

SPECIAL ACCESS AUXILIARY UNITS
DESCRIPTION
TYPE F SIGNALING SYSTEM

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1. GENERAL		
1.01	This section describes the FL_, FP_, FR_, and FS_ single-frequency auxiliary signaling	

units, a component part of the type F signaling system.

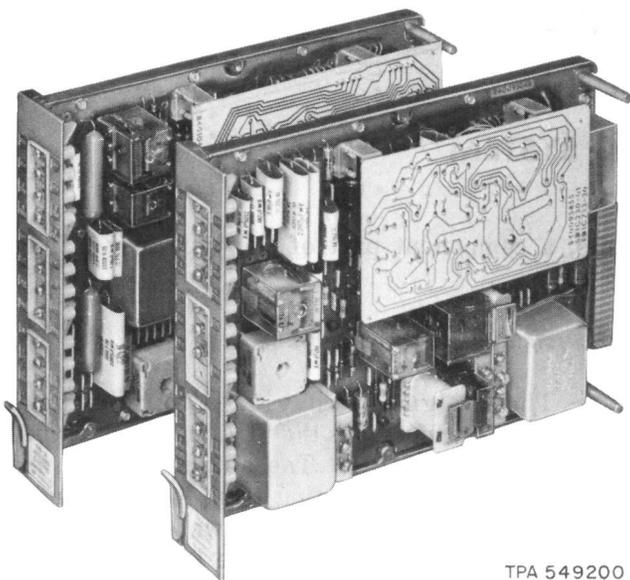
A. System and Unit Description

1.02 The F signaling bay used to hold these auxiliary units plus the FUA units is described in Section 179-363-101. The auxiliary 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.

1.03 Components in these units are mounted on a printed wiring board. The board is attached to a die cast aluminum frame approximately 10-1/2 inches by 1-1/2 inches. All interconnections between the bay and the unit is via a 40-pin connector which are part of the printed wiring board. The connector is slotted and the socket into which it is plugged is keyed to prevent the insertion of the wrong unit.

1.04 On the face of the FL_, FPA, FRA, and FS_ units are screw switches which allow for the selection of the internal compromise or external balancing network and NBO capacitors and for impedance matching and gain-frequency equalization. These units have screw switches on the face of the unit to connect the carrier failure trunk release and make busy circuit. An LPGA screw switch is on the face of the unit to put the unit in ground-start or loop-start operation. A colored coding label is also on the face of each unit. The color code for the FL_ and FPA units consists of black lettering on a cream background. Coding for the FRA and FS_ units, employs red lettering on a cream background.

1.05 Fig. 1 is a photograph of an FPA and FRA unit which shows some of the components which are used in unit construction. Fig. 2 gives the details of the various faceplates.



TPA 549200

Fig. 1—FPA and FRA Units

B. Application and Compatibility

1.06 The auxiliary units provide the interface with the switching equipment on one side and the FUA unit on the other (Fig. 3). An auxiliary unit plus a converter unit is required at one end of a signaling link and a compatible type E or F unit is required at the other end. Table A lists each unit; function, application, and the type E unit it is capable of replacing. Table B lists the units that are compatible with each other. The FLA, FLB, and FPA units are used at the central office end of a trunk whereas the FSA, FSB, and FRA units are used at the station end.

1.07 The FLA and FSA units are used for all 900-ohm 2-wire application. These units are suitable for maximum external circuit resistance of up to 1200 ohms for the FLA unit and 1800 ohms for the FSA unit. The FLB and FSB units are used for all 600-ohm 2-wire applications and have the same loop resistance limits as the FLA and FSA unit. Where longer extensions are required, the 4-wire units, FPA and FRA, are employed utilizing the built-in simplex A & B leads. The FPA and FRA units may also operate with E & M Control.

1.08 These units can be used either in loop-start or ground start operation. In the loop-start

mode, the A & B leads or E & M leads may be used, while in the ground-start mode only the A & B leads may be used. Selection of the ground-start or loop-start mode is made by the LPGS screws.

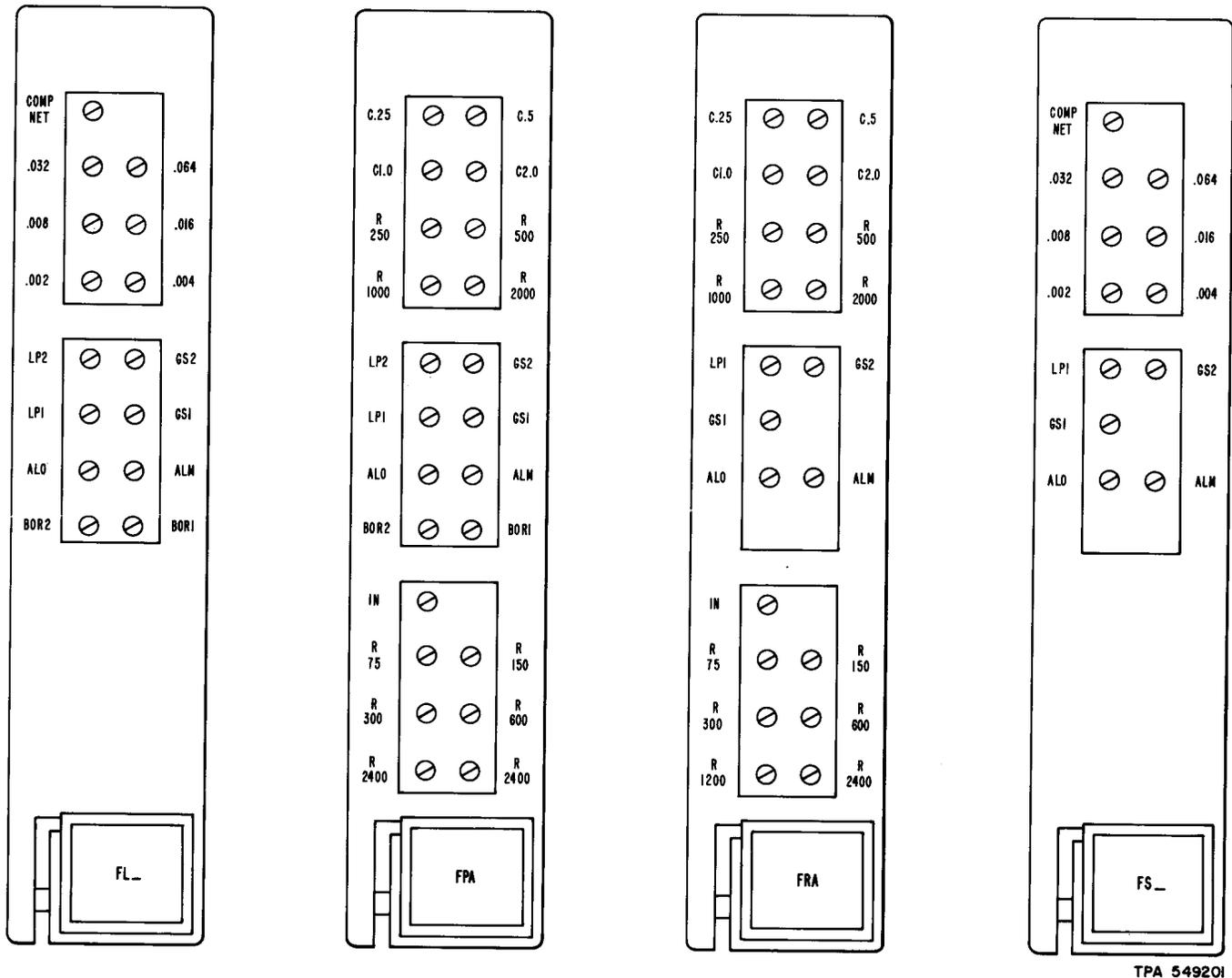
2. SIGNALING UNIT OPERATION

2.01 The following tables and figures are provided to accompany the description of the operation of the auxiliary units.

- (1) Table C lists conditions of the E & M leads, A and B leads and the application of 2600-Hz tone under various circuit conditions.
- (2) Fig. 4 through 7 show a simplified schematic of the auxiliary and FUA units transmitting and receiving circuits.

A. FL and FPA Units

2.02 As shown in Fig. 4 and 5 the FL and FPA units can be divided into six main circuits. The "ringing detector" circuit detects a 20-Hz ring from the switching equipment and causes the FUA to send 2600-Hz tone toward the station at high level. This circuit also sends signals to the FUA unit to control the cut inserted in the speech transmission path. In ground-start operation the "ringing detector" and "ground-start circuits" function together to change 20-Hz ringing to 20 pps alternations of the M relay which, in turn, causes the transmitted 2600-Hz tone to be interrupted at 20 pps. In the reverse direction, with ground-start operation, the incoming "seizure detector" informs the switching equipment when a station seizure has occurred. The "supervisory delay" circuit and the H relay recognize a seizure or dial tone connection by the switching equipment in the ground-start mode. This circuit along with the H relay, will cause the transmitted tone to be removed when either of the two conditions occurs. For ground-start operations the "supervisory delay" circuit is removed from the line and the H relay is held operated during the dialing and talking conditions by an operated S relay. This relay is operated by the "supervisory control" circuit during pulsing, and by the operated CS relay in the talking condition. The CS relay is controlled by the "loop current detector" circuit which operates the CS relay when loop current is flowing. The "receive pulse corrector" circuit provides pulse correction and guarantees a constant 56 percent break output.



TPA 549201

Fig. 2—FL_, FPA, FRA, and FS_ Unit Faceplates

A and B Lead—Loop-Start

2.03 To place the circuit in the loop start mode, the LPGS switches must be in the LP position. In this condition, tone is received but no tone is transmitted in the idle state.

2.04 On station originated calls, the station goes off-hook causing 2600-Hz tone to be removed. Upon the removal of tone, the FUA unit at the switching end commands the receive pulse corrector circuit to operate the R relay. This closes the loop

toward the central office equipment and when the office equipment is ready to receive dial pulsing, dial tone is applied to the line and transmitted to the station end. When a dial tone connection has been established, the switching equipment grounds the tip conductor. The station end can now proceed to dial. The dial pulses are changed to tone pulses by the station unit. The FUA unit associated with the FL_ or FPA auxiliary unit receives the tone pulses and sends dc pulses to the receive pulse corrector circuit in the auxiliary unit. This circuit corrects the pulses and provides a constant 56

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percent break output through contacts of the R relay which presents the pulses to the switching equipment as the opening and closing of the loop.

2.05 When a call is originated at the switching end, the FL or FPA unit is seized by the application of ringing on the ring conductor. The ringing is detected by the loop-start circuit which operates the M relay. Through operated contacts of the M relay, 2600-Hz tone is transmitted toward the station end during the ringing cycle. A command is also sent to the FUA unit to insert a cut in the transmission path, terminating the line and drop with 600 ohms. The cut remains in during the ringing interval and releases during the silent interval.

2.06 For calls originating at the switching equipment end, the tone transmitted by the station SF unit is removed when the station end answers. The FUA unit detects the removal of tone and causes the R relay in the auxiliary unit to operate which closes the loop. The loop closure trips the ringing in the central office.

2.07 Disconnect is recognized only if it occurs at the station end. When the station end disconnects, SF tone is received and the loop is opened toward the central office equipment.

E and M Lead—Loop-Start

2.08 On a station originated call, a station seizure is indicated when the received 2600-Hz tone is removed. The removal of tone is detected by the FUA unit which sends a command to the receive pulse corrector to operate the R relay. The operated contacts of R relay grounds the E lead to the switching equipment. The switching equipment responds to the ground and establishes a dial tone connection. Pulsing is the same as described in 2.04 except the output is on the E lead instead of the A and B leads.

2.09 When a call is originated at the switching end, the FL or FPA unit is seized by a ground on the M lead which indicates a ringing signal. The ground causes the loop-start circuit to operate the M relay. Through operated contacts of the M relay, 2600-Hz tone is transmitted toward the line during the ringing interval.

2.10 The conditions that follow disconnect or called party answering are the same as

described in 2.06 and 2.07 except the operated R relay applies ground to the E lead and the released R relay removes the ground, instead of opening and closing the A and B loop.

A and B Lead—Ground Start

2.11 To place the transmitting circuit in the ground-start mode, the LPGS switches must be in the GS position. In this condition tone is received and transmitted in the idle state.

2.12 For station originating calls, when seizure occurs, the received tone is removed. The FUA unit detects the removal of tone and commands the receive pulse corrector circuit to operate the R relay which grounds the B lead as a seizure signal to the switching equipment. This activates the supervisory delay circuit which operates the H relay. Through operated contacts of the H relay, the D and M relays are released removing transmitted 2600-Hz tone and closing the loop. The FPA unit is now ready to receive dial pulses. Dialing is the same as described in 2.04.

2.13 When a call is originated at the switching end, the FL or FPA unit is seized by the switching equipment when a ground is placed on the tip conductor. The supervisory delay circuit detects the ground and operates the H relay. Operation of the H relay causes the M relay to release, removing the transmitted tone. Within 4 seconds after the ground is applied, 20-Hz ringing will be applied to the ring conductor. The ringing causes the loop-start and ground-start circuits to send dc pulses to the M relay at 20 pps rate. Through contacts of the M relay transmitted tone is interrupted at 20 pps rate as a ringing signal to the station. A command is also sent to the FUA unit to insert a cut in the transmission path, terminating the line and drop with 600 ohms. The cut remains in during the ringing interval and releases during the silent interval.

2.14 For calls originating at the switching equipment end, the tone transmitted by the station SF unit is removed when the station end answers. The FUA unit at the central office detects the removal of tone and causes the R relay in the auxiliary unit to operate closing the A and B loop. The loop closure trips the ringing in the office.

