF	.054	ABDE
2250 — 2349	.068	BF	.054	ABDE
2350 — 2449	.066	AF	.052	BDE
2450 — 2549	.064	F	.052	BDE
2550 — 2649	.062	ABCDE	.050	ADE
2650 — 2749	.060	BCDE	.048	DE
2750 — 2849	.060	BCDE	.048	DE
2850 — 2949	.058	ACDE	.046	ABCE
2950 — 3049	.056	CDE	.046	ABCE
3050 — 3149	.054	ABDF	.044	BCE
3150 — 3249	.052	BDE	.042	ACE
3250 — 3349	.052	BDE	.042	ACE
3350 — 3449	.050	ADE	.040	CE
3450 — 3549	.048	DE	.040	CE
3550 — 3649	.046	ABCE	.038	ABE
3650 — 3749	.044	BCE	.036	BE
3750 — 3849	.044	BCE	.036	BE
3850 — 3949	.042	ACE	.034	AE
3950 — 4049	.040	CE	.032	E
4050 — 4149	.038	ABE	.032	E
4150 — 4249	.038	ABE	.030	ABCD
4250 — 4349	.036	BE	.030	ABCD
4350 — 4449	.034	AE	.028	BCD
4450 — 4549	.032	E	.026	ACD

E. Signaling Switches

2.14 The 4-2 and 2-4 repeaters provide signaling lead access to the transmission facility. This access plus on-board switches makes the repeaters compatible with most of the common signaling arrangements. In each application, the signaling switches must be set to match the particular signaling arrangements. The switches and their functions that are associated with signaling are listed below.

- NOR-SXSH: Provides shorting capability to the SX inductor in the 2-wire circuit.
- NOR-RV
- NOR-RV/T: These two switches operate in combination to provide reversals of the signaling unit to the transmission unit or through signaling when no signaling unit is used.
- NOR-SX RV: Reverses the 4-wire signaling access leads (SX, SX1) to the signaling unit.
- NOR-A/B REV (4-2 repeaters, only, except RJ): signaling access leads (A, B) to the signaling unit.
- NOR-DISABLE: Disable allows the repeaters to be controlled by the idle/busy condition of the associated signaling unit. When no signaling unit is used, the switch should be set to NOR.

3. APPLICATION GUIDELINES

3.01 The application guidelines in the following paragraphs are applicable to various installation and testing arrangements associated with the 4-2 and 2-4 repeaters. These arrangements generally are single repeater sections which include the respective repeater and associated cable facility.

A. Repeater Gain

3.02 In setting an MFT repeater to a specified gain, it is important that the actual gain of the repeater (input to output) is the sum of the gain and the equalizer circuits. The gain circuit compensates for internal repeater losses. The equalizer circuit provides active adjustable equalization which results in an additional 1 kHz gain being added to the circuit. The additional gain required varies with respect to the equalizer setting, which varies with the type and length of associated cable. Tables B and C gives the gain associated with the various slope (Table B) and bump-height and bandwidth (Table C) settings. The total 1 kHz gain of the repeater is represented in the following:

$G_{TOTAL} = G_{SWITCH\ SETTINGS} + G_{SLOPE} + G_{BUMP}$

> ***Note:*** The J99343RB, RG (4-2) and J99343 RD, RH (2-4) do not have an equalizer circuit in one direction of transmission. In these repeaters, the gain in that directon of transmission is a function of the gain circuit only.

TABLE B

1-KHZ GAIN IN DB FOR SLOPE SETTINGS

SLOPE SETTING	NL/L SWITCH	
	NL	L
0*	0	0
1	0.4	1.4
2	0.9	2.6
3	1.4	3.7
4	1.8	4.7
5	2.3	5.5
6	2.8	6.3
7	3.4	7.2
8	3.7	7.8
9	4.2	8.4
10	4.6	9.0
11	5.0	9.5
12	5.4	10.0
13	5.8	10.5
14	6.2	11.0
15	6.6	11.4

* SLOPE setting 0 disables the slope unit.

TABLE C

1-KHz GAIN IN dB FOR HT AND BW SETTINGS

		HT SETTING															
		0*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
BW SETTING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1
	5	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1
	6	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.2
	7	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3
	8	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4
	9	0	0	0	0	0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.5
	10	0	0	0	0	0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.7
	11	0	0	0	0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.6	0.7	0.9
	12	0	0	0	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.8	0.9	1.2
	13	0	0	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.1	1.3	1.7
	14	0	0	0.1	0.1	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.2	1.4	1.7	2.0	2.5
	15	0	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.2	1.5	1.7	2.0	2.4	2.8	3.3	3.9

* HT setting 0 disables the bump unit for all BW settings.

3.03 Charts 5 and 6 give the procedures for setting MFT 4-2 and 2-4 repeaters for a specified gain using the J99343TB MFT test extender.

B. Level Requirements

3.04 To avoid interference with other circuits and provide stability, transmission levels at repeater interfaces are restricted to minimum and maximum 1-kHz levels with respect to a given transmission level point (TLP). Table D gives the levels for the various applications. When the repeater section adjacent to a PBX or other customer location consists of both loaded and nonloaded cable, the levels for nonloaded cable can be used if the nonloaded facility is at least 9 Kft in length.

3.05 Transmission levels are often specified on the circuit layouts as a way to establish the gain in the circuit and still stay within the limits specified for transmission levels in Table D. Charts 7 through 9 give the procedures for obtaining specified levels for the 4-2 and 2-4 repeaters in various circuit arrangements.

C. Impedance Selection

3.06 Each of the 4-2 and 2-4 repeaters described in this practice include a 600/1200 impedance switch to match the repeater to the impedance of the 4-wire facility which it interfaces. Setting information is given in Table E.

> ***Note:*** The nonloaded setting (600) for mixed facility assumes at least 9 Kft of cable between the repeater and the first load coil. If loss than 9 Kft of nonloaded cable is present, the cable section should be considered as loaded and a 1200 setting should be used.

Other 4-wire impedance considerations may be found in 332-912-234.

TABLE D

LIMITS ON TRANSMIT AND RECEIVE 1-KHZ LEVELS WITH RESPECT TO THE 0 TLP

LOCATION	CABLE TYPE	MINIMUM INPUT LEVEL	MAXIMUM OUTPUT LEVEL
At Central Office	Nonloaded	−9 dB	+6 dB
	H88 Loaded	−9 dB	+6 dB
At PBX or other customer location	Nonloaded	−9 dB	+6 dB
	H88 Loaded	−6 dB	+3 dB

TABLE E

4-WIRE IMPEDANCE SELECTION RULES

4-WIRE CABLE TYPE	IMPEDANCE SELECTION
Nonloaded	600 ohms both ends
H88 loaded	1200 ohms both ends
Mixed (nonloaded and loaded; see para. 7.08)	600 ohms on the nonloaded end 1200 ohms on the loaded end

D. Frequency Response Measurements

3.07 Equalizer settings for most circuit arrangements can normally be found in the prescription tables in Sections 332-912-222 and -223. When the cable makeup is not known or is incorrect on the CLR, or if the facility consists of cable combinations that are not given in the prescription tables, then the frequency response procedures may be used. From these procedures given in Chart 10 through 15, the equalizer setting can be determined from cable loss data taken in the frequency response tests.

E. Precision Balance Network (PBN)

3.08 PBN settings for most applications can be found in the prescription settings tables in Sections 332-912-222 and -223. Charts 2 through 4 give the manual procedures for determining those settings not covered by the tables. Procedures are given for both the loaded (4240A or 4240C) and nonloaded (4240B) PBNs.

4. TESTS AND ADJUSTMENTS USING THE MFT TEST EXTENDER

A. General

4.01 In making tests and adjustments to the MFT repeaters, it is necessary to obtain jack access to certain circuits and to be able to switch the PBN in and out. The J99343TB and the J99380TB MFT test extenders are used to obtain ready access to these circuits when the repeater is in a normal operating configuration. Detailed descriptions of the test extenders are contained in Section 332-910-102 for the J99343TB and Section 332-610-500 for the J99380TB test extender.

4.02 The following four test adjustment procedures are described in this part:

- Obtaining (or improving) the PBN setting by measurement
- Adjusting the repeater for a specified gain
- Adjusting the repeater for a specified output level
- Measurement of loss vs frequency data. This data is then used in setting the equalizer (see Part 5).

4.03 The general rule is that the PBN should always be set first after initial setup adjustments. This is because the data on predicted gain and loss from such sources as the Universal Cable Circuit Analysis Program (UNICCAP) and the prescription tables assume there is good balance. High gain settings can be used only when the PBN is set properly.

4.04 The balancing network setting procedure is a repetitive method in which an initial setting is improved and the improved setting becomes a new initial setting which is improved by a repetition of the procedure. The procedure is repeated until satisfactory performance is obtained. The equalizers are turned off during the PBN setting procedure.

4.05 The procedures which adjust for a specified gain and output level necessitate that the equalizer be previously set, since any changes in the equalizer will affect the 1-kHz gain of the repeater. If the equalizer setting is not known, it must either be found in a table or determined using the procedure in Part 4E of this section.

4.06 The fourth procedure requires that the PBN be properly set and ***that the equalizers, which are to be set, are initially set to zero (HT=0, SLOPE=0).*** Minor changes to an existing equalizer setting can be made by using the touchup guidelines given in Part 6.

B. PBN Setting by Measurements

4.07 The following procedure describes an orderly way to determine a PBN setting by the measurement of echo return loss (ERL), singing return loss (SRL), and high singing return loss (SRL HI). A return-loss measuring set [(RLMS) KS-20501, L3 or equivalent] arranged to measure 4-wire return loss is connected to the 4-wire side of the repeater. The three return-loss readings are maximized by making a series of trial settings of the PBN switches. See Fig. 14 for a diagram of the equipment arrangement for making these measurements.

4.08 Since there are different repeaters for nonloaded and loaded cable, it must be known beforehand whether or not the cable is loaded. Otherwise, both a nonloaded repeater and loaded repeater might have to be tried. To avoid this the following rules should be observed:

Rule I If the distance from the repeater to the first load coil (near end section length) plus the length of any bridged taps in the end section exceeds 8000 feet, or the facility does not contain any load coils, it is nonloaded.

Rule II If the near end section length plus the length of any bridged taps in the end section is less than 8000 feet, the facility is loaded.

4.09 The following test equipment is required:

- One MFT Test Extender (J99343TB or J99380TB)
- One KS-20501, L3 RLMS or equivalent
- Nominal termination at the far end.

4.10 In the following procedures of Part 4, either the J99343TB or the J99380TB test extender can be used. Test setup for both is described. Chart 1 describes the initial test setup using the MFT test extender.

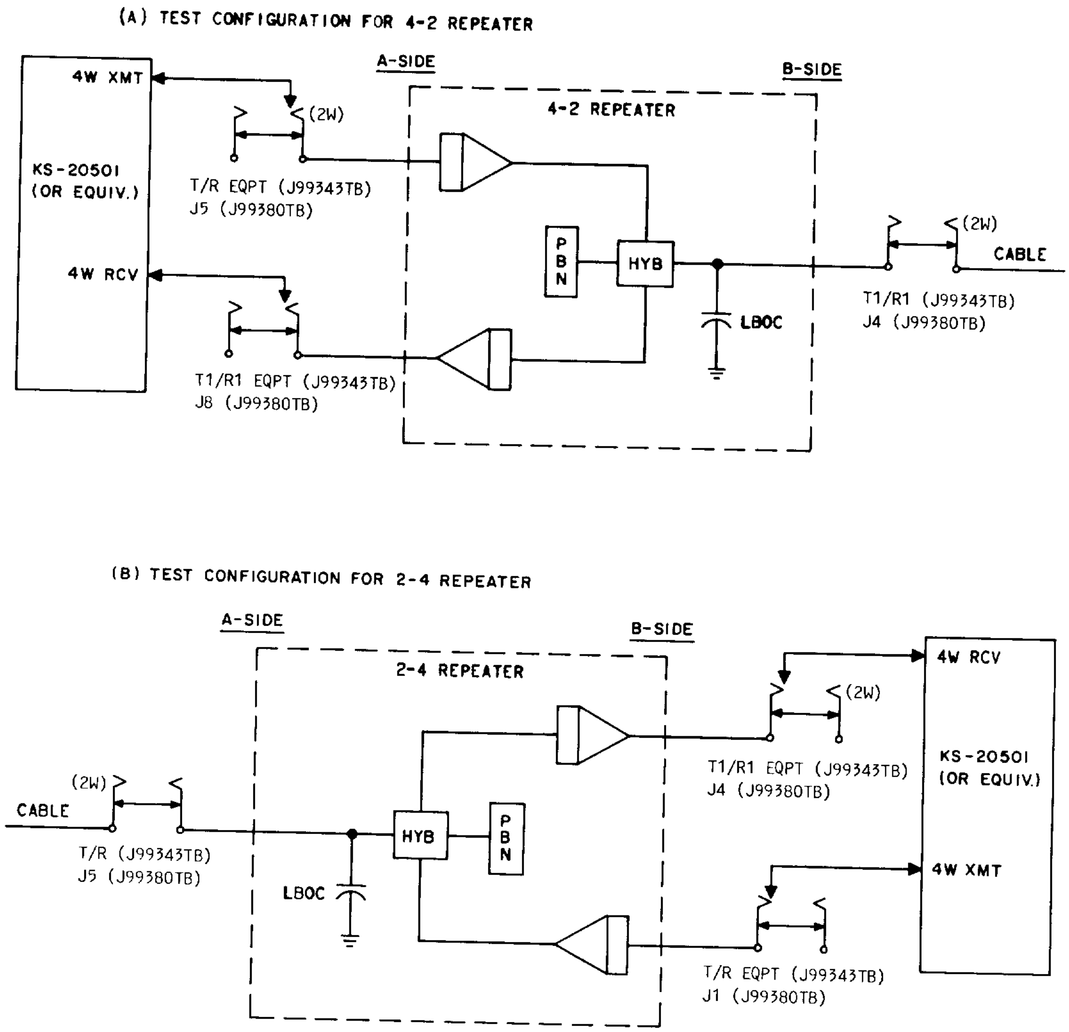


Fig. 14—Test Configuration For Setting the Precision Balancing Network by Measurement

CHART 1

INITIAL SETUP PROCEDURE

STEP	PROCEDURE
1	Terminate the far end of the circuit in its nominal impedance. If the far end is a switch or PBX, a compromise network (600 or 900 ohms + 2.15 μF) should be used. If the far end terminates in a telephone set, use a 4066H network.
2	Insert the repeater into the slot on the side of the J99343TB test extender or into the J928A connector of the J99380TB test extender. Plug the cable extender card of the J99343TB into the shelf or mounting slot. The entire assembly of the J99380TB which contains the repeater is plugged into the shelf or mounting slot.
3	Set the repeater options as follows: (a) Gain—Switches off, potentiometer fully counterclockwise (b) Equalizers—Set to zero (HT=0; SLOPE=0) (c) Signaling options as specified on CLR (RV, RV/T, A/B or SX/RV, SX SH) (d) NOR/DISABLE to NOR (e) LBOC as specified on CLR or from Table A (f) Midpoint capcitor as specified on CLR (g) Output impedance (OUT 600/1200) to 600.

