

E AND M AND LOOP AUXILIARY UNITS
DESCRIPTION
TYPE F SIGNALING SYSTEM

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1. GENERAL

1.01 This section describes the FA_, FB_, FCA, and FD_ single-frequency auxiliary signaling units, a component part of the type F signaling system. These units, along with the FUA unit, converts DC office signals into AC tone signals which are suitable for transmission over carrier facilities.

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

1.03 Components in the auxiliary unit are mounted on a printed wiring board. The board is held in a die cast aluminum frame approximately 10-1/2 inches by 1-1/2 inches. All interconnections between the bay and the SF unit are via a 40-pin connector which is 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 Screw switches are provided on the face of the unit to connect such features as network buildout capacitors, buildout resistance, reverse make-busy feature, and carrier group alarm control feature. The color coding label located on the face of each unit is blue lettering on a cream background for the FA_ and FB_ units and green lettering on a cream background for the FCA and FD_ units.

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

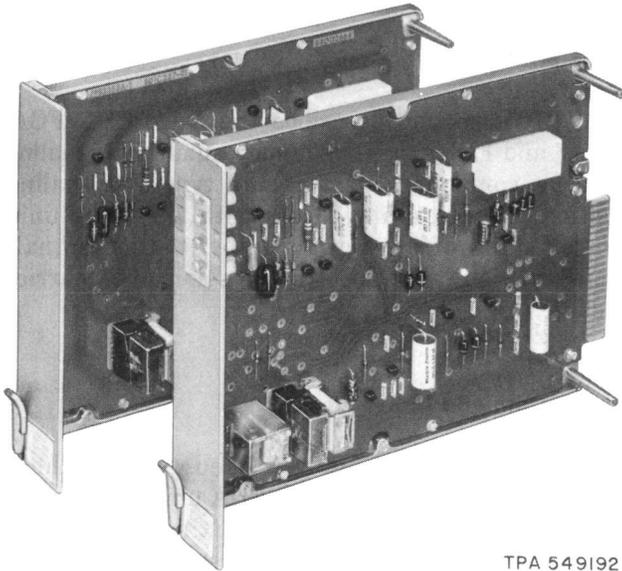


Fig. 1—FBA and FBB Units

B. Application and Compatibility

1.06 The auxiliary units provides one interface with the switching equipment and another interface with the FUA unit (Fig. 3). An auxiliary unit plus a converter unit are required at one end of a signaling link and a compatible E- or F-type unit at the other end. The FA₁ and FB₁ units provide 2-wire transmission and 4-wire transmission, respectively, with E and M lead signaling. The FCA and FD₁ units are used at originating and terminating offices, respectively, for one-way trunks using reverse battery supervision on a 2-wire loop. Table A lists each unit function, application, and the comparable type E unit. Table B lists the units that are compatible.

1.07 The FA₁ units provide a term set for use in 2-wire offices. The FAA and FAC units are designed for use in 900-ohm offices and the FAD unit is designed for use in a 600-ohm office. The FAC and FAD units are arranged to allow the 1 μ F capacitor across the A and B leads to be

removed. The FAC unit also allows the matching capacitor to be increased to 4 μ F.

2. SIGNALING UNIT OPERATION

2.01 The following references may be helpful in discussing the auxiliary units operation.

- (1) Table C—Lists conditions of E and M leads under operating conditions. The effect of a condition on the M lead at one end of the trunk can be seen on the E lead at the other end of the trunk.
- (2) Table D—Lists conditions of the closure of the loop under operating conditions.
- (3) Table E—Lists conditions of transmitting and receiving circuits related to changes in 2600-Hz tone.
- (4) Fig. 4 through 8—Simplified schematic of the auxiliary and FUA units transmitting and receiving circuits.

