

## SIGNALING BYPASS AUXILIARY UNITS

### DESCRIPTION

#### TYPE F SIGNALING SYSTEM

CONTENTS	PAGE
1. GENERAL . . . . .	1
2. EQUIPMENT DESCRIPTION . . . . .	2
3. TRANSMISSION CHARACTERISTICS . . . . .	2
A. 2-Wire Operation . . . . .	2
B. 4-Wire Operation . . . . .	3
4. MAINTENANCE . . . . .	4

#### 1. GENERAL

**1.01** This section describes the FMA, FMB, FMC, FMD, FME, FMF, FMG, FMJ, and FMK units (SD-1C296-01) to be used with the Type F Signaling System. These units provide no signaling function. They are intended primarily for use in special service applications and through circuit applications where the signaling function is not required or is provided elsewhere. Fig. 1 shows a typical application of the FMJ and FMK units. Each circuit function is listed in Table A.

**1.02** This section is reissued to change the direction of the operational amplifiers in the transmit circuit of the FUD unit in Fig. 8 and to change switch symbols in the simplified schematic of the FMD, FME, FMF, and FMJ units in Fig. 6, 9, 10, 11, 12, 13, 14, 15, and 16. Arrows have not been used to indicate changes.

**1.03** Components in these units are mounted on a printed wiring board. The board is mounted on a die cast aluminum frame approximately 10-1/2 inches deep by 1-1/2 inches wide by 7 inches high. All interconnections between the bay and the unit

are via a 40-pin connector which is part of the printed wiring board.

**1.04** These units are placed in service by inserting them into the guides of the shelf and sliding them toward the rear of the bay. A locking device on the face of the unit locks the unit in place when sufficient contact with the bay mounting is made. To remove the unit, release the locking device and withdraw the unit.

**1.05** Slide switches on the face of the FMA, FMF, and FMJ units adjust the attenuators for the desired attenuation. The slide switches on the FMG unit are located on the printed wiring board. The FMG unit must be plugged into a test extender in order to adjust the attenuators. Screw switches adjust the impedance and equalization in the FMC unit and network buildout capacitance (NBOC) in the FMD and FME units. The color coded label on the face of the FMA through FME units is red with gold lettering. The FMF, FMG, FMJ, and FMK units are not color coded. These units have a silver label with the code number stamped on it.

**1.06** The FMA, FMF, FMG, and FMJ units may be used in the FUA- or FUD-type double module installation. These units may also be used in the FWA-, FWB-, or FWC-type single module installation. When the FMA, FMF, FMG, or FMJ unit is substituted for the FUA or FUD unit, an FMB, FMC, FMD, FME, or FMK unit will be used in the auxiliary position.

**1.07** Figure 2 is a photograph of an FMC unit which shows some of the components which are used in unit construction. Figure 3 shows the details of the various FM\_ faceplates.

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## 2. EQUIPMENT DESCRIPTION

**2.01** The FMA unit (Fig. 4) provides a 4-wire transmission path through the bay. Built-in 34-type attenuators enable transmission level adjustments from 0 to 16.5 dB loss in 0.1 dB increments. If the bay is equipped with connections to external echo suppressors or equalizers, they may be included in the circuit.

**2.02** The FMB unit (Fig. 4 and 9) provides only a zero loss 4-wire transmission path. It contains no attenuators and bypasses the echo suppressor access terminal.

**2.03** The FMC unit (Fig. 5 and 10) provides 4-wire line matching and loss-frequency equalization on the transmit side. Additional resistance and capacitance can be inserted by screw switches for impedance matching. The taps on the equipment side of transformers T101 and T202 can be varied by screw switches to provide impedance matching at this point.

**2.04** The FMD and FME units (Fig. 6, 11, and 15) have 4-wire terminating sets. The difference between the FMD unit and the FME unit is that the FMD provides a 900 ohm 2-wire impedance and the FME provides 600 ohm 2-wire impedance. Access is provided for an external precision network if required. Provision is made for NBOC adjustments from 0.0 to 0.127  $\mu\text{f}$  in .002  $\mu\text{f}$  steps. In circuits where an external capacitor is provided across the A and B leads, a screw switch (S1) on the FMD and FME units allows the internal A and B lead capacitor in the terminating set to be removed. For the FMD unit only, additional capacitance on the equipment side of the terminating set may be provided by the NB4 screw switch. The additional capacitance (3  $\mu\text{f}$ ) is required to balance the terminating set due to additional capacitance present on the A and B leads. For applications where 2600-Hz signaling is not present in the voice path, the FUD may be used with the FMD or FME unit to allow up to 9 dB of cable on the drop side and to provide equalization of loaded and nonloaded cable (Fig. 8).

**2.05** The FMF unit (Fig. 9 through 12) is similar to the FMA unit except the FMF has 8 dB pads in the TRMT and RCV paths. These pads can be added or removed from the circuit path by opening and closing screw switches. These pads, 8 dB plus the 16.5 dB, are not intended to be used

universally in lieu of external pads in the transmit and receive paths. These pads will be used in conjunction with external pads where external pads are available. The FMF provides the capability to connect directly between a carrier which is not terminated in F signaling bays and a carrier having no level control included.

**2.06** The FMG unit (Fig. 4 through 7) is equivalent to the FMA and the FMF unit without the 8 dB fixed pad. The FMG unit provides zero loss transmission from the unit line side to its echo suppressor access terminals. This unit is primarily intended for use where interoffice signaling functions are replaced by Common Control Intertoll Signaling and where front panel attenuator access is not required.

**2.07** The FMJ unit (Fig. 13 through 16) is similar to the FMF in that it has the 24.5 dB of switchable attenuation in both the TRMT and RCV paths. In addition to the attenuation, the FMJ has a carrier group alarm circuit which is activated by the FYH when carrier failure occurs. The FMJ also has screw switch adjustments which allow for trunk conditioning. This trunk conditioning is for end-to-end signaling on 2-way trunks and FX lines for both office and station ends. The FMJ unit operates in the FUA or FUD position. In order for the carrier group alarm circuit in the FMJ unit to function, an FMK unit must be installed in the auxiliary position. Table B shows the screw switch settings for the carrier group alarm and level adjustment circuits.

**2.08** The FMK unit (Fig. 7, 12, and 16) is similar to the FMB unit inasmuch as it provides zero loss transmission from the line to the trunk circuit equipment. When the FMK is plugged into the FW( ) position, the echo suppressor access terminals are bypassed and the level adjustments are omitted. The FMK unit provides carrier group alarm and -48 volt through connections for the FMJ unit when plugged into the auxiliary position.

## 3. TRANSMISSION CHARACTERISTICS

### A. 2-Wire Operation

**3.01** The envelope delay distortion present in the transmit and receive circuits can be seen in Fig. 17. In the FMD and FME units, the delay distortion is about 15 microseconds for frequencies of 3000 Hz and above for either the transmit or

receive portions. The rise in distortion is quite rapid below 2000 Hz. The delay increases from 18  $\mu$ s delay at 2000 Hz to 160  $\mu$ s delay at 500 Hz as shown by the transmit and receive curves.

**3.02** The transmit and receive path of the FMA, FMB, FMF, FMG, or FMJ unit (excluding the P-pads) insert virtually no loss. Therefore, when one of these units is used in the place of the FUA or FUD unit, the loss in the transmission path is due to the FMD or FME unit. The 2- to 4-wire and the 4- to 2-wire transmission loss for the FMD and FME units is shown in Fig. 18 and 19.

**3.03** The 2-wire return loss and the transhybrid loss curves for the FMD and FME units are shown in Fig. 20 through 23.

#### B. 4-Wire Operation

**3.04** The FMC unit contains a line match network which is used with 4-wire cable facilities. Impedance matching is obtained by selecting the proper transformer impedance ratio by the use of screw switches located on the printed wiring board. Both transmitting and receiving cable pairs must be matched. Transformer T101 is associated with the T and R leads, and transformer T102 is associated with the T1 and R1 leads. The L(150), M(600), and H(1200) screw switches associated with each transformer are to be turned down as determined by the following:

SCREW SWITCH	SPECIFIC USE
H(1200)	To be used when cable extension associated with FMC signaling link is loaded H88 cable (see Tables E through I).
M(600)	To be used when associated FMC signaling link is a nonloaded short cable (see Table C, column 1).
L(150)	To be used when cable extension associated with FMC signaling link is a nonloaded, long-length cable (see Table C, columns 2 and 3).

**Note:** When screw switches L(150) and M(600) are operated per Table C, the IN switch on the faceplate should be screwed out and

screw switches R250, R500, R1000, and R2000 on the faceplate should be screwed in. Screw switches C.25, C.5, C1.0, and C2.0 can be in any position.

Table D shows the loss-frequency and delay-frequency characteristics of a typical FMC unit as measured between nominal impedances.

**3.05** For loaded H88 cable, independently adjustable low- and high-frequency equalization sections for the receiving cable pair provide the necessary equalization to obtain a substantially flat frequency response over the range of 250 to 3000 Hz (Tables E through I). These tables assume that the equipment at the far end is a 24V4 repeater or equivalent. The 1000-Hz insertion loss varies between 3.3 and 6.3 dB as equalization is adjusted. If these controls are not set as prescribed in the prescription adjustment tables (Tables E through I), the insertion losses could be as high as 20 dB. The 1000-Hz loss in the transmit path toward the cable pair is 0.3 dB.

**3.06** Figures 24 through 29 are curves that illustrate the effect of varying the values of the components of the equalizer sections of the network.

**3.07** The series arm low-frequency components ( $R_{LF}$  and  $C_{LF}$ ) provide compensation for the 4-wire line facilities at frequencies up to approximately 1000 Hz. Figures 24 and 25 illustrate typical equalization losses which can be obtained by various combinations of  $C_{LF}$  and  $R_{LF}$ . Figure 24 shows the results of keeping  $C_{LF}$  constant at 0.25  $\mu$ F and varying  $R_{LF}$  with the HF section out of the circuit. Figure 25 shows the results of keeping  $R_{LF}$  constant at 1500 ohms and varying  $C_{LF}$  with the HF section out of the circuit.

**3.08** The shunt arm high-frequency components provide equalization H88 loaded, high-capacitance cable where the nominal cutoff is 3500 Hz. Capacitor  $C_{HF}$  and inductor  $L_{HF}$  form a parallel resonant circuit tuned to 3000 Hz which is in series with the adjustable resistor  $R_{HF}$ . Varying resistor  $R_{HF}$  adjusts the amount of high-frequency equalization for various lengths and gauges of facilities (Tables E through I). Figure 26 illustrates the typical corrective losses which may be obtained by various settings of  $R_{HF}$ .

**3.09** While the series arm low-frequency components ( $R_{LF}$  and  $C_{LF}$ ) provide compensation, they introduce delay distortion at the same time. Figures 27 and 28 illustrate typical delay-frequency characteristics obtained by various combinations of  $C_{LF}$  and  $R_{LF}$ . Figure 24 illustrates the results of keeping  $C_{LF}$  constant at  $0.25 \mu F$  and varying  $R_{LF}$  with the HF section out of the circuit. Figure 28 shows the results of keeping  $R_{LF}$  constant at 1500 ohms varying  $C_{LF}$  with the HF section out of the circuit.

**3.10** While the shunt arm high-frequency components provide compensation for amplitude distortion, they also introduce delay distortion. Figure 29 illustrates typical delay-frequency characteristics obtained by varying  $R_{HF}$ .

**4. MAINTENANCE**

**4.01** No field maintenance adjustments are provided on the FMA, FMB, FMC, FMD, FME, FMF,

FMG, FMJ, and FMK units. SF units not meeting circuit requirements after verification of proper screw switch settings should be sent to Western Electric Company for repair. Defective units should be replaced with spare units.

**4.02** The Type F Test Extender SD-1C241-02 may be used to provide jack access to the transmission and signaling ports. Use of the test extender will necessitate the removal of the SF units from the bay. The test extender provides jack access to all transmission and signaling ports of the SF units.

**4.03** Bell System Practices covering related equipment components within the Type F Signaling System are listed in Section 179-000-000.

TABLE A

CODE	FUNCTIONAL DESCRIPTION	GENERAL APPLICATION	SPECIFIC USE
FMA	Through Circuit	Through Circuit	4-wire with level adjusting
FMB	Through Circuit	Through Circuit	4-wire path only
FMC	Through Circuit	Through Circuit	4-wire line matching and equalization
FMD	Through Circuit	Through Circuit	2-wire 900 ohms
FME	Through Circuit	Through Circuit	2-wire 600 ohms
FMF	Through Circuit	Through Circuit	4-wire with 16.5 or 24.5 dB level adjustment
FMG	Through Circuit	Through Circuit	4-wire with level adjusting
FMJ	Through Circuit	Through Circuit	4-wire with 16.5 or 24.5 dB level adjustment and CGA circuit
FMK	Through Circuit	Through Circuit	4-wire path and CGA circuit path for use with FMJ

TABLE B

CGA AND LEVEL ADJUSTMENT TABLE

END-TO-END SIGNALING TANDEM ANALOG CARRIER	WITH CGA		ATT.		TRANS. ONLY F SIG.
			RCV	TRMT	
	W/ALM OVRD	W/O ALM OVRD	23dB	16dB	
TWO WAY TRUNK F SIGNALING TERMINATING EACH CARRIER	ALO, ALB	ALM, ALB	S2, S5	S1, S3 S4, S6	FMJ & FMK
(OFFICE END) TWO WAY TRUNK FOR FX LINES F SIG TERMINATING EACH CARRIER	ALO, ALB	ALM, ALB	S2, S5	S1, S3 S4, S6	FMJ & RMK
ONE CARRIER NOT TERMINATED IN F SIGNALING, NO CGA			S2, S5	S1, S3 S4, S6	FMF & FMB FMJ & FMK
(STATION END) TWO WAY TRUNK FOR FX LINES F SIG TERMINATING EACH CARRIER	ALO, TC	ALM, TC	S2, S5	S1, S3 S4, S6	FMJ & FMK

TABLE C

NON-LOADED REPEATER SECTION				
WIRE GAUGE	COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
	(600-600)	(150-600)	(150-150)	(150-150)
	SHORT LENGTH	MEDIUM LENGTH	LONG LENGTH	EXTRA LONG LENGTH
19LC*	8 - 11 Kf	11.1 - 18 Kf	18.1 - 33 Kf	33.1 - 45 Kf
19HC**	7 - 9	9.1 - 16	16.1 - 28	28.1 - 38
22	4 - 8	8.1 - 14	14.1 - 22	22.1 - 30
24	3 - 7.5	7.6 - 12	12.1 - 17	17.1 - 22
25 MAT	3 - 9.0	9.1 - 15	15.1 - 18	18.1 - 25
26	2 - 7	7.1 - 10	10.1 - 15	15.1 - 20

\* Low Capacitance

\*\* High Capacitance

*Note 1:* In computing the length of a facility, include the length of all bridged taps. Gauge of bridge taps is immaterial.

*Note 2:* The upper lengths in columns 1 through 3 have been chosen to limit the loss at 3 Kc to about 1.0 dB more than at 1 Kc.

*Note 3:* The ranges of lengths in column 4 confine the 3 Kc roll-off to the range 1.0 to 3.0 dB.

*Note 4:* The impedance values (600-600), (150-600), and (150-150) shown above indicate the impedance at the F signaling unit and at the far end equipment.

TABLE D

FMC UNIT - TYPICAL LOSS-  
FREQUENCY AND DELAY-  
FREQUENCY CHARACTERISTICS

FREQUENCY HZ	LOSS (DB) RELATIVE TO 1000 HZ	DELAY (MICROSECONDS)
100	0.15	65.0
200	0.10	30.0
300	0.08	12.0
400	0.06	7.0
500	0.04	4.5
700	0.02	2.5
1000	0	2.0
2000	-0.04	1.5
8000	-0.07	1.2

**TABLE E**  
**PRESCRIPTION ADJUSTMENTS AND COMPONENT VALUES OF**  
**EQUALIZER SECTION OF FMC UNIT FOR CABLE END SECTIONS**  
**1500 TO 4500 FEET**

CABLE GAUGE: 19H88 HC								
CABLE LENGTH KILO FEET*		12-42	42-60	60-78	78-96	96-108	108-114	114-150
CABLE LENGTH MILES*		2-8.0	8.0-11.4	11.4-14.8	14.8-18.2	18.2-20.5	20.5-21.6	21.6-28.4
SCREW DESIGNATION			SCREW SETTINGS					
HF	IN	○	●	●	●	●	●	●
	75	○	●	●	●	●	●	○
	150	○	●	●	○	●	○	●
	300	○	○	●	○	○	●	●
	600	○	●	●	○	○	○	○
	1200	○	○	○	●	●	●	●
	2400	○	●	●	●	●	●	●
LF	.25	○	○	○	○	○	○	○
	.50	○	○	○	○	○	○	○
	1.00	○	○	○	○	○	○	○
	2.00	○	○	○	○	○	○	○
	250	●	●	●	●	●	●	●
	500	●	●	●	●	●	●	●
	1000	●	●	●	●	●	●	●
	2000	●	●	●	●	●	●	●
HF TOTAL RES. (OHMS)		∞	1500	1200	1050	900	750	675
LF TOTAL CAP. (UF)		0	0	0	0	0	0	0
LF TOTAL RES. (OHMS)		0	0	0	0	0	0	0

\* For an exact cable length shown at the top of the table, use the adjustment for the shorter lengths.  
 Example: For 60 kilofeet, use the adjustment for the range 42-60 kilofeet.