CHART 1 (Contd)

STEP	PROCEDURE
4	Set the J99343TB test extender as follows:

(a) For 4-2 Repeaters

A-Side	B-Side
2W/4W to 4W	2W/4W to 2W
600/900 to 600	600/900 to 900
COMP NET IN/OUT to IN	COMP NET IN/OUT to OUT

(b) For 2-4 Repeaters

A-Side	B-Side
2W4W to 2W	2W/4W to 4W
600/900 to 900	600/900 to 600
COMP NET IN/OUT to IN	COMP NET IN/OUT to OUT

Set the J99380TB test extender as follows:

For 4-2 and 2-4 Repeaters set S2 to NORMAL.

5 Connect the RLMS to the J99343TB test extender as follows:

(a) For 4-2 Repeaters

4-Wire transmit to T/R EQUIP (2W) on the A-side of the test extender

4-Wire receive to T1/R1 EQUIP on the A-side of the test extender

(b) For 2-4 Repeaters

4-Wire transmit T/R EQUIP on the B-side of the test extender

4-Wire receive to T1/R1 EQUIP (2W) on the B-side of the test extender

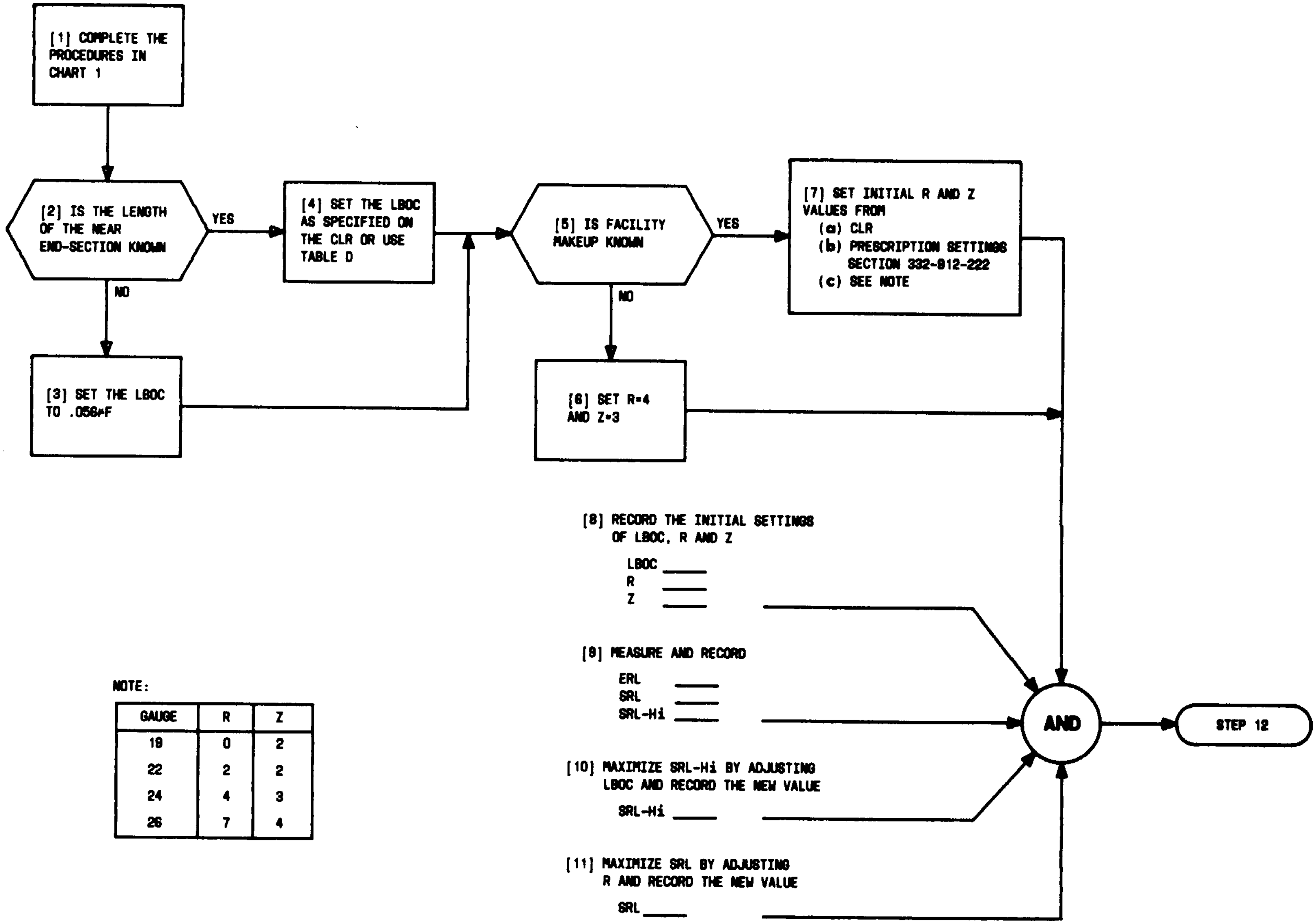
Connect the RLMS to the J99380TB test extender as follows:

(a) For 4-2 Repeaters

4-Wire transmit to J5 (EQPT) of test extender

CHART 1 (Contd)

STEP	PROCEDURE
	4-Wire receive to J8 (EQPT) of test extender
	(b) For 2-4 Repeaters
	4-Wire transmit to J1 (LINE) of test extender
	4-Wire receive to J4 (LINE) of test extender
6	See Section 103-106-115 for operation of the KS-20501, L3 RLMS.
7	For setting the 4240A PBN (for loaded cable), go to Chart 2.
	For setting the 4240B PBN (for nonloaded cable), go to Chart 3.
	For setting the 4240C PBN (for loaded cable including MAT cable), go to Chart 4.
	For setting the RJ/RK IC PBN, go to Charts 3 or 4.
	Note: The procedures in Charts 2 through 4 describe PBN settings by measurement. When the makeup of the cable facility is known, the prescription setting tables in Section 332-912-222 may be used.



NOTE:

GAUGE	R	Z
19	0	2
22	2	2
24	4	3
26	7	4

Chart 2—Adjustment of 4240A Precision Balance Networks (Sheet 1 of 2)

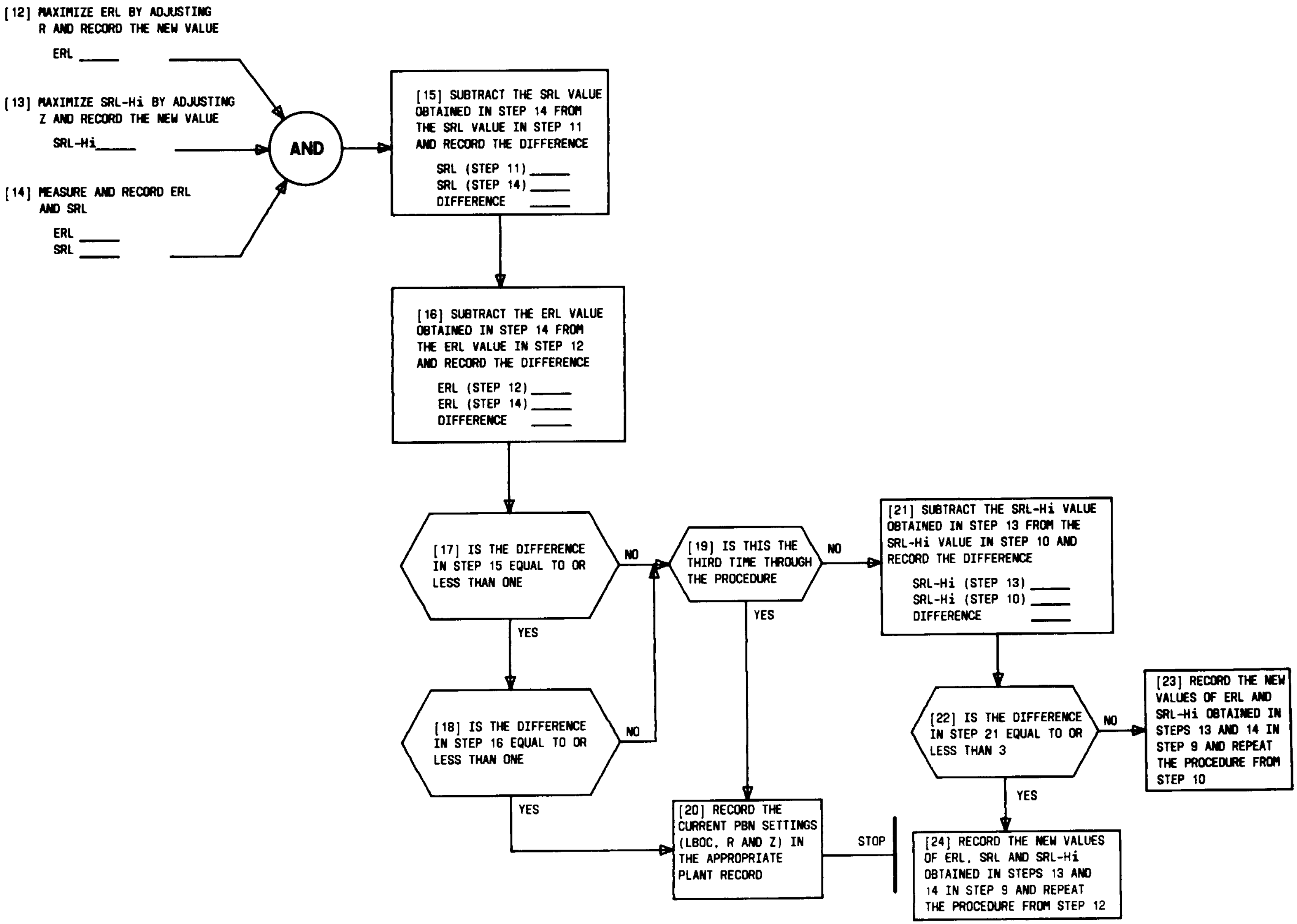


Chart 2—Adjustment of 4240A Precision Balance Networks (Sheet 2 of 2)

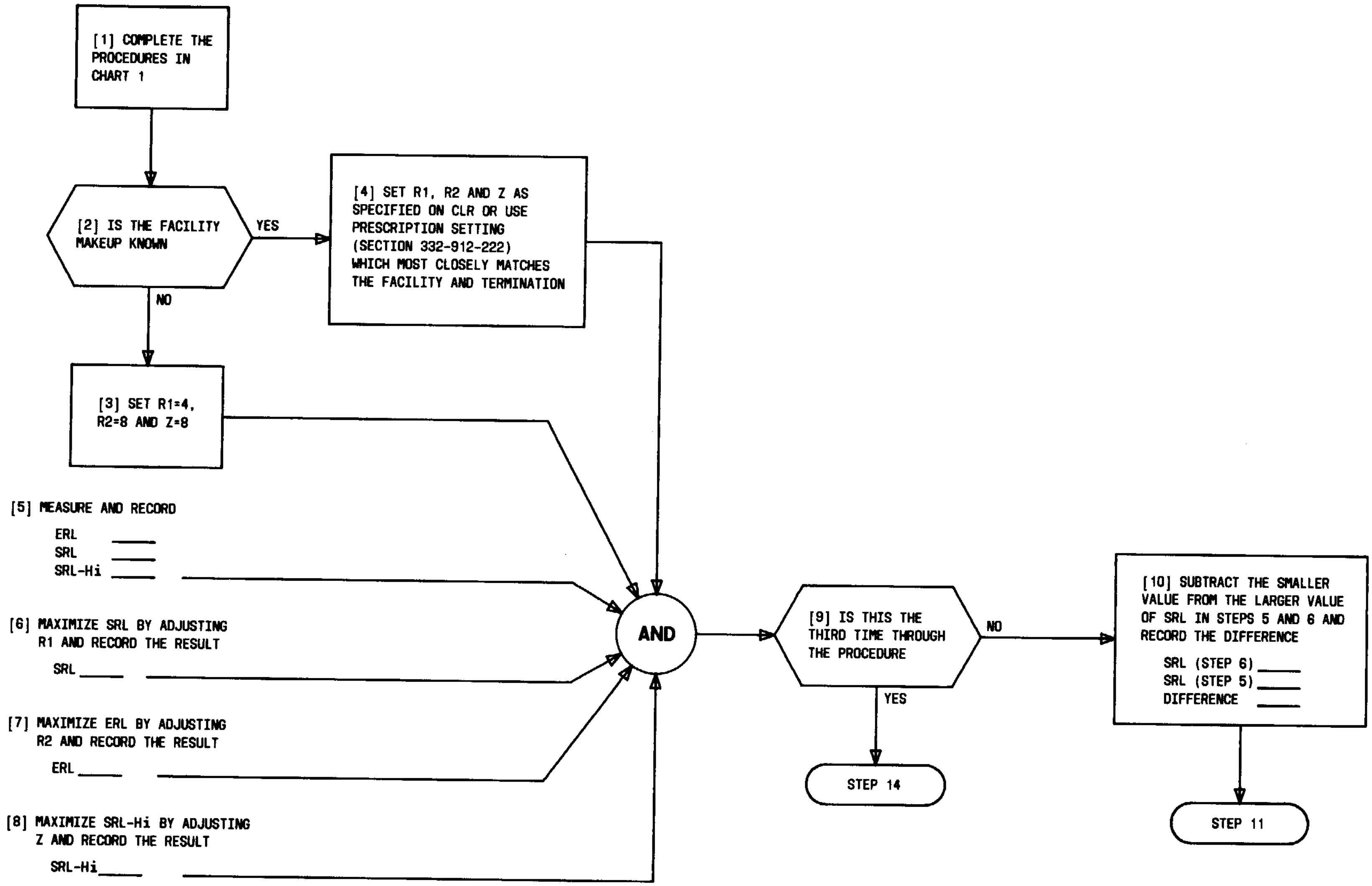


Chart 3—Adjustment of 4240B Precision Balance Networks (Sheet 1 of 2)