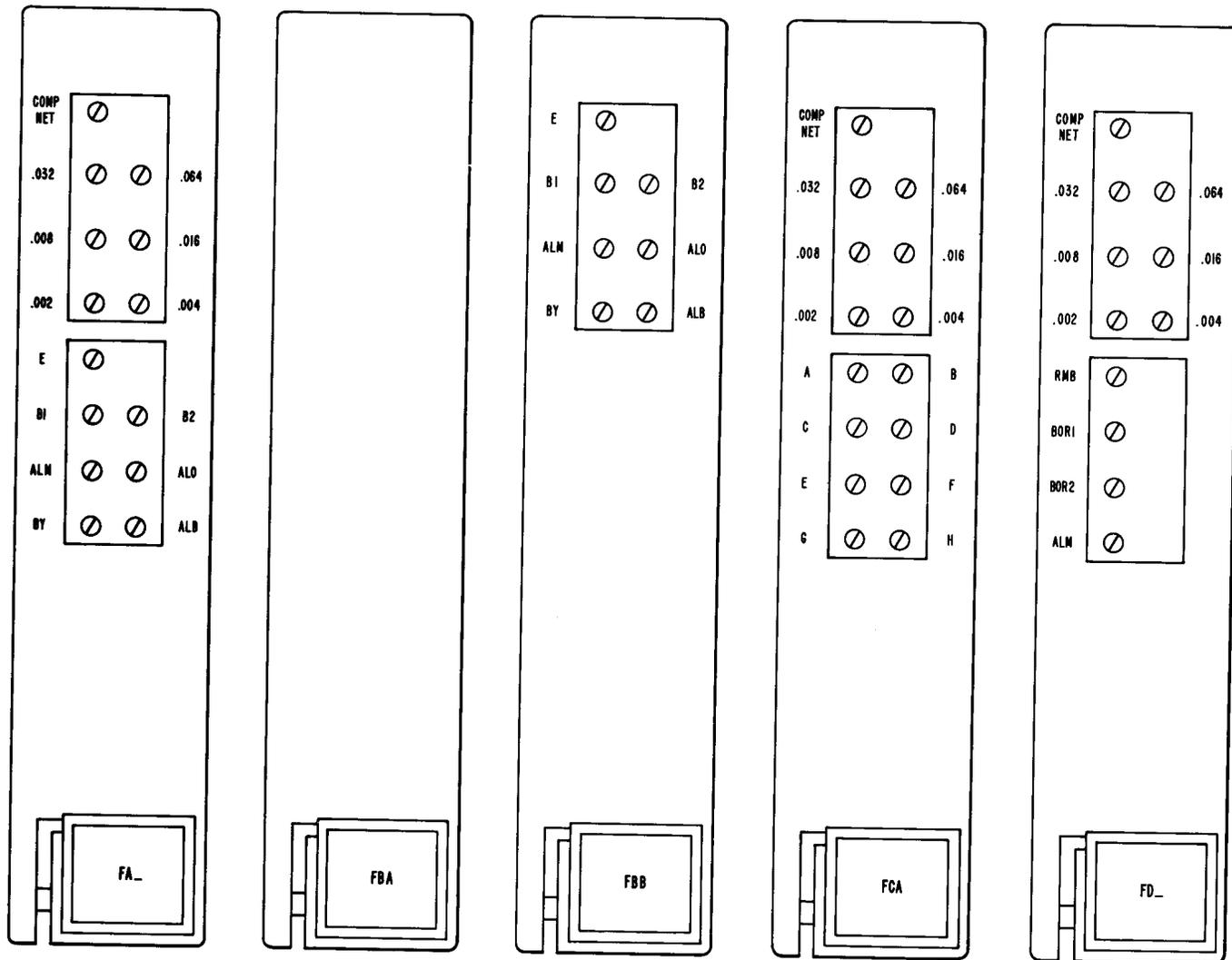
2.02 In the idle condition both ends of the trunk are on-hook and 2600-Hz tone is transmitted toward the line facility in both directions. The M or AM relay is operated and the R relay is released in the idle condition.

A. FA₁ and FB₁ Units—DP Operation

2.03 The FA₁ and FB₁ units are designed to be used at either or both ends of a signaling link. Although the FA₁ and FB₁ units are compatible with many different units (See Table B), the following discussion will assume that an FAA unit is being used at the originating end and an FBA unit is used at the terminating end.

DP Operation-Transmitting

2.04 The FAA and FBA signal transmitting circuit is divided into three parts: (1) M relay timing circuit (2) M lead interface and (3) cut control timer. When the originating end goes off-hook, battery is placed on the M lead toward the FAA unit which causes its M relay to release. Release of the M relay removes 2600-Hz tone from the FUA unit and thus from the line. The battery on the M lead also causes the CT relay, after a delay of 125 milliseconds, to release.



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Fig. 2—FA₋, FBA, FBB, FCA, and FD₋ Unit Faceplate

2.05 When pulsing starts, battery and ground pulses are applied to the M lead. The cut control timer in the FUA unit causes the CT relay to reoperate and holdover during pulsing. The line and drop facilities of the transmitting talking path are terminated with 600 ohms while the CT relay is operated. At the end of pulsing the release of the CT relay is delayed 625 milliseconds by the FAA unit to prevent noise or speech from interfering with the line.

2.06 The battery and ground pulses on the M lead are presented to the timing circuit for

control of the M relay. The timing circuit assures a "tone on" interval of approximately 50 milliseconds and a "tone off" interval of at least 26 milliseconds. Contacts of the M relay apply and remove 2600-Hz tone towards the FUA unit.