2.15 Disconnect can occur at the station or central office for a call in the ground start mode.

If the disconnect originates from the station, SF tone is received and the R relay releases. This results in an open loop which indicates a disconnect to the central office. The central office responds to the open loop by removing ground from the tip conductor. This causes the A and B lead ground detector to turn off and, after a 210 millisecond delay, causes the H relay to release. When the H relay releases, the M relay operates to transmit SF tone to the station end. If the disconnect originates at the central office, loop current is interrupted, ground is removed from the tip, causing the loop current detector to release. After a short delay, the H relay releases and the M relay operates, causing 2600-Hz SF tone to be transmitted to the station end. The D relay will not operate during the disconnect interval since the R relay is operated. When a disconnect signal is returned from the station, SF tone is received, the R relay releases, and the D relay operates to establish the idle condition.

B. FRA and FS_ Units

2.16 The FRA and FS_ units can be divided into five main circuits: the current detector, ring trip circuit, ground-start control circuit, ringing detector, and ringing delay circuit. (See Fig. 6 and 7.) The current detector circuit recognizes when the station goes off-hook, either as a seizure or called party answering, and causes the AM relay to release removing tone toward the central office end. This circuit also detects station disconnect and causes the AM relay to operate and apply tone toward the central office. Commands from this circuit are sent to the FUA to control the cut inserted in the transmission path. In the ground-start mode, when either end disconnects, the ground-start circuit causes the GS relay to open the tip conductor toward the station. This circuit also causes the GS relay to apply ground on the tip toward the station when a seizure occurs at the central office. For ground-start operation the ringing detector circuit converts the received 20 pps tone alternations to a steady on-off signal for the ringing delay circuit which applies ringing to the station by controlling the R relay. The ringing delay circuit provides immunity to voice frequencies.

A and B Lead—Loop Start

2.17 To place the unit in the loop-start mode, the LPGS switches must be in the LP

position. In this condition, tone is transmitted but no tone is received in the idle state.

2.18 When the station goes off-hook (loop closed), the current detector recognizes the closure and releases the AM relay which removes tone toward the central office end. The office will make a dial tone connection and returns dial tone to the station allowing the station to dial. The AM relay follows the pulsing, applying and removing 2600-Hz tone toward the central office end.

2.19 When a call is originated at the central office end, tone is transmitted to the station end as a ringing signal. The FUA unit recognizes the tone and commands the ringing delay circuit to operate the R relay. The operated R relay sends 20-HZ ringing voltage to the subscriber on the ring conductor.

2.20 The customer may answer during the silent interval or during the ringing interval. If the customer answers during the silent interval, the auxiliary unit is informed of the condition by the loop being closed. The answer condition causes the current detector to release the AM relay. A command is also sent to the FUA unit to release the CT relay. The release of the AM relay removes the tone toward the central office as indication of the customer answering. The release of the CT relay cuts through the transmission path. If the customer answers during the ringing interval, the ring trip detector operates the RT relay. Break contacts of the RT relay remove the ringing. Supervision now proceeds as previously described for answering during the silent interval.

2.21 For loop-start operation, the converter plus the auxiliary unit is under control of the station end. This is true for either station end disconnect or central office end disconnect. No supervision is returned from the central office in either case. When the station end goes on-hook the loop is opened for A & B lead operation. This is detected by the current detector which initiates operation of the AM relay. The operated AM relay applies tone to the line toward the central office.

E and M Lead—Loop Operation

2.22 To place the receiving circuit in the loop-start mode, the LPGS switches must be in the LP position. In this condition, tone is transmitted but no tone is received in the idle state.

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2.23 When the station end originates a call, the FRA or FS₋ unit is seized by the application of battery on the M lead. The battery will cause the current detector to release the AM relay, removing tone from the line. The switching office will make a dial tone connection and return dial tone to the station. The calling customer may then proceed to dial. The AM relay follows dial pulsing which applies and removes tone toward the central office.

2.24 A call originated at the central office end causes tone to be transmitted toward the station as a ringing signal. The FUA unit commands the ringing delay circuit to operate the R relay. The operated R relay opens the E lead. The E lead is opened during the ringing cycle and grounded during the silent cycle. Station answer is the same as described in 2.20 except when the customer answer battery is placed on the M lead for passage of the trip signal to the central office end. Tripping is accomplished, in this case, only at the central office.

2.25 Disconnect is the same as described in 2.21 except when the station end goes on-hook, battery is removed from M lead instead of the loop being opened.

A and B Lead—Ground Start

2.26 To place the unit in the ground-start mode, the LPGS switches must be in the GS position. In this condition tone is received and transmitted in the idle state.

2.27 When the station goes off-hook, the ring conductor is grounded. The ground activates the current detector and releases the AM relay thus removing tone toward the central office end. The received tone is removed when the dial tone connection at the central office is made. The FUA unit detects the removal of tone and commands the ground-start control circuit to release the GS relay. The GS relay releases following a short delay and grounds the A lead. Dial tone can now be heard by the subscriber at the station. The customer may now proceed to dial. The AM relay will follow the pulsing and applies and removes 2600-Hz tone toward the central office end.

2.28 When a call is originated at the central office end, the received tone is removed. The FUA unit detects the removal of tone and commands

the ground start circuit to release the GS relay placing a ground on the A lead toward the station. Within 4 seconds the ringing signal is applied from the central office end toward the station end. This ringing signal is 2600-Hz tone at a 20 pps rate. DC pulses from the FUA unit are passed on to the ringing detector circuit which responds to pulses within a range of 20 ± 3 pps. This circuit commands the ringing delay circuit to operate the R relay. The operated R relay applies 20-Hz ringing to the station. At the end of the ringing cycle the R relay will release.

2.29 If the station end is the originating end of a call, no supervision is returned when the called party answers.

2.30 A disconnect signal can be recognized from either the station end or the central office end. If the station end goes on-hook, (loop opened), the current detector recognizes the condition and operates the AM relay. The operated AM relay applies tone to the line via the FUA unit. After the central office releases the customer's line circuit, the central office signaling unit responds by applying tone to the line toward the station end. The ground-start circuit receives the tone and operates the GS relay. This opens the tip toward the customer. If the disconnect is originated at the central office, the process proceeds as previously described except the signaling unit at the station end does not wait for the station to go on-hook before applying tone toward the central office. The AM relay is operated, applying tone toward the central office immediately after the GS relay operates and opens the tip toward the customer.

C. FL₋, FPA, FRA and FS₋ Unit—TOUCH-TONE Operation

TOUCH-TONE Operation—Transmitting Toward the Central Office

2.31 When TOUCH-TONE signals are to be transmitted by the FRA or FS₋ Unit, battery is put on the M lead or the A & B loop is closed for loop-start operation or the B lead is grounded for ground-start operation. This signal initiates the release of the AM relay, which removes the 2600-Hz tone transmitted toward the central office end. A signal is also sent to the FUA unit to release the CT relay. When the CT relay releases, the transmission path is cut through to the line

facility. TOUCH-TONE signals can now be passed through the transmit path of these units.

TOUCH-TONE Operation—Receiving From the Station

2.32 When the 2600-Hz tone is removed from the line facility by the station-end signaling unit, the FUA unit at the central office end detects it and sends a signal to the FL₋ or FPA auxiliary unit to operate the R relay. The operated R relay informs the switching equipment of the incoming call. In ground-start operation, when the central office is ready to receive the TOUCH-TONE signals, ground is applied on the tip conductor causing the signaling unit to remove tone toward the station end which closes the station loop. For both loop-start and ground-start operations, when the A & B loop is closed and the central office is ready to accept the tone signals, the central office sends dial tone to the station.

3. CARRIER GROUP ALARM (CGA)

3.01 Each of these units is provided with a CGA control feature. The circuit is placed into service by turning down either the ALM or ALO screw switches on the face of these units. Circuit release is the only condition the circuit can provide in these units.

A. FL₋, FPA Units

3.02 Ground applied to the ALM (or ALO) lead following a carrier failure causes the R relay to release. The released R relay removes the ground from E lead and opens the A & B loop.

B. FRA, FS₋ Units

3.03 Ground applied to the ALM (or ALO) lead following a carrier failure operates the CGA relay. Make contacts of the CGA relay ground the E lead to prevent ringing from being applied to the customer and opens the A and B leads.

4. TRANSMISSION CIRCUITS

4.01 The FPA and FRA units incorporate a 4-wire extension circuit for use with 4-wire cable extensions. This circuit allows impedance matching and frequency equalization. Impedance matching is obtained by selecting the transformer impedance ratio by the use of screw-type switches. Equalization is obtained by taps on the transformer in the

transmit and receive paths. When the 1200-ohm tap is used, independently controlled low and high frequency equalization sections can be used. This circuit also has a transformer center tap on the cable side for simplex circuits. A and B screw switches are used to incorporate the simplex arrangement.

4.02 The FL₋ and FS₋ units allow conversion from 2-wire (900 ohms—FLA and FSA, 600 ohms—FLB and FSB) operation to the 4-wire (600 ohm) interface with the FUA unit (Fig. 4 or 7). This conversion is obtained by a 2-transformer hybrid in the auxiliary unit. The NBOC may be varied from 0.0 to 0.127 μ F in 0.002 μ fd steps. This permits balancing against office cabling. These units also have a compromise network of 900 or 600 ohms (R1) plus 2.15 μ F (C1). Access is provided for an external precision network if required.

5. PULSING CHARACTERISTICS

A. Transmitting

5.01 The FS₋ and FR₋ units will accept dial pulses on the M lead or the A and B loop as follows:

PULSES-PER-SECOND	PERCENT BREAK
7.5	15-90
10.0	20-90
12.5	25-90

Note: The tone pulse output of the shaper is limited to a minimum of 50 ms.

B. Receiving

5.02 The FL₋ and FPA units are limited to receiving dial pulses in the range of 7.5 to 12.5 pps. A minimum pulse of 29 ms is required to operate the receiver and a minimum interval of 15 ms between dial pulses is required for the pulse corrector to recycle completely. The output of the receiver is a constant 56% break independent of the input percent break within the range from 29 to 90% break at 7.5 pps, to 48 to 85% break at 12.5 pps.

6. TRANSMISSION CHARACTERISTICS

6.01 The following discussion assumes that the temperature is approximately 70°F, and the dc power converter is within $\pm 5\%$ of $-24V$.

A. 2-Wire Operation

6.02 The envelope delay distortion present in the transmit and receive circuits can be seen in Fig. 8. In the FL_L and FS_L units, the 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 milliseconds at 2000 Hz to 160 millisecond at 500 Hz as shown by the transmit and receive circuit curves in Fig. 8.

6.03 The transmit path (excluding the P-pads) in the FUA unit has a negligible amount of loss. The combined loss of the transmit circuit transmission path for FUA unit and the auxiliary unit can be seen in Fig. 9 and 10.

6.04 The output level of the receiving circuits transmission path for FUA unit is within 0.4 dB of the input signal level between 300 and 3000 Hz. The combined variation due to the FUA unit plus the auxiliary unit between the input and output level in the voice frequency range with and without the band elimination filter in the circuit is demonstrated in Fig. 11 through 14. The high loss between 2200 and 2800 Hz shown in Fig. 11 and 12 is provided by the band-elimination filter.

6.05 The 2-wire loss and the transhybrid loss curves are shown in Fig. 15 through 18. The difference in transhybrid loss between the FLA and FSA units and the FLB and FSB units is due to the absence of SX inductors in the FLB and FSB units.

B. 4-Wire Operation

6.06 Impedance ratios suitable for the connecting line facilities are selected by means of the screw-type switches located on the face of the FPA and FRA units. Equalization for long lengths of nonloaded cable is obtained by using the 150-ohm taps on the transformer in the transmit and receive paths. The 150-ohm impedance faces the cable. The resulting deliberate impedance mismatch between the network and cable is larger at low

frequencies and thus produces reflection loss that tends to complement cable loss and flattens the overall loss-frequency response. Some equalization for short lengths of nonloaded cable is obtained by using the 600:600-ohm taps on the network. The small amount of equalization required is provided by the low-frequency loss in the transformers. The 1200-ohm taps on the transformers are used to match the cable impedance when loaded H88 cable is used.

6.07 For loaded H88 cable, independently adjustable low- and high-frequency equalization sections provide the necessary equalization to obtain a substantially flat frequency response over the range of 250 to 3000 Hz. The 1000-Hz insertion loss varies between 0 and 3 dB as equalization is adjusted.

6.08 Fig. 19 through 24 are curves that illustrate the effect of varying the values of the components of the equalizer sections of the network. These curves do not include any variance in the transformers.

6.09 The series arm low-frequency components (R_{LF} and C_{LF}) provide compensation for amplitude distortion in the 4-wire line facilities at frequencies up to approximately 1000 Hz. Fig. 19 and 20 illustrate typical equalization losses which can be obtained by various combinations of C_{LF} and R_{LF} . Fig. 19 shows the results of keeping C_{LF} constant at 0.25 μF and varying R_{LF} and the HF section out of the circuit. Fig. 20 shows the results of keeping R_{LF} constant at 1500 ohms and varying C_{LF} with the HF section out of the circuit.

6.10 The shunt arm high-frequency components provide amplitude equalization for 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. Fig. 21 illustrates the typical corrective losses which may be obtained by various settings of R_{HF} .

6.11 While the series arm low-frequency components (R_{LF} and C_{LF}) provide compensation for

amplitude distortion, they introduce delay distortion at the same time. Fig. 22 and 23 illustrate typical delay-frequency characteristics obtained by various combinations of C_{LF} and R_{LF} . Fig. 22 illustrates results of keeping C_{LF} constant at $0.25 \mu F$ and varying R_{LF} with the HF section out of the circuit. Fig. 23 shows the results of keeping R_{LF} constant at 1500 ohms and varying C_{LF} with the HF section out of the circuit.

6.12 While the shunt arm high-frequency components provide compensation for amplitude distortion, they also introduce delay distortion. Fig. 24 illustrates typical delay-frequency characteristics obtained by varying R_{HF} .