○ indicates "screw up" (3 full turns).

● indicates "screw down."

TABLE F

**PRESCRIPTION ADJUSTMENTS AND COMPONENT VALUES OF  
EQUALIZER SECTION OF FMC UNIT FOR CABLE END SECTIONS  
1500 TO 4500 FEET**

CABLE GAUGE: 22H88						
CABLE LENGTH KILOFEET*		12-18	18-24	24-60	60-90	90-108
CABLE LENGTH MILES*		2-3.4	3.4-4.5	4.5-11.4	11.4-17.0	17.0-20.5
SCREW DESIGNATION		SCREW SETTINGS				
HF	IN	○	●	●	●	●
	75	○	●	●	●	●
	150	○	●	●	●	○
	300	○	●	●	○	○
	600	○	●	●	●	○
	1200	○	○	●	○	●
	2400	○	○	○	●	●
LF	.25	○	●	○	○	●
	.50	○	●	●	○	○
	1.00	○	●	●	○	●
	2.00	○	●	●	●	○
	250	●	●	●	●	●
	500	●	●	●	●	●
	1000	●	○	○	○	●
	2000	●	○	○	○	○
HF TOTAL RES. (OHMS)		∞	3600	2400	1500	1050
LF TOTAL CAP. (UF)		○	3.75	3.50	2.0	1.25
LF TOTAL RES. (OHMS)		○	3000	3000	3000	2000

\* For an exact cable length shown at the top of the table, use the adjustment for the shorter lengths.

Example: For 60 kilofeet, use the adjustment for the range 24-60 kilofeet.

- indicates "screw up" (3 full turns).
- indicates "screw down."

TABLE G

**PRESCRIPTION ADJUSTMENTS AND COMPONENT VALUES OF  
EQUALIZER SECTION OF FMC UNIT FOR CABLE END SECTIONS  
1500 TO 4500 FEET**

CABLE GAUGE: 24H88						
CABLE LENGTH KILOFEET*		12-18	18-30	30-42	42-60	60-72
CABLE LENGTH MILES*		2-3.4	3.4-5.7	5.7-8.0	8.0-11.4	11.4-13.6
SCREW DESIGNATION		SCREW SETTINGS				
HF	IN	○	●	●	●	●
	75	○	●	●	●	●
	150	○	●	●	●	●
	300	○	●	●	○	●
	600	○	○	●	●	●
	1200	○	○	●	○	○
	2400	○	○	○	●	●
LF	.25	○	○	○	○	●
	.50	○	●	●	○	●
	1.00	○	●	●	●	○
	2.00	○	○	○	○	○
	250	●	○	●	○	●
	500	●	●	○	○	●
	1000	●	●	●	●	○
	2000	●	●	●	●	●
HF TOTAL RES. (OHMS)		∞	4200	2400	1500	1200
LF TOTAL CAP. (UF)		○	1.5	1.5	1.0	0.75
LF TOTAL RES. (OHMS)		○	250	500	750	1000

\* For an exact cable length shown at the top of the table, use the adjustment for the shorter lengths.

Example: For 42 kilofeet, use the adjustment for the range 30-42 kilofeet.

- indicates "screw up" (3 full turns).
- indicates "screw down."

TABLE H

**PRESCRIPTION ADJUSTMENTS AND COMPONENT VALUES OF  
EQUALIZER SECTION OF FMC UNIT FOR CABLE END SECTIONS  
1500 TO 4500 FEET**

CABLE GAUGE: 25H88 MAT						
CABLE LENGTH KILOFEET*		10-12	12-18	18-24	24-42	42-60
CABLE LENGTH MILES*		2-2.3	2.3-3.4	3.4-4.5	4.5-8.0	8.0-11.4
SCREW DESIGNATION		SCREW SETTINGS				
HF	IN	○	○	○	○	○
	75	○	○	○	○	○
	150	○	○	○	○	○
	300	○	○	○	○	○
	600	○	○	○	○	○
	1200	○	○	○	○	○
	2400	○	○	○	○	○
LF	.25	○	○	○	●	○
	.50	○	●	○	●	●
	1.00	○	●	●	○	○
	2.00	○	○	○	○	○
	250	●	○	●	●	●
	500	●	●	○	○	○
	1000	●	●	●	○	○
	2000	●	●	●	●	○
HF TOTAL RES. (OHMS)		∞	∞	∞	∞	∞
LF TOTAL CAP. (UF)		○	1.5	1.0	.75	.5
LF TOTAL RES. (OHMS)		○	250	500	1500	3500

*Note:* No HF equalization is required for MAT cable.

\* For an exact cable length shown at the top of the table, use the adjustment for the shorter lengths.

Example: For 60 kilofeet, use the adjustment for the range 42-60 kilofeet.

○ indicates "screw up" (3 full turns).

● indicates "screw down."

**TABLE I**  
**PRESCRIPTION ADJUSTMENTS AND COMPONENT VALUES OF**  
**EQUALIZER SECTION OF FMC UNIT FOR CABLE END SECTIONS**  
**1500 TO 4500 FEET**

CABLE GAUGE: 26H88							
CABLE LENGTH KILOFEET*		0-12	12-18	18-24	24-30	30-36	36-42
CABLE LENGTH MILES*		2-2.3	2.3-3.4	3.4-4.5	4.5-5.7	5.7-6.8	6.8-8.0
SCREW DESIGNATION			SCREW SETTINGS				
HF	IN	○	●	●	●	●	●
	75	○	○	○	○	○	○
	150	○	○	○	○	○	○
	300	○	○	○	○	○	○
	600	○	○	○	○	○	○
	1200	○	○	○	○	○	○
	2400	○	○	○	○	○	○
LF	.25	○	●	●	●	○	○
	.50	○	●	●	●	●	●
	1.00	○	○	○	○	○	○
	2.00	○	○	○	○	○	○
	250	●	○	●	○	○	●
	500	●	●	○	○	●	●
	1000	●	●	●	●	○	●
	2000	●	●	●	●	●	○
HF TOTAL RES. (OHMS)		∞	4725	4725	4725	4725	4725
LF TOTAL CAP. (UF)		○	0.75	0.75	0.75	0.50	0.50
LF TOTAL RES. (OHMS)		○	250	500	750	1250	2000

\* For an exact cable length shown at the top of the table, use the adjustment for the shorter lengths.

Example: For 30 kilofeet, use the adjustment for the range 24-30 kilofeet.

○ indicates "screw up" (3 full turns).

● indicates "screw down."