DP Operation—Receiving

2.07 The FA₋ and FB₋ receiving circuit consists mainly of the R relay timing circuit. When the originating end removes the tone from the line, the FUA unit at the terminating end detects it and removes the -24V from the E1 lead. After

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300 ms, the F relay is released which removes the band elimination filter from the voice path. Unlike E-type SF units the receive speech path is never cut. The R relay timing circuit responds to the dc indication on the E1 lead and operates the R relay after a 33-millisecond delay. Contacts of the R relay connect the E and EG leads together toward the switching equipment and causes the G relay in the FUA unit to operate putting it in the narrow-band condition. Pulsing is detected by the converter and transfers the signals to the auxiliary unit by application and removal of -24V on the E1, GA, and GC leads. When 2600-Hz tone is being received, the -24V is applied to the previously mentioned leads.

Supervision

2.08 When the terminating end answers, battery is placed on the M lead to the associated auxiliary unit. Battery on the M lead initiates the release of the M relay in the auxiliary module and the CT relay in the FUA. The CT relay waits 125 milliseconds before it releases. The M relay releasing causes 2600-Hz tone to be removed from the FUA and the line. Removal of the tone is detected at the originating end and operates the R relay at the originating end. This causes the originating units receive circuit to be placed in the narrowband condition.

Disconnect

2.09 When either end goes on-hook, battery is removed from the M lead to the associated SF unit. This causes the M relay in that unit to operate and applies tone to the converter and hence to the line. At the other end, the tone condition is detected by the FUA unit which applies -24V to the E1 lead. Battery on the E1 lead causes the R relay to be released and the connection between the E and EG leads to be broken.

B. FCA and FD_ Units—DP Operation

2.10 The FCA unit is designed to be used at the originating end of a trunk and the FDA and FDB units are designed for the terminating end. Although the FCA and FD_ units are compatible with many different units, the following discussion will assume that an FCA unit is used at the originating end and an FD_ unit is used at the terminating end.

2.11 In loop operation, a seizure signal to the originating end SF unit is a low dc resistance path applied across the tip and ring causing the SF unit to remove 2600-Hz tone from the line. This is detected by the terminating office SF unit which applies a low dc resistance path across the tip and ring, toward the switching equipment. Pulsing is applied to the originating SF unit by opening and closing the loop and is passed on to the terminating end by the application and removal of 2600 Hz tone. The terminating SF unit transfers these pulses to the switching equipment by opening and closing the low resistance dc path between the tip and ring. During seizure and pulsing, battery is applied to the ring lead and ground is applied to the tip lead by the switching equipment to the terminating SF unit. The originating SF unit applies battery and ground to the tip and ring with the same polarity that is received by the terminating SF unit. When the called party answers the polarity of the tip and ring leads is reversed causing the terminating office SF unit to remove 2600-Hz tone which is a signal to originating SF unit of an answered call condition.

DP Operation—Transmitting

2.12 The FCA transmitting circuit can be divided into three parts: (1) AM relay timing circuit, (2) loop detector, and (3) sleeve lead control. When the originating end goes off-hook, a closure on the T and R leads occurs. This is detected by the loop detector via the A and B leads in the term set which causes the AM relay to be released. Release of the AM relay removes 2600-Hz tone to the FUA unit and thus from the line. The output of the loop detector is presented to the timing circuit for control of the AM relay. This circuit assures a minimum pulse of approximately 51 msec. A blanking circuit is also included in the timing circuit to prevent the transmitter from releasing due to transients created when the loop is reversed. A sleeve lead control is also provided for offices that require it. In the busy condition, the B relay is operated and applies ground to the sleeve lead. The auxiliary unit also sends commands to the FUA unit to control the transmission path cut(CT) relay. During the idle state or dial pulsing this relay is operated and the transmitting transmission path is cut and each side is terminated in 600 ohms. When there is a delay in pulsing of at least 625 milliseconds (interdigital timing or end of dialing) the CT relay may release.

DP Operation—Receiving

2.13 The FDA and FDB are similar, but the FDA has a relatively simple receive signal timer which provides a minimum break interval of 46 milliseconds. The FDB has a pulse corrector which generates an output with constant percent break independent of the input percent break. The FDB unit is intended to be used in step-by-step offices but may be substituted for the FDA unit. In the following discussion the FDA unit will be used to describe the operation.

2.14 When the originating end removes the tone from the line, the FUA unit at the receiving end detects it and removes the dc signals from the auxiliary unit and operates the R relay. Contacts of the R relay cause the FUA unit to switch to the narrowband condition. Pulsing is detected by the converter and transfers the signal to the auxiliary unit by application and removal of dc signals on the E1 and GA leads for tone-on and tone-off conditions respectively.

Supervision

2.15 The transmitter in the FD₋ unit can be divided into three main parts: (1) reverse battery detector, (2) M relay timing circuit, and (3) cut control timer. When the terminating end goes off-hook, reversal of polarity occurs on the T and R leads and is detected by the reverse battery detector in the FD₋ unit. This detection causes the release of the M relay in the FD₋ and the CT relay in the associated FUA unit. The CT relay releases after a 125-millisecond delay. The release of the M relay removes the 2600-Hz tone.