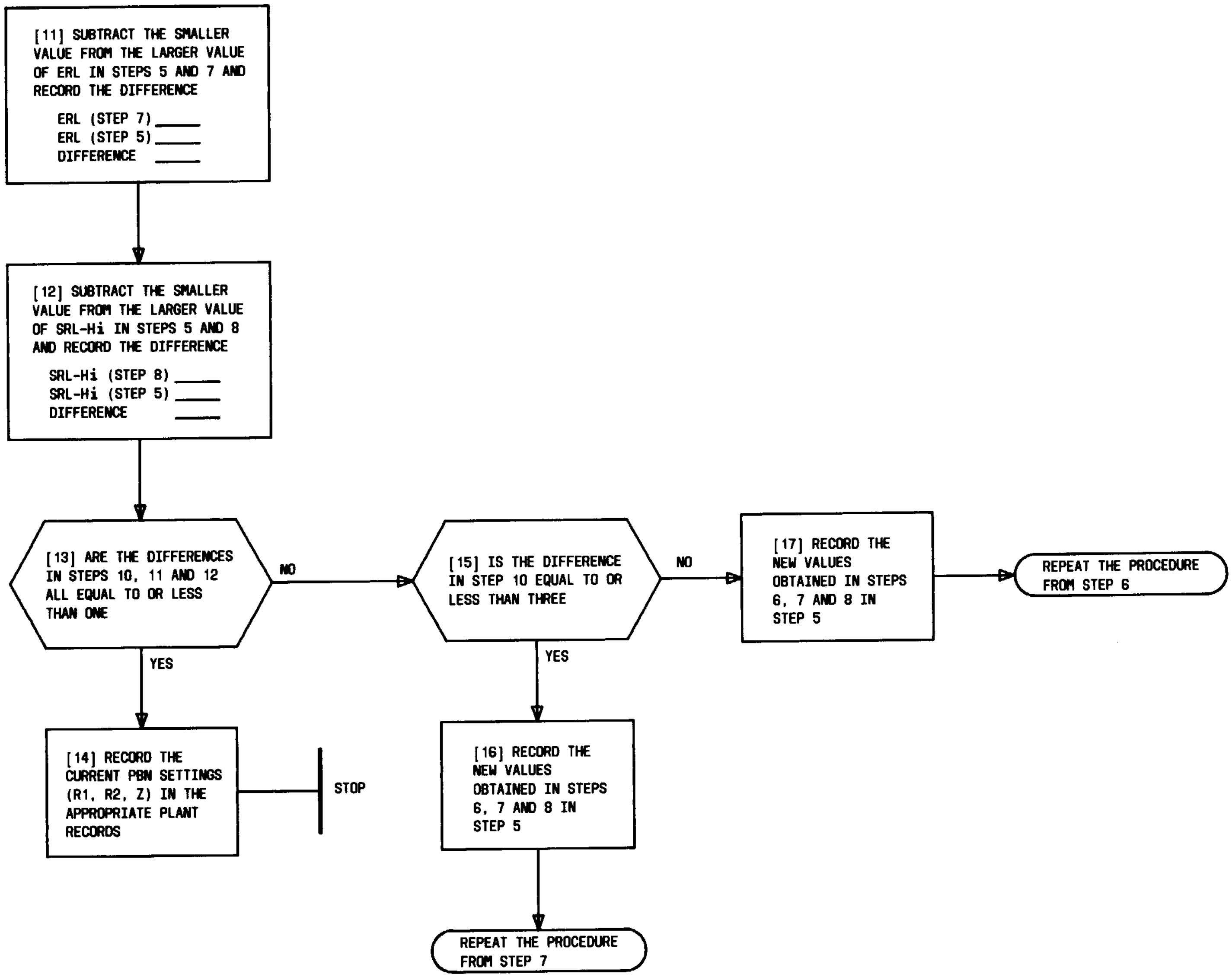
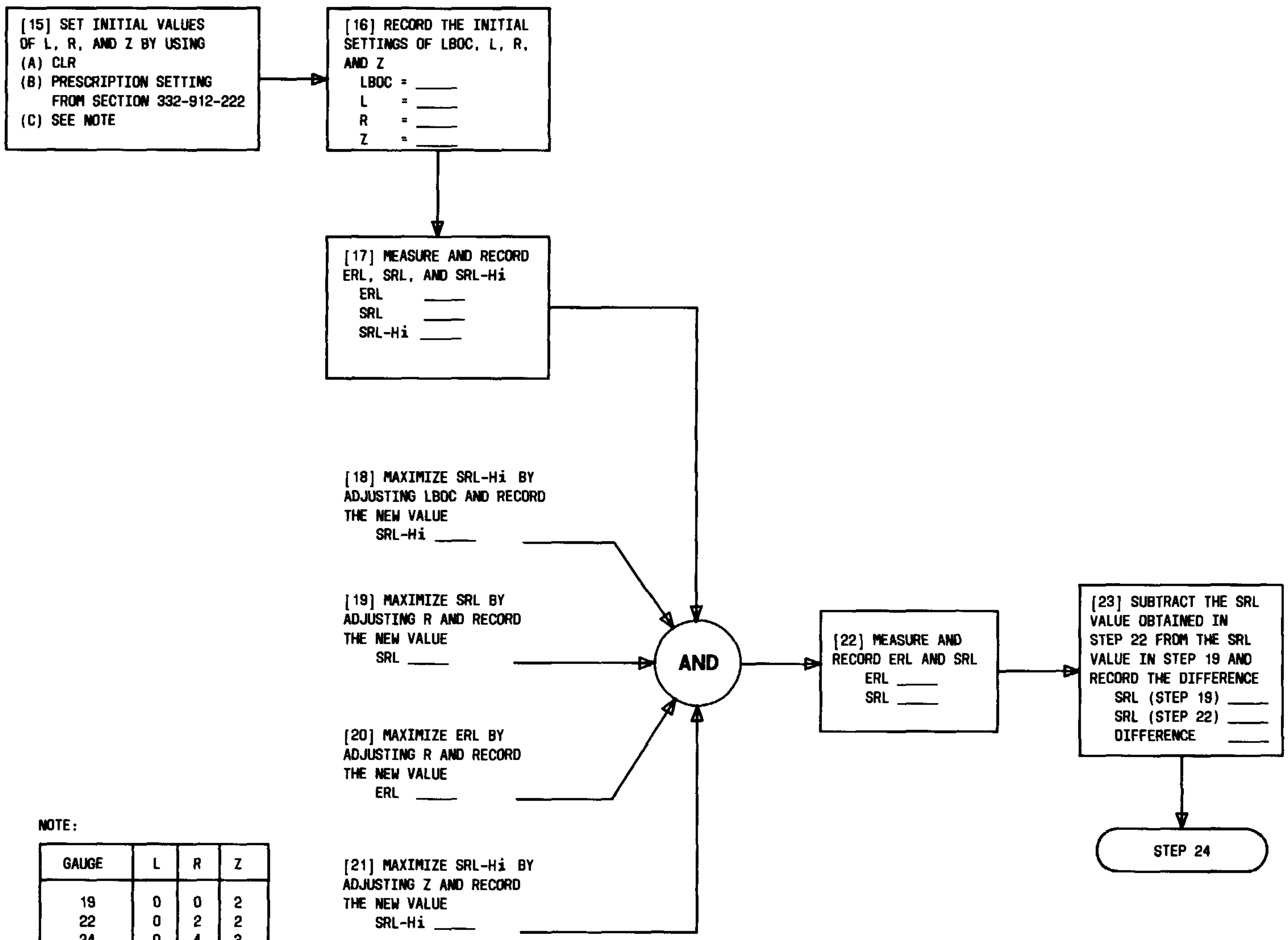


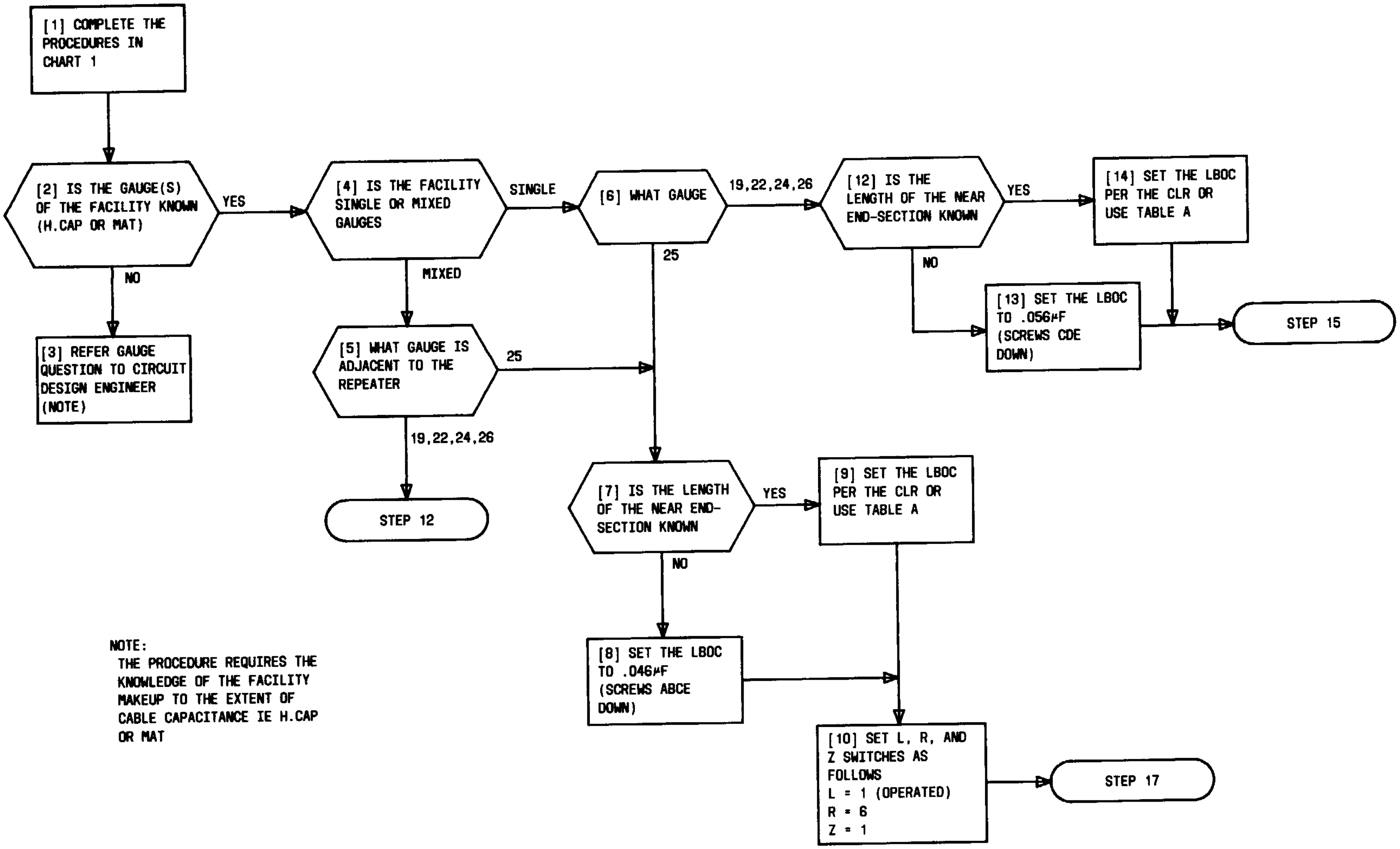
Chart 3—Adjustment of 4240B Precision Balance Networks (Sheet 2 of 2)



NOTE:

GAUGE	L	R	Z
19	0	0	2
22	0	2	2
24	0	4	3
26	0	7	4
UNKNOWN	0	4	3

Chart 4—Adjustment of 4240C Precision Balance Networks (Sheet 1 of 3)



NOTE:
THE PROCEDURE REQUIRES THE KNOWLEDGE OF THE FACILITY MAKEUP TO THE EXTENT OF CABLE CAPACITANCE IE H.CAP OR MAT

Chart 4—Adjustment of 4240C Precision Balance Networks (Sheet 2 of 3)