7. MAINTENANCE

7.01 There are no field adjustments provided on the FL_, FPA, FRA, and FS_. Units not

meeting circuit requirements should be sent to Western Electric Company for repair. Defective units should be replaced with spare units.

7.02 The Type F Test Extender SD-1C241-02 is provided to gain 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.

7.03 Descriptive or test practices on other related components within the F-type signaling system can be found under individual component headings in the BSP index 179-000-000.

TABLE A

TYPE F AUXILIARY SIGNALING UNITS GENERAL INFORMATION AND APPLICATION

CODE	FUNCTIONAL DESCRIPTION	GENERAL APPLICATION	SPECIFIC USE	TYPE E SF UNITS REPLACED
FLA	Special Access CO end	Special Access Loop-Start or Ground-Start	2W-900 ohm	E2L-E2LA E1P + Term. Set
FLB	Special Access CO end	Special Access Loop-Start or Ground-Start	2W-600 ohm	E1P + Term. Set
FPA	Special Access CO end	Special Access Loop-Start or Ground-Start	4-wire extension	E1P + Type 4182 network
FRA	Special Access Station End	Special Access Loop-Start or Ground-Start	4-wire extension	E1R + Type 4182 network
FSA	Special Access Station End	Special Access Loop-Start or Ground-Start	2W-900 ohm	E2S-E2SA E1R Term. Set
FSB	Special Access Station End	Special Access Loop-Start or Ground-Start	2W-600 ohm	E1R Term. Set

TABLE B

COMPATIBILITY OF AUXILIARY UNITS WITH E – AND F – TYPE UNITS

CENTRAL OFFICE END	MODE OF OPERATION	CUSTOMER END								
		FRA	FSA FSB	FA- FB- FWA	E2B, E3BK OR KA, E4B	E2S	E23A	E1R		
FLA & FLB	Loop Start	✓	✓	1, 3	1	✓	No	✓		
	Ground Start	✓	✓	No	No	✓	✓	✓		
FPA	Loop Start	✓	✓	1, 3	1	✓	No	✓		
	Ground Start	✓	✓	No	No	No	✓	✓		
FA-, FB-, FWA	Loop Start	2, 3	2, 3							
	Ground Start	No	No							
E2L	Loop Start	✓	✓							
	Ground Start	✓	✓							
E2LA	Loop Start	No	No							
	Ground Start	✓	✓							
E1P	Loop Start	✓	✓							
	Ground Start	✓	✓							

Note 1: When used with SD-96252-01 DLL Circuit

Note 2: When used with SD-96251-01 DLL Circuit

Note 3: Not a desirable arrangement

TABLE C

MODE OF OPERATION	CONDITION OF TRUNK	FP – AND FL – UNITS					FR – AND FS – UNITS				
		CONDITION OF SIG & TRMSN LEADS					CONDITION OF SIG & TRMSN LEADS				
		M LEAD	E LEAD	A & B LOOP	2600-Hz TONE		M LEAD	E LEAD	A & B LOOP	2600-Hz TONE	
TRMT	RCV				TRMT	RCV					
LOOP-START CALL ORIGINATED AT STATION END	Idle	BATT	Open	Open	OFF	ON	GRD	GRD	Open	ON	OFF
	Seizure	BATT	GRD	Closed	OFF	OFF	BATT	GRD	Closed	OFF	OFF
	Pulsing	BATT	Open-GRD	Open-Closed	OFF	ON-OFF	BATT-GRD	GRD	Open-Closed	ON-OFF	OFF
	Talking	BATT	GRD	Closed	OFF	OFF	BATT	GRD	Closed	OFF	OFF
LOOP-START CALL ORIGINATED AT CENTRAL OFFICE END	Idle	BATT	Open	Open	OFF	ON	GRD	GRD	Open	ON	OFF
	Seizure	GRD	Open	Ready for Ringing	ON	ON	GRD	OPEN	Open	ON	ON
	Ringling	GRD	Open	Open	ON	ON	GRD	OPEN	Open	ON	ON
	Talking	BATT	GRD	Closed	OFF	OFF	BATT	GRD	Closed	OFF	OFF
GROUND-START CALL ORIGINATED AT STATION END	Idle	—	—	Open	ON	ON	—	—	Open	ON	ON
	Seizure	—	—	B Lead Grounded	ON	OFF	—	—	B Lead Grounded	OFF	ON
	Pulsing	—	—	Open-Closed	ON	ON-OFF	—	—	Open-Closed	ON-OFF	ON
	Talking	—	—	Closed	OFF	OFF	—	—	Closed	OFF	OFF
GROUND-START CALL ORIGINATED AT CENTRAL OFFICE END	Idle	—	—	Open	ON	ON	—	—	Open	ON	ON
	Seizure	—	—	A Lead Grounded	OFF	ON	—	—	Open	ON	OFF
	Ringling	—	—	Open	ON*	ON	—	—	Open	ON	ON*
	Talking	—	—	Closed	OFF	OFF	—	—	Closed	OFF	OFF

* In the GROUND-START Mode, during the ringing interval, 2600-Hz tone is interrupted at a 20 pps rate.

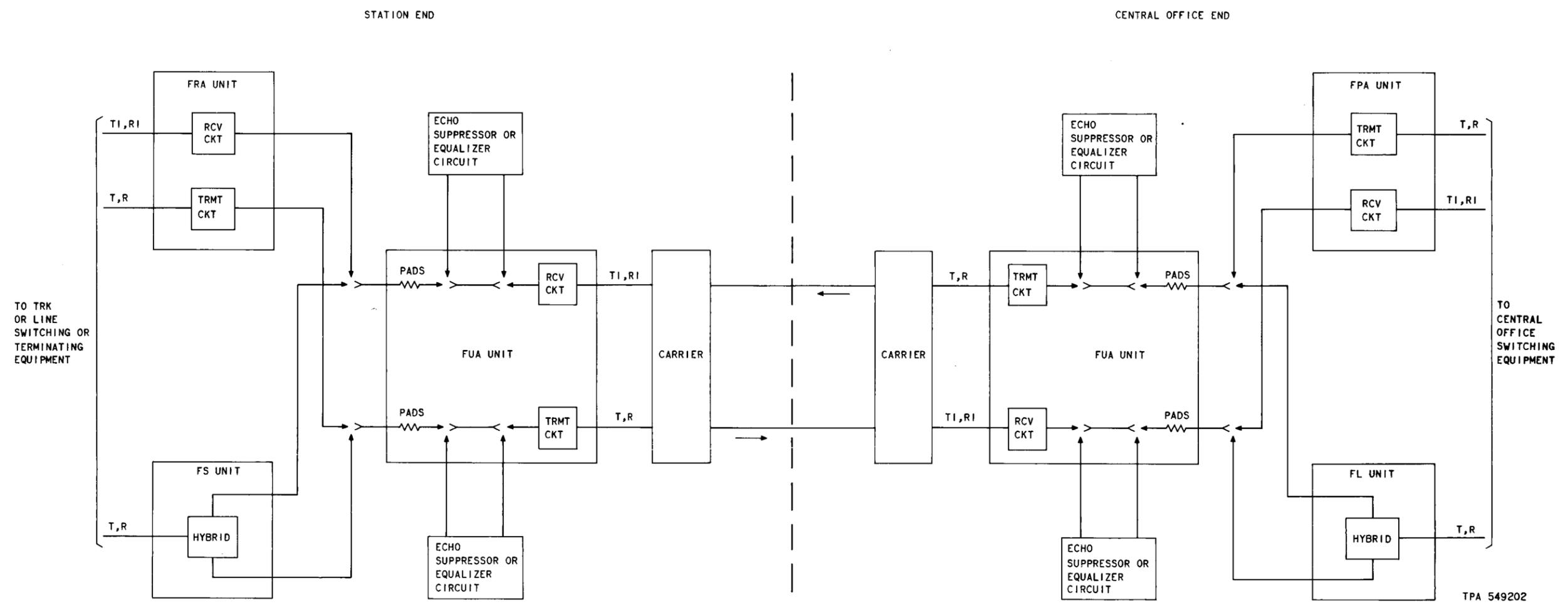
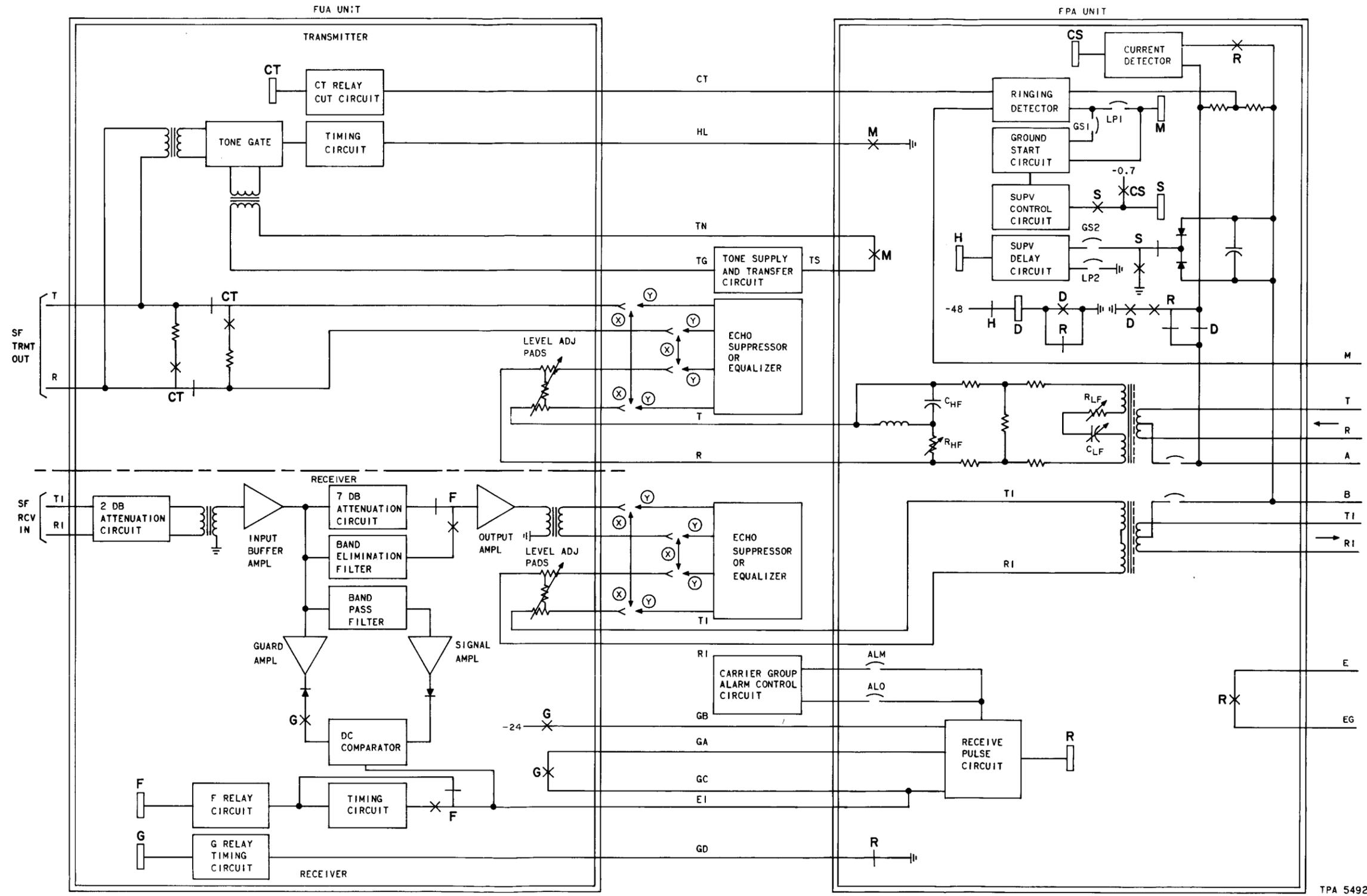
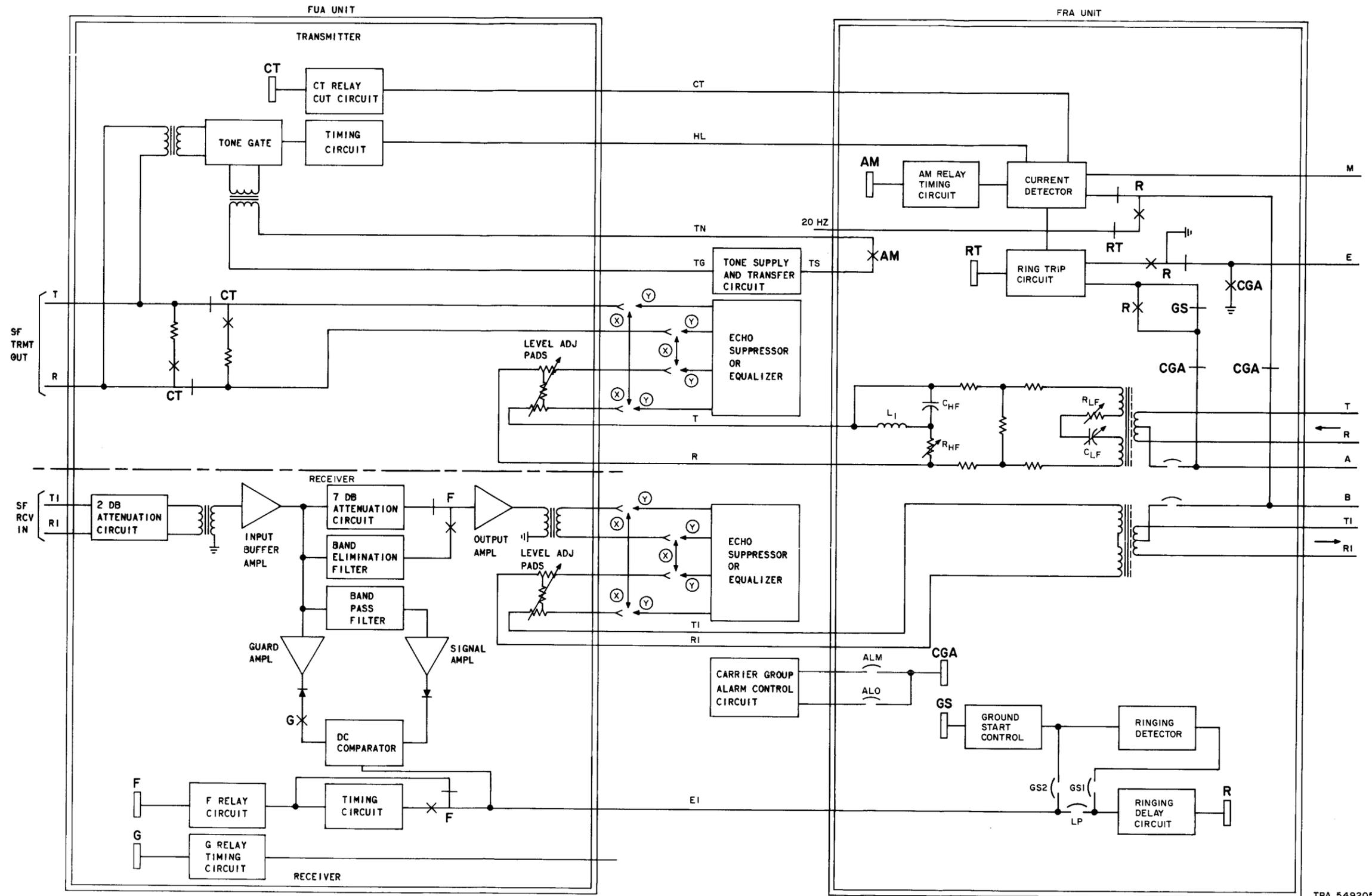