2.16 The receiver in the FCA unit consists mainly of the R relay timing circuit. Removal of 2600-Hz tone is detected by the FUA unit at the originating end. The FUA unit then applies a DC signal to E1 lead as a command to the FCA unit to operate the R relay. The FUA unit at the originating end switches to the narrowband condition at this time.

Disconnect

2.17 When the originating end goes on-hook, the T and R leads will be opened. This will be recognized by the loop detector in the transmit portion of the auxiliary unit. This disconnect command initiates the operation of the AM relay

in the FCA unit. The operation of this relay applies tone to the FUA unit and thus to the line. At the terminating end, the "tone on" condition is detected by the FUA unit at that end and the disconnect signal is repeated into the switching equipment. A disconnect from the terminating end is handled much in the same manner except that the loop battery polarity is the controlling signal.

C. FA₋, FB₋, FCA, and FD₋ Units—MF Operation

2.18 These units operate exactly the same way on MF trunks as they do on DP trunks except MF tones take the place of dial pulses and are passed through the transmission path.

3. CARRIER GROUP ALARM

3.01 Each of these auxiliary units, except the FBA unit, is provided with a CGA control features which can be placed in effect by screw switches on the face of the unit. When a carrier failure occurs, the FYG control unit applies ground to the ALO and/or ALM leads of the auxiliary units. A trunk may be placed in one of three conditions: (1) circuit release and make busy (2) circuit release with delayed make busy or (3) circuit released. Table F lists the circuit release and make busy screw switches to tighten down to obtain the correct condition for each circuit. The ALO lead is used to obtain the alarm override feature when the circuit is to be patched to another facility via the VF or carrier patch bay. The delayed make-busy signal is presented as battery on the ALB lead. The W₋ leads are used with FCA units to release the SXS switch train.

A. FA₋, FB₋ Units**Circuit Release—Delay Make Busy**

3.02 Ground on the ALM or ALO lead causes the release of the R relay. In releasing, the R relay removes the ground on the E lead releasing the switching equipment. After approximately 10 seconds, the FYG control circuit applies -48V to the ALB lead operating the CGA relay in the auxiliary unit. Through make contacts of CGA relay, ground is reapplied to the E lead making the circuit appear busy to the switching system.

Circuit Release—Make Busy

3.03 Ground on the ALM or ALO lead causes the release of the R relay and the operation of the CGA relay. Through make contacts of the CGA relay, ground is applied to the S1 or MS lead (if the B1 screw switch is down) or closes the loop between the B1 and B2 leads (if the B2 screw switches is down). This makes the trunk circuit busy to outgoing traffic.

Circuit Release

3.04 Ground on the ALM or ALO lead causes the release of the R relay. In releasing, the R relay removes ground from the E lead releasing the central office equipment.

B. FCA Unit

Circuit Release—Delayed Make Busy

3.05 A carrier failure produces a ground on the ALM and W₋ lead. Ground on the ALM lead releases the R relay restoring normal battery to the loop which releases the switching equipment. For step-by-step offices with a trunk circuit, the ground on the ALM lead also initiates the operation of the B relay. This breaks the path of the sleeve lead control. The sleeve lead is then under control of the W₋ lead which applies ground on the sleeve toward the switching equipment. After approximately 10 seconds ground is removed momentarily from the W₋ lead to release the SXS train. Ground is then reapplied to the W₋ lead and thus to the sleeve lead making the trunk busy. For SXS offices without trunk circuits the operation is similar except the sleeve lead is controlled by the B relay which is controlled in turn by the W₋ lead.

Circuit Busy

3.06 Ground on the ALM lead initiates the release of the R relay which restores normal battery to the loop releasing the trunk circuit. The B relay operates when ground is on the ALM lead. For No. 1 Crossbar or Crossbar Tandem offices the operated B relay applies ground to the sleeve lead. For No. 5 Crossbar, the operated B relay supplies a closure of the B1 and B2 leads. These conditions make the trunk circuit busy to outgoing traffic. For No. 1 and No. 2 ESS offices the B relay is never used, the trunk make-busy function is performed by the control processor.

C. FD₋ Unit

Circuit Release

3.07 Ground on the ALM lead causes the release of the R relay. This opens the 2-wire loop and releases the trunk circuit or switching equipment.

4. TRANSMISSION CIRCUITS

4.01 The FB₋ unit has a 4-wire transmission path. Zero loss transmission is provided from the FUA interface to the drop side of the circuit (Fig. 9).