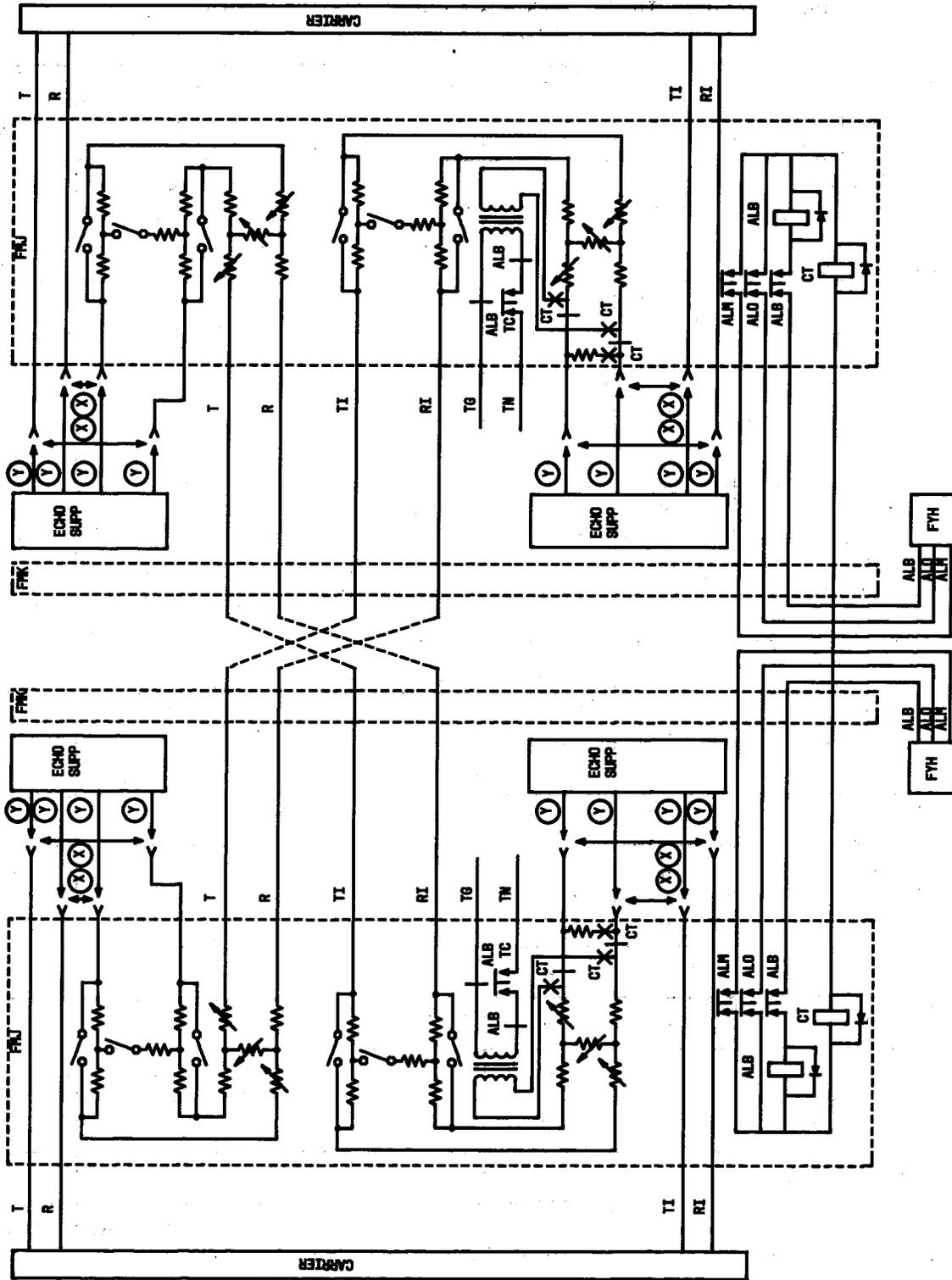


Fig. 1—Typical Application of the FMJ and FMK Units

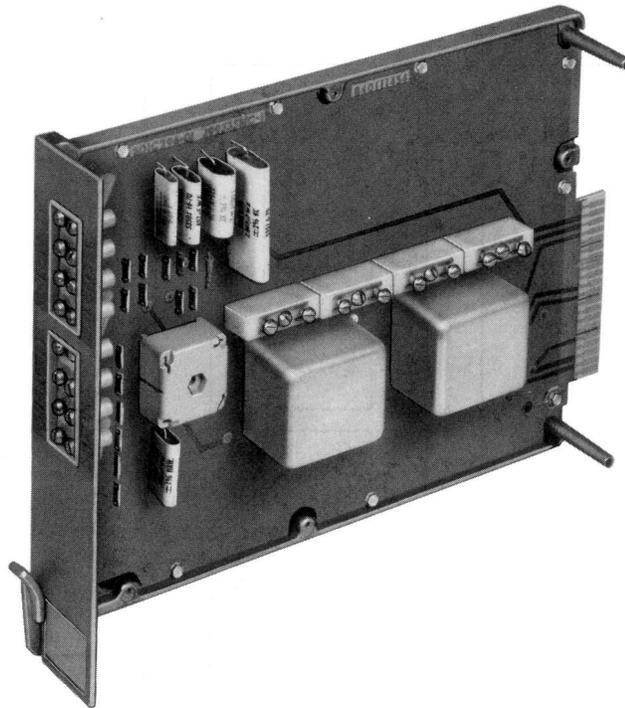


Fig. 2—FMC Unit

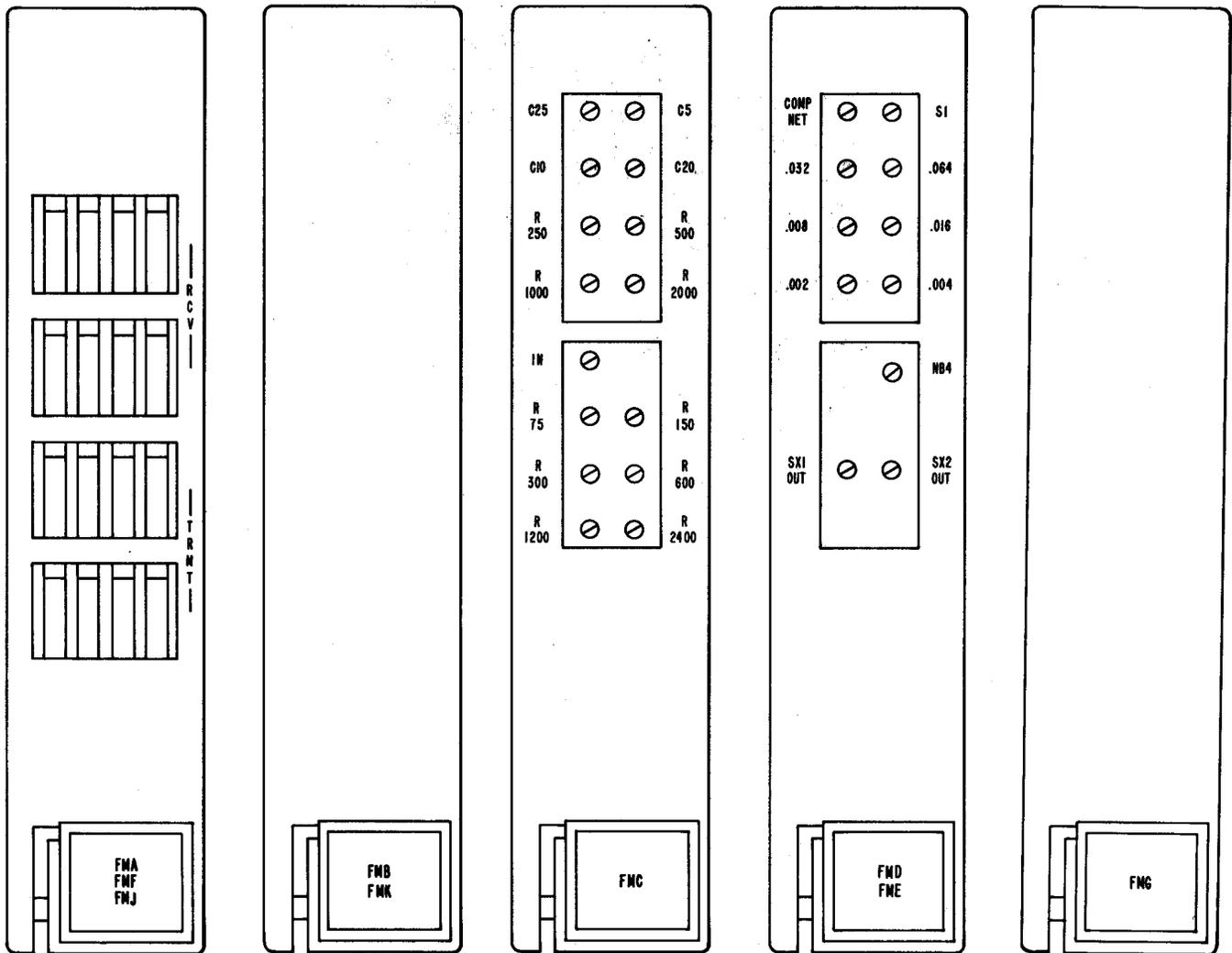


Fig. 3—FMA, FMB, FMC, FMD, FME, FMF, FMG, FMJ, and FMK Unit Faceplates

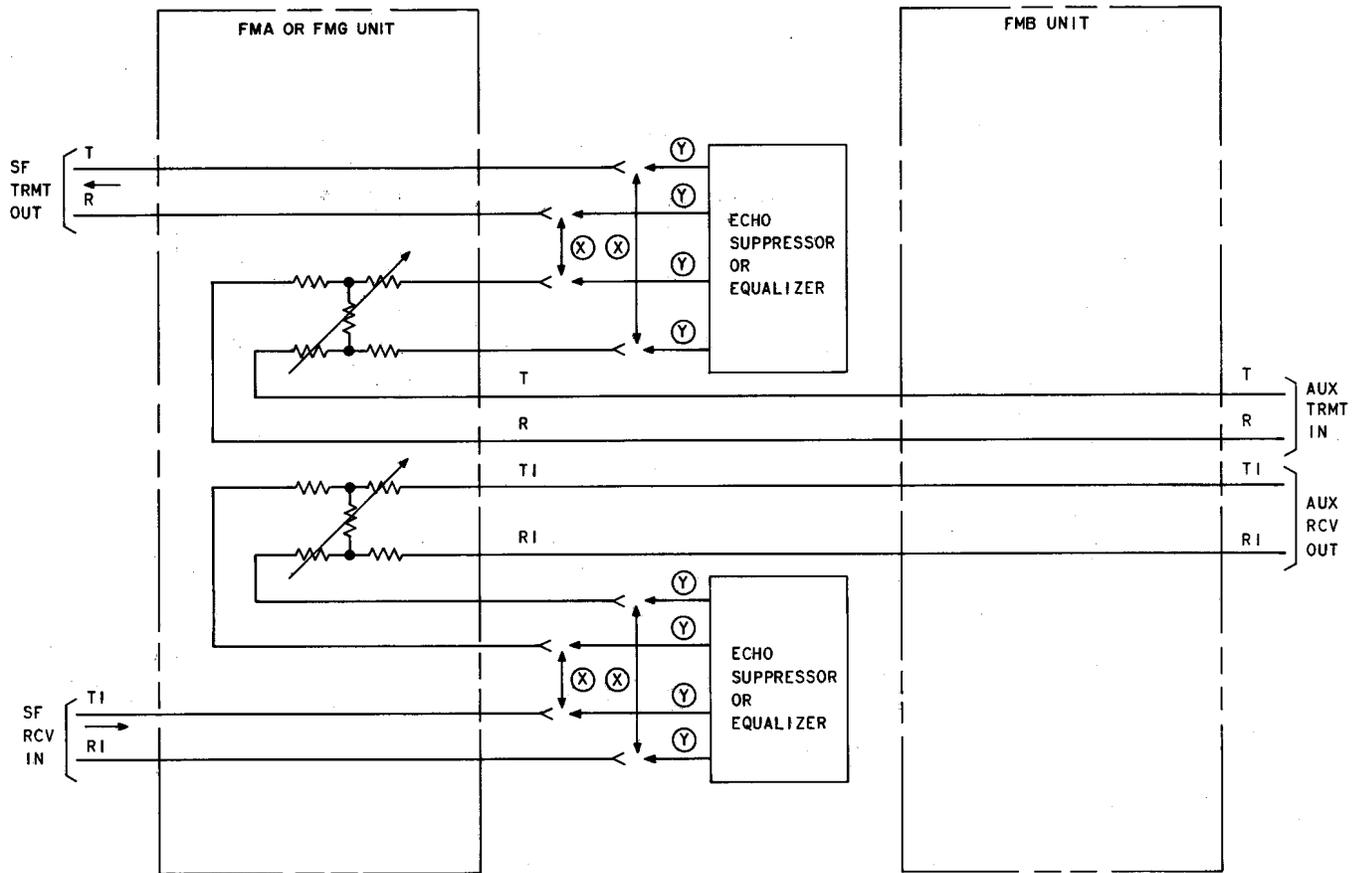


Fig. 4—FMA or FMG Plus FMB

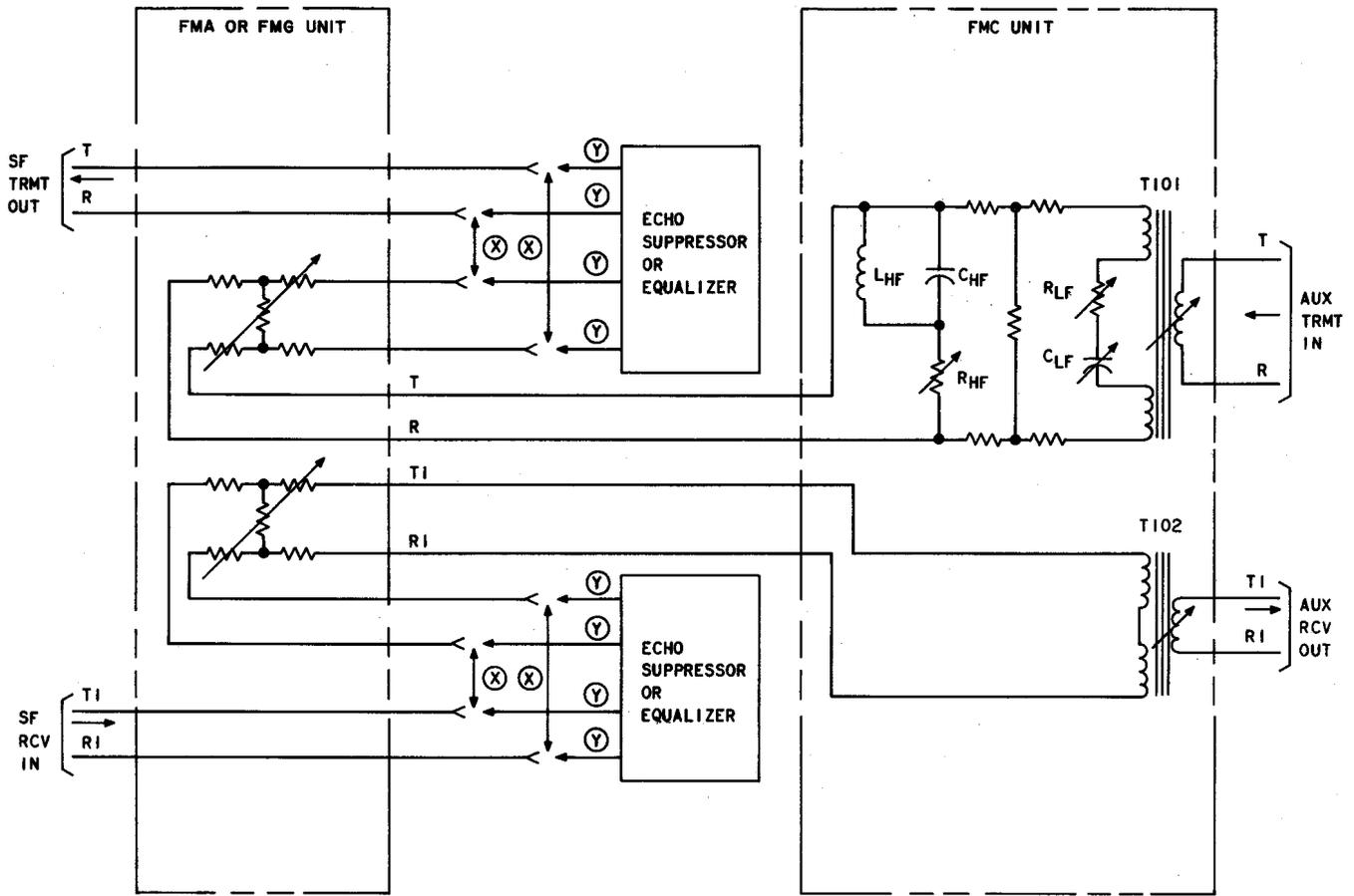


Fig. 5—FMA or FMG Plus FMC

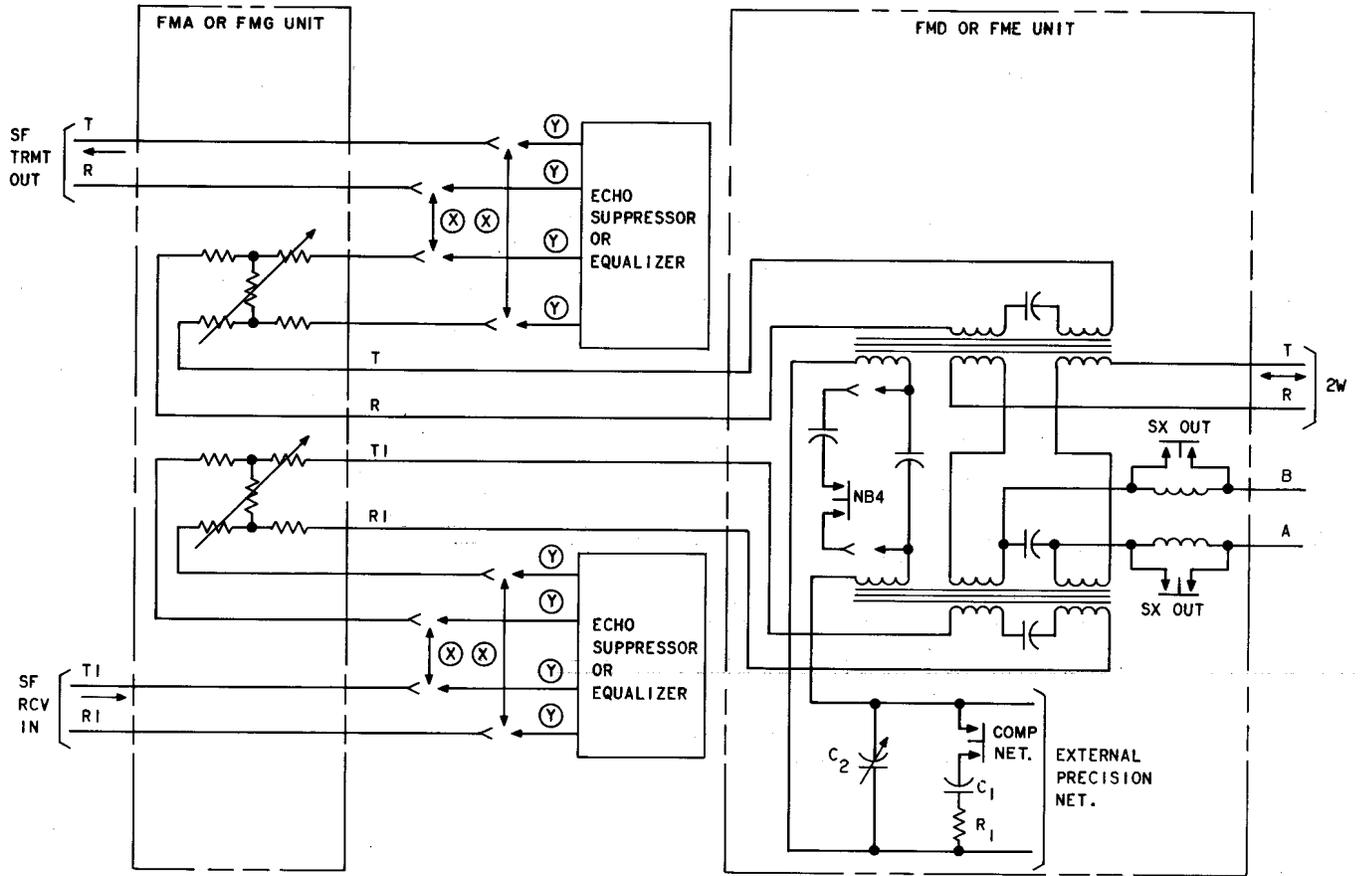


Fig. 6—FMA or FMG Plus FMD or FME Units

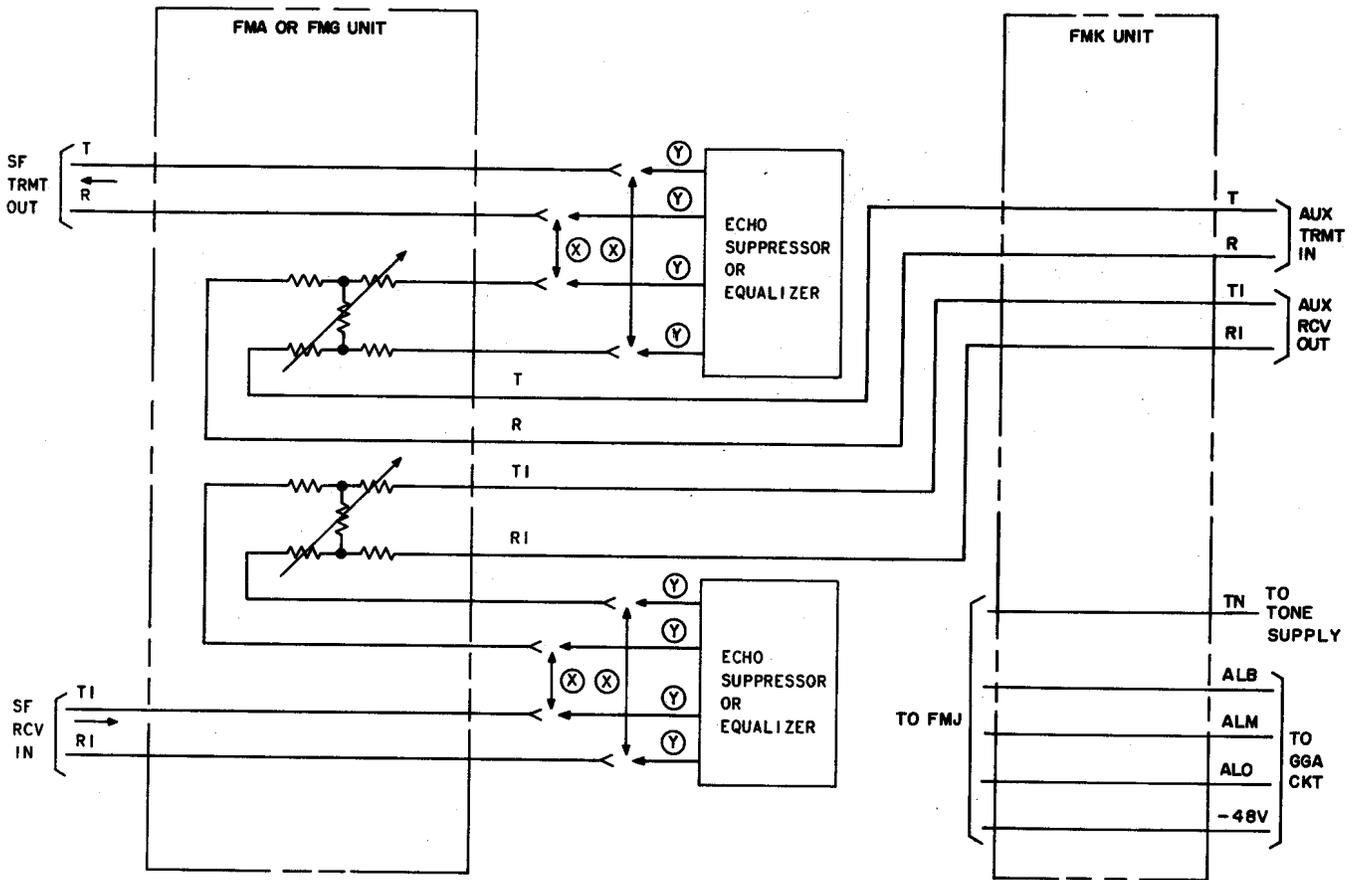
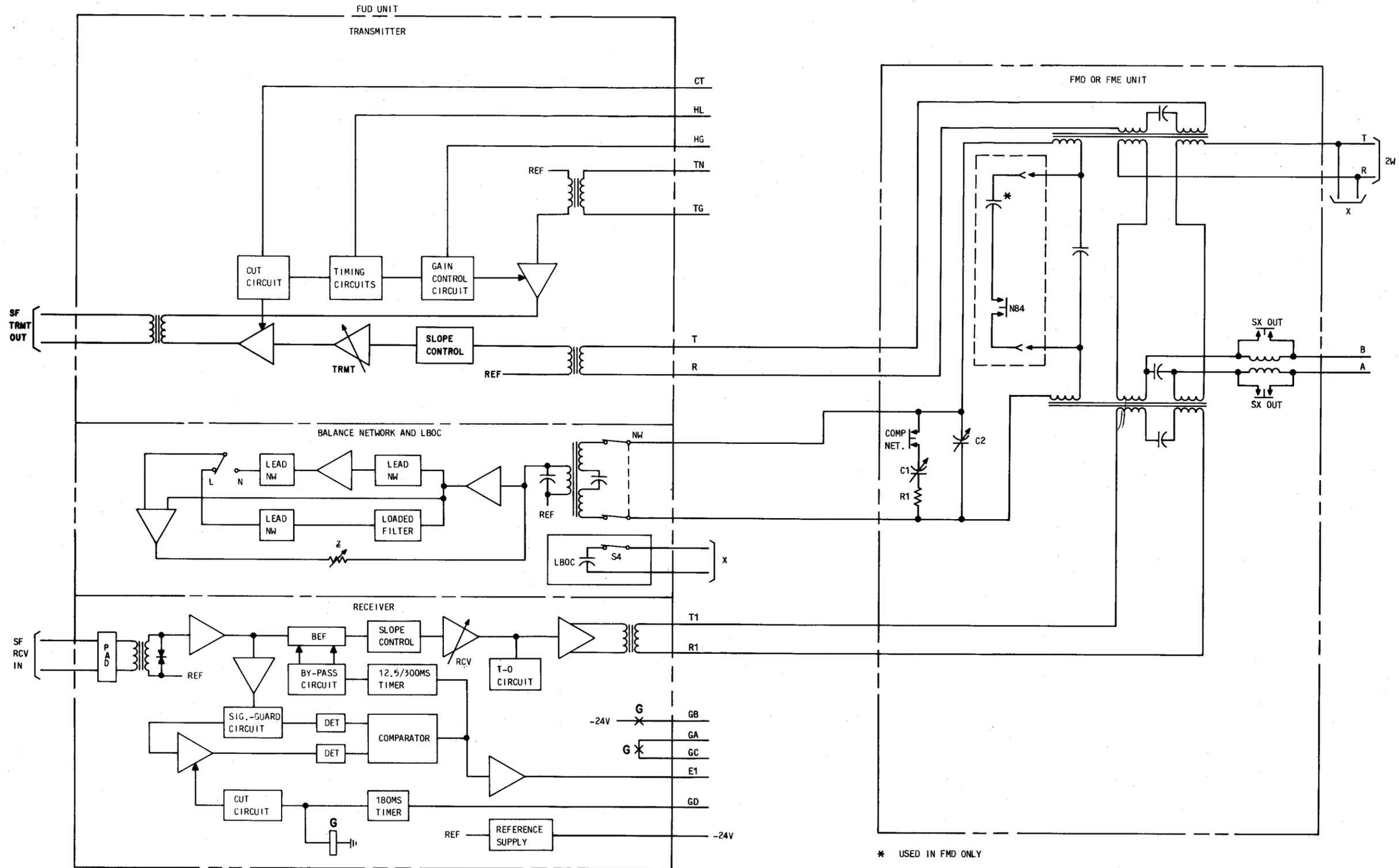