Fig. 3—Simplified Application Schematic of the FUA Unit Plus the Auxiliary Unit



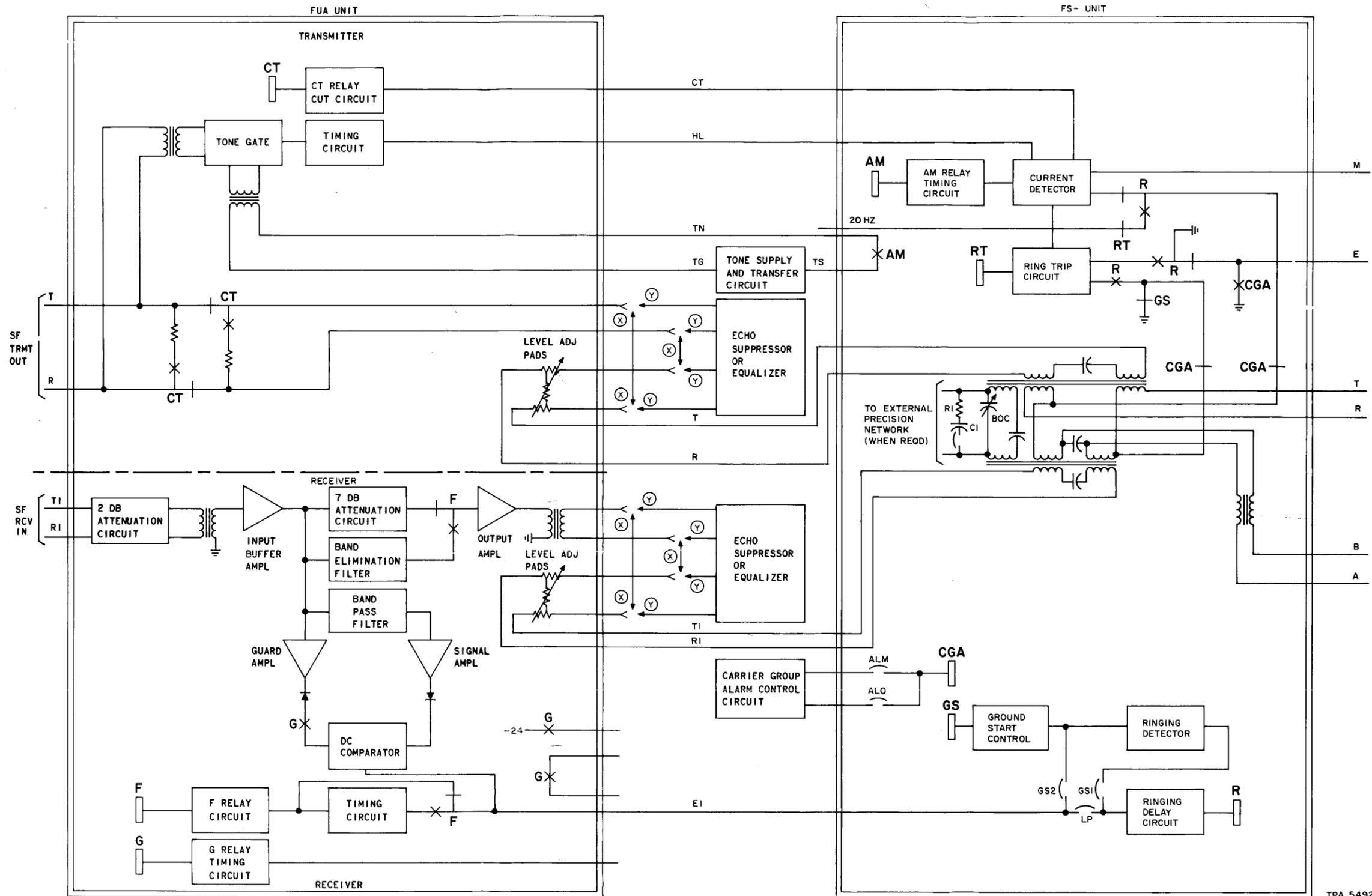
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Fig. 5—FUA Plus FPA Units



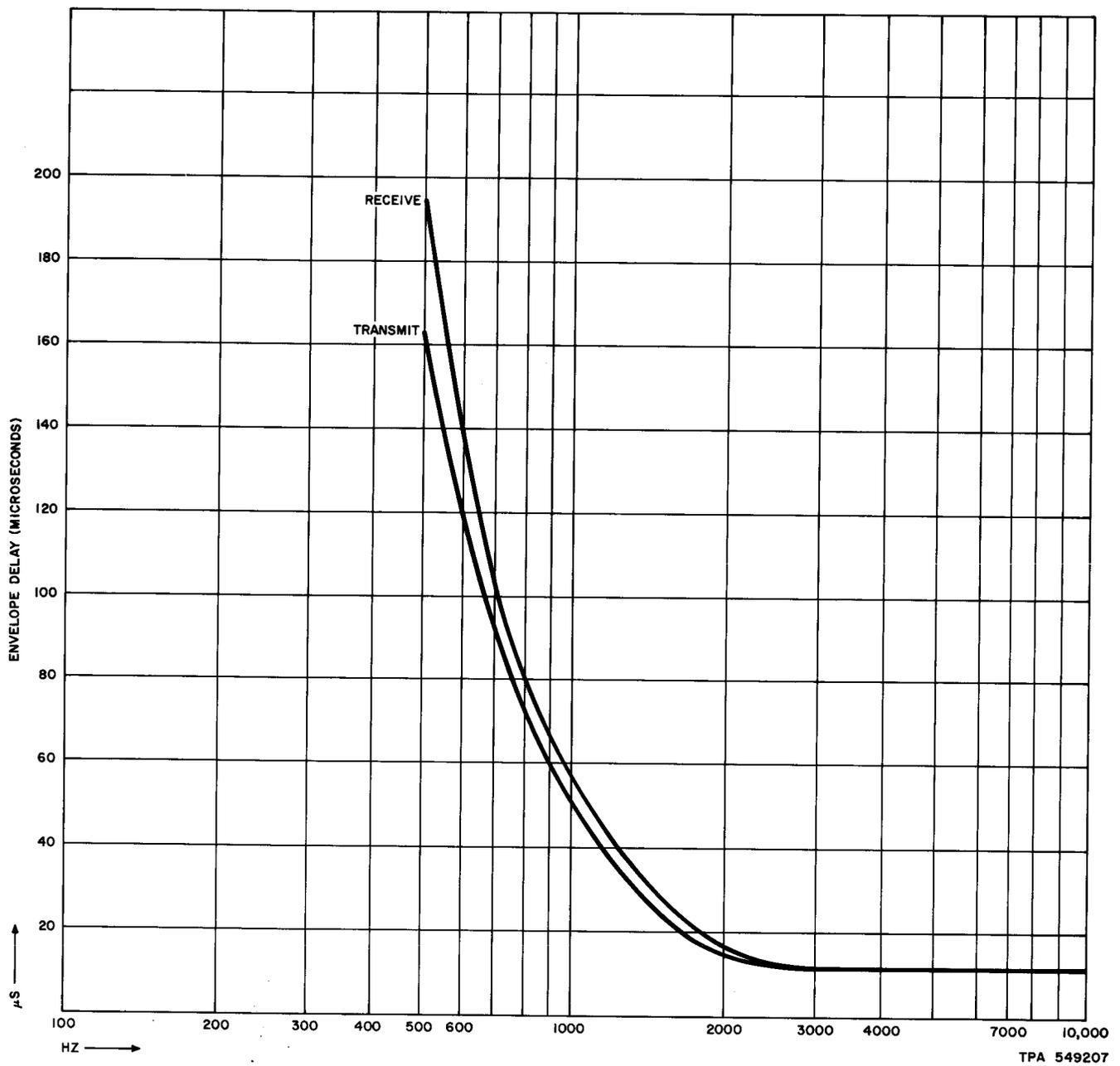
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Fig. 6—FUA Plus FRA Units



TPA 549206

Fig. 7—FUA Plus FS Units



TPA 549207

Fig. 8—Nominal Envelope Delay Distortion For the FL, FP, FR, and FS Units Plus the FUA Unit

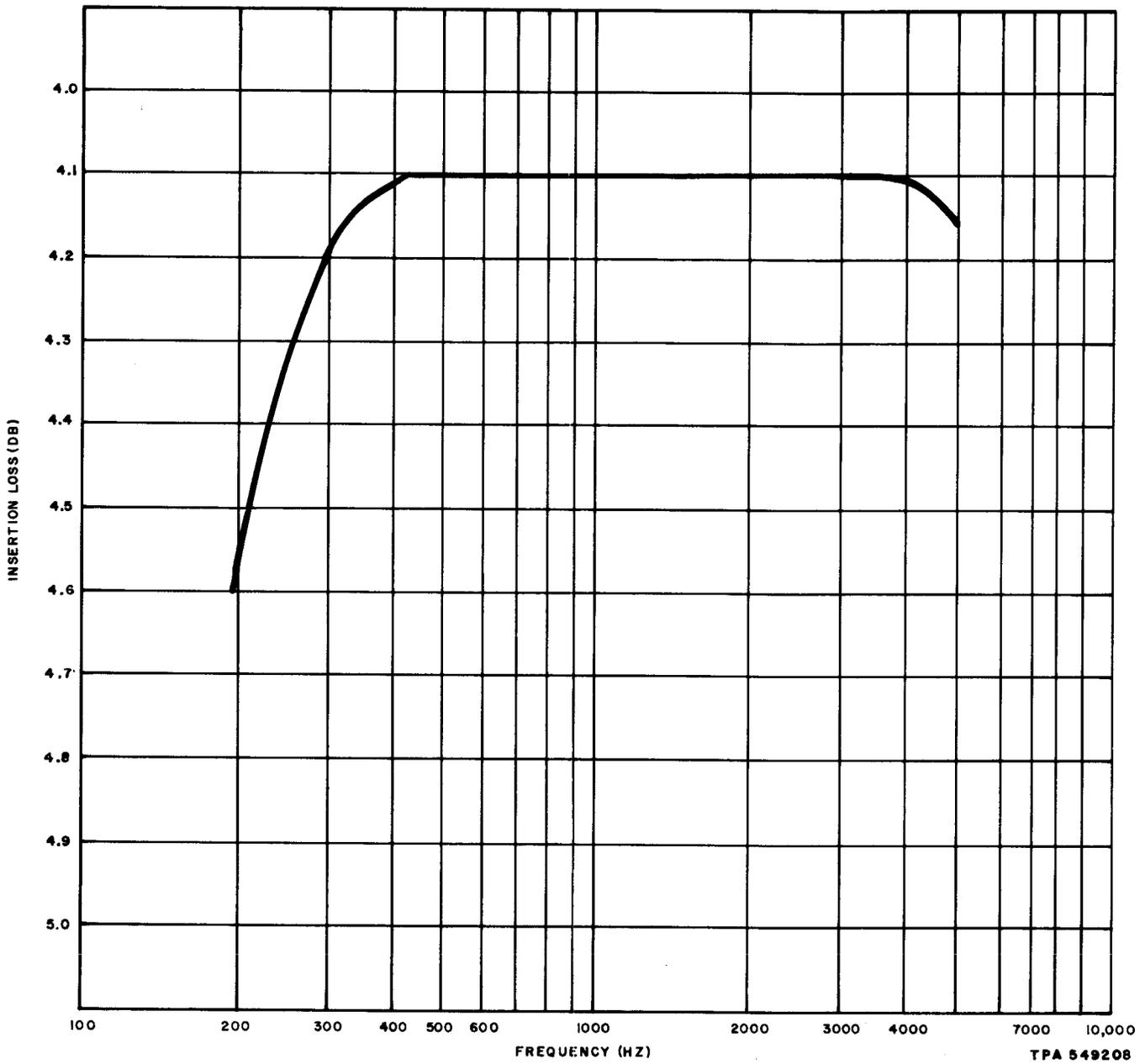


Fig. 9—Nominal Transmit Circuit Insertion Loss for the FLA and FSA Units Plus the FUA Unit