4.02 The FA₋ unit provides conversion from 2-wire (900 ohms for FAA and FAC, 600 ohm for FAB and FAD) operation to the 4-wire (600 ohms) interface with the FUA (Fig. 9). This conversion is provided by a 2-transformer hybrid in the FA₋ unit. Provision is made for network buildout capacitance (NBOC) adjustment from 0.0 to 0.127 μF (C_2) in 0.002 μF step. This permits balancing against office cabling.

4.03 The FCA and FC₋ units provide conversion from 2-wire (900 ohms) operation to the 4-wire (600 ohms) interface with the FUA (Fig. 9). The conversion is provided by a 2-transformer hybrid in the FD₋ unit. Provision is made for NBOC adjustments from 0.0 to 0.127 μF in 0.002 μF steps. This permits balancing against office cabling. Inductors are provided in series with the A and B leads to isolate the dc loop signaling from the talking path. Buildout resistors in the FD₋ unit are provided in the A and B leads to compensate for short conductor loop resistance variation. This increases the pulsing capability for the unit and improves the operation of the reverse battery detector when the unit is used with short loops. The BOR resistors must be inserted by opening screw switches BOR1 and BOR2 if the external conductor loop resistance is less than 500 ohms.

5. PULSING CHARACTERISTICS

A. Transmitting

5.01 The FA₋ and FB₋ units are limited to transmitting dial pulses in the range of 7.5 to 12.5 pps. The percent break on the M lead can vary as follows:

PPS	% BREAK
7.5	15-90
10.0	20-90
12.5	25-90

Note: For M lead inputs of less than 50 msec, the output tone pulse to the FUA will be 49.5 ± 3.5 msec. For inputs with a make interval greater than 2 msec but less than 30 msec, the output no-tone interval will be 26 ± 4 msec.

5.02 The FCA unit is limited to transmitting dial pulses in the range of 7.5 to 12.5 pps. A minimum dial pulse of 18 msec is required to operate the transmitter. The dial pulses can vary as follows:

PPS	% BREAK
7.5	13.5-86
10.0	18.0-81
12.5	22.5-77

Note: Dial pulses between 18 and 52 msec will give a tone output of 51 ± 4 msec. Dial pulses greater than 52 msec will give a tone output within ± 2 ms of the input pulse.

5.03 The FD₋ unit is limited to transmitting only winks and supervisory signals. A reversal in polarity of the tip and ring leads from the connecting office equipment initiates transmitting circuit action. A blanking circuit in the FD₋ unit blanks the transmitting circuit for 37 milliseconds upon receipt of the reversed condition.

B. Receiving

5.04 The FA₋ and FB₋ units are limited to receiving dial pulse in the range of 7.5 to 12.5 pps. (See Fig. 10.) A minimum of 35 msec is required to operate the receiver. The receiver pulses can vary as follows:

PPS	% BREAK
7.5	26-90
10.0	35-85
12.5	42-80

Note: Received pulses less than 50 msec will give an output on the E lead of 50 ± 3 msec. Pulses greater than 60 msec will give an output within ± 2 msec of the input pulse. Pulses between 50 and 60 msec will give an output between 50 ± 3 and 60 ± 2 msec.

5.05 The FDA unit is limited to receiving dial 2600-Hz pulses in the range of 7.5 to 12.5 pps. (See Fig. 10.) A minimum pulse of 35 msec is required to operate the receiver. The received pulses can vary as follows:

PPS	% BREAK
7.5	28-90
10.0	38-85
12.5	47-80

Note: Received tone pulses less than 50 msec will give an output of 49 ± 3 msec. Pulses greater than 60 msec will give an output within ± 2 msec of the input pulse. Pulses between 50 and 60 msec will give an output between 46 and 62 msec.

5.06 FDB unit is limited to receiving dial pulses in the range of 7.5 to 12.5 pps. A minimum pulse of 35 msec is required to operate the receiver, and a minimum interval between dial pulse of 15 msec is required for the pulse connector to recycle completely. The output of the receiver is 56 ± 5 percent break independent of the input percent break.

5.07 The FCA unit is limited to receiving wink or supervisory signals. The removal of 2600-Hz tone at the terminating end is recognized by the FCA unit which responds to the "tone off" condition and reverses the polarity of the tip and ring leads towards the connecting equipment. A blanking circuit in the FD₋ unit at the terminating end blanks the removal of 2600-Hz tone for 37 milliseconds.

6. TRANSMISSION CHARACTERISTICS

6.01 The stability of the transmit and receive circuits is dependent upon certain environmental conditions, such as impedance, temperature, aging, and operating voltage. The discussion that follows assumes that the temperature is approximately 70°F, and the dc power converter is within $\pm 5\%$

of -24V. The auxiliary units will however remain stable unless there are severe changes in environmental conditions.