Fig. 7—FMA or FMG Plus FMK



\* USED IN FMD ONLY

Fig. 8—FUD Plus FMD or FME

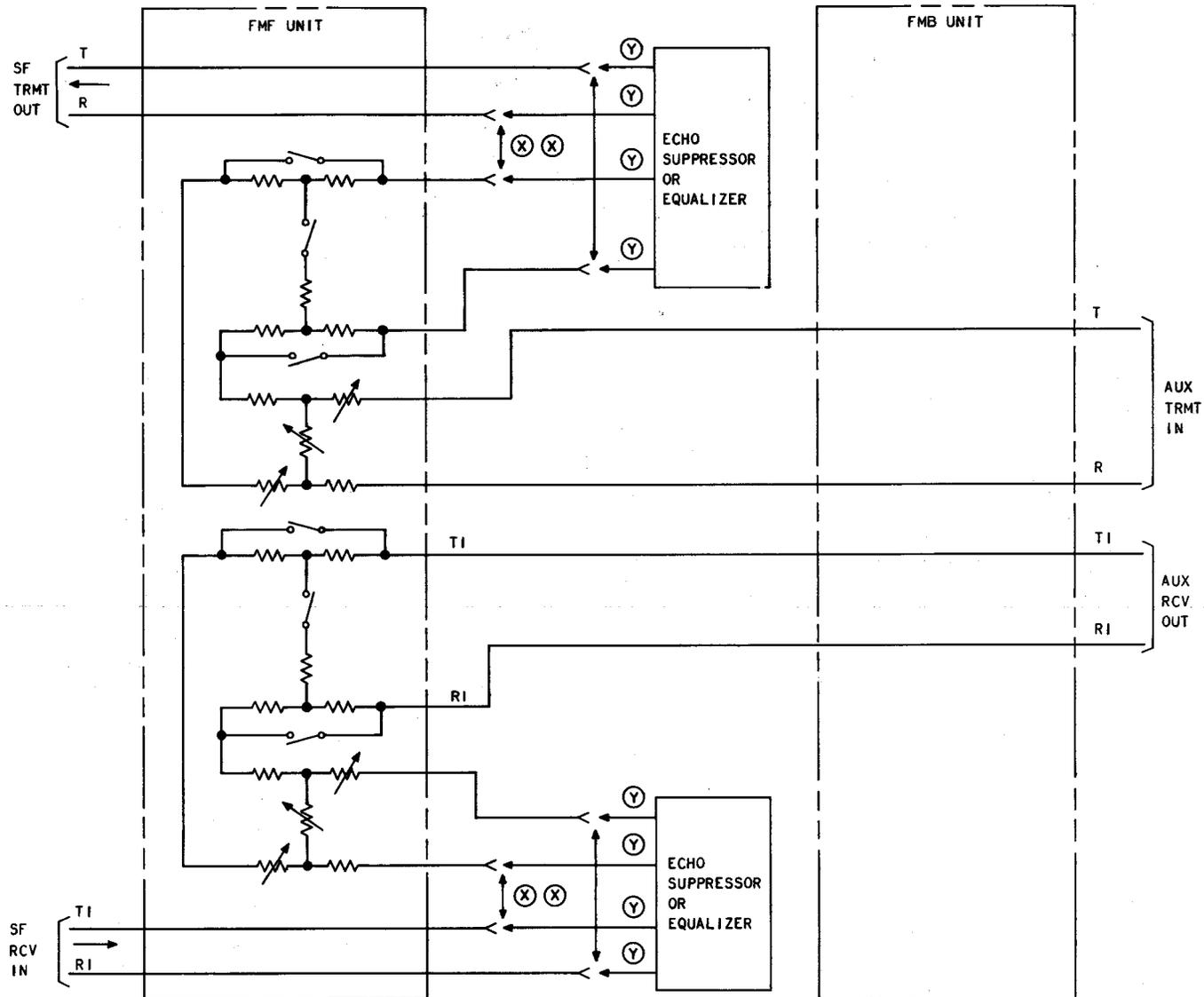


Fig. 9—FMF Plus FMB

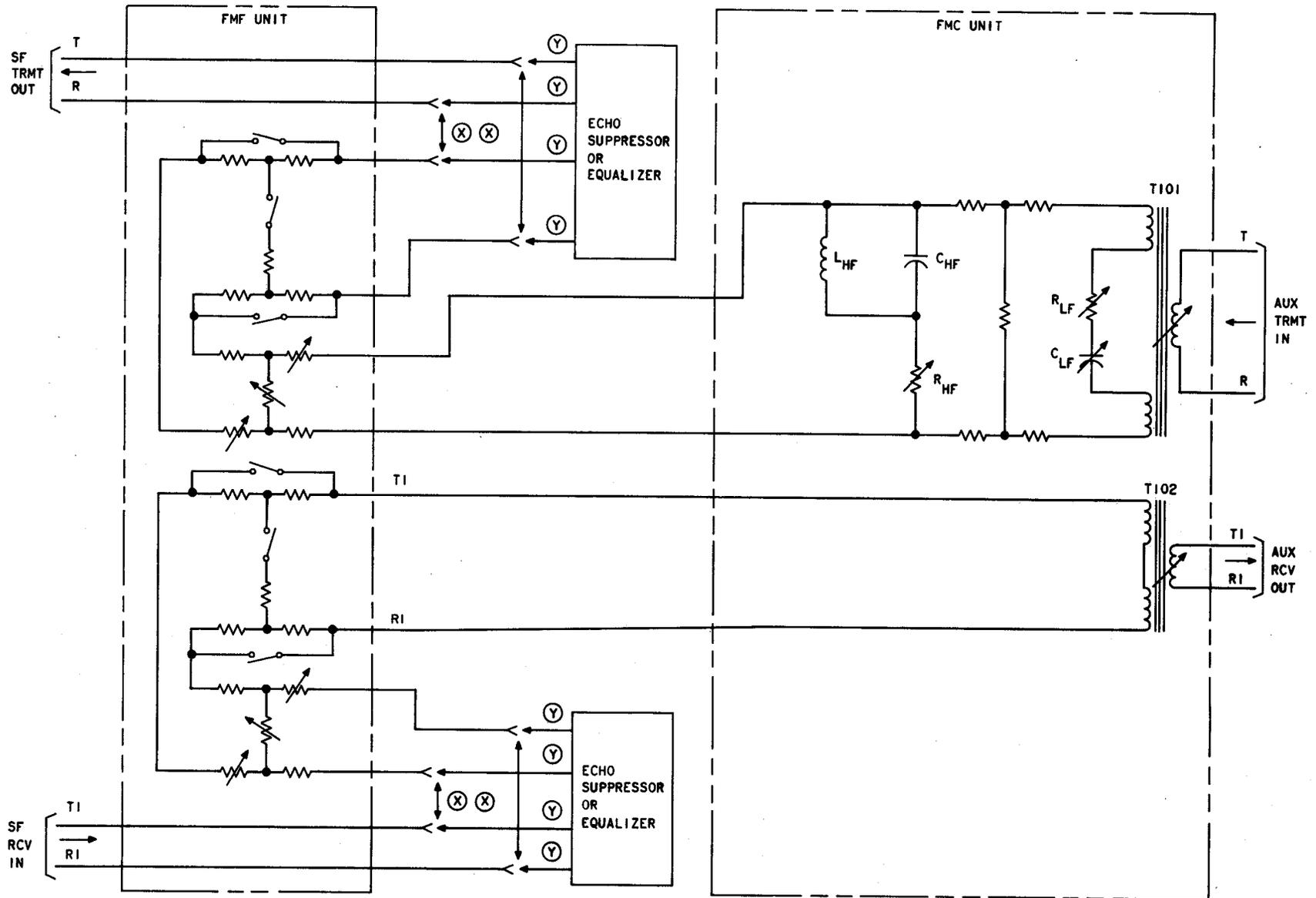


Fig. 10—FMF Plus FMC

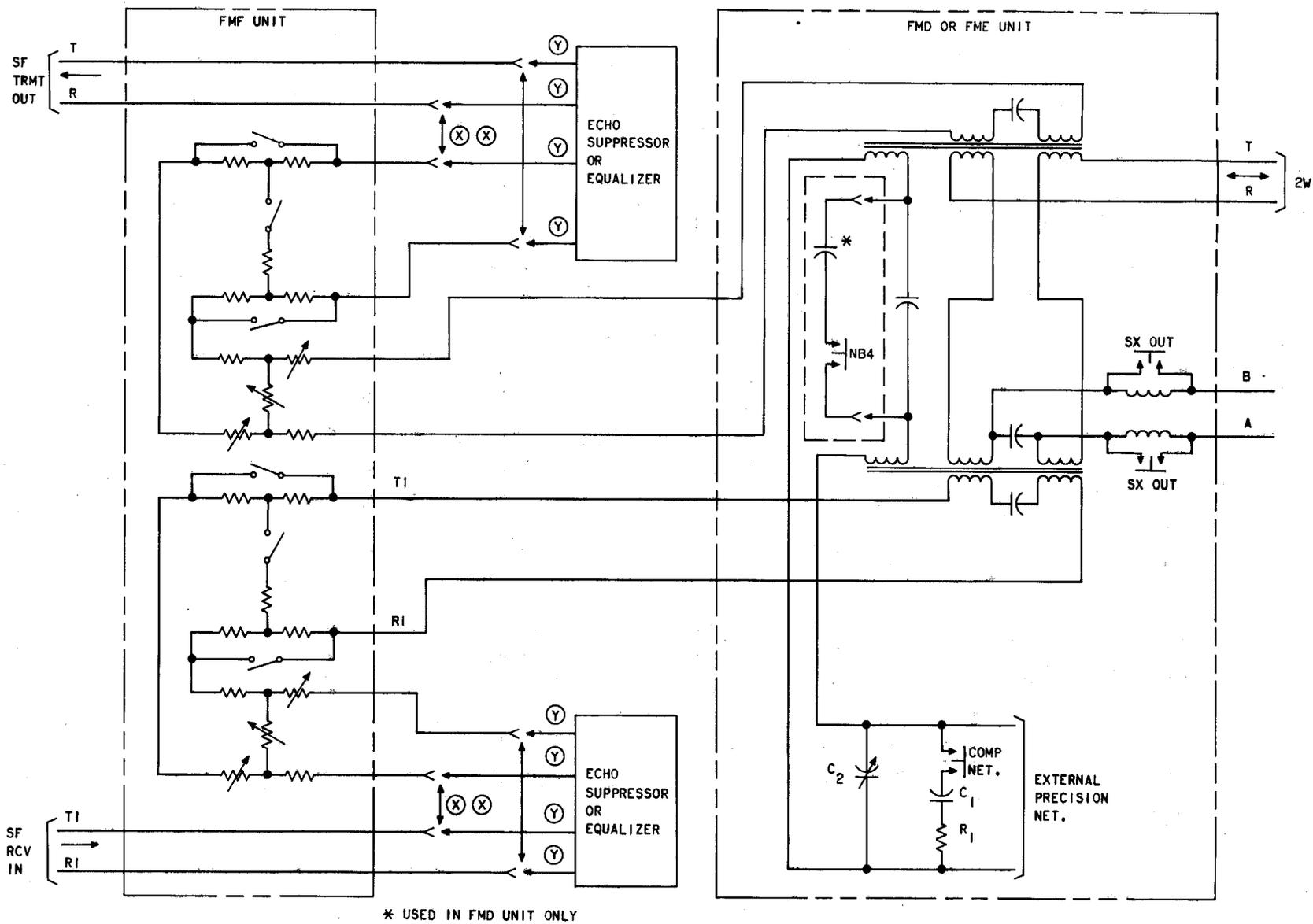


Fig. 11—FMF Plus FMD or FME

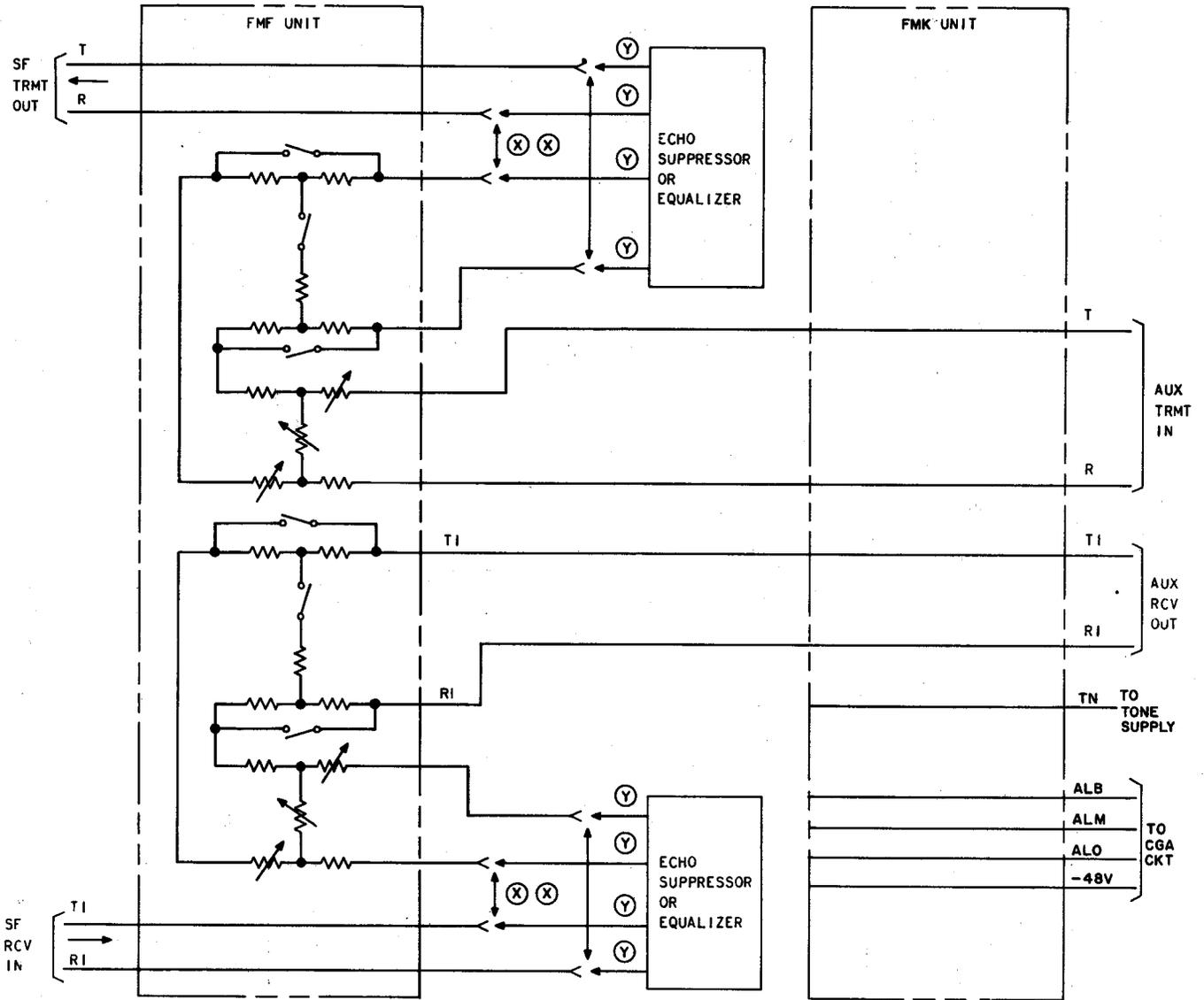


Fig. 12—FMF Plus FMK

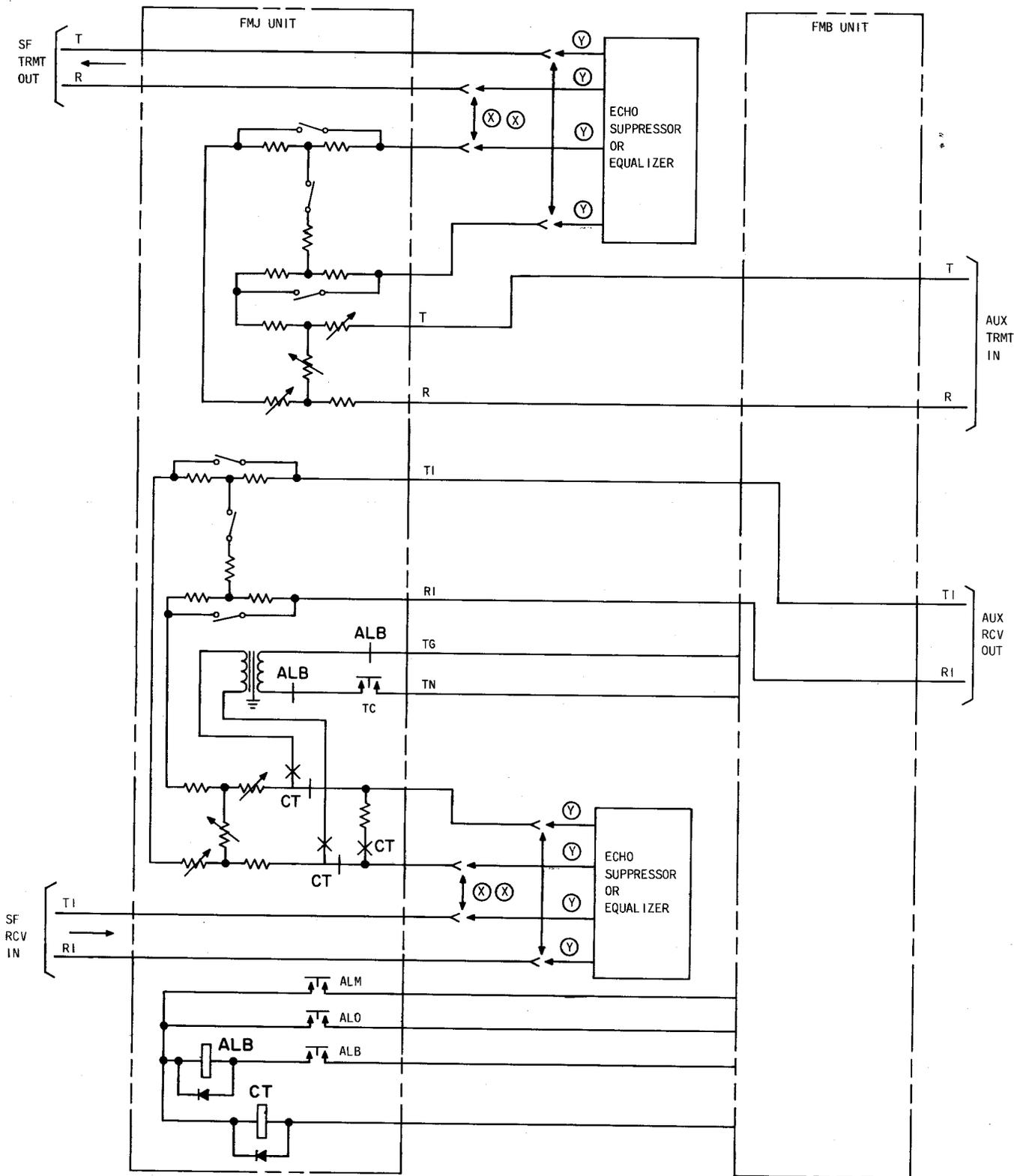


Fig. 13—FMJ Plus FMB

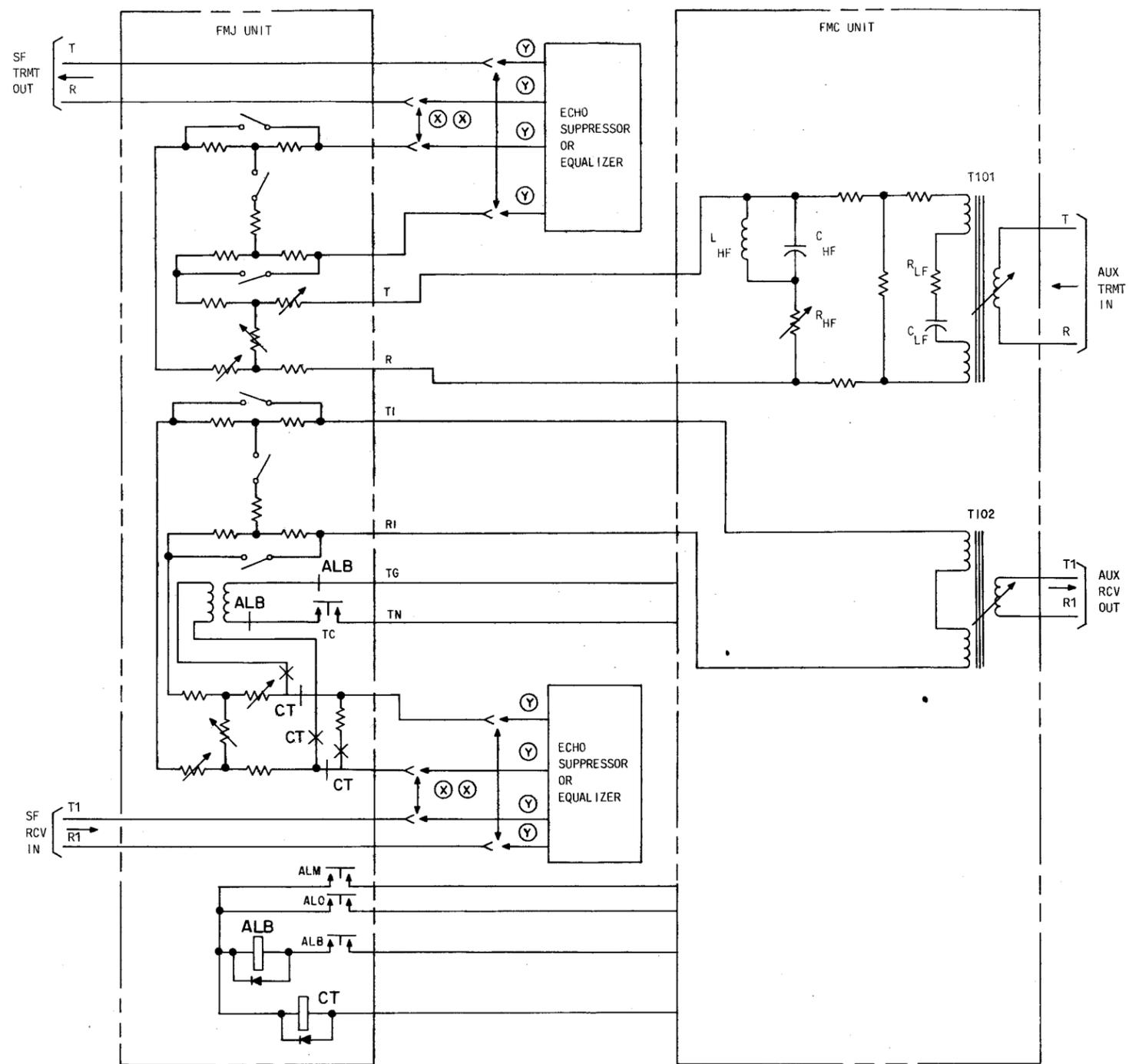