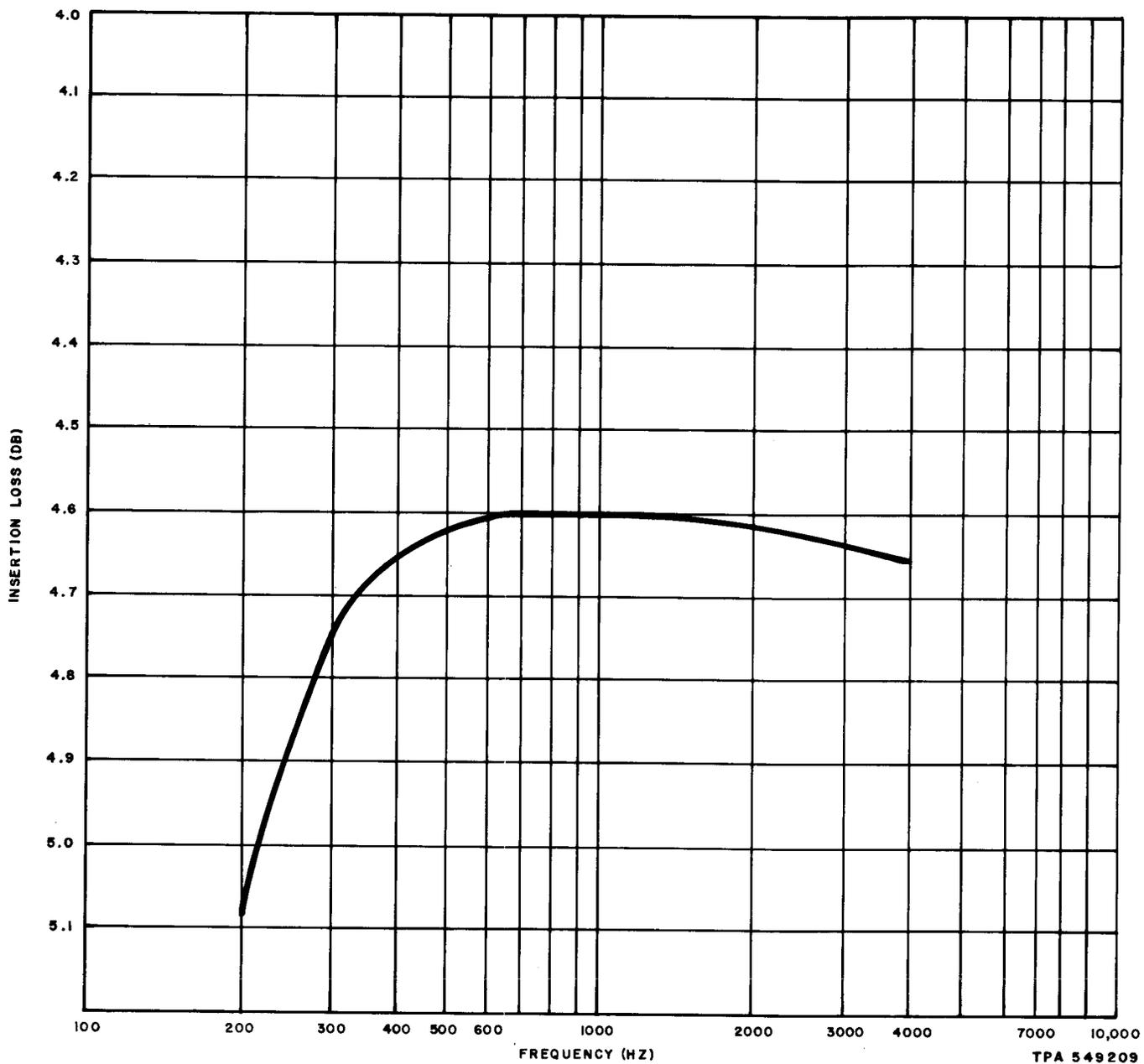


Fig. 10—Nominal Transmit Circuit Insertion Loss for the FLB and FSB Units Plus the FUA Unit

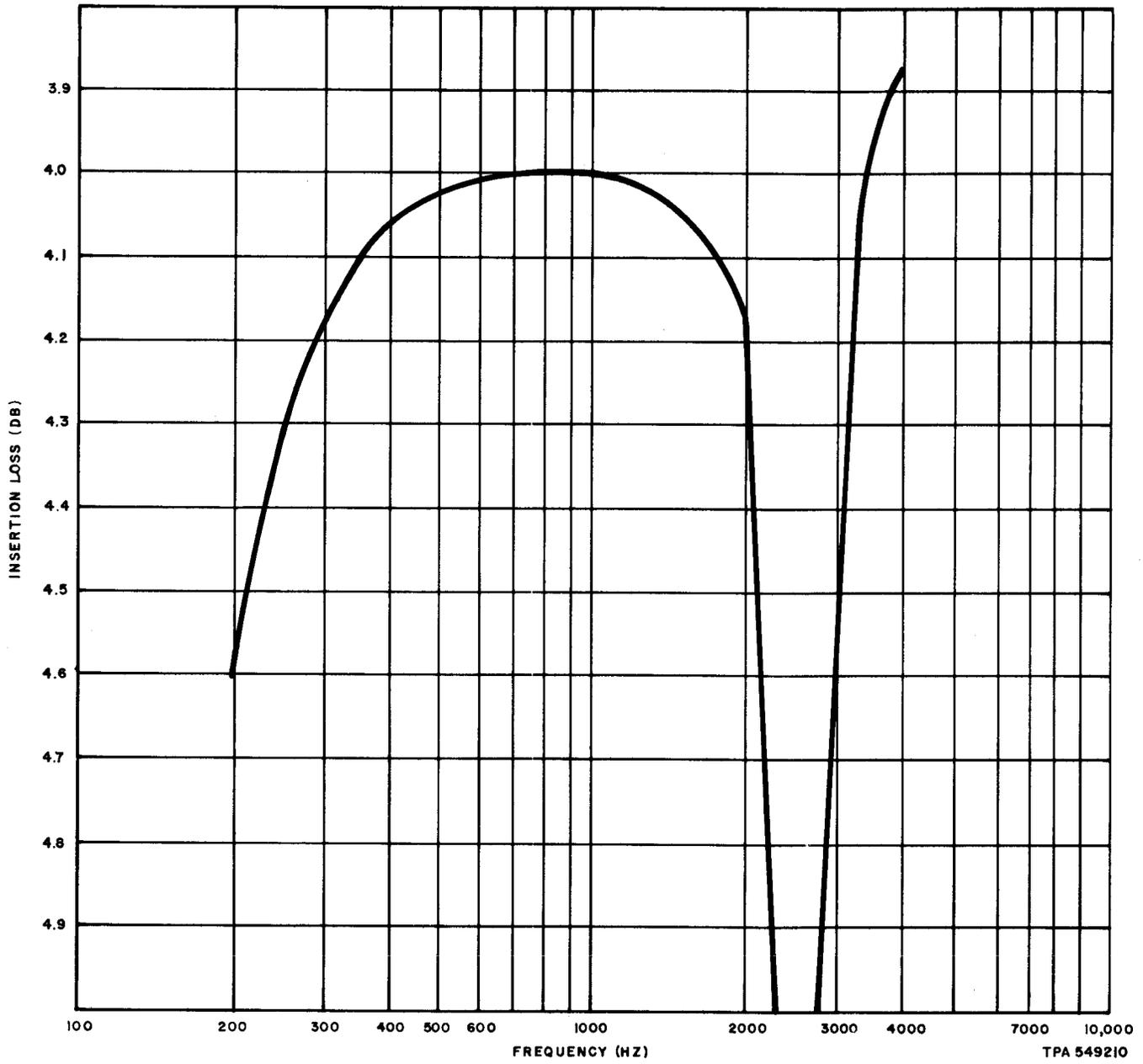


Fig. 11—Nominal Receive Circuit Insertion Loss With Band Elimination Filter In For the FLA and FSA Units Plus the FUA Unit

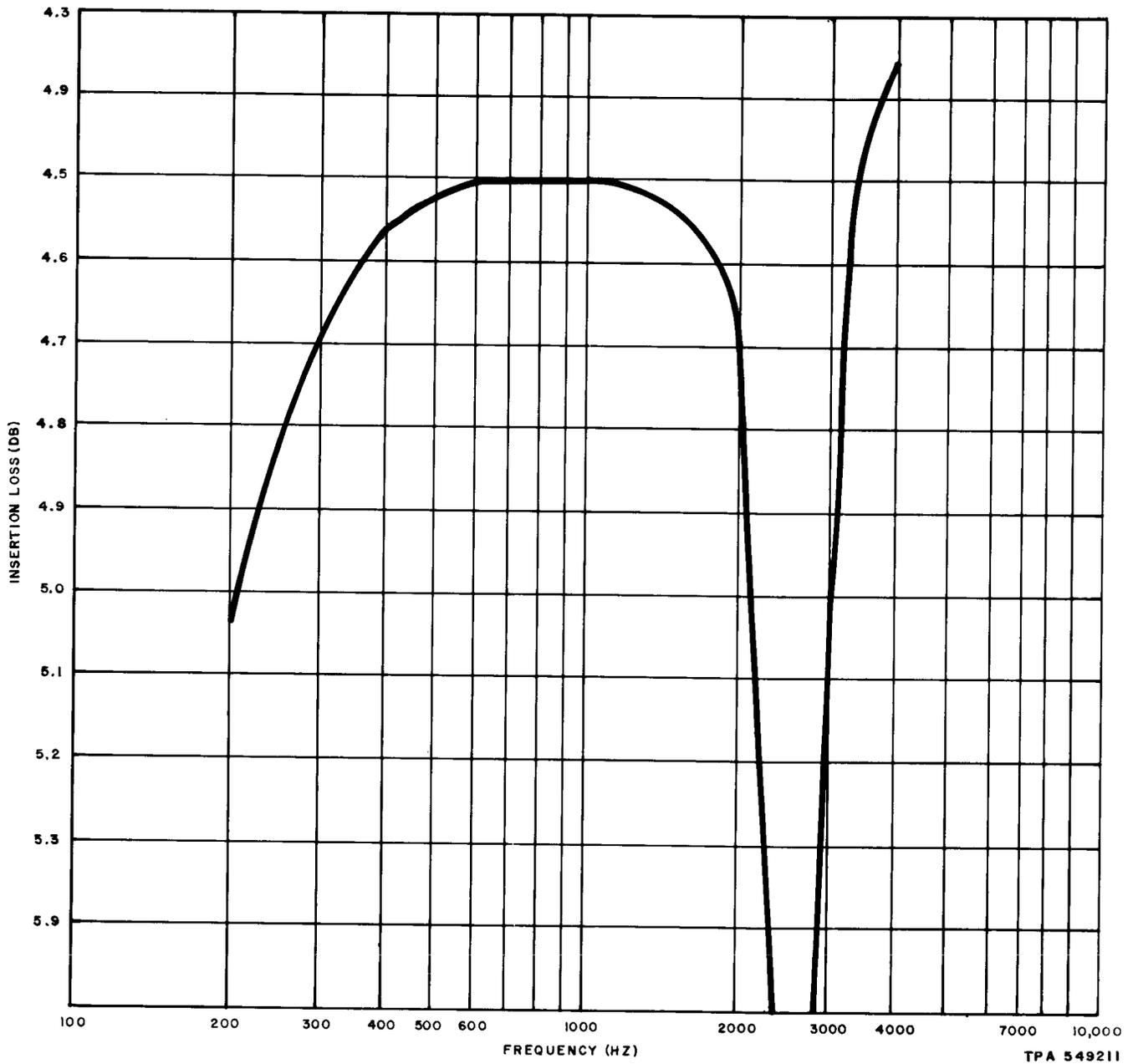


Fig. 12—Nominal Receive Circuit Insertion Loss With Band Elimination Filter In For the FLB and FSB Plus the FUA Unit