A. Transmitting

6.02 The envelope delay distortion present in the transmit and receive circuits can be seen in Fig. 11 and 12. For the FB_ units, the transmit curve from 1000 Hz and up shows that there is practically no delay. Between 300 and 1000 Hz, the delay does not exceed 17 microseconds. On the receive curve the delay is below 10 microseconds on frequencies above 1000 Hz. The rise in delay is quite rapid at frequencies below 1000 Hz, and at 300 Hz exceeds 100 microseconds. For the FA_, FCA, and FD_ 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 delay is quite rapid below 2000 Hz as shown by the transmit and receive curves. The difference in the curves is due to the terminating sets in the FA_, FCA, and FD_ units.

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. 13, 14, and 15. The curves show much more loss in the FA_, FCA, and FD_ units plus the FUA unit than in the FB_ unit plus the FUA unit. This larger amount of loss is due to the terminating sets in the auxiliary units.

B. Receiving

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 levels in the voice frequency range with and without the band elimination filter in the circuit is shown in Fig. 16 through 21. The terminating sets in the FA_, FCA, and FD_ units can again be seen to add more loss to the circuit. A sharp dip between 2200 and 2800 Hz in Fig. 16 through 18 is caused by the band-elimination filter.

6.05 The 2-wire return loss and the transhybrid loss curves are given in Fig. 22 through 25. The difference in transhybrid loss between the FA_ and FB_ units and the FCA and FD_ units is due to the absence of inductors in the FA_ and FB_ units.

7. MAINTENANCE

7.01 There are no field adjustments provided on the FA_, FB_, FCA, and FD_ units. SF 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 designed to provide access to the transmission and signaling ports. Use of the test extender necessitates 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, except between the echo suppressor or equalizer and P pads.

7.03 Descriptive or test practices on other related components within the type F 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 APPLICATIONS

CODE	FUNCTIONAL DESCRIPTION	GENERAL APPLICATION	SPECIFIC USE	SIMILAR E-TYPE SF UNIT
FAA	900 ohm 2W E&M Lead	2-way trunks*	2-wire switching	E1A or E - B + Term. Set
FAB	600 ohm 2W E&M Lead	2-way trunks* broadband carrier	2-wire switching	E1A or E - B + Term. Set
FAC	900 ohm 2W E&M Lead	2-way trunks	2-wire switching	E1A or E - B + Term. Set
FAD	600 ohm 2W E&M Lead	2-way trunks broadband	2-wire switching	E1A or E - B + Term. Set
FBA	4W E&M Lead	2-way trunks*,	4-wire switching DP or MF	E - B + "P" pads
FBB	4W E&M Lead	2-way trunks*, N carrier	4-wire switching DP or MF	E - B + "P" pads
FCA	Loop reverse battery, originating	1-way outgoing trunks†	DP or MF 2W-900 ohm	E3C, E4C, E5C
FDA	Loop reverse battery, terminating	1-way incoming trunks†	DP or MF 2W-900 ohm non SXS	E3D, E4D, E5D
FDB	Loop reverse battery, terminating	1-way incoming trunks†	Primarily DP 2W-900 ohm into SXS	E4D, E5D

* Intertoll, Toll Connecting or Exchange Trunks.

† May also be used in other applications in association with external equipment.

TABLE B
COMPATIBILITY OF AUXILIARY UNITS WITH TYPE E- OR F- SF UNITS

		TERMINATING END														
		FAA, FAC, FAD		FBA, FBB		FDA, FDB		FWA	FWB	E1AK, E1AKD, E1BK, E1BKD	E2B, E3BK, E3BKA, E4B	E2D	E3D	E4D	E5D	
		DP	MF	DP	MF	DP	MF									
ORIGINATING END	FAA, FAC, FAD	DP	✓		✓		4		✓	No	✓	✓	4	No	2,4	4
		MF		✓		✓		4	✓	✓	✓	✓	4	✓	2,4	4
	FBA, FBB	DP	✓		✓		4		✓	No	✓	✓	4	No	2,4	4
		MF		✓		✓		4	✓	✓	✓	✓	4	✓	2,4	4
	FCA	DP	✓		✓		4		✓	No	✓	✓	4	No	2,4	4
		MF		✓		✓		4	✓	✓	✓	✓	4	✓	2,4	4
	FWA		✓	✓	✓	✓	4	4								
	FWB		✓	✓	✓	✓	4	4								
	E1AK, E1AKD, E1BK, E1BKD		1	✓	1	✓	1,4	4								
	E2B, E3B, E3BKA, E4B		3	3	3	3	3,4	4								
	E2C		✓	No	✓	No	✓	No								
	E3C		No	✓	No	✓	No	4								
E4C		✓	✓	✓	✓	4	4									

Notes:

1. Transmission cut circuit SD-99778-01 required in all DP applications.
2. Release current of associated A relay or its equivalent must be greater than 3.7 ma.
3. M lead pulse corrector SD-99766-01 required in all non-senderized SXS applications.
4. Compatible only in association with long disconnect trunk circuits.