Fig. 14—FMJ Plus FMC

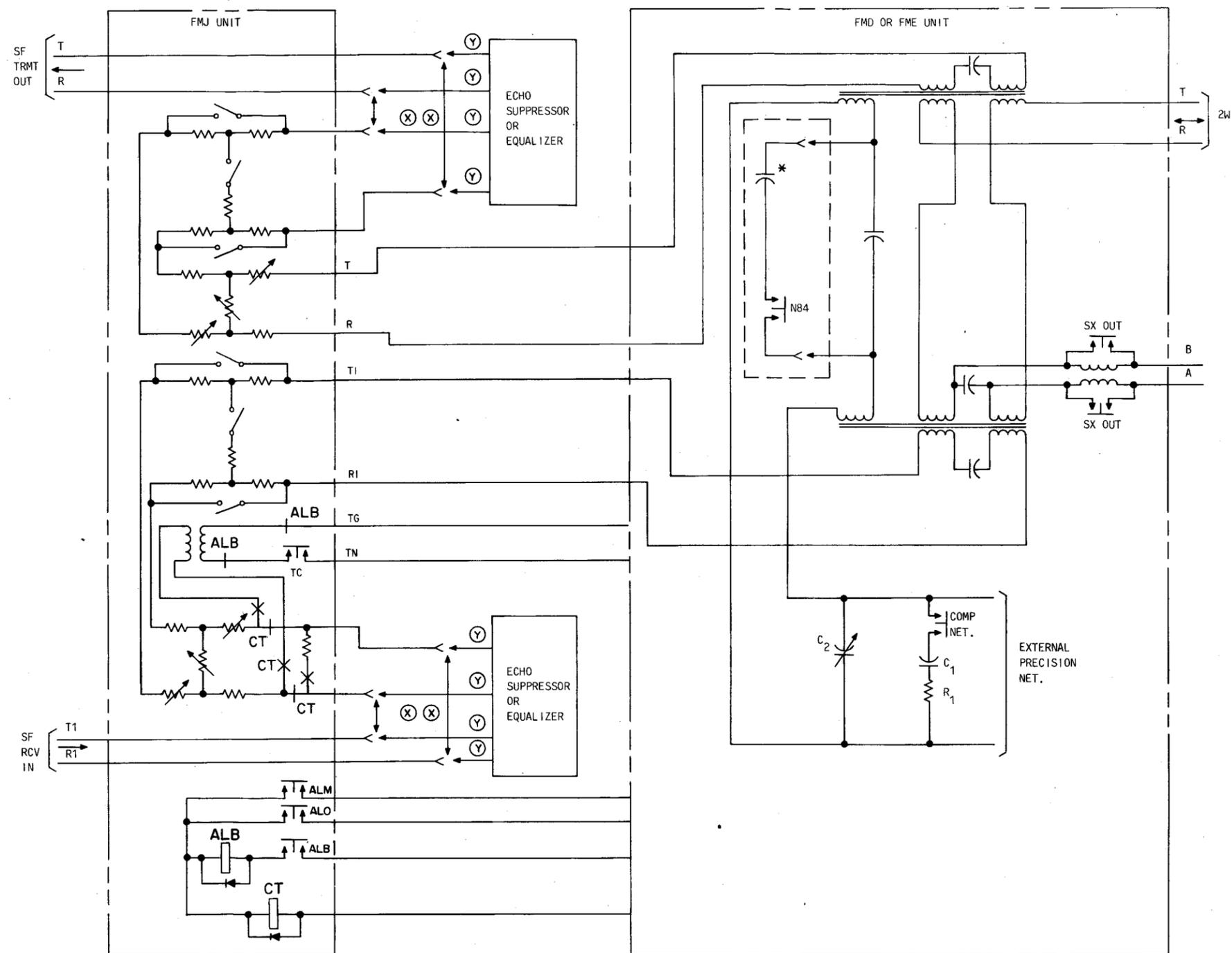


Fig. 15—FMJ Plus FMD or FME

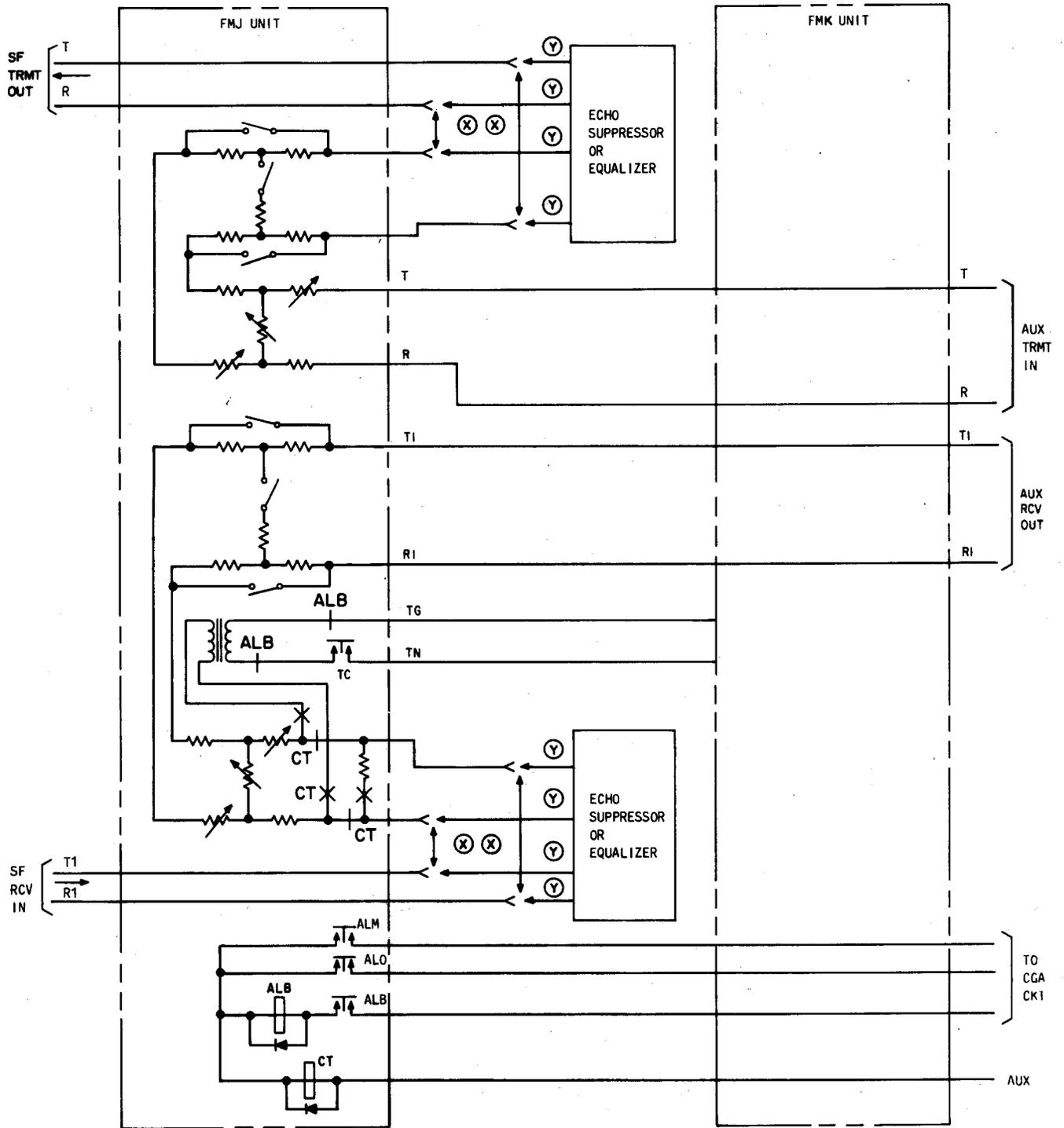


Fig. 16—FMJ Plus FMK

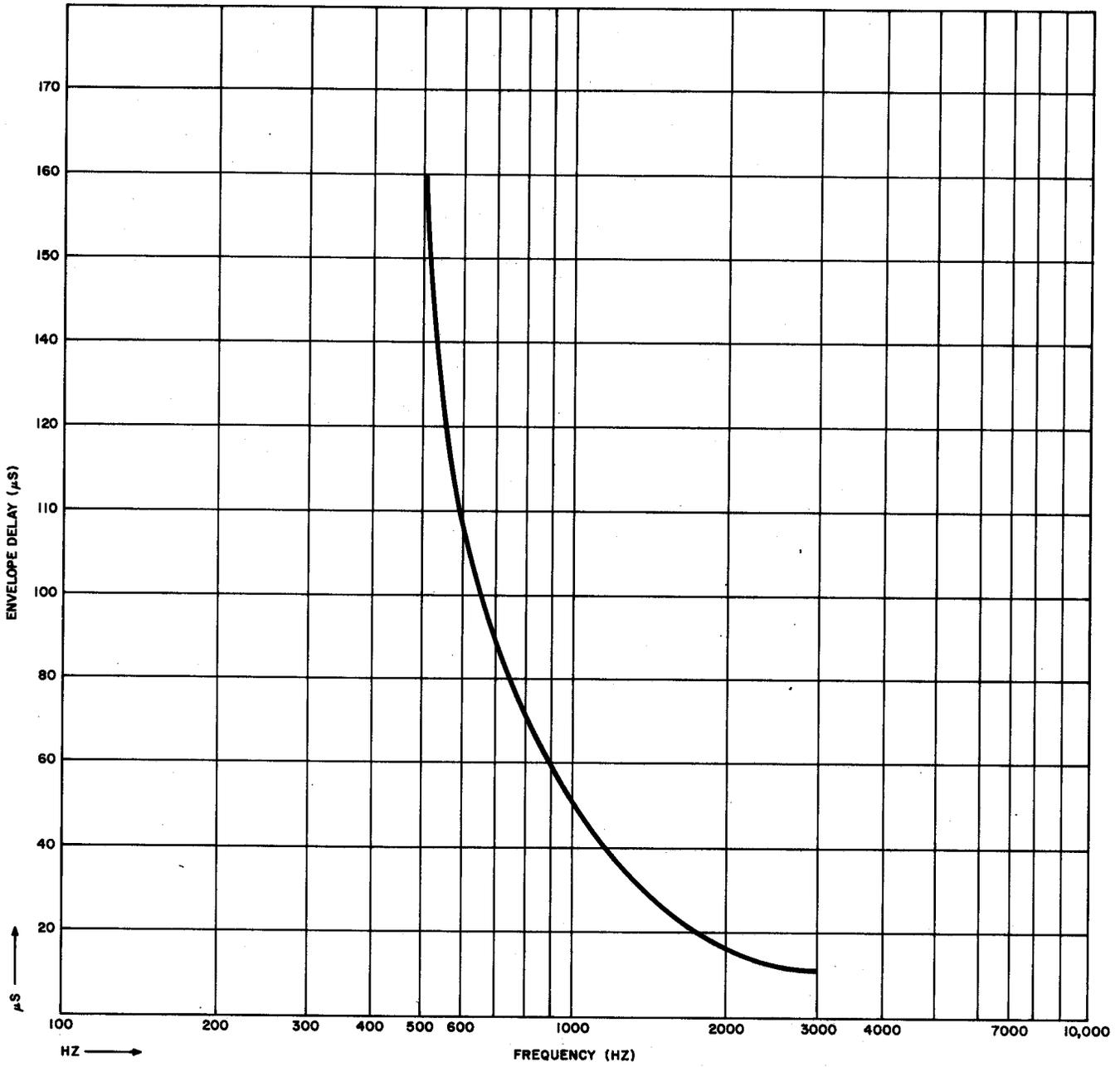


Fig. 17—Nominal Envelope Delay Distortion for the FMD and FME Units

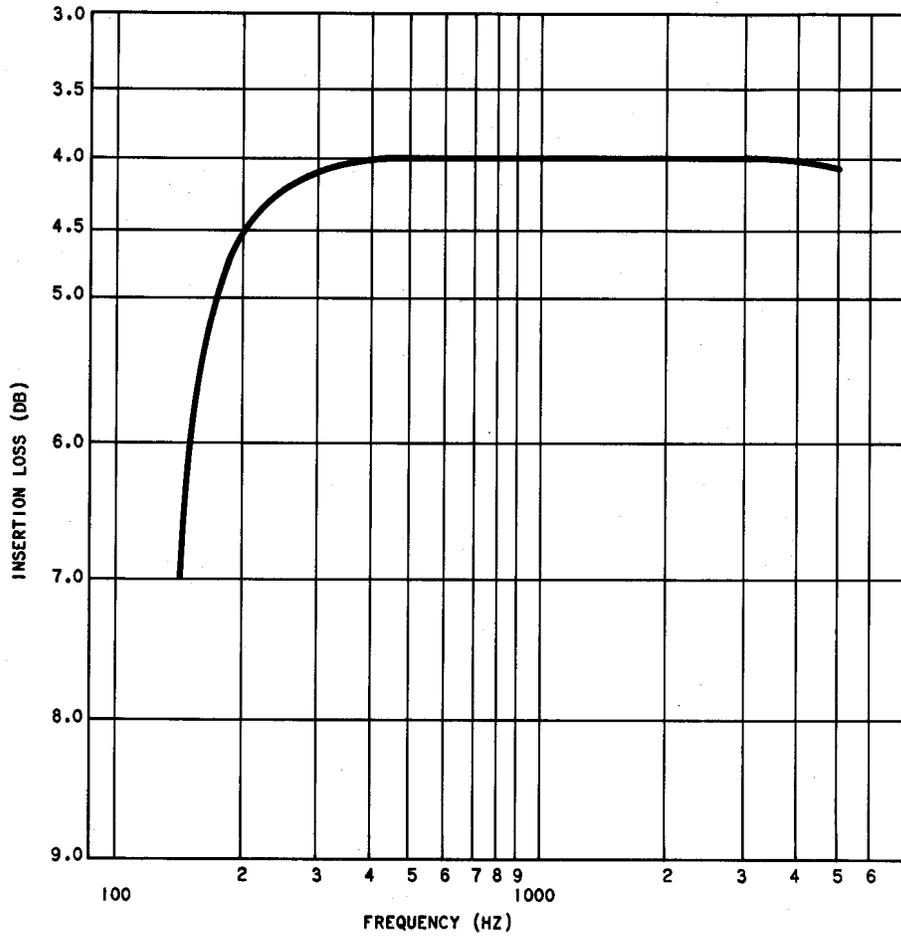


Fig. 18—Nominal 2-Wire to 4-Wire Loss Frequency Characteristics for the FMD Unit

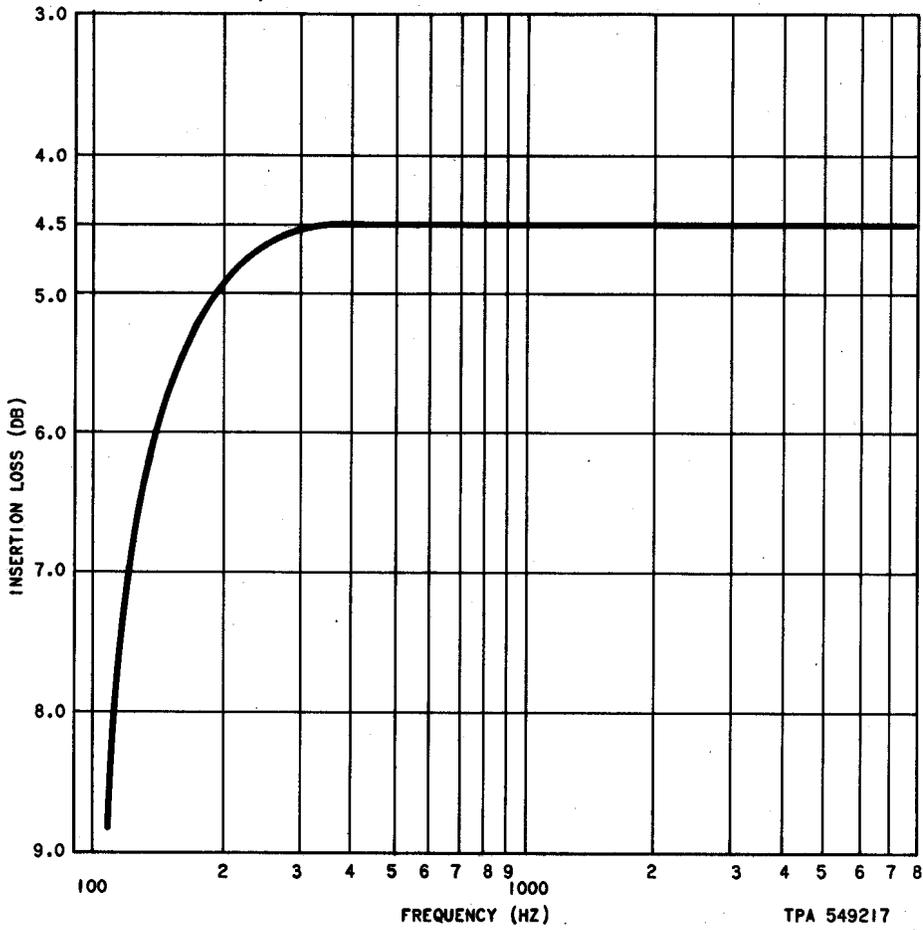