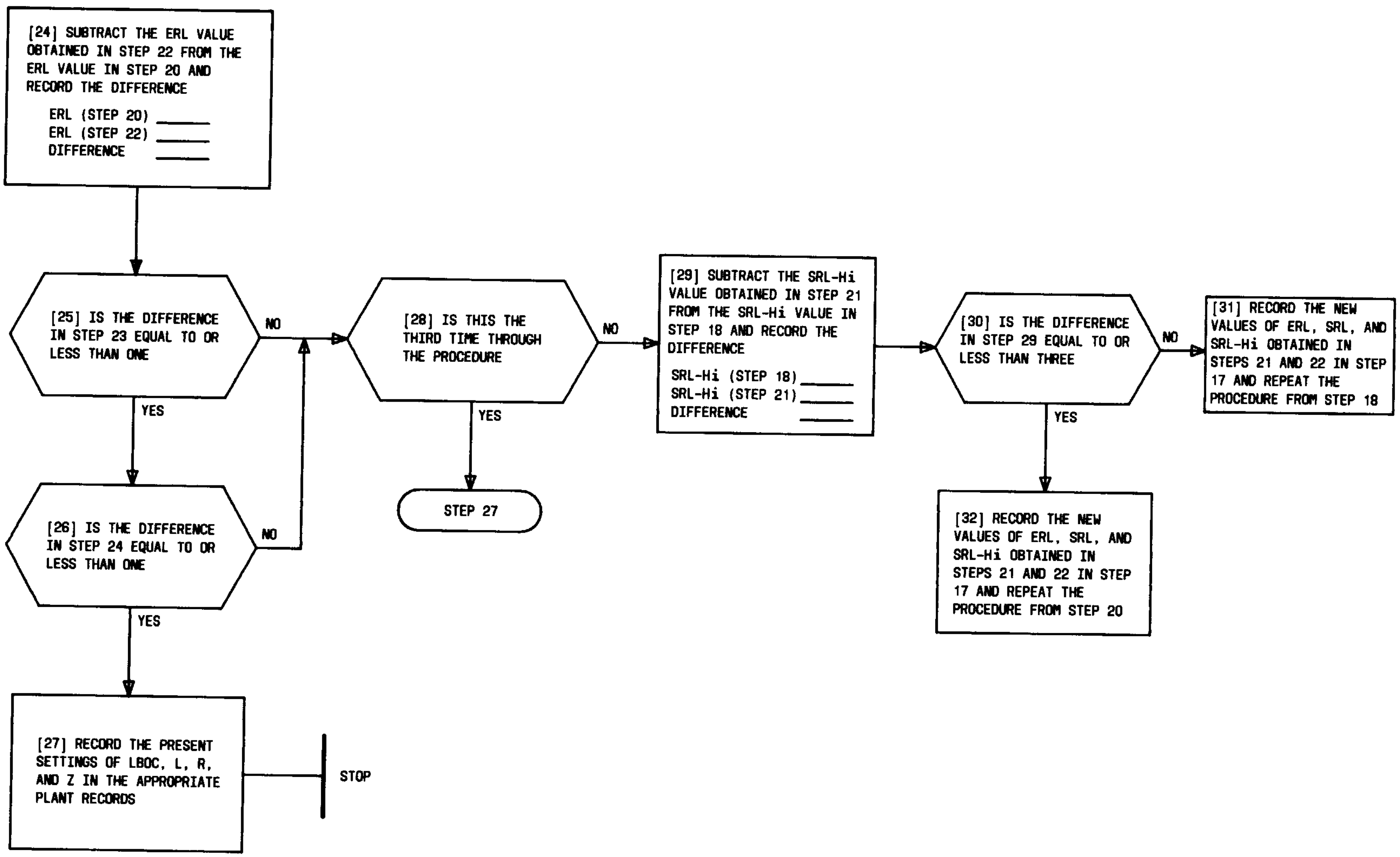


Chart 4—Adjustment of 4240C Precision Balance Networks (Sheet 3 of 3)

C. Adjusting for a Specified Gain

4.11 This procedure requires that the equalizer(s) be set to its final setting and that the repeater output impedance (600 or 1200 on the 4-wire side) be selected. The following test equipment is required:

- One MFT Test Extender J99343TB or J99380TB
- One oscillator with adjustable output power, preferably with a 900-ohm impedance capability
- One transmission measuring set, preferably with a 900-ohm impedance capability.

The oscillator and measuring set may be combined in a single test instrument.

4.12 The test configuration for the 4-2 repeaters is shown in Fig. 15 and the configuration for the 2-4 repeaters is shown in Fig. 16.

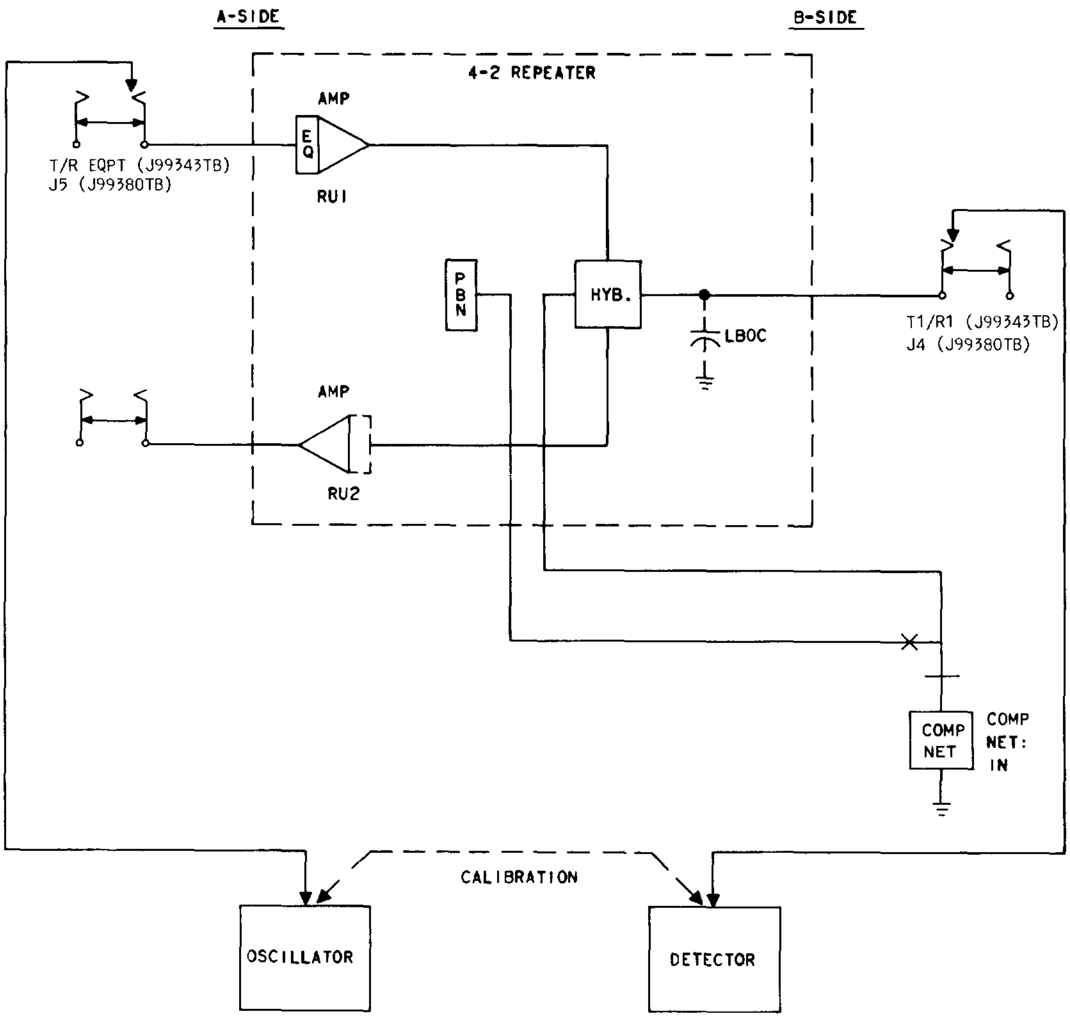


Fig. 15—Test Configuration for Adjusting the 4-2 Repeaters for a Specified Gain

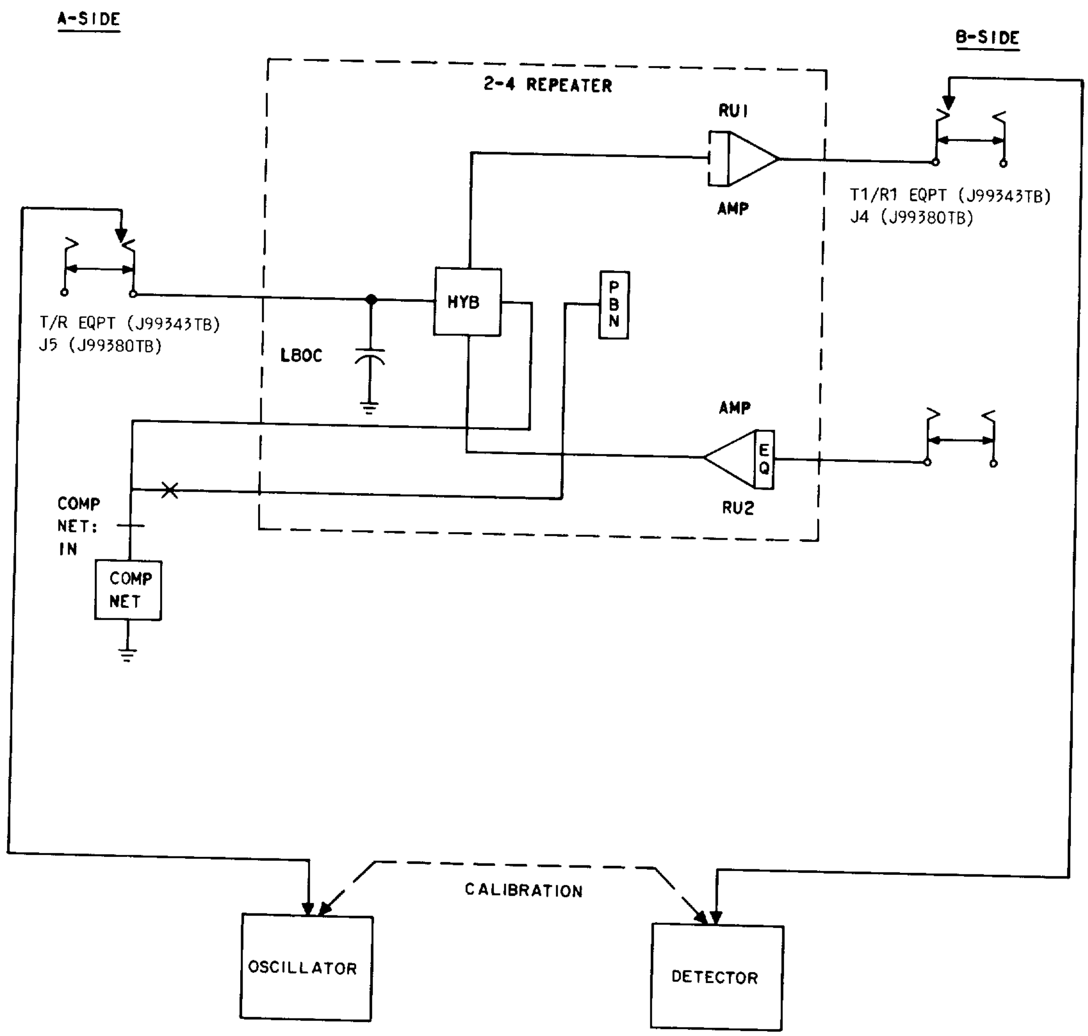


Fig. 16—Test Configuration for Adjusting the 2-4 Repeaters for a Specified Gain

CHART 5

ADJUSTING THE 4-2 REPEATERS FOR A SPECIFIED GAIN

STEP	PROCEDURE
1	Verify (or set) the proper transmission and signaling options on the repeater. (a) Set the 4-wire impedance (OUT switch). (b) Set the equalizer(s). (See Parts 4E and 5.) (c) Make sure the LBOC screws (A through F) are UP (applicable to J99343RB, RG, RD, and RH) or the LBOC switches are operated away from the value (applicable to J99343RJ, RK). (d) Set the midpoint capacitor switches S1=Open, S2=CLOSED. (e) Set the signaling options (RV, RV/T, SX SH, A/B REV, SXRV.) (f) Set gain range switches off; rotate gain potentiometers to full counterclockwise. (g) Set DISABLE switch to NOR position.
2	Set switches on the J99343TB MFT test extender as follows: **A-Side**: 2W/4W to 4W; 600/900 to 900; COMP NET IN/OUT to IN **B-Side**: 2W/4W to 2W; 600/900 to 900; COMP NET IN/OUT to IN Set switches on the J99380TB MFT test extender as follows: S1 to B IN S2 to TEST S3 to 900
3	Insert repeater into the test extender and connect test extender into the proper slot of the MFT shelf or bay.

CHART 5 (Contd)

STEP	PROCEDURE
4	Note the specified gain for RU1 and call it G. If the test equipment is not 900 ohms, G may need to be modified by a correction factor C:

4-WIRE SIDE IMPEDANCE SETTING	CORRECTION FACTOR C	
	600 OHM TEST EQUIPMENT	900 OHM TEST EQUIPMENT
600 ohms	None	None
1200 ohms	0.7 dB	None

G = (specified gain)—C

STEP	PROCEDURE
5	Connect oscillator to the detector. Adjust the output of the oscillator to obtain a reading of -G dBm on the detector.
6	Connect oscillator and detector to the test extender (refer to Fig. 15). Adjust repeater gain to measure 0 dBm on the detector. It may be necessary to operate a gain range (GN) switch to add -10 dB or +10 dB to the potentiometer gain in order to obtain the 0 dBm reading on the detector.
7	Repeat Steps 4 through 6 to set the gain of RU2.
8	Set the PBN, LBOC, midpoint capacitor switches, and DISABLE switch to their specified settings (CLR card).
9	Disconnect all test equipment from repeater and re-insert into its proper shelf location.

CHART 6

ADJUSTING THE 2-4 REPEATERS FOR A SPECIFIED GAIN

STEP	PROCEDURE
1	Verify (or set) the proper transmission and signaling options on the repeater: (a) Set 4-wire output impedance (OUT switch). (b) Set the equalizer(s). (See Parts 4E and 5.) (c) Make sure LBOC screws (A through F) are UP (applicable to J99343RB, RG, RD, and RH).

CHART 6 (Contd)

STEP	PROCEDURE
	(d) Set the signaling options (RV, RV/T, SX SH, SX RV).
	(e) Set gain range switches off; rotate gain potentiometers to full counterclockwise.
	(f) Set DISABLE switch to NOR position.
2	Set switches on the J99343TB MFT test extender as follows: **A-Side**: 2W/4W to 2W; 600/900 to 900; COMP NET IN/OUT to IN **B-Side**: 2W/4W to 4W; 600/900 to 900; COMP NET IN/OUT to OUT Set switches on the J99380TB MFT test extender as follows: S1 to A IN S2 to TEST S3 to 900
3	Insert repeater into the test extender and connect test extender into the proper slot of the MFT shelf or bay.
4	Note the specified gain for RU1 and call it G. If the test equipment is not 900 ohms, G may need to be modified by a correction factor C. See the correction factor table above in Step 4 of the procedure for adjusting the 4-2 repeaters for a specified gain.
5	Connect oscillator to the detector. Adjust the output of the oscillator to obtain a reading of -G dBm on the detector.
6	Connect oscillator and detector to the test extender (refer to Fig. 16). Adjust repeater gain to measure 0 dBm on the detector. It may be necessary to operate a gain range (GN) switch to add -20 dBm, -20 dB, or +10 dB to the potentiometer gain in order to obtain the 0 dBm reading on the detector.
7	Repeat Steps 4 through 6 to set the gain of RU2.
8	Set the PBN, LBOC, and DISABLE switch to their specified settings.
9	Disconnect all test equipment from repeater and re-insert into its proper shelf location.