TABLE C
SF SIGNALS USED IN E AND M LEAD SIGNALING

FA- OR FB- UNIT (ORIGINATING END)				FA- OR FB- UNIT (TERMINATING END)			
SIGNAL OR STATE	M LEAD	E LEAD	SF TONE OUT	SF TONE OUT	E LEAD	M LEAD	SIGNAL OR STATE
Idle	Ground	Open	On	On	Open	Ground	Idle
Connect ¹	Batt	Open	Off	On	Ground	Ground	Connect
Stop Dialing	Batt	Ground	Off	Off	Ground	Batt	Stop Dialing ¹
Start Dialing	Batt	Open	Off	On	Ground	Ground	Start Dialing ¹
Dial Pulsing ¹	Ground	Open	On	On	Open	Ground	Dial Pulsing
	Batt		Off		Ground		
Answer (Off-Hook)	Batt	Ground	Off	Off	Ground	Batt	Answer (Off-Hook)
Ring Forward ¹	Ground	Ground	On	Off	Open	Batt	Ring Forward
	Batt		Off		Ground		
Ringback	Batt	Open	Off	On	Ground	Ground	Ringback ¹
		Ground		Off		Batt	
Flashing	Batt	Open	Off	On	Ground	Ground	Flashing ¹
		Ground		Off		Batt	
Disconnect (On-Hook)	Batt	Open	Off	On	Ground	Ground	Disconnect ¹ (On-Hook)
Disconnect ¹	Ground	Open	On	On	Open	Ground	Disconnect

Note 1: Terminal originating signal.

TABLE D
SF SIGNALS USED IN REVERSE BATTERY T AND R LOOP SIGNALING

FCA UNIT (ORIGINATING END)				FD- UNIT (TERMINATING END)			
SIGNAL OR STATE	OFFICE T AND R TO SF UNIT	SF UNIT TO OFFICE T AND R	2600 SF TONE OUT	2600 SF TONE OUT	SF UNIT TO OFFICE T AND R	OFFICE T AND R TO SF UNIT	SIGNAL OR STATE
Idle	Open	Normal Batt	On	On	Open	Normal Batt	Idle
Connect ¹	Closure	Normal Batt	Off	On	Closure	Normal Batt	Connect
Stop Dialing	Closure	Rev Batt	Off	Off	Closure	Rev Batt	Stop Dialing ²
Start Dialing	Closure	Normal Batt	Off	On	Closure	Normal Batt	Start Dialing ²
Dial Pulsing ¹	Open	Normal Batt	On	On	Open	Normal Batt	Dial Pulsing
	Closure		Off		Closure		
Answer (Off-Hook)	Closure	Rev Batt	Off	Off	Closure	Rev Batt	Answer ² (Off-Hook)
Ring Forward ¹	Open	Rev Batt	On	Off	Open	Rev Batt	Ring Forward
	Closure		Off		Closure		
Ringback	Closure	Normal Batt	Off	On	Closure	Normal Batt	Ringback ²
		Rev Batt	Off	Off	Rev Batt		
Flashing	Closure	Normal Batt	Off	On	Closure	Normal Batt	Flashing ²
		Rev Batt	Off	Off		Rev Batt	
Disconnect (On-Hook)	Closure	Normal Batt	Off	On	Closure	Normal Batt	Disconnect ² (On-Hook)
Disconnect ¹	Open	Normal Batt	On	On	Open	Normal Batt	Disconnect

Note 1: Originating office generates signal.