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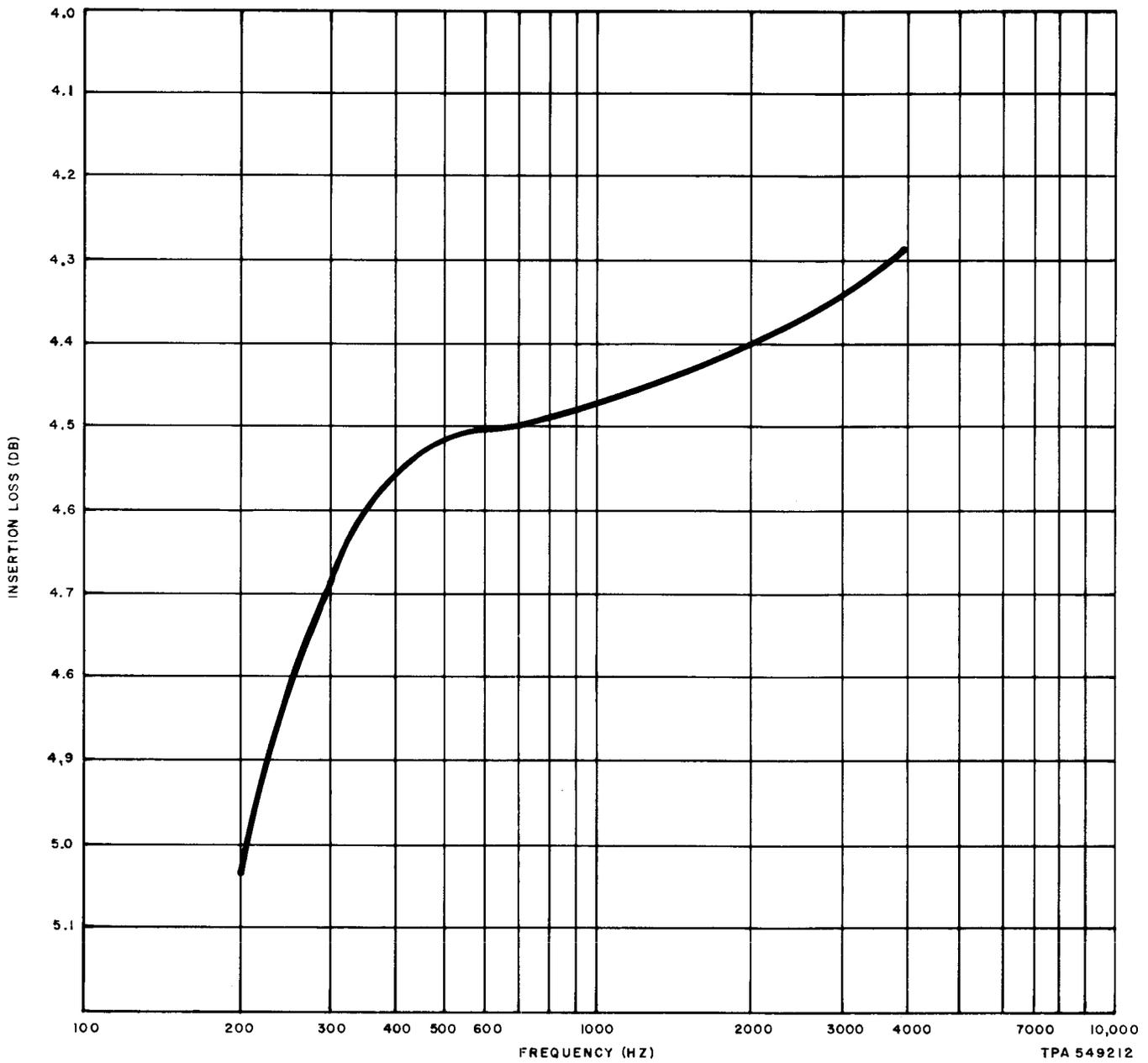


Fig. 13—Nominal Receive Circuit Insertion Loss With Band Elimination Filter Out For the FLA and FSA Units Plus the FUA Unit

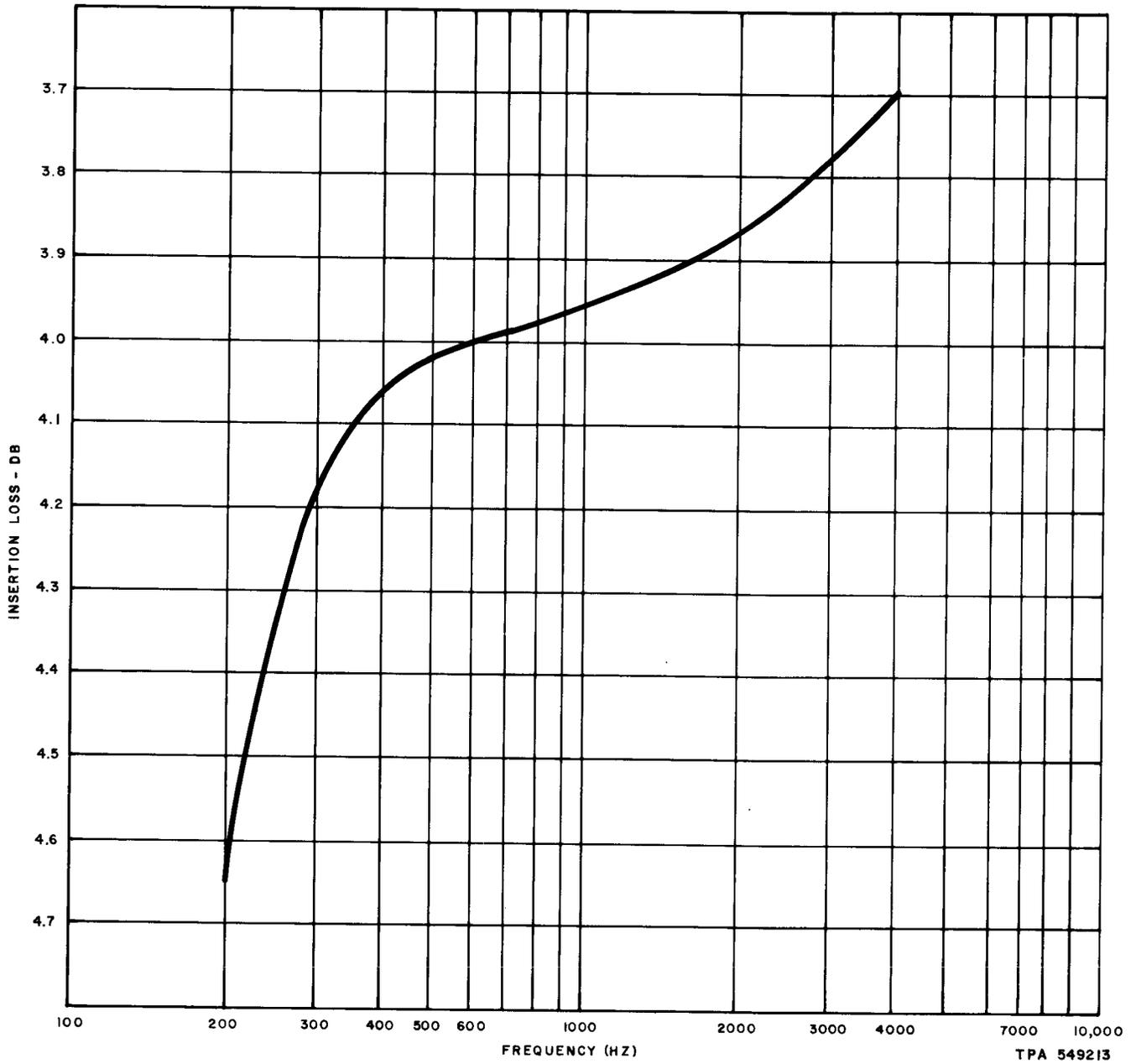


Fig. 14—Nominal Receive Circuit Insertion Loss With Band Elimination Filter Out For the FLB and FSB Units Plus FUA Unit

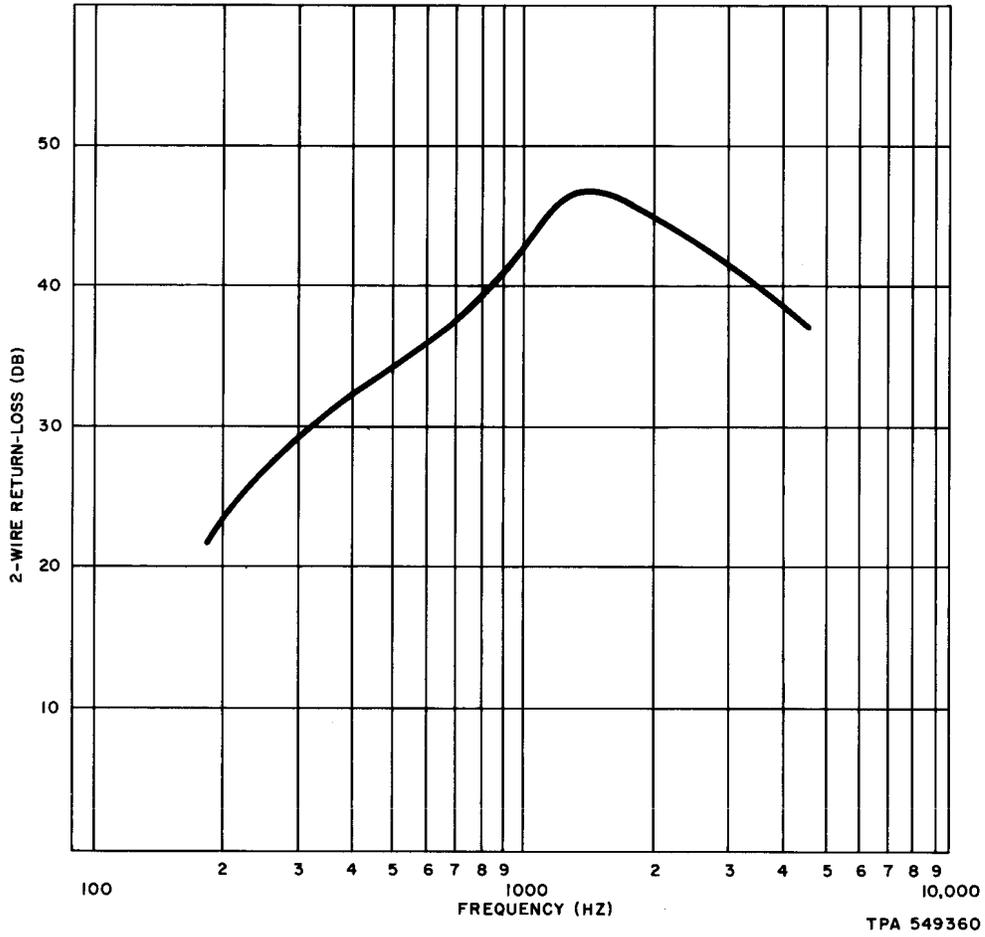


Fig. 15—FLA and FSA Units—Return Loss-Frequency Characteristics—2-Wire Line Against 900-Ohms Plus 2.15 μ f

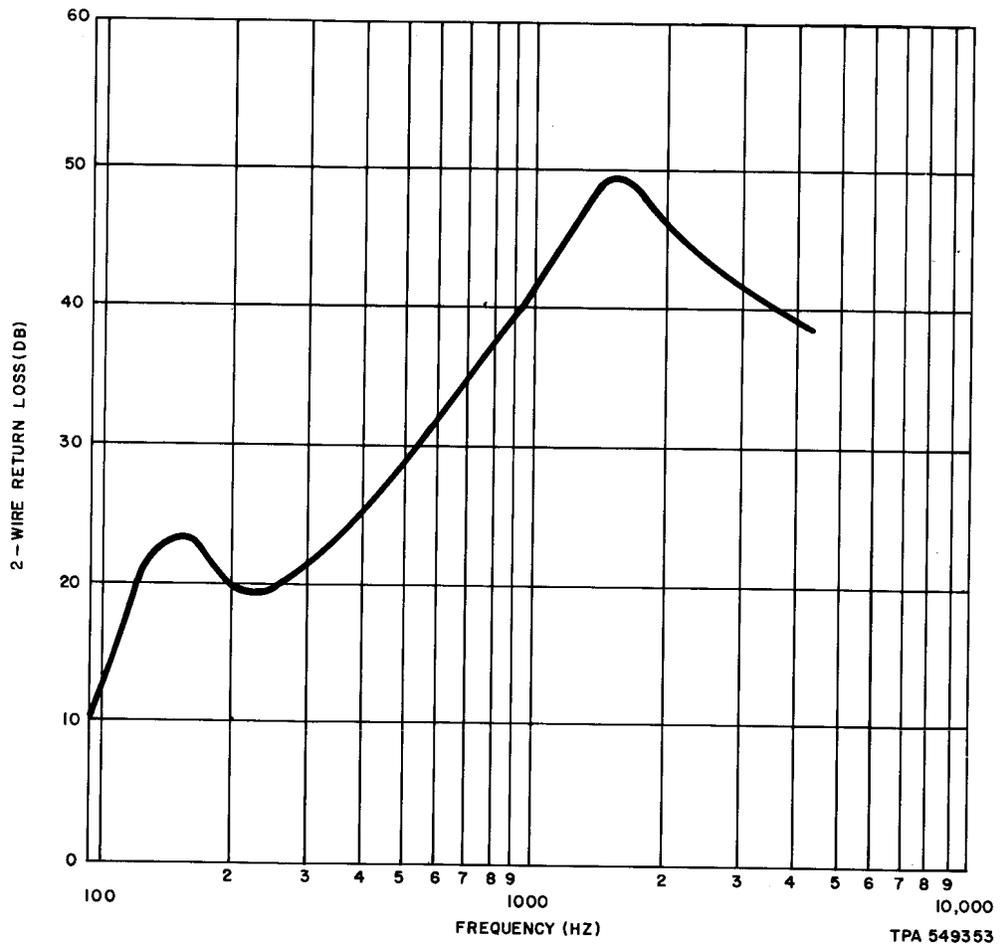


Fig. 16—FLB and FSB Unit—Nominal Return Loss—Frequency Characteristic—2-Wire Side Against 600 Ohms Plus 2.15 μ f