D. Adjusting For a Specified Output Level

4.12 The following procedure is given for adjusting the repeater output to a specified level. The equalizer settings for the repeater must be known and installed. Changes in the equalizer settings will affect the repeater 1-kHz gain.

4.13 In addition, the LBOC setting (loaded repeater only) must be known but is not installed until after the level on the 2-wire side has been set. The LBOC is then set to its proper value so that the 4-wire output level setting will be correct (LBOC has a slight effect on the 2-wire cable loss at 1 kHz). The PBN should also be set to its proper value.

> ***Note:*** If LBOC and PBN settings are not known, follow the procedures outlined in Part 4. Determine equalizer settings from part 5.

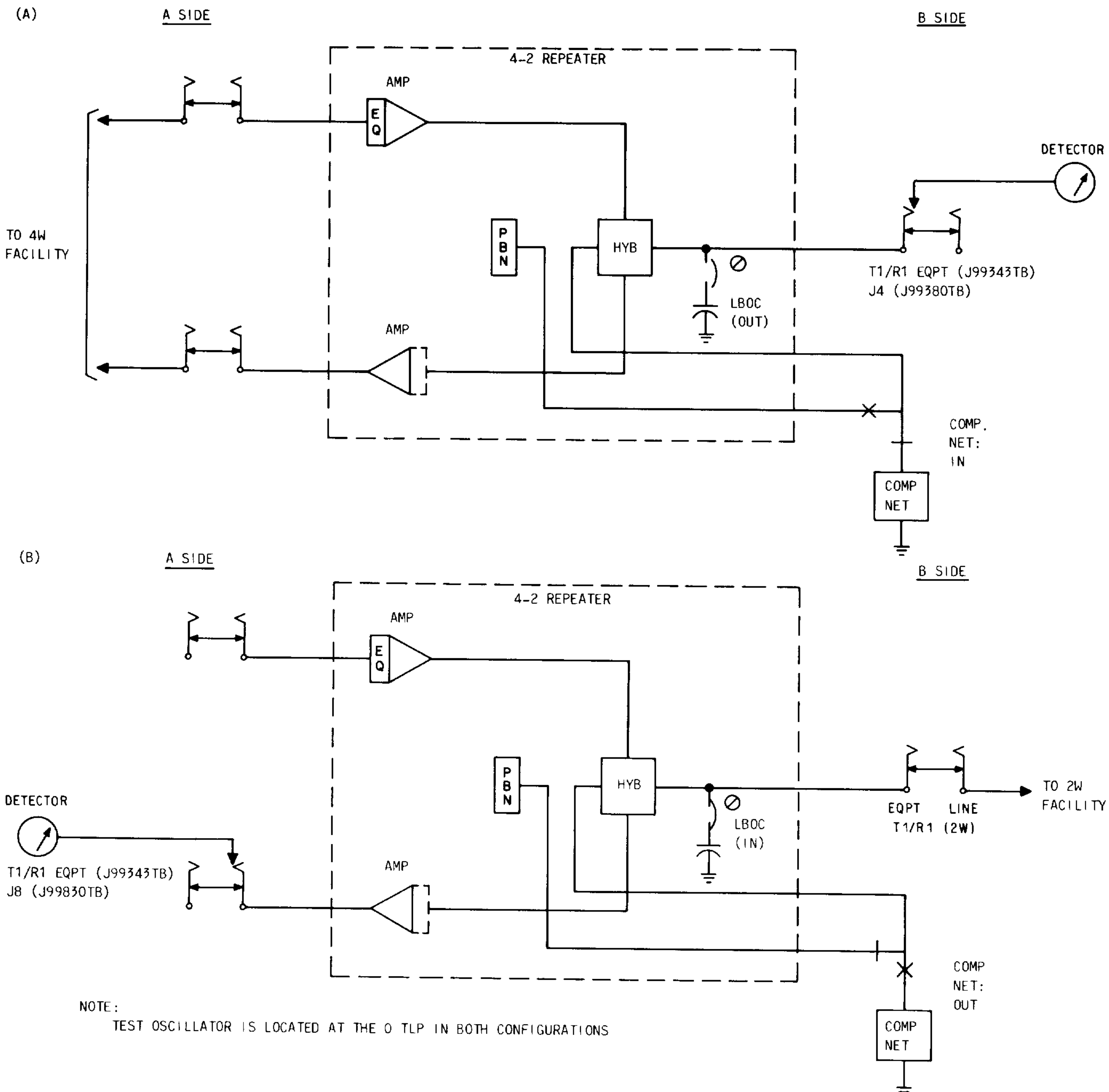


Fig. 17—Test Configuration for Adjusting the 4-2 Repeaters for a Specified Output Level

4.14 The procedures assume that a signal source of 0 dBm at 1 kHz is being applied at the 0 TLP of the circuit. The following test equipment is required:

- One MFT test extender (J99343TB or J99380TB)
- One transmission measuring set, preferably with a 900-ohm impedance capability.

4.15 The test configurations for the 4-2 repeaters are shown in Fig. 17 and the configurations for the 2-4 intermediate repeaters are shown in Fig. 18. The figures show the test connection for each direction of transmission.

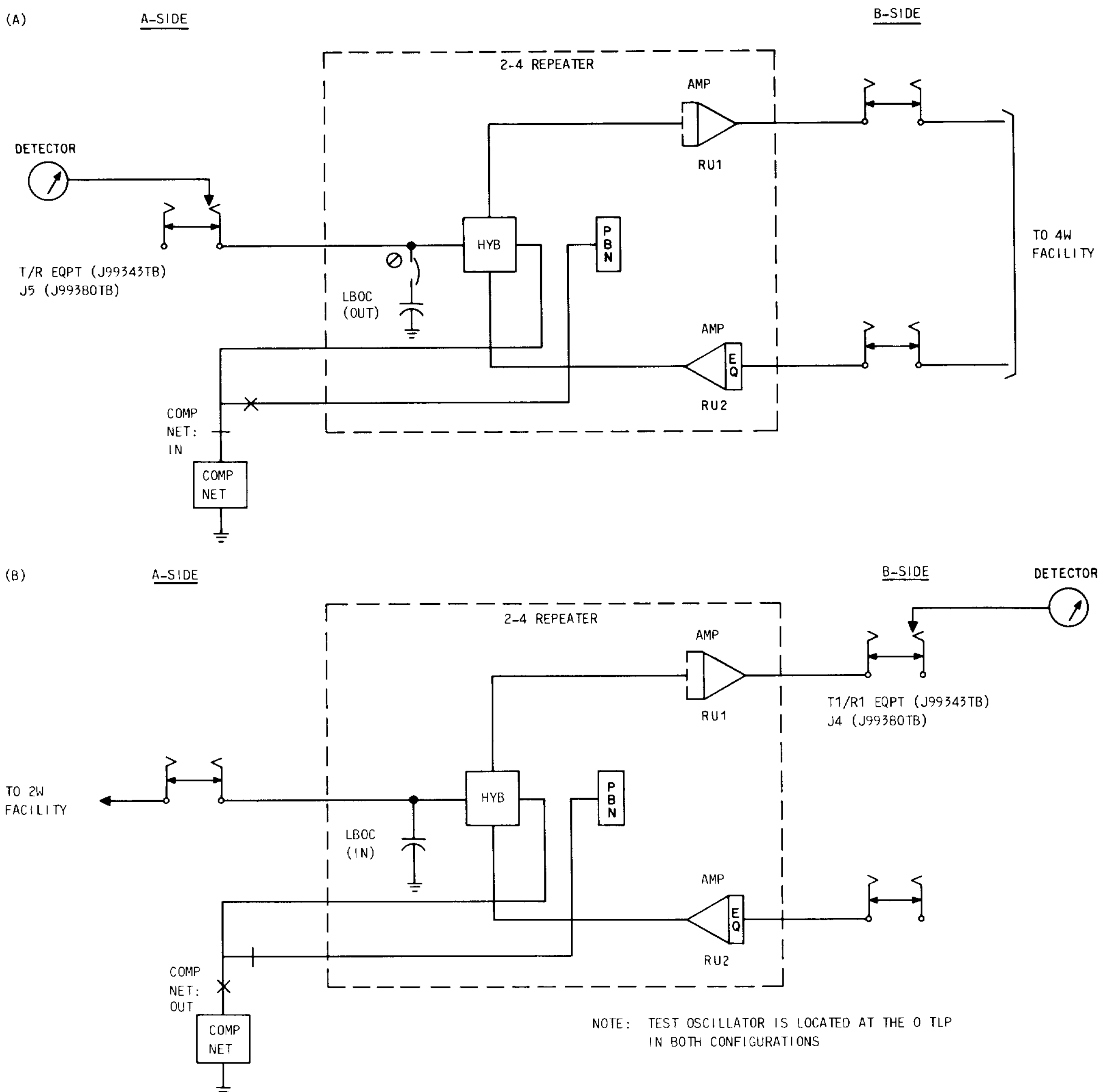


Fig. 18—Test Configuration for Adjusting the 2-4 Repeaters for a Specified Output Level

CHART 7

ADJUSTING THE 4-2 REPEATERS FOR A SPECIFIED OUTPUT LEVEL

STEP	PROCEDURE
1	Verify (or install) the proper transmission and signaling options on the repeater. (a) Set the 4-wire impedance (OUT switch). (b) Set the equalizer(s). (See Parts 4E and 5.) (c) Set the midpoint capacitor switches S1=OPENl, S2=CLOSED. (d) Make sure that the LBOC screws (A through F) are all UP (applicable to J99343RB, RG, RD, and RH) or the LBOC switches are operated away from the value applicable to J99343RJ, RK). (e) Set the DISABLE switch to the NOR position. (f) Set the signaling options (RV, RV/T SX SH, A/B REV, SX RV). (g) If an attempt has been made to install the proper gain setting, verify that the gain setting is approximately the desired value. Otherwise, turn all GN switches off and rotate the GN ADJ potentiometer fully counterclockwise.
2	Set the switches on the J99343TB MFT test extender as follows:

A-Side	B-Side
2W/4W to 4W	2W/4W to 2W
600/900 to 900	600/900 to 900
COMP NET IN/OUT to OUT	COMP NET IN/OUT to IN

CHART 7 (Contd)

STEP	PROCEDURE
	Set the switches on the J99380TB MFT test extender as follows: S1 to B IN S2 to TEST S3 to 900
3	Insert the repeater into the test extender and connect test extender into the proper slot of the MFT shelf or bay.
4	Connect the detector to the test extender as shown in Fig. 17(A).
5	If the measuring instrument is not 900 ohms, a correction factor C may be needed to compensate for the mismatch between the repeater impedance and the measuring set impedance:

REPEATER IMPEDANCE AT DETECTOR	CORRECTION FACTOR C	
	600 OHM TEST EQUIPMENT	900 OHM TEST EQUIPMENT
600 ohms	None	None
900 ohms	None	None
1200 ohms	0.5 dB	None

STEP	PROCEDURE
6	Note the 2-wire output level on the CLR card and call it L. Adjust the gain of RU1 to obtain a reading of L on the detector. If a correction factor C has been called for (table above), RU1 should be adjusted to produce a reading of L-C on the detector.
7	On the B-side of the test extender, set the COMP NET switch OUT on the J99343TB test extender or operate switch S2 to NORMAL on the J99380TB test extender.
8	Install the proper LBOC setting.
9	Connect the detector to the proper A-side jack as shown in Fig. 17(B).
10	Repeat Steps 5 and 6 adjusting RU2.
11	Set the midpoint capacitor switches (S1, S2) and the DISABLE switch to the positions specified on the CLR card.

CHART 8

ADJUSTING THE 2-4 REPEATERS FOR A SPECIFIED OUTPUT LEVEL

STEP	PROCEDURE
1	Verify (or install) the proper transmission and signaling options on the repeater: (a) Set the 4-wire impedance (OUT switch). (b) Set the equalizer(s). (See Parts 4E and 5.) (c) Make sure that the LBOC screws (A through F) are all UP. (d) Set the DISABLE switch to the NOR position. (e) Set the signaling options (RV, RV/T, SX SH, SX RV). (f) If an attempt has been made to install the proper gain setting, verify that the gain setting is approximately the desired value. Otherwise, turn all GN switches off and rotate the GN ADJ potentiometer fully counterclockwise.
2	Set the switches on the J99343TB MFT test extender as follows: **A-Side**: 2W/4W to 2W; 600/900 to 900; COMP NET IN/OUT to IN **B-Side**: 2W/4W to 4W; 600/900 to 900; COMP NET IN/OUT to OUT Set switches on the J99380TB MFT test extender as follows: S1 to B IN S2 to TEST S3 to 900
3	Insert the repeater into the test extender and connect test extender into the proper slot of the MFT shelf or bay.
4	Connect the detector to the test extender as shown in Fig. 18(A).
5	If the measuring instrument is not 900 ohms, a correction factor C may be needed to compensate for the mismatch between the repeater impedance and the measuring set impedance. See the correction factor table above in Step 5 of the procedure for adjusting the 4-2 repeaters for a specified output level.

CHART 8 (Contd)

STEP	PROCEDURE
6	Note the 2-wire output level on the CLR card and call it L. Adjust the gain of RU2 to obtain a reading of L on the detector. If a correction factor C has been called for Step 5), RU2 should be adjusted to produce a reading of L-C on the detector.
7	On the A-side of the test extender, set the COMP NET switch OUT on the J99343TB test extender or operate switch S2 to NORMAL on the J99380TB test extender.
8	Install the proper LBOC setting.
9	Connect the detector to the proper A-side jack (output of RU1) as shown in Fig. 18(B).
10	Repeat Steps 5 and 6 adjusting RU1.
11	Set the midpoint capacitor switches (S1, S2) and the DISABLE switch to the positions specified on the CLR card.