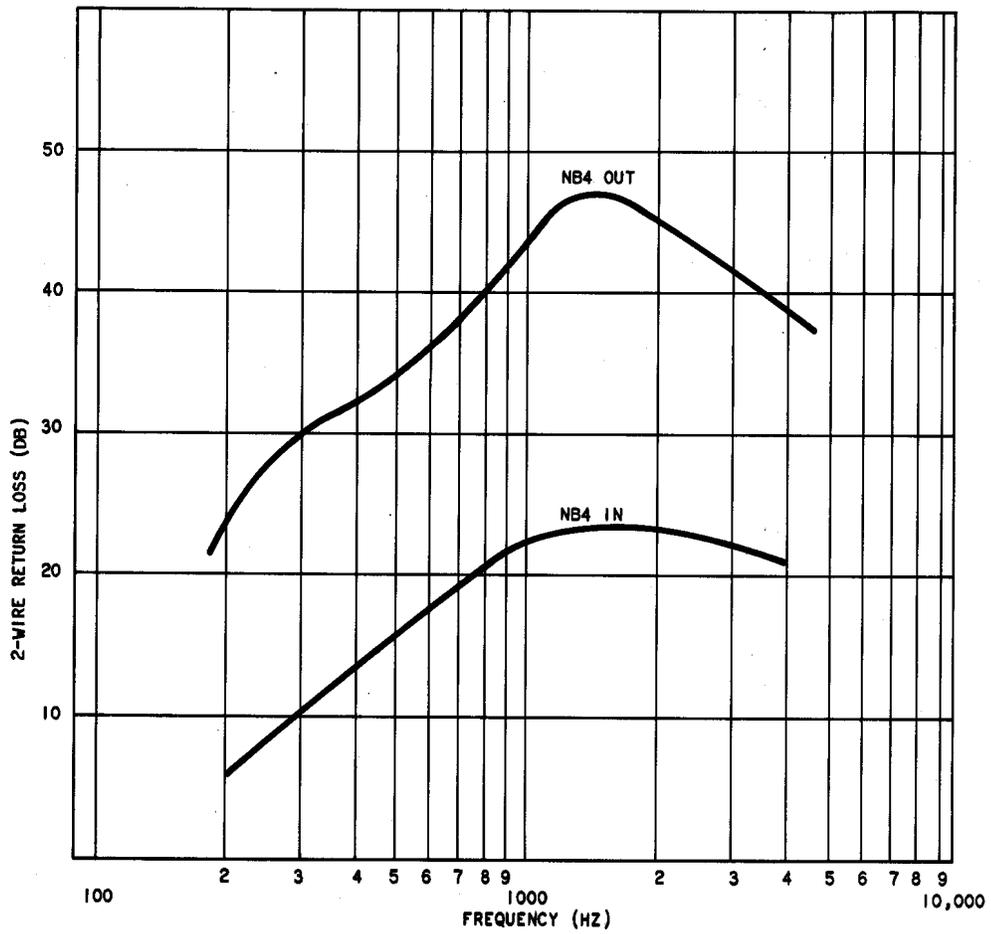


Fig. 19—Nominal 2-Wire to 4-Wire Loss Frequency Characteristics for the FME Unit



NOTE:  
 WITH NB4 IN THERE IS 4 $\mu$ F ON NETWORK SIDE  
 AND WITH NB4 OUT THERE IS 1 $\mu$ F ON NETWORK SIDE.

Fig. 20—FMD Unit—Nominal Return Loss Frequency Characteristics—2-Wire Line Against 900-Ohms Plus 2.15  $\mu$ f

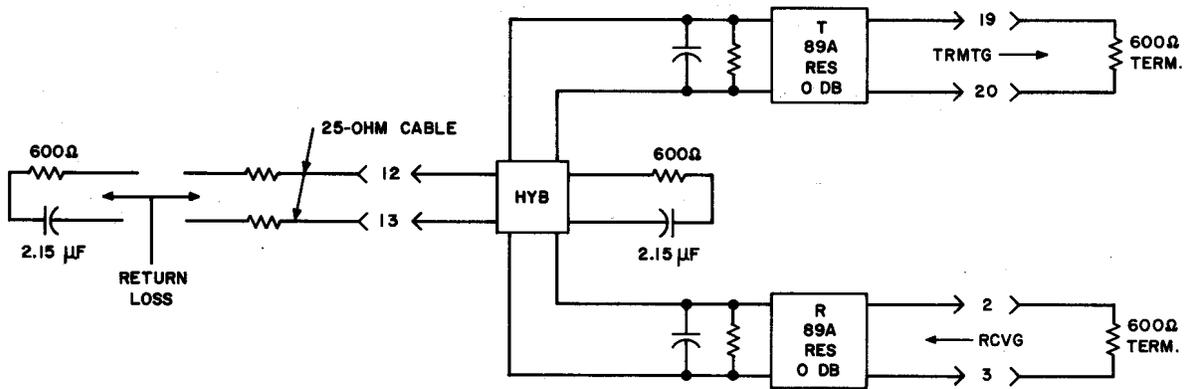
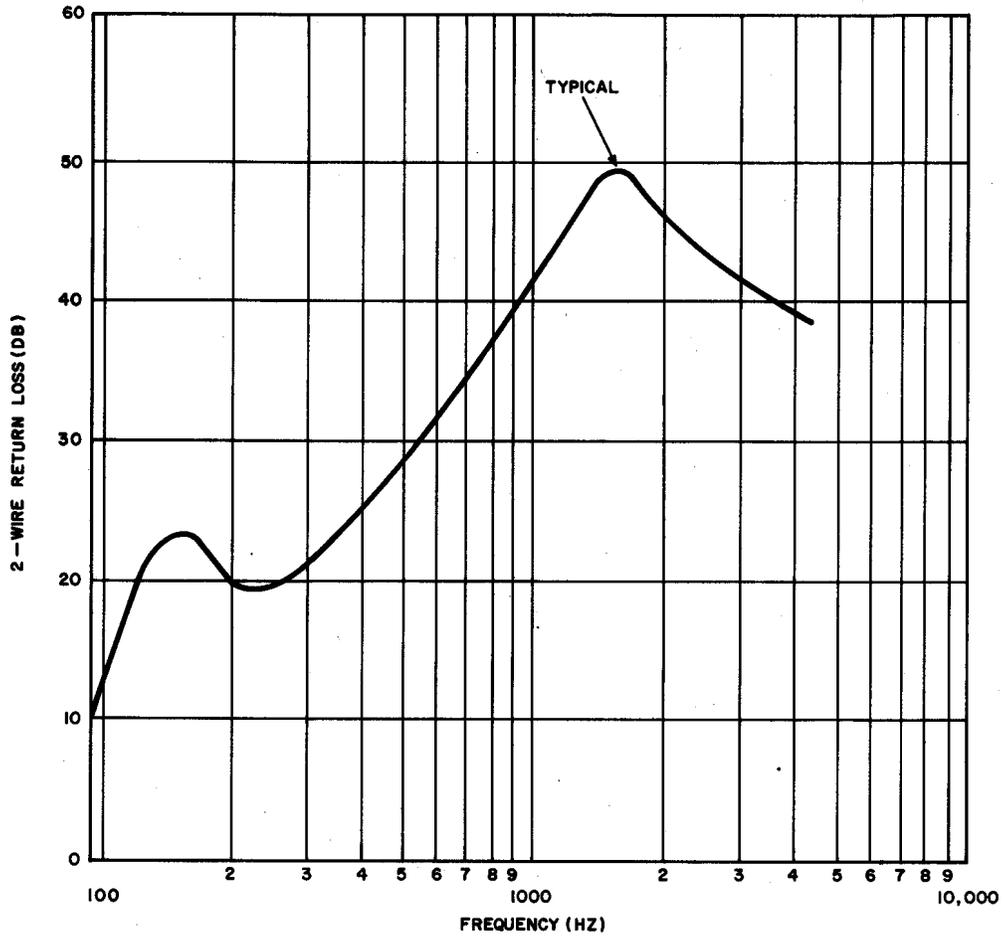