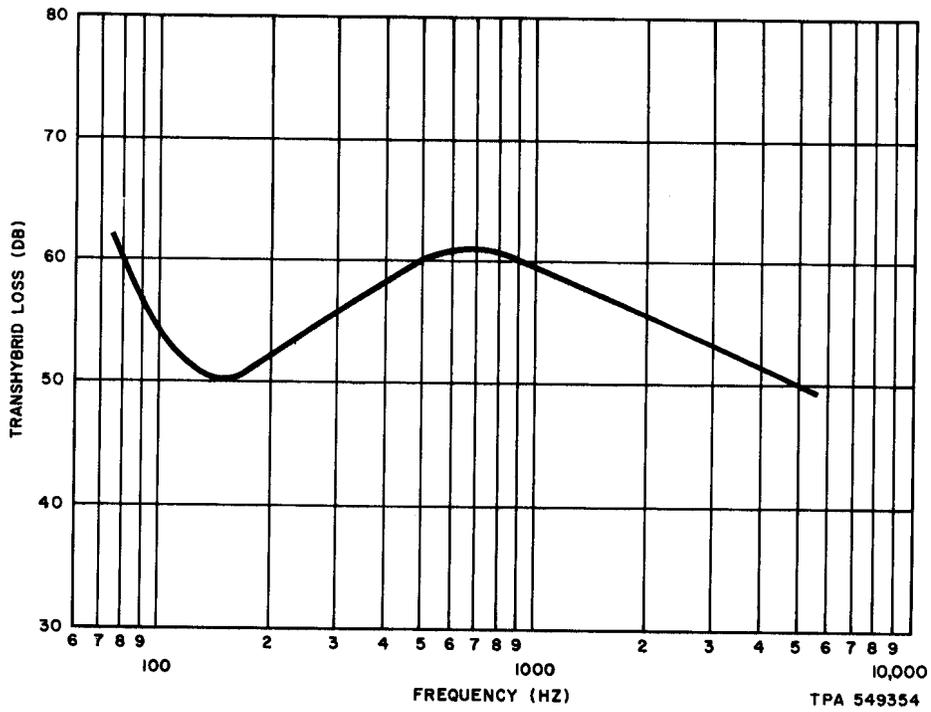


Fig. 17—FLA and FSA Units—Nominal Transhybrid Loss

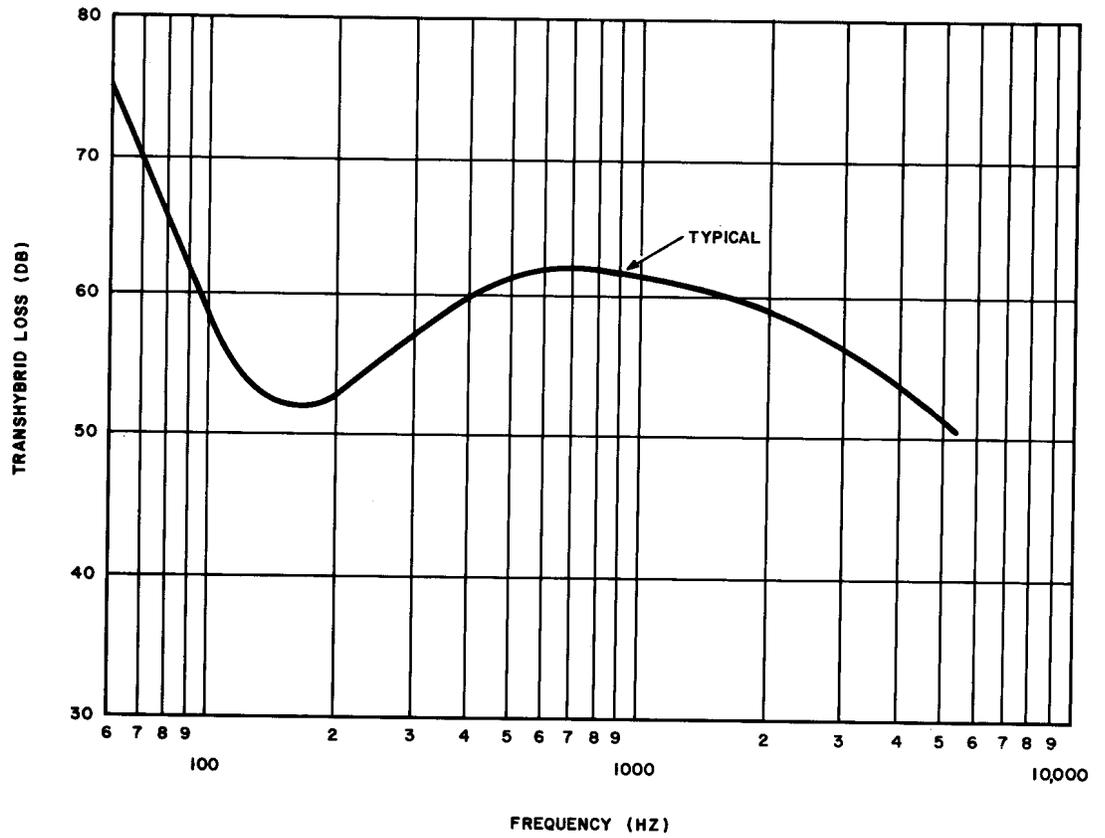


Fig. 18—FLB and FSB Units—Nominal Transhybrid Loss

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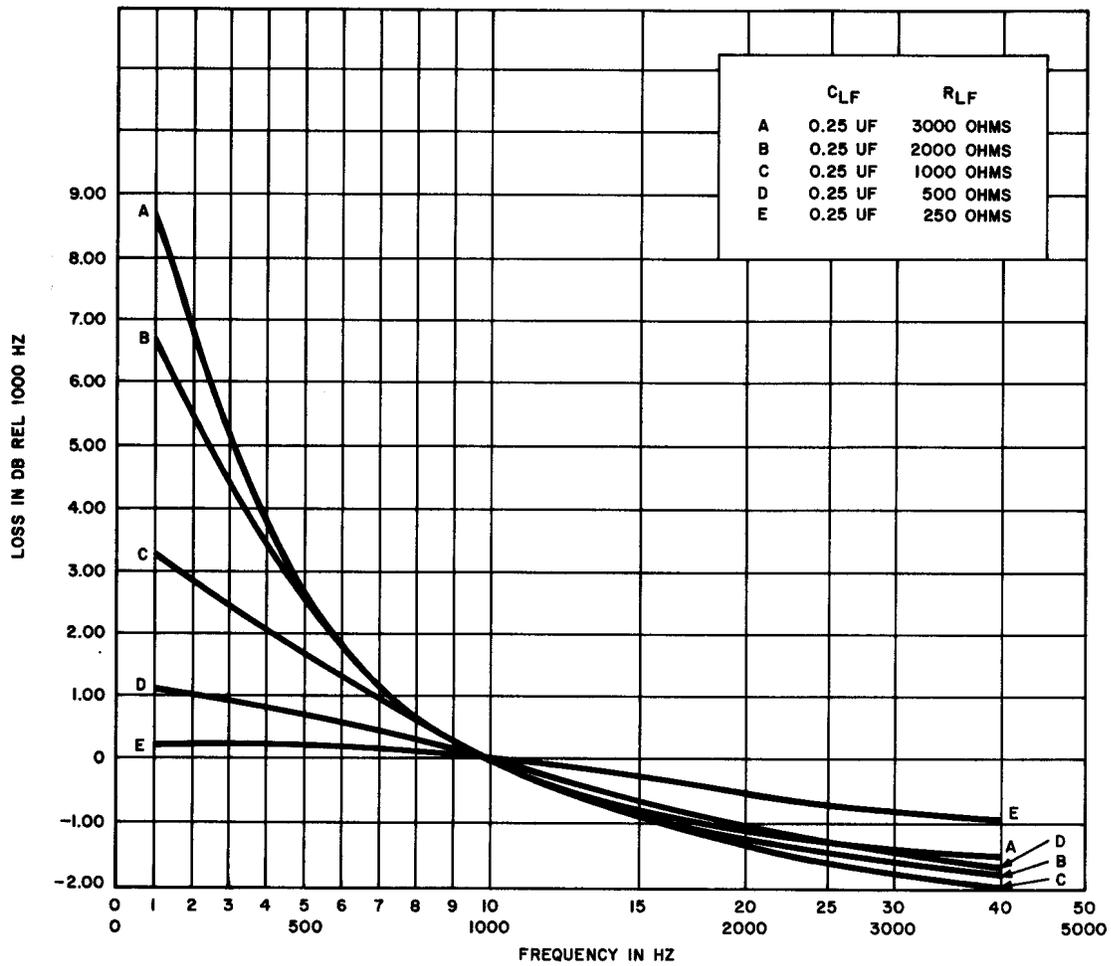


Fig. 19—FPA, FRA Units, Low-Frequency Section, Loss-Frequency Characteristics Between 1200-ohm Input and 600-ohm Output Impedance—Varying RLF For CLF Constant at 0.25 μ f

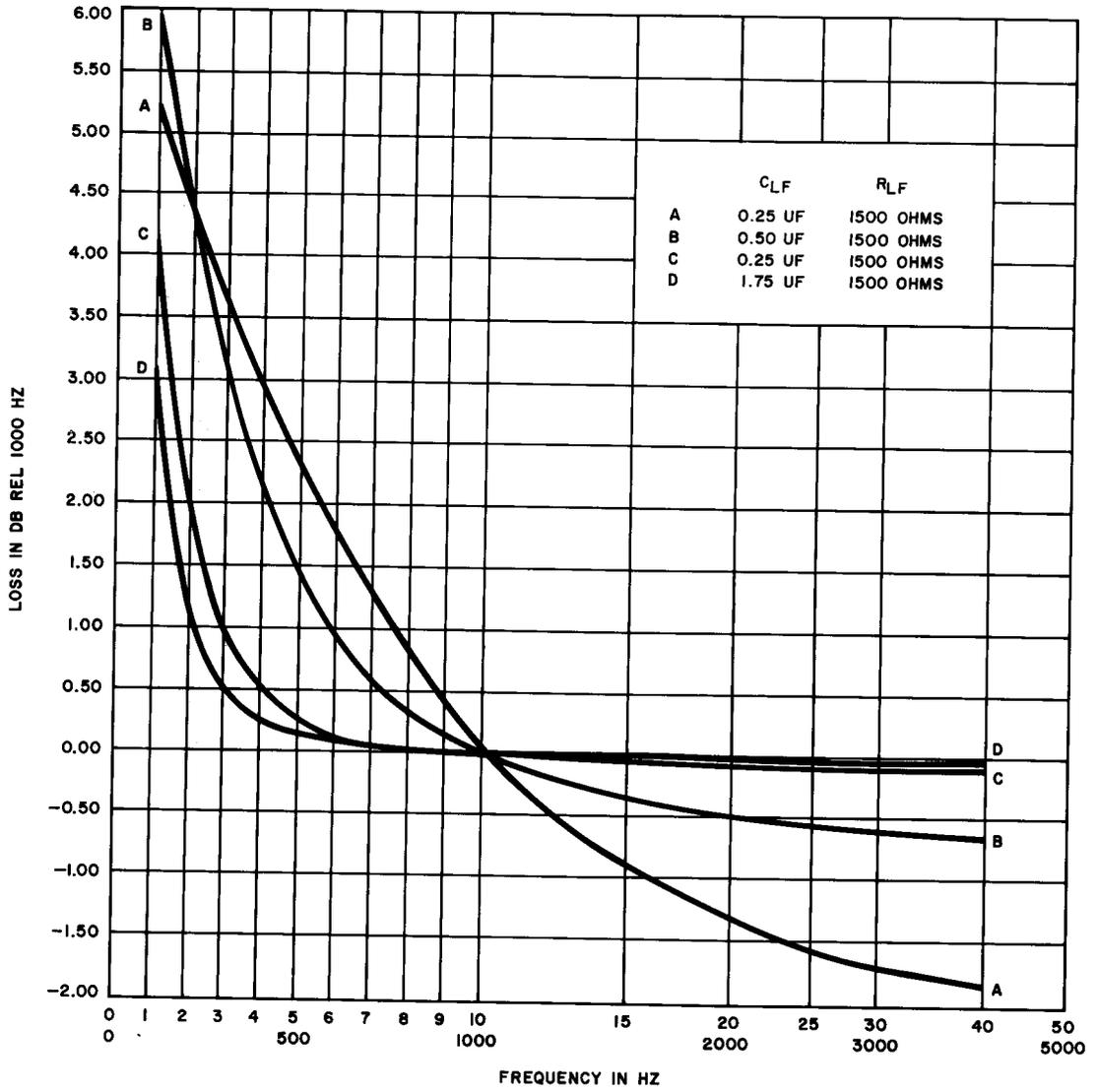


Fig. 20—FPA, FRA Unit Low-Frequency Section, Loss-Frequency Characteristics Between 1200-ohm Input and 600-ohm Output Impedances—Varying CLF For RLF Constant at 1500 Ohms

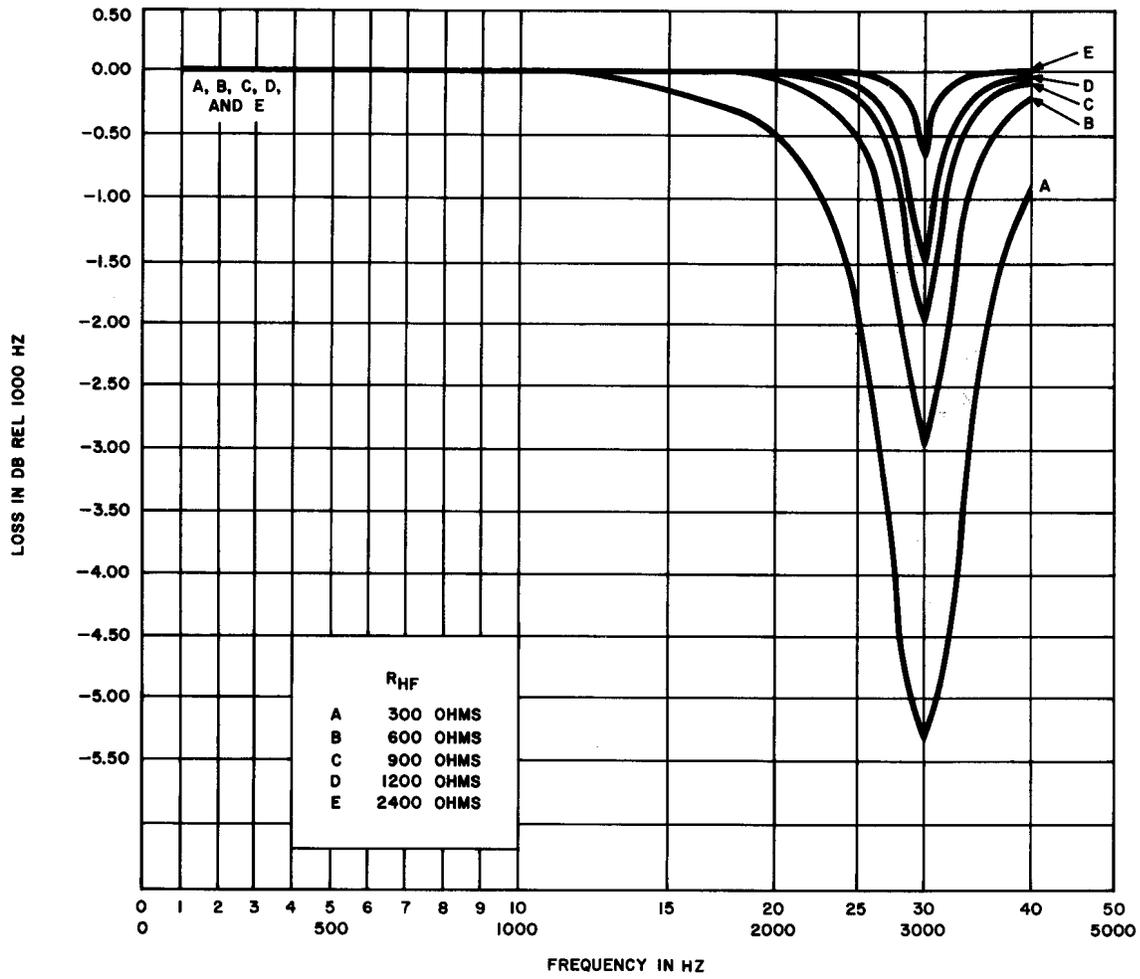


Fig. 21—FPA, FRA Unit High-Frequency Section, Loss-Frequency Characteristics Between 1200-ohm Input and 600-ohm Output Impedances—At Various Settings of RHF