4.19 In cases where the milliwatt supply is not available on both ends of the circuit, a combination of the two procedures can be used as follows:

CHART 9

ADJUSTING FOR A SPECIFIED OUTPUT LEVEL WHERE MILLIWATT SUPPLY IS NOT AVAILABLE AT ONE END OF THE CIRCUIT

STEP	PROCEDURE
1	Use the procedure in 4D to set the level in the direction served by the milliwatt supply.
2	In the same direction, measure the gain of the repeater which was set in Step 1.
3	Note this gain and call it G. No correction factor is necessary.
4	Use the procedure in 4C to set the gain in the other direction to G, omitting any correction factors from the procedure.

E. Loss Versus Frequency Measurements

4.20 The following procedure describes how to obtain the loss versus frequency characteristics of a facility consisting of at least one repeater and at least one cable section. The method will determine the input data for use in Part 5.

4.21 The PBN and the LBOC section, if included on the repeater, must both be set correctly prior to using this procedure. Use the procedure in 4B if the settings are not specified on the CLR.

> ***Note:*** When the procedures in the following paragraphs are used on circuits requiring terminal balance, the loss measurements must be made through the impedance compensator.

4.22 The measurements outlined below are made with the equalizer set to zero (HT=0, SLOPE=0). After the measurements are made and the equalizer set, the facility can then be remeasured to verify the accuracy of the setting. The setting is then also applied to a corresponding equalizer in the opposite transmission direction.

4.23 Because pre-equalization is utilized in many of the circuits, it is not recommended that a 0-dBm signal be connected directly to the 4-wire input of a 4-2 or 2-4 repeater. This is because the resulting high gain at the higher frequencies (to compensate for the higher cable loss at high frequencies) places an excessive level at the balancing network and the line.

4.24 The equalizer configurations described below are chosen to avoid this condition. However, if a connection of the oscillator to the 4-wire input of a repeater is made, the oscillator should be set to -10 dBm and the readings of the detector at the other end corrected to account for the lower input level. The oscillator and detector should enclose the entire facility addressed by the equalizer.

4.25 Since the equalizers are set in pairs, only one facility need be measured per equalizer pair. Figure 20 illustrates the four types of equalizer configurations for 4-wire repeaters. The cases shown can be combined to form any 4-wire circuit with a 2-wire extension employing the 4-2 and 2-4 repeaters covered in this section

> ***Note:*** For Cases 1 and 2 of Fig. 19, the equalizer is at a third location from the oscillator and the TMS. Therefore, arrangements should be made to have the repeater at the third location set up properly and installed into the circuit. For Case 3, the equalizer to be set is located at the receiving end.

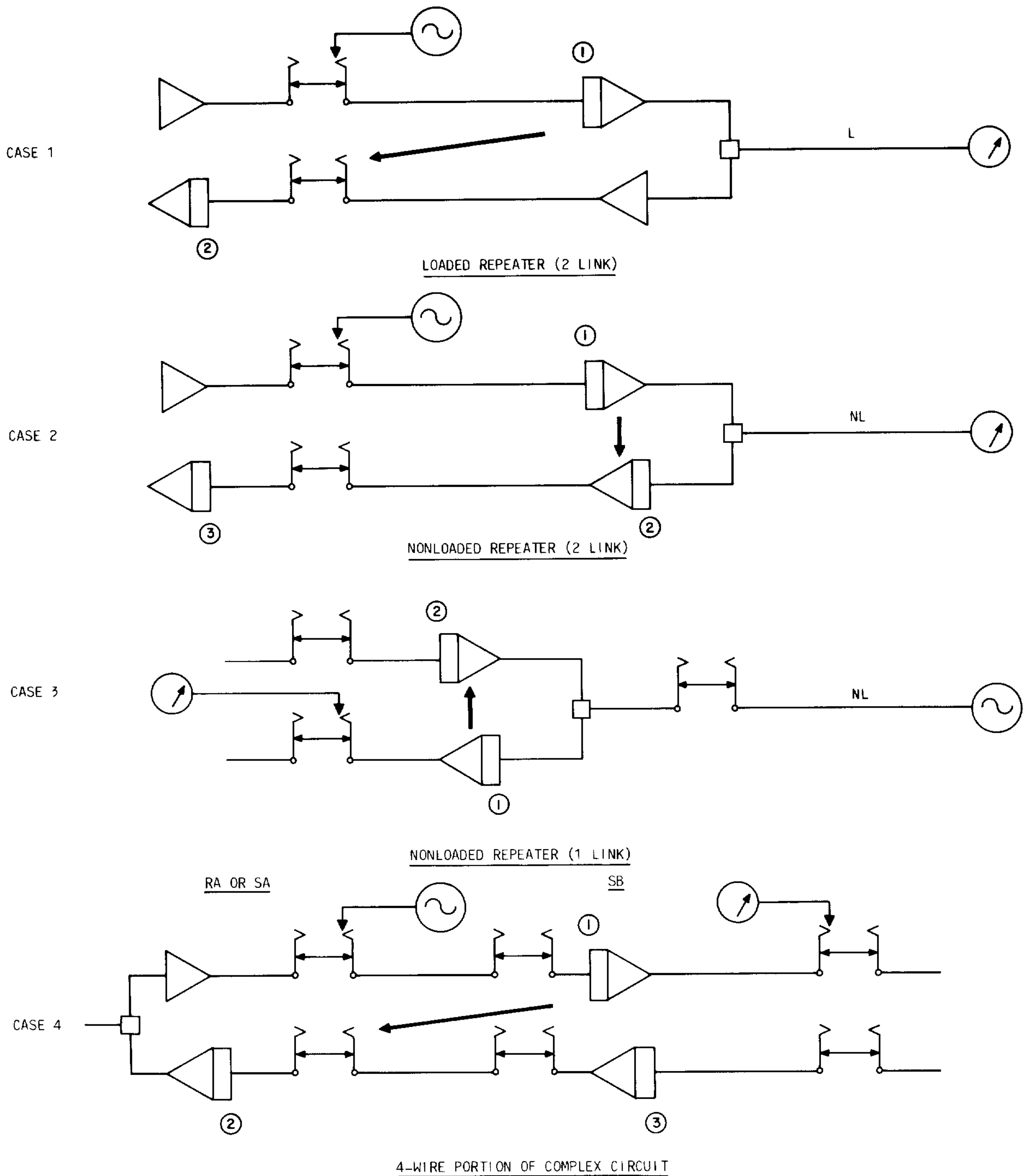
Case 1: Here the measurement is set up to obtain settings for equalizer 1. The oscillator is connected to the proper jack of the test extender at the left of the figure, and the detector is connected at the 2-wire far end. Equalizer 1 has been set to zero before measurements are made. After settings have been obtained for equalizer 1, these settings are also applied to equalizer 2 as indicated by the arrow.

Case 2: Again the oscillator is connected to the far end of the 4-wire link and detector connected at the 2-wire link. With the equalizer set to zero (HT=0, SLOPE=0), the facility is measured and settings for equalizer 1 are derived. These settings are then also applied to equalizer 2 in the figure.

Case 3: In this case the oscillator is connected at the far 2-wire end and detector at the A-side output of the 4-wire port. The 2-wire link plus repeater is then measured and settings for equalizer 1 are derived. These equalizer settings are then applied to equalizer 2.

Case 4: This part of the circuit could also be part of an all 4-wire circuit and is equalized in the same manner. At the terminal repeater end of the circuit, the oscillator is connected at the B-side LINE T1/R1 jack on the J99343TB test extender or to J3 of the J99380TB test extender with terminating plug inserted into J4. The detector is connected at the output of the 4-4 intermediate repeater. Settings are thus obtained with equalizer 1 set to zero, measuring the facility and determining the settings for equalizer 1. These settings are then also applied to equalizer 2 on the 2-4 terminal or 4-4 terminal repeater.

Note: The settings arrived at in Case 4 will not be the same as those in the tables in Section 332-912-222 because this method introduces roll-off while the tables do not. If flat settings are desired, refer to the all 4-wire documentation (Sections 332-912-231, 232).



NOTES:

1. EQUALIZERS INDICATED BY (1) ARE SET USING THE PROCEDURES IN THIS SECTION WITH THE TEST INSTRUMENTS CONNECTED AS SHOWN. THE ARROW IN EACH DIAGRAM POINTS TO A SECOND EQUALIZER WHICH IS THEN SET EXACTLY AS EQUALIZER (1).
2. ALTHOUGH CASE 4 APPEARS TO BE A 4-WIRE CIRCUIT WHICH SHOULD BE EQUALIZED BY THE TECHNIQUES GIVEN IN 332-912-231, IT IS INCLUDED HERE BECAUSE OF ITS USE IN COMPLEX CIRCUITS WHICH INCLUDE A 2-WIRE EXTENSION.

Fig. 19—Equalizer and Cable Configurations

4.26 The following test equipment is required for these measurements:

Transmitting End

- One MFT test extender J99343TB or J99380TB (required only if the transmitting end has an MFT repeater)
- One oscillator with a 900-ohm output impedance capability

Receiving End

- One MFT test extender (J99343TB or J99380TB)
- One transmission measuring set with a 900-ohm output impedance capability.

4.27 Figure 20 shows the test access for making loss measurements of typical circuits. Figure 20A contains only 2-4 and 4-2 repeaters; Figure 20B also contains a 4-4 intermediate repeater. Note that the A-side and B-side designations chosen for this example are arbitrary and do not dictate how this type of circuit should be wired.

CHART 10

INTERMEDIATE LOCATION (Cases 1 and 2)

STEP	PROCEDURE
1	Install the repeater as follows: (a) Equalizer(s) turned off (HT=0, SLOPE=0). (b) PBN and LOBCs (if included) set properly. ***Note:*** If settings for PBN and LBOC are not available, perform the procedure in Part 4B before proceeding. (c) Slide switches set per CLR card. (d) DISABLE switch set to NOR.
2	After settings have been determined from measurements at the transmitting and receiving ends, install the resulting settings to the equalizer(s).
3	When all measurements are complete, note the final settings in the appropriate plant records.
4	If specified on the CLR card, return the DISABLE switch to the DISABLE position.

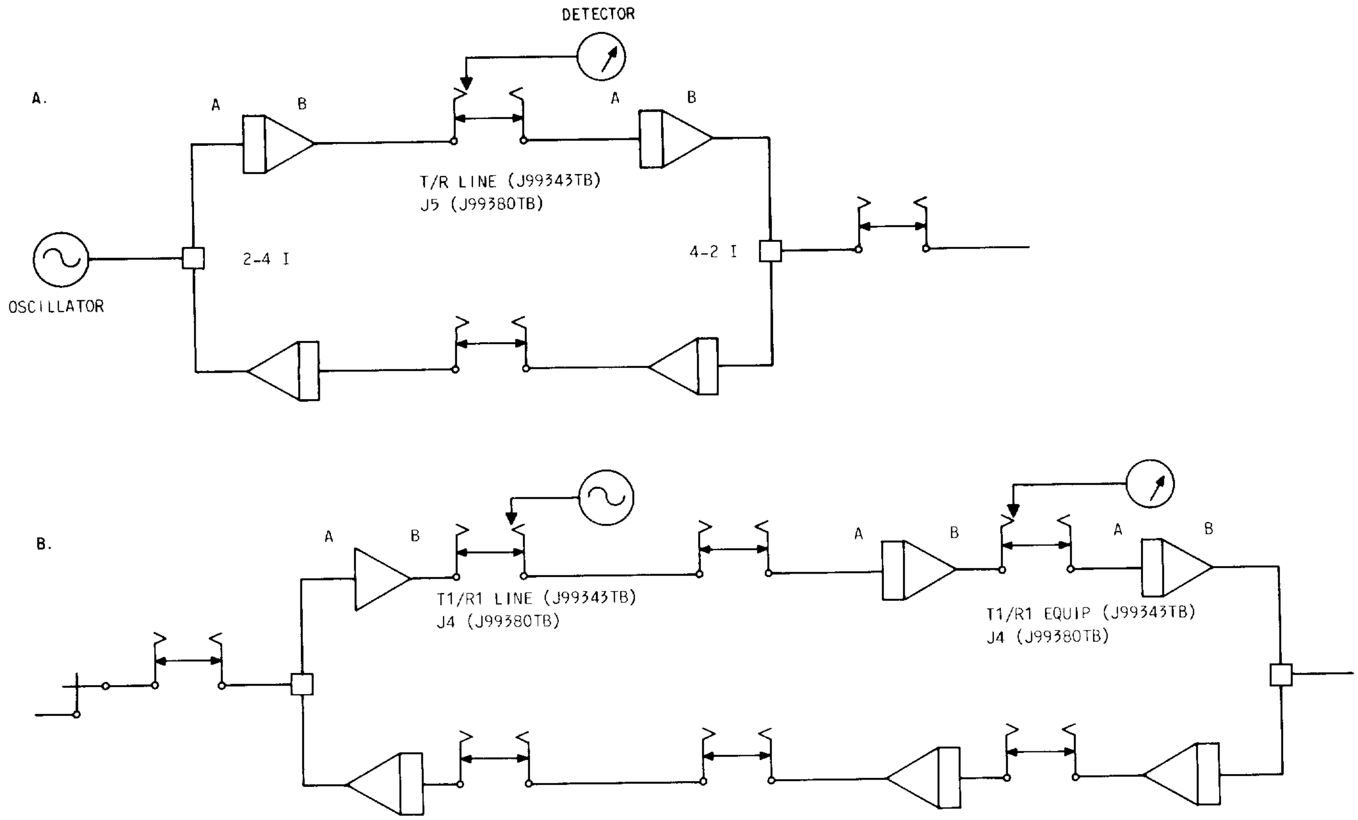


Fig. 20—Oscillator and Detector Connections for Loss Measurements of Typical Circuits

CHART 11

TRANSMITTING LOCATION (Cases 1 and 2)

STEP	PROCEDURE
1	Insert the repeater into the test extender and connect test extender into the proper slot of the MFT shelf or bay.
2	If the facility to be measured is on the A-side, connect a 900-ohm oscillator to the T1/R1 LINE jack of J99343TB or to J8 of the J99380TB test extender. If the facility to be measured is on the B-side, connect a 900-ohm oscillator to the T1/R1 (2W) LINE jack of J99343TB or to J4 of the J99380TB test extender as shown for Case 1 and 2 of Fig. 20.
3	Make sure that the repeater at the intermediate location has been installed as described above.