Fig. 21—FME Unit—Nominal Return Loss-Frequency Characteristics—2-Wire Line Against 600 Ohms Plus 2.15μf

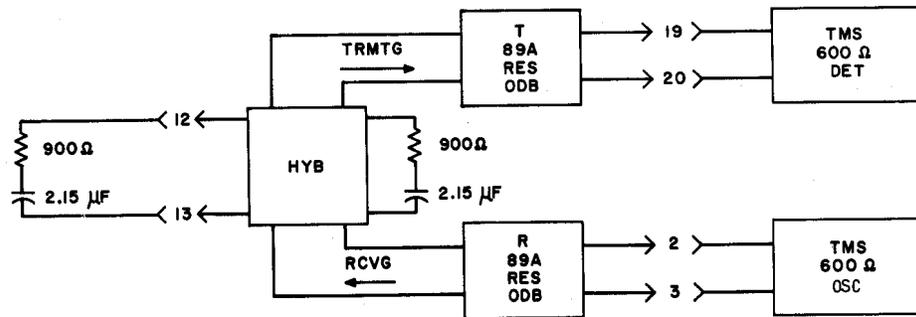
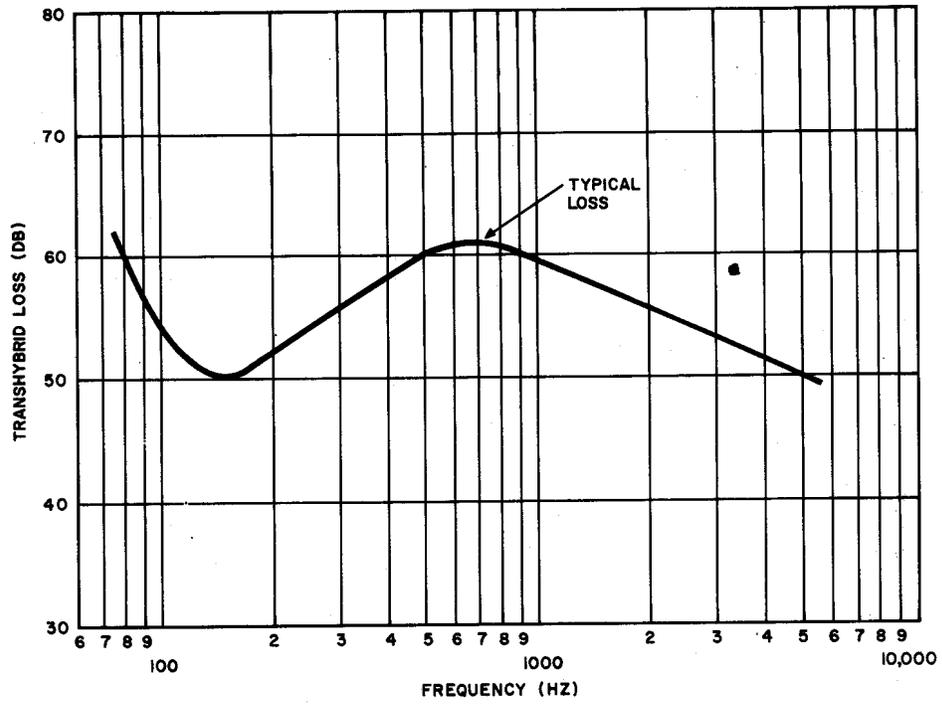


Fig. 22—FMD Unit—Nominal Transhybrid Loss

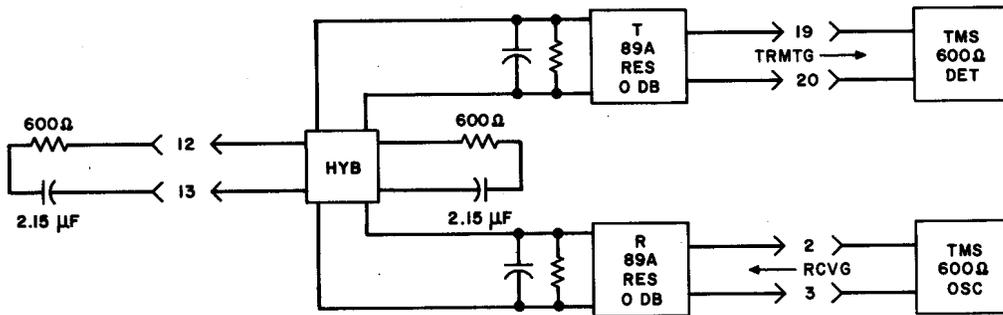
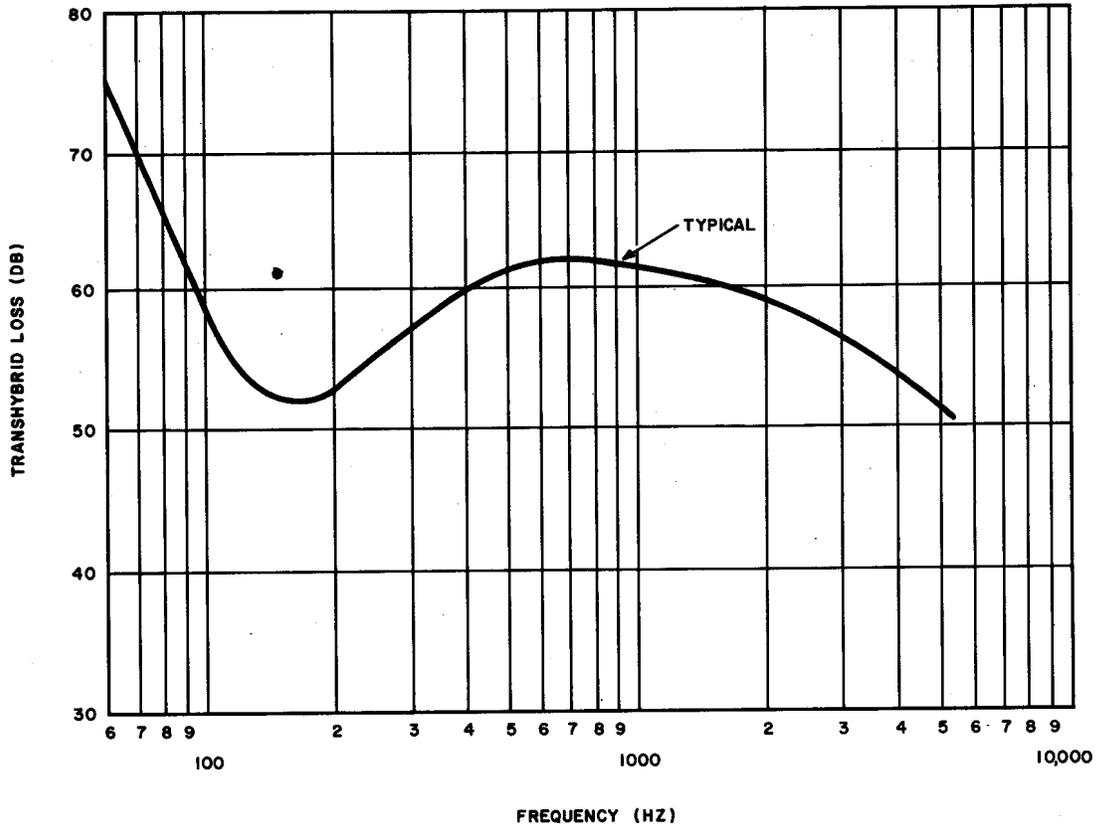


Fig. 23—FME Unit—Nominal Transhybrid Loss

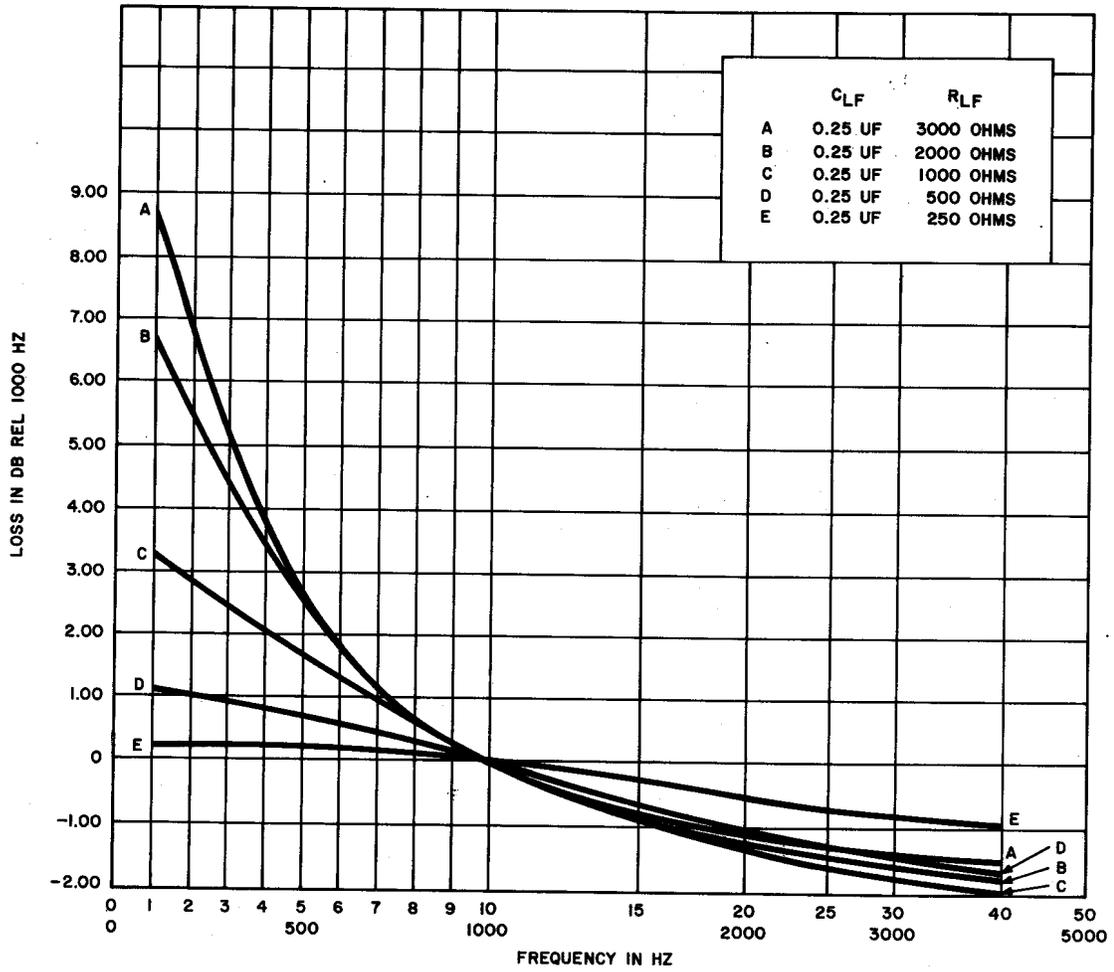


Fig. 24—FMC Unit—Nominal Low-Frequency Section, Loss-Frequency Characteristics for the 1200-Ohm Taps on Transformer (T1) and 1200-Ohm Input and 600-Ohm Output Impedance—Varying RLF for CLF Constant at 0.25  $\mu$ f