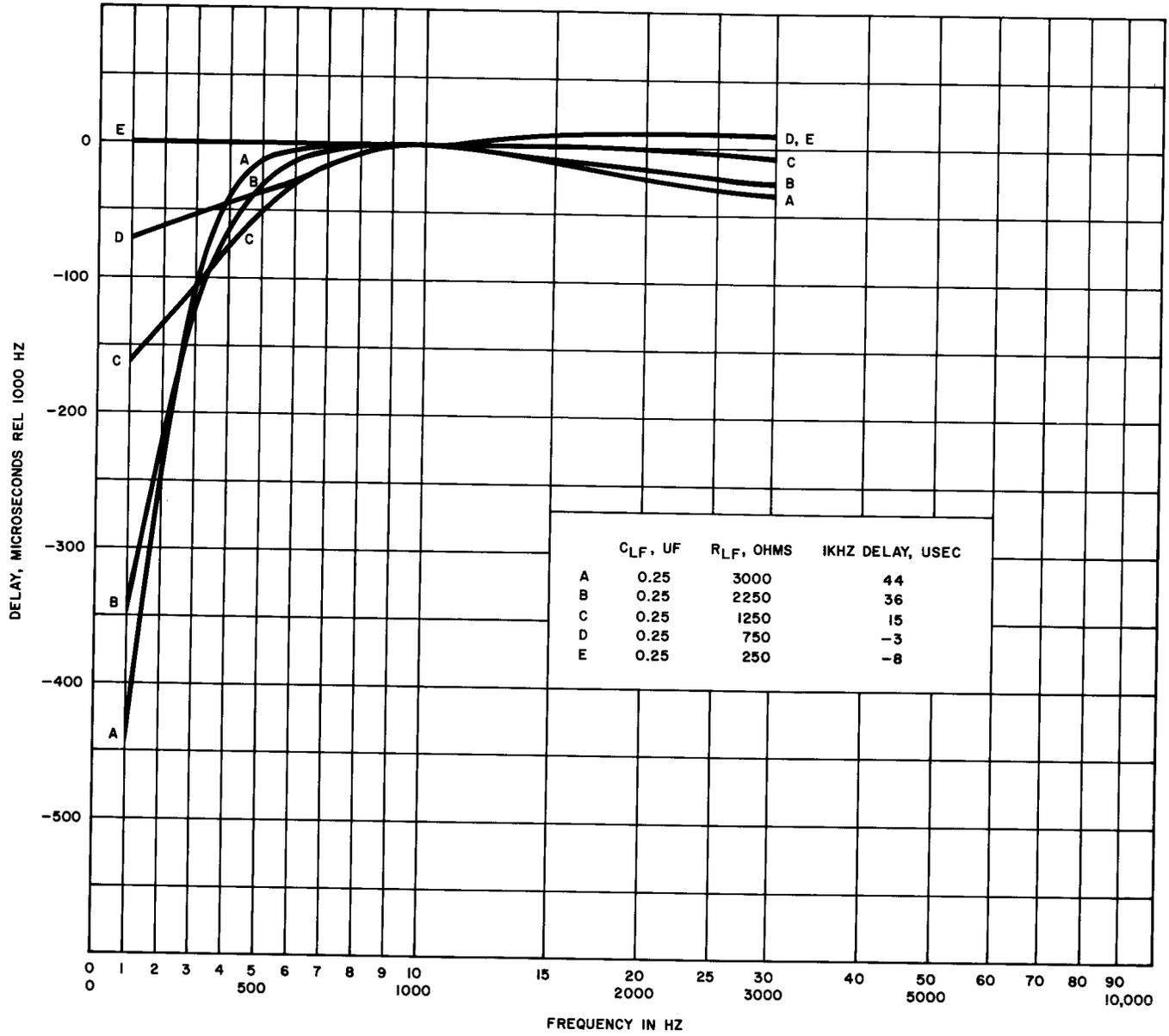


Fig. 22—FPA, FRA Unit Low-Frequency Section, Delay-Frequency Characteristics Between 1200-ohm Input and 600-ohm Output Impedances—Varying RLF For $C_{LF} = 0.25 \mu f$

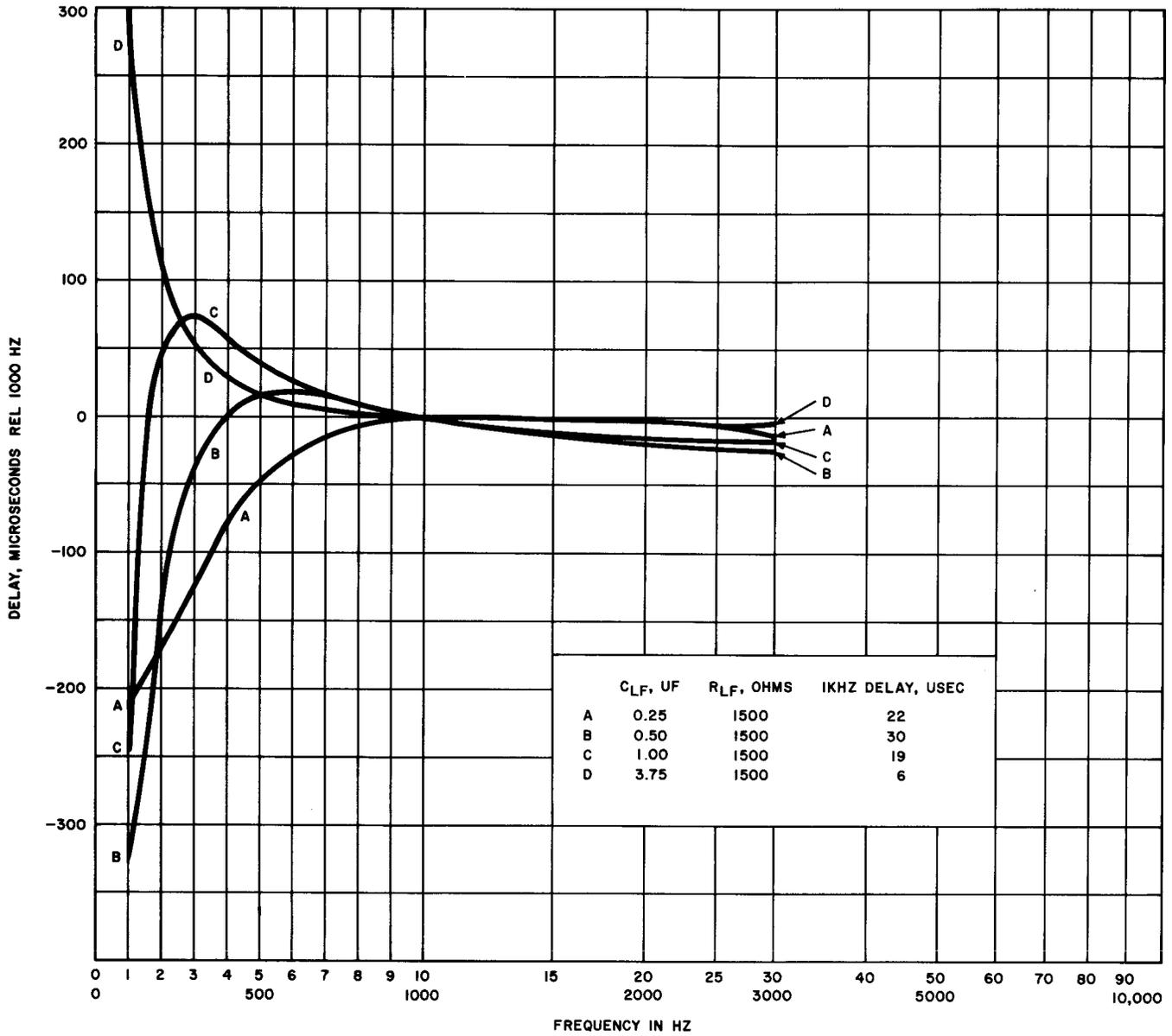


Fig. 23—FPA, FRA Unit, Low-Frequency Section, Delay-Frequency Characteristics Between 1200-ohm Input and 600-ohm Output Impedances—Varying CLF For RLF = 1500-ohms

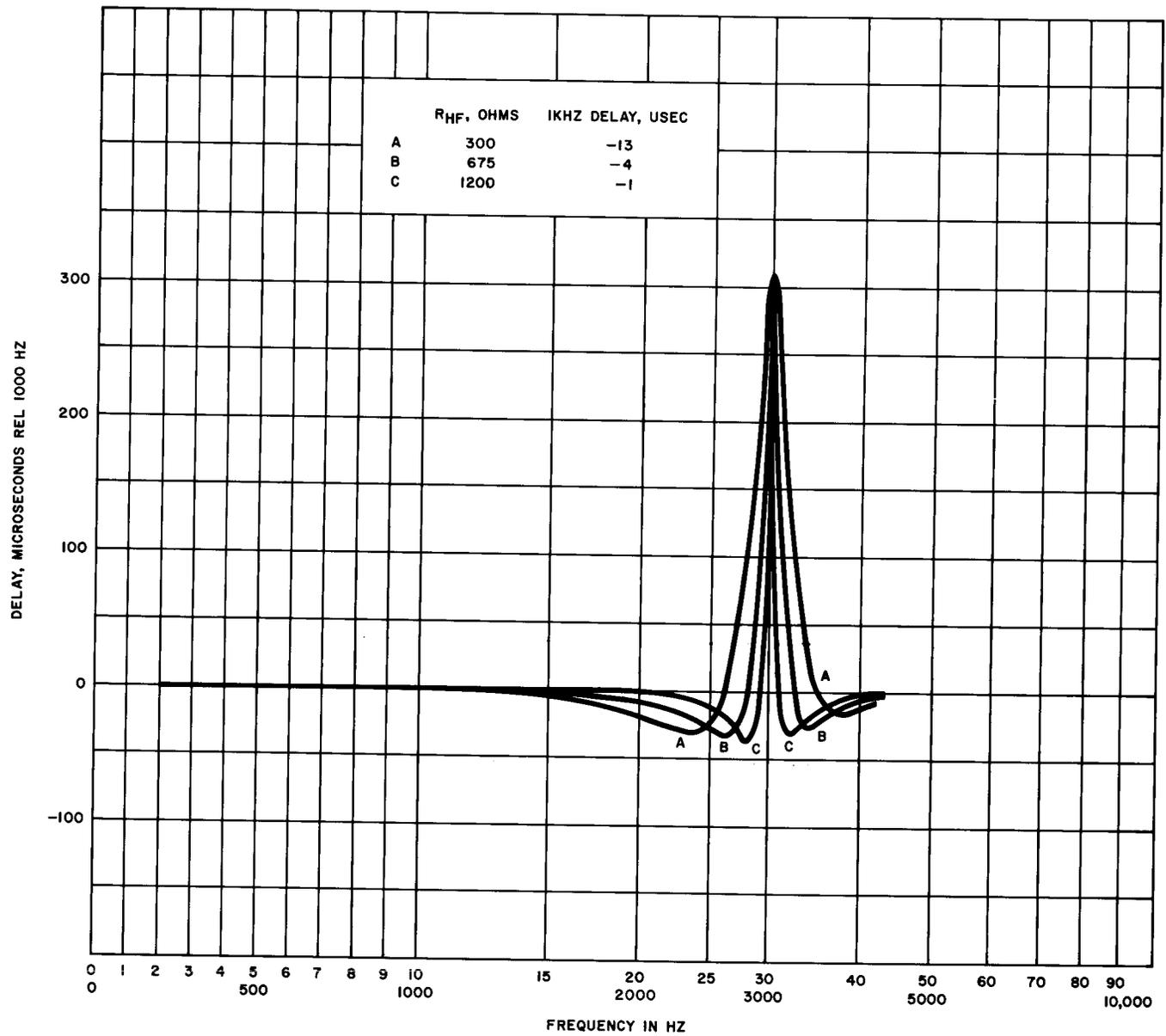


Fig. 24—FPA, FRA Unit High-Frequency Section, Delay-Frequency Characteristics Between 1200-ohm Input Impedances—At Various Settings of RHF