CHART 11 (Contd)

STEP	PROCEDURE
4	Coordinate with the receiving location to measure the facility loss of 400, 1000, and 2800 Hz.
5	From these measurements, settings can now be determined by applying the procedure in Part 5. The settings should be determined and the results given to the intermediate location.
6	If the facility conforms to Case 1, also install the same settings determined in Step 5 on the "receive" equalizer (2 in Fig. 19, Case 1).
7	Measure the facility with the equalizer settings installed to verify their accuracy.
8	When measurements are complete, record the final settings in the appropriate plant records.

CHART 12

RECEIVING LOCATION (Cases 1 and 2)

STEP	PROCEDURE
1	Connect the transmission measuring set (TMS) to the line.
2	Make sure that the intermediate location repeater has been properly set.
3	Coordinate with the transmitting end to measure the facility response at 400, 1000, and 2800 Hz.
4	Using the data from the measurements and the procedure in Part 5, determine the proper equalizer settings.
5	Relate the settings to the intermediate and transmitting locations for installation on the proper repeaters.
6	Remeasure the facility with the settings installed to verify their accuracy.
7	Record the final settings in appropriate plant records.

CHART 13

TRANSMITTING LOCATION (Case 3)

STEP	PROCEDURE
1	Connect a 900-ohm oscillator directly to the line.
2	After the receiving section has set its repeater properly, coordinate the measurement of the facility response to measure the loss at 400, 1000, and 2800 Hz.
3	From these loss measurements, settings for the equalizer can be derived by applying the procedure in Part 5. The settings should be determined and applied to the equalizers at the receive end.
4	Measure the facility loss with the equalizer settings installed to verify their accuracy.
5	Record the final equalizer settings in the appropriate plant records.

CHART 14

RECEIVING LOCATION (Case 3)

STEP	PROCEDURE
1	Insert the repeater into the test extender and connect test extender into the proper slot of the MFT shelf or bay.
2	Set the repeater as follows: (a) Equalizers turned off (HT=0, SLPE=0). (b) PBN set properly. ***Note:*** If the setting for the PBN is not available, perform the procedure in Part 4B before proceeding. (c) Slide switches and screw switches set per the CLR card. (d) DISABLE switch set to NOR.
3	If the facility to be measured is on the A-side of the repeater connect the TMS to the T1/R1 (2W) EQUIP jack of the J99343TB test extender or to J4 of the J99380TB. If the facility to be measured is on the B-side, connect the TMS to the T1/R1 EQUIP jack of the J99343TB or to J8 of the J99380TB test extender as shown for Case 3 in Fig. 19.

CHART 14 (Contd)

STEP	PROCEDURE
4	Coordinate with the transmitting end to measure the facility loss at 400, 1000, and 2800 Hz.
5	Using the data from the measurements and the procedure in Part 5, determine the proper equalizer settings.
6	Install the settings on both the equalizers.
7	Remeasure the facility with the equalizer set to verify the accuracy of the settings.
8	Record the final settings in the appropriate plant records.
9	If called for on the CLR card, return the DISABLE switch to the DISABLE position.

5. EQUALIZER SETTINGS FROM LOSS DATA

5.01 The procedure described in the following paragraphs can be used to obtain 309B equalizer settings using measured facility loss data. Such a procedure is necessary when a facility is not covered by the tables in Section 332-912-222 or if the facility makeup is not known.

5.02 The procedure assumes that the facility to be equalized has been measured with the equalizer set to zero. To improve upon a setting which has already been determined, use the touchup guidelines in Part 6.

5.03 The inputs to the procedure are the facility losses at 400, 1000, and 2800 Hz measured between 900-ohm impedances. This data may come from any source such as actual measurements of the facility (see Part 4E), artificial cable kit simulation, UNICCAP, or other simulation programs.

5.04 The results of the procedure are the BW, HT, SLOPE, and NL/L switch settings for an equalized facility response which has a controlled amount of roll-off with respect to 1000 Hz (4-wire systems with gain transfer require roll-off at 400 Hz and 2800 Hz for stability purposes).

5.05 To use the procedure, the loss at the three frequencies is entered and a loss difference is calculated. This difference is then looked up in a range chart to determine either the HT or SLOPE setting. If the difference falls on a dividing line, use the setting to the right of the number.

5.06 Table F is used to compute a 400-Hz adjustment using the HT setting. This table is necessary to correct for the low-frequency effect of a particular HT setting. The BW setting is always 15 (all BW switches operated, see paragraph 6.05).

5.07 The procedure for determining equalizer settings is shown in Chart 15. Following are two examples using Chart 15:

TABLE F

400-HZ ADJUSTMENT FOR HT SETTING

HT SETTING	400 Hz ADJ
0	0.0
1	.1
2	.1
3	.2
4	.3
5	.4
6	.6
7	.8
8	1.0
9	1.2
10	1.4
11	1.6
12	1.9
13	2.2
14	2.6
15	3.1

Example 1: (The following data was obtained from cable loss measurement.)

STEP	PROCEDURE	
1	400-Hz loss	8.3 dB
	1000-Hz loss	8.3 dB
	2800-Hz loss	11.4 dB
2	2800-Hz loss	11.4 dB
	1000-Hz loss	8.3 dB
	Difference	3.1 dB is not greater than 5.5 dB
	From Fig. 21(A) HT = 1 when 2800-Hz difference = 3.1 dB.	
	From Table F the 400-Hz adjustment corresponding to HT = 1 is 0.1.	
3	1000-Hz loss	8.3 dB
	400-Hz loss	8.3 dB
	Difference	0 dB
	Add	1.5 dB
	Total	1.5 dB
	400-Hz Adj	0.1 dB
	Difference	1.4 dB
	From Fig. 21(B) SLOPE = 4 when 400-Hz difference = 1.4 dB.	
	NL/L = L	
	Go to Step 6	

STEP	PROCEDURE	
6	BW = 15 HT = 1 SLOPE = 4 NL/L = L	
	The facility was then remeasured to obtain the following results:	
	400-Hz loss	5.0 dB
	1000-Hz loss	3.5 dB
	2800-Hz loss	5.8 dB
	Notice that at 400 Hz the equalized response has 1.5 dB more loss than at 1000 Hz while the unequalized response is flat between 400 and 1000 Hz. This roll-off is necessary for stability and the procedure will use the equalizer to achieve this effect.	

Example 2: (The following data was obtained from cable loss measurements.)

STEP	PROCEDURE	
1	400-Hz loss	9.0 dB
	1000-Hz loss	11.2 dB
	2800-Hz loss	19.8 dB
2	2800-Hz loss	19.8 dB
	1000-Hz loss	11.2 dB
	Difference	8.6 dB
	This is greater than 5.5 so proceed to Step 4.	
4	From Fig. 21(C) HT = 6, and from Table F the 400-Hz adjustment is 0.6.	
5	1000-Hz loss	11.2 dB
	400-Hz loss	9.0 dB
	Difference	2.2 dB
	Add	1.5 dB
	Total	3.7 dB
	400-Hz Adj	0.6 dB
	Difference	3.1 dB
	From Fig. 21(D) SLOPE = 9 NL/L = NL	
6	BW = 15 HT = 6	

STEP	PROCEDURE
	SLOPE = 9 NL/L = NL The above settings were installed and the facility remeasured. The following results were obtained: 400-Hz loss 7.6 dB 1000-Hz loss 6.3 dB 2800-Hz loss 8.4 dB

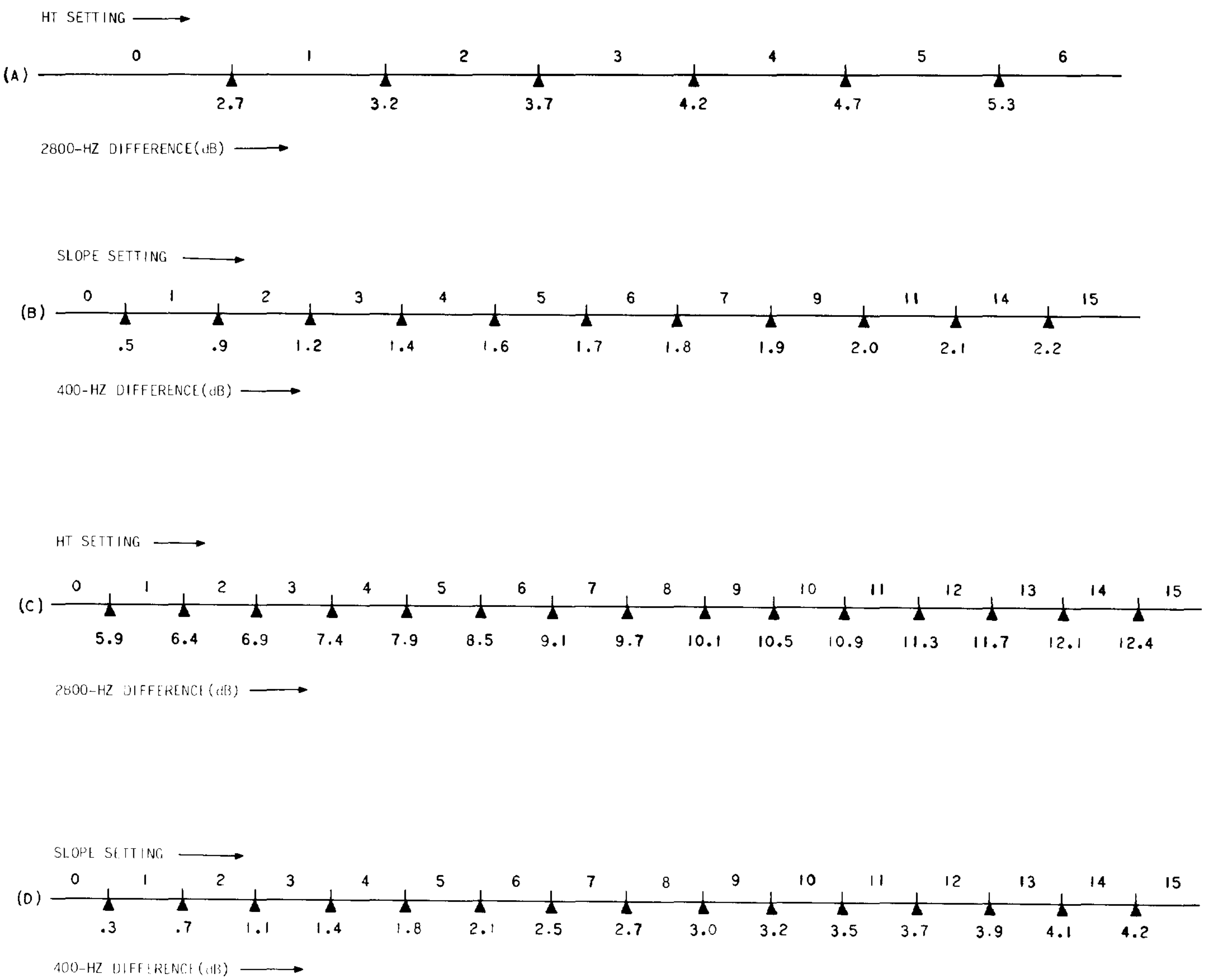


Fig. 21—Loss Range Charts for Obtaining 309B Equalizer Settings

5.08 To put the facility in Example 2 into service, some flat gain (set by potentiometer) must be added. Note that again there is a controlled amount of roll-off for stability reasons.

5.09 In long cable circuits where this procedure is used to obtain settings for two different facilities in the same circuit, the combined effect of the two responses may be on the border line of trunk requirements. Complying with trunk requirements may necessitate a variation of the equalizer setting procedure for long cable circuits. Rather than setting the two facilities separately, the first should be set and then the ***entire circuit*** measured with the second equalizer set to zero. This will cause the second set of measurements to produce settings for the second equalizer which are more compatible with the equalization needs of the entire circuit.

CHART 15

EQUALIZER SETTINGS FROM CABLE LOSS DATA

STEP	PROCEDURE
1	Determine cable loss 400 Hz ________ 1000 Hz ________ 2800 Hz ________
2	2800-Hz loss__ 1000-Hz Loss__ DIFFERENCE__If greater than 5.5, enter this difference in Step 4 and proceed to Step 4. From Fig. 21(A), select HT setting and enter in Step 6. From Table F, find the 400-Hz adjustment corresponding to this HT setting and enter at * in Step 3.
3	1000-Hz Loss ________ 400-Hz Loss ________

CHART 15 (Contd)

STEP	PROCEDURE
	DIFFERENCE ______ ADD ____1.5____ TOTAL ______ 400-Hz Adj. ____*____ DIFFERENCE ______ From Fig. 21(B), select SLOPE setting and enter in Step 6. Enter NL/L = L in Step 6. Proceed to Step 6.
4	DIFFERENCE From Step 2 ______ From Fig. 21(C), select HT setting and enter in Step 6. From Table F, find the 400-Hz adjustment corresponding to this HT setting and enter at † in Step 5.
5	100-Hz Loss ______ 400-Hz Loss ______ DIFFERENCE ______ ADD ____1.5____ TOTAL ______ 400-Hz Adj. ______ † DIFFERENCE ______ From Fig. 21(D), select SLOPE setting and enter in Step 6. Enter NL/L = NL in Step 6.
6	BW = 15 HT = __ SLOPE = __ NL/L = __ END OF SETTING CALCULATION

6. EQUALIZER TOUCHUP GUIDELINES

6.01 The following guidelines explain how to improve an initial equalizer setting by measurements and also describe the effect of the various equalizer controls. This procedure assumes that the initial setting is reasonably close to the correct value. For cases where an initial setting is not available, use the procedure outlined in Part 5.

6.02 Figure 22 shows the desired equalized facility frequency response. Unlike an all 4-wire facility (no 2-wire extension) which strives for a flat response across the band, the response objective here has 1.5 dB roll-off at 400 Hz and 2.25 dB roll-off at 2800 Hz. Of the two objectives, the 400

Hz one is the more critical because, in many cases, the stability of the circuit is directly related to the loss at 400 Hz.

Note: This is an ***objective***—not a requirement. Actual response limits are determined by the requirements of the overall circuit. By adjusting each facility of a circuit to the loss shape of Fig. 22, the overall circuit will be set for optimum stability while still meeting its end-to-end loss objectives.