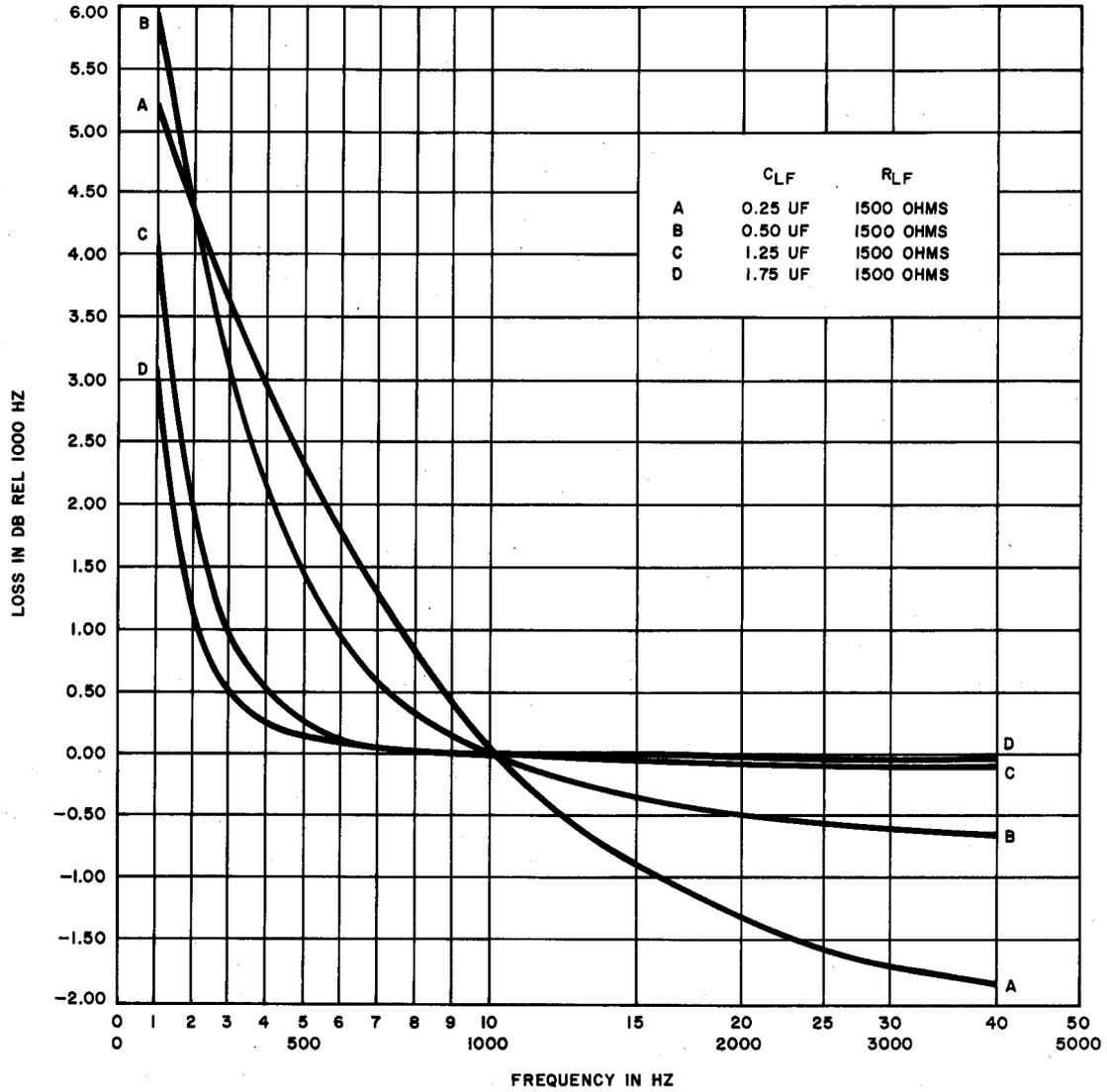
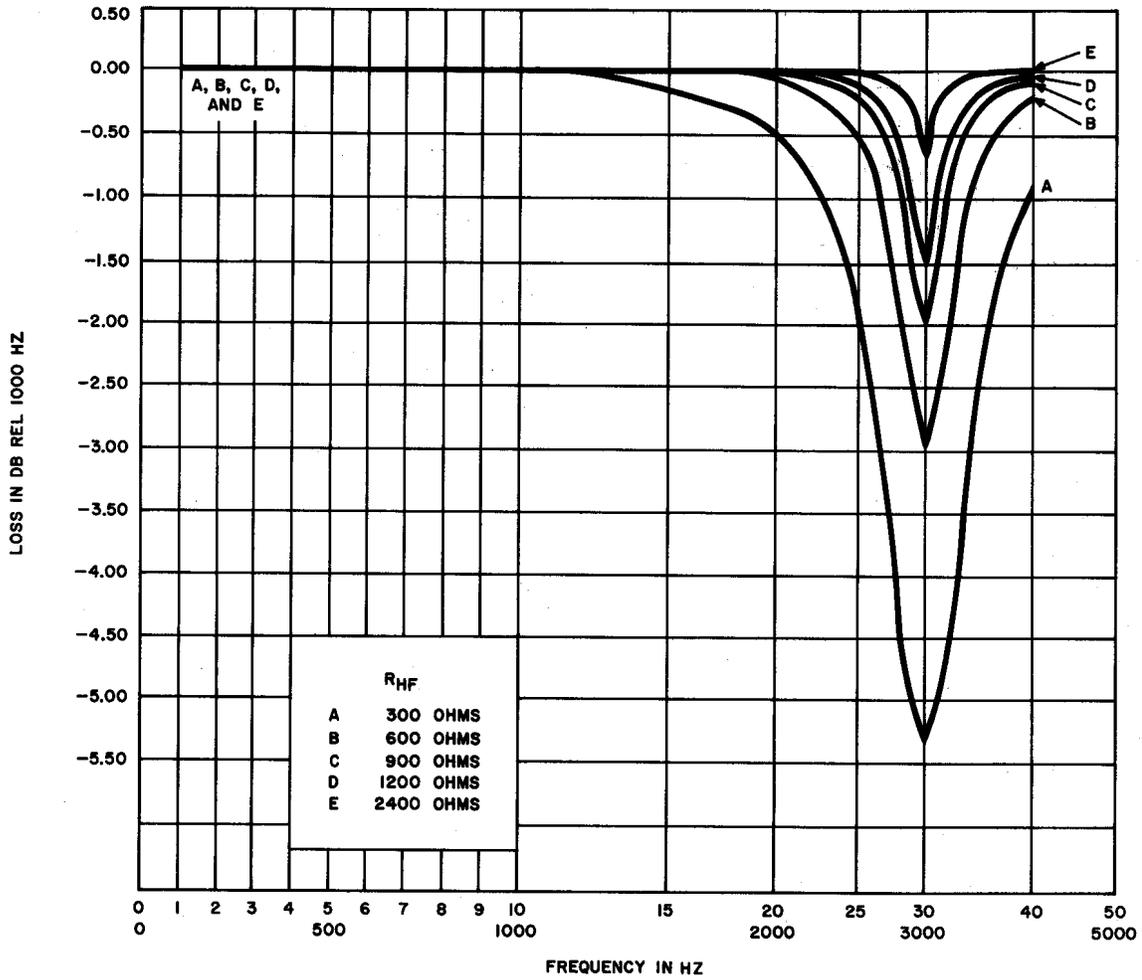


Fig. 25—FMC Unit—Nominal Low-Frequency Section, Loss-Frequency Characteristics for the 1200-Ohm Taps on Transformer (T1) and 1200-Ohm Input and 600-Ohm Output Impedance—Varying CLF and RLF Constant at 1500 Ohms



**Fig. 26—FMC Unit—Nominal High-Frequency, Loss-Frequency Characteristics for the 1200-Ohm Taps on Transformer (T1) and 1200-Ohm Input and 600-Ohm Output Impedances—At Various Settings of RHF**

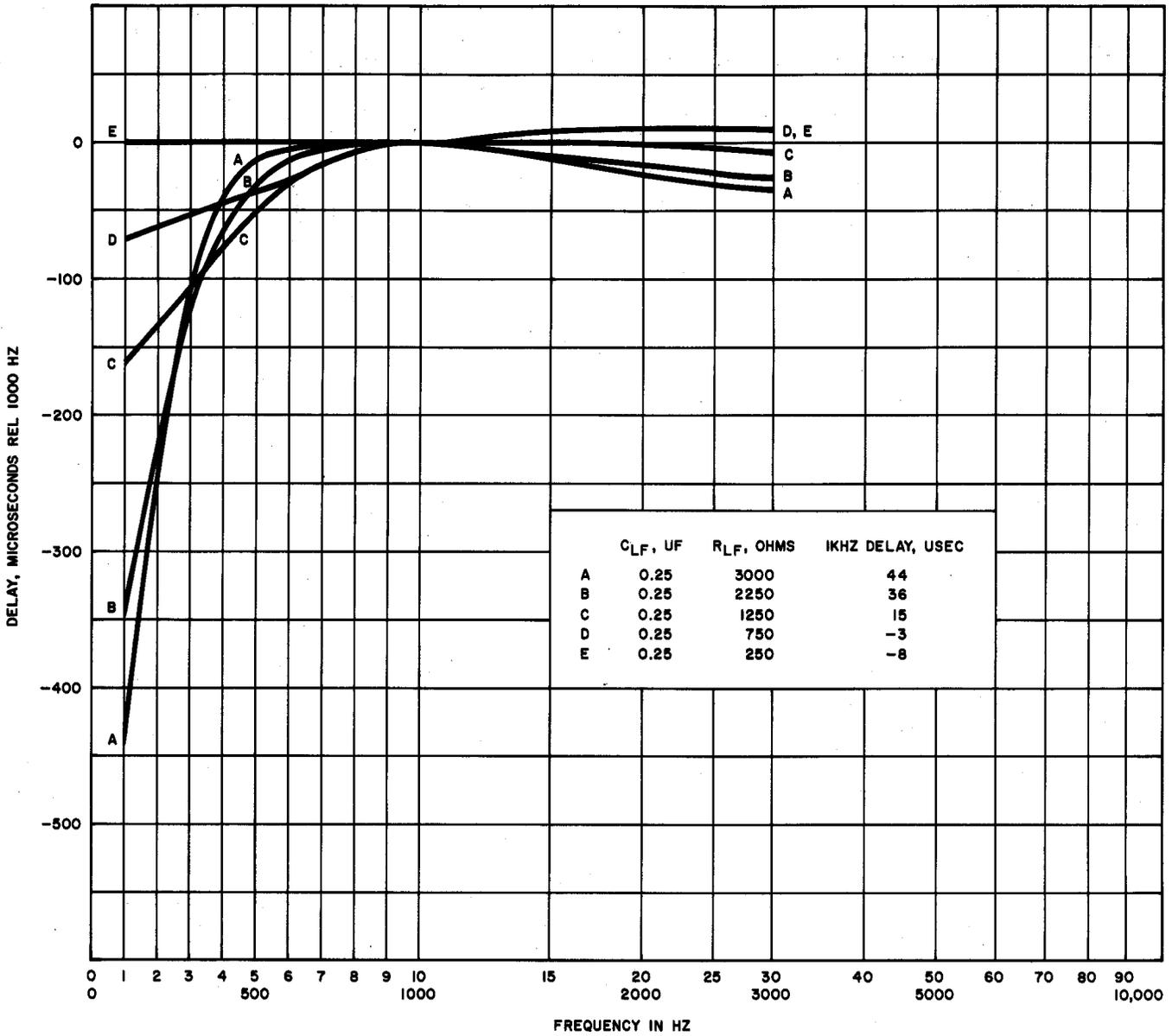
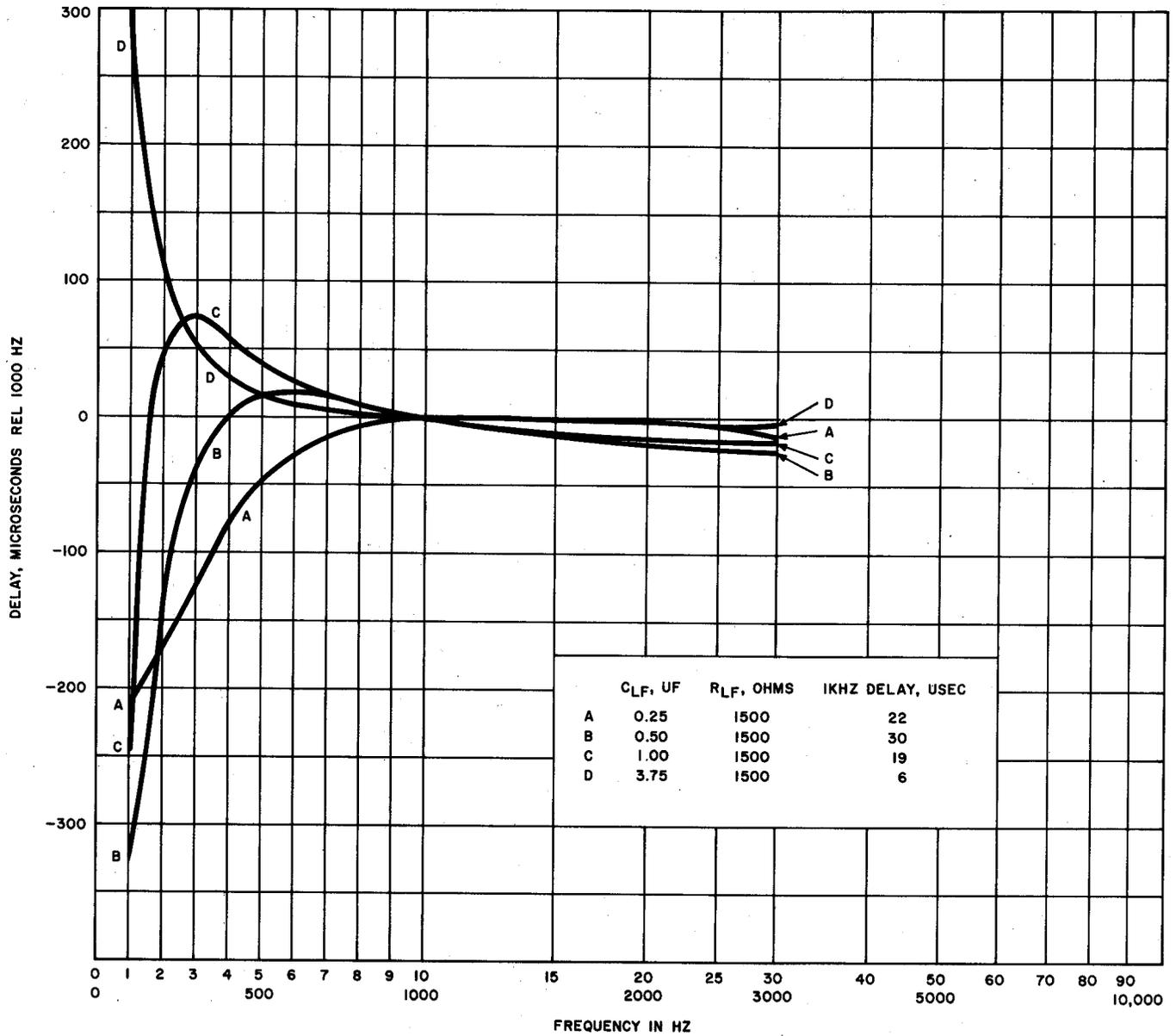


Fig. 27—FMC Unit—Nominal Low-Frequency Section, Delay-Frequency Characteristics for the 1200-Ohm Taps on Transformer (T1) and 1200-Ohm Input and 600-Ohm Output Impedance—Varying RLF for  $C_{LF} = 0.25 \mu f$



**Fig. 28—FMC Unit—Nominal Low-Frequency Section, Delay-Frequency Characteristics for the 1200-Ohm Taps on Transformer (T1) and 1200-Ohm Input and 600-Ohm Output Impedances—Varying CLF for R<sub>LF</sub> = 1500 Ohms**

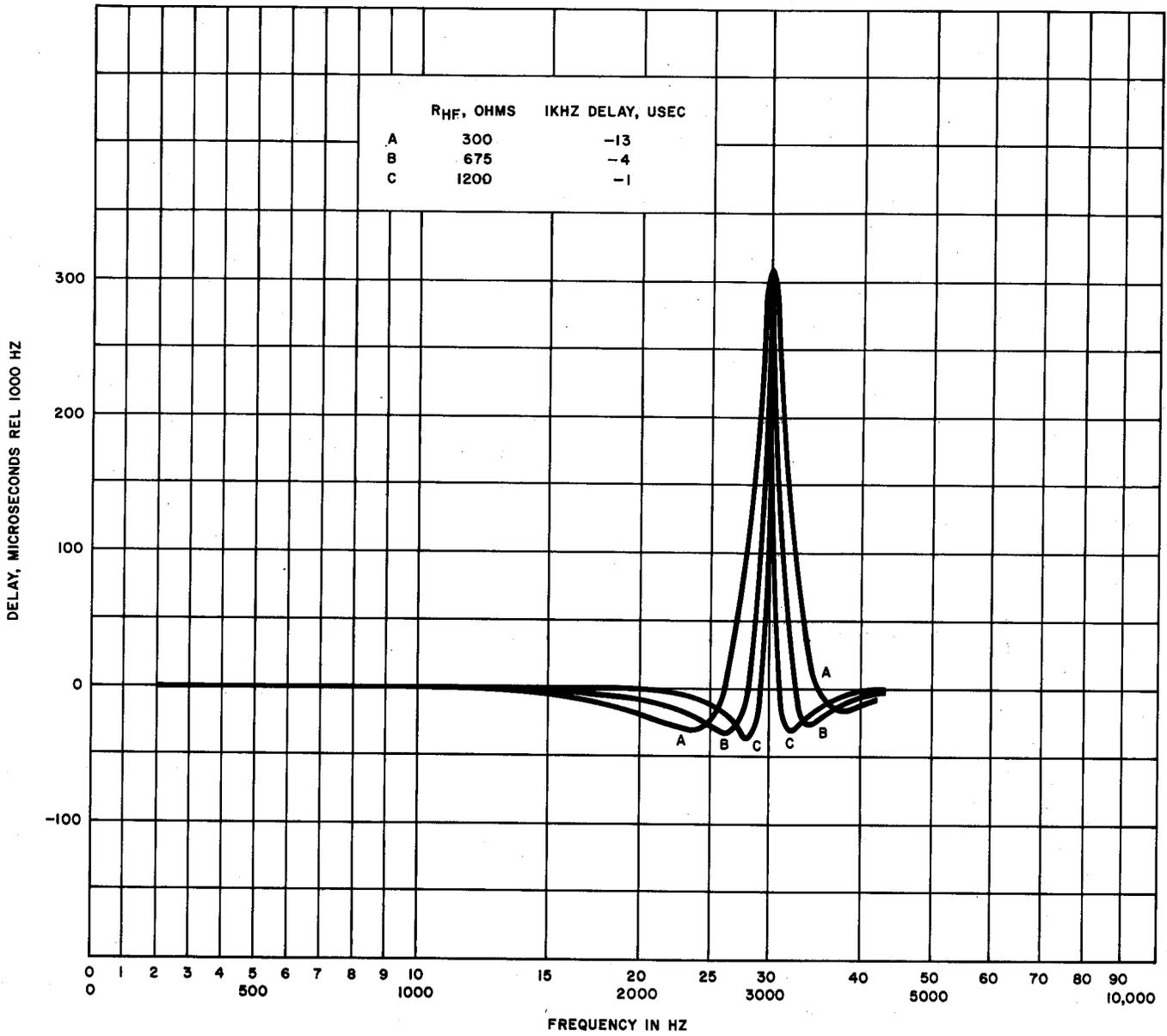


Fig. 29—FMC Unit—Nominal High-Frequency Section, Delay-Frequency Characteristics for the 1200-Ohm Taps and Transformer (T1) and 1200-Ohm Input and 600-Ohm Output Impedances—At Various Settings of RHF