6.03 Low-frequency equalization is controlled by the SLOPE adjustment in combination with the NL/L switch:

- With NL/L = L

  Increasing SLOPE—more loss at low frequencies relative to 1 kHz

  Decreasing SLOPE—more gain at low frequencies relative to 1 kHz

  There is almost no effect at frequencies above 1 kHz with NL/L = L

- With NL/L = NL

  Increasing SLOPE—more loss at low frequencies and more gain in the midband relative to 1 kHz

  Decreasing SLOPE—more gain at low frequencies and more loss in midband relative to 1 kHz

Note: Changing the slope setting ***always*** affects the 1-kHz gain of the repeater.

6.04 The equalization for frequencies above 1 kHz is controlled by a "bump" function centered at 3250 Hz. The height of the bump is controlled by the HT (height) switches and the width of the bump is controlled by the BW (bandwidth) switches.

6.05 Since none of the facilities discussed in this section have requirements beyond 2800 Hz, small BW settings are not necessary. By setting BW = 15, most cases can be handled without significantly impairing the flexibility of the equalizer.

6.06 When touching up equalization, always adjust the low-frequency roll-off first (SLOPE). Changes in the HT and BW settings can then be made because these will have a minor effect on the low-frequency response. Changing the SLOPE setting can have a major effect on the high-frequency response.

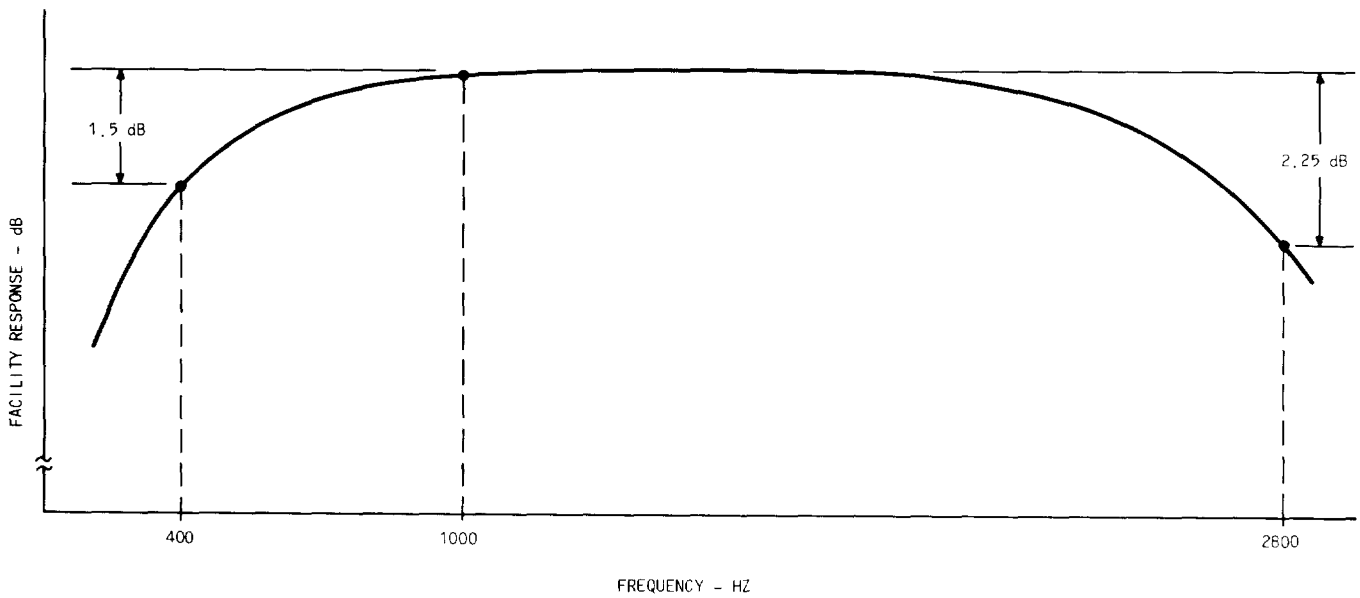


Fig. 22—Objective for Equalized Response on a 4-Wire Circuit with 2-Wire Extension

6.07 The following guidelines should be considered when touching up equalization:

- Check roll-off at 400 Hz (compared to 1 kHz)

  too much loss - decrease SLOPE

  too much gain - increase SLOPE

- Since the NL/L switch affects the gain characteristic significantly, this switch should not be changed during touchup.

- Check roll-off at 2.8 kHz compared to 1 kHz

  too much loss - increase HT

  too much gain - decrease HT

- Most circuits covered in this section can be equalized by leaving the BW (bandwidth) control set to 15. However, if the response is acceptable at 400 Hz and 2800 Hz, but too much gain at 2000 Hz, decrease the BW setting.

- If good results cannot be obtained in two or three adjustments, the initial settings were probably too far from optimum. It is suggested that the equalizer settings be determined by the procedure outlined in Part 5.

6.08 Circuits consisting of more than one equalized link should have the equalization for the overall circuit "touched up" as discussed below and as shown in Fig 23. Equalization of the overall circuit on an end-to-end basis may be required to meet trunk objectives. Circuits consisting of one or two equalized links will normally meet trunk loss objectives with prescription settings (ie, no touchup adjustments should be required). When touchup is necessary for complex circuit configurations, this should be done in a sequence as indicated in Fig. 23. First, the touchup procedures are applied to a single equalized section as shown in Step 1. After adjusting the two equalizers designated "A", touchup procedures are then applied to the next section (Step 2). The remaining sections of the circuit are touched up in a like manner without any further adjustment to the equalizers of the previously touched up section(s).

7. PROCEDURES FOR CIRCUITS REQUIRING TERMINAL BALANCE

7.01 The MFT 4-2 terminal repeaters in combination with 837- or J99380-type impedance compensators may be used for circuits with terminal balance requirements. The following paragraphs discuss the use of these repeaters on circuits requiring terminal balance (the 2-4 intermediate repeaters are not used with impedance compensators).

7.02 Prescription settings for the repeaters (PBNs and equalizers) and the impedance compensating networks are contained in Section 332-912-222. It is important to note that the special tables found in Section 332-912-222 must be used for MFT applications which include the above impedance compensators.

7.03 If the cable makeup does not fit the tables (eg, includes bridged taps or more than two gauges of wire), a manual adjustment procedure must be used. Chart 16 gives the manual lineup procedures for MFT/837D or J99380AA network configurations on nonloaded cable.

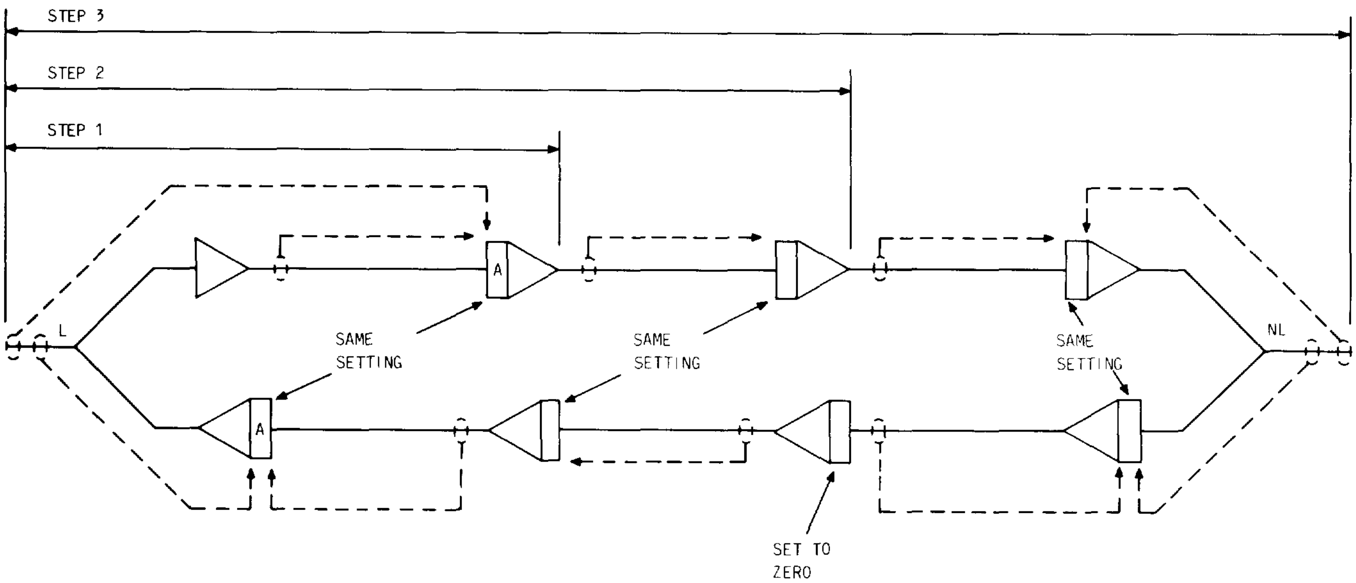


Fig. 23—Equalizer Touch-Up Procedure for a Complex Circuit

CHART 16

MANUAL ADJUSTMENT OF J99343RC, RJ REPEATER AND 873D OR J99380AA NETWORK

STEP	PROCEDURE
1	If the facility does not fit the prescription setting tables contained in Section 332-912-222, a group of initial settings should be chosen using an equivalent gauge and length which most closely resembles the actual facility.
2	Insert the J99343RC, RJ 4-2 terminal/intermediate repeater (nonloaded) into the MFT test extender and connect test extender into the proper slot of the MFT shelf or bay.
3	Set the switches on the J99343TB test extender as follows:

A-Side	B-Side
2W/4W to 4W	2W/4W to 2W
600/900 to 600	600/900 to 900
COMP NET IN/OUT to OUT	COMP NET IN/OUT to OUT

CHART 16 (Contd)

STEP	PROCEDURE
	Set switch on the J99380TB test extender as follows: S2 to NORMAL
4	On the B-side of the J99343TB test extender, terminate the cable facility in 900 ohms + 2.15 μF by inserting a 310 dummy plug into the T1R1 2W EQUIP jack. If using the J99380TB test extender, terminate the cable facility by inserting a 900 ohm + 2.15 μF terminating plug into J4. These terminations will permit positive identification of the 2-wire pair under test at the impedance compensator (see Section 332-205-500).
5	To prevent the repeater from singing during the setting of the 837D or J99380AA, remove the repeater from the test extender.
6	Have the 837D or J99380AA settings optimized using the procedures in Section 332-205-500 or 311-100-551.
7	After obtaining satisfactory terminal balance on the drop side of the 837D or J99380AA: (a) Remove the 310 dummy plug from the J99343TB test extender or the terminating plug from J4 of the J99380TB test extender. (b) Reconnect the repeater. (c) Terminate the drop side of the 837D or J99380AA in the proper impedance (600 or 900 ohms + 2.15 μF).
8	Optimize the PBN using the procedures in Part 4B (Chart 3) of this section.
9	Determine the equalizer settings using the procedures in Part 5 (Chart 15) of this section.
10	After installing the equalizer settings, adjust the levels of the amplifier units using the procedures in Part 4 (Chart 7) of this section.
11	Insure that the circuit requirements are met, and touch up the 837D or J99380AA "R" potentiometer as required to improve the terminal balance.

7.04 The following procedure should be used for manual adjustment of the J99343RB, RG, or RJ 4-2 intermediate/terminal repeater (L) when used with 837A, B, E, F, G, or J99380AB, AC networks.

CHART 17

MANUAL ADJUSTMENT OF THE J99343RB, RG, OR RJ REPEATER AND 837A, B, E, F, G, OR J99380AB, AC NETWORKS

STEP	PROCEDURE
1	Choose and install the initial precision balance network settings, using the table in Section 332-912-222 for the facility which most nearly matches the actual facility.
2	If the end section length adjacent to the 837-type or J99380-type network is known, the initial settings may be found in Sections 332-206-251 through -257.
3	If the end section length adjacent to 837-type or J99380-type network is unknown, the initial settings may be determined using the procedures in Section 332-205-500 or 311-100-552.
4	Insert the repeater into the test extender and plug test extender into the proper shelf position of the repeater.
5	Set the switches on the J99343TB test extender as follows:

A-Side	B-side
2W/4W to 4W	2W/4W to 2W
600/900 to 600	600/900 to 900
COMP NET IN/OUT to OUT	COMP NET IN/OUT to OUT

Set switch on the J99380TB test extender as follows:

S2 to NORMAL

STEP	PROCEDURE
6	On the B-side of the J99343TB test extender, terminate the cable facility in 900 ohms + 2.15 μF by inserting a 310 dummy plug into the T1R1 2W EQUIP jack. If using the J99380TB test extender, terminate the cable facility by inserting a 900 ohm + 215 μF terminating plug into J4. These terminations will permit positive identification of the 2-wire pair under test at the impedance compensator (see Section 332-205-500).
7	To prevent the repeater from singing during adjustment of the 837- or J99380-type network, remove the repeater from the test extender.
8	Optimize the 837- or J99380-type network settings using the procedures in Section 332-205-500 or 311-100-552.
9	After obtaining satisfactory terminal balance on the drop side of the 837- or J99380-type network:

(a) Remove the 310 dummy plug from the J99343TB test extender or the terminating plug from J4 of the J99380TB test extender.

CHART 17 (Contd)

STEP	PROCEDURE
	(b) Reconnect the repeater in its shelf or bay mounting.
	(c) Terminate the drop side of the 837- or J99380-type network in the proper impedance (600 or 900 ohms + 2.15 μF).
10	Optimize the 4240A network using the procedures in Part 4B (Chart 2) of this section.
11	After setting the PBN and LBOC to their proper values, adjust the levels of the amplifier units using the procedures in Part 4D (Chart 7) of this section.
12	Insure that circuit requirements are met, and touch up the 837- or J99380-type network as necessary to improve the terminal balance.

8. REFERENCES

8.01 The following references may be referred to for additional information.

REFERENCE	TITLE
332-910-100	General Description of the Metallic Facility Terminal (MFT)
332-910-102	MFT Test Extender—Description and Operation
332-910-180	General MFT Applications Information
332-912-121	4-2 and 2-4 Wire Repeaters—Description
332-912-222	4-2 and 2-4 Wire Repeaters—Prescription Settings
SD-1C359-01	Metallic Facility Terminal Circuit
CD-1C359-01	Common Systems—Metallic Facility Terminal Circuit
332-610-500	Customer Premises Facility Terminal For MFT Plug-In Equipment Maintenance and Testing Information