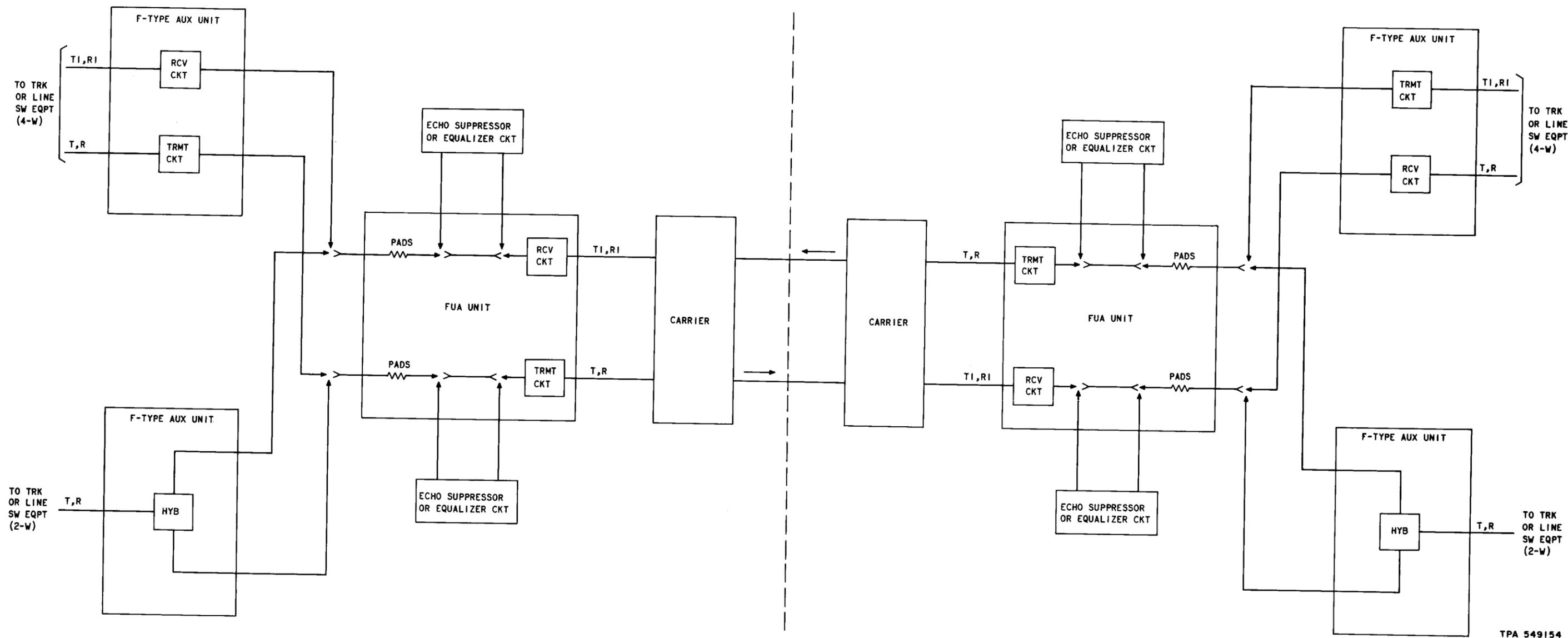
Note 2: Terminating office generates signal.

TABLE E
TYPES FA-, FB-, FCA AND FD- AUXILIARY UNITS
CONDITION OF TRANSMITTING AND RECEIVING SPEECH PATHS RELATED TO CIRCUIT AND SIGNAL TONE CONDITIONS
(REFERENCES ARE TO SF UNIT AT NEAR END)

CIRCUIT CONDITION	SIGNAL TONE CONDITION		CONDITION OF TRANSMITTING SPEECH PATH			RECEIVING SPEECH PATH BANDSTOP FILTER
	OUTGOING	INCOMING	BEFORE	CHANGE	AFTER	
1. Idle	On	On	Cut	—	Cut	In circuit
2. Near End Seized	On-Off Transition	On	Cut	Stays cut additional 125±50 MS	Not Cut	In circuit
3. Far End Returns "Delay" Signal	Off	On-Off Transition	Not Cut	—	Not Cut	Switched out after 50±5 MS
4. Far End Returns "Start" Signal	Off	Off-On Transition	Not Cut	—	Not Cut	Switched in after 13±8 MS
5. Near End Dial Pulsing	Off-On Transition, Then On-Off, Off-On, Etc., Ending with On-Off Transition	On	Not Cut	Precut 8±7 MS, remains cut as long as outgoing on-off transitions are less than 75 MS apart. Remains cut 125±50 MS after last outgoing on-off transition	Not Cut	In circuit
6a. Far End Answers—Free Call	Off	On	Not Cut	—	Not Cut	In circuit
6b. Far End Answers—Pay Call	Off	On-Off Transition	Not Cut	—	Not Cut	Switched out after 50±5 MS
7. Talking—Pay Call	Off	Off	Not Cut	—	Not Cut	Out of circuit
8. Near End Hangs Up First	Off-On Transition	Off	Not Cut	Precut 8±7 MS, then cut 625±150 MS	Not Cut	Out of circuit
9. Far End Hangs Up Later	On	Off-On Transition	Not Cut	Cut within 9±4 MS	Cut	Switched in after 13±8 MS
10. Far End Seized	On	On-Off Transition	Cut	Stays cut additional 625±150 MS	Not Cut	Switched out after 50±5 MS
11. Near End Returns "Delay" Signal	On-Off Transition	Off	Not Cut	Cut 125±50 MS	Not Cut	Out of circuit
12. Near End Returns "Start" Signal	Off-On Transition	Off	Not Cut	Precut 8±7 MS, then cut 625±150 MS	Not Cut	Out of circuit
13. Far End Dial Pulsing	On	Off-On Transition, Then On-Off, Off-On, Etc., Ending with On-Off Transition	Not Cut	Cut within 9±4 MS, remains cut as long as incoming on-off transitions are less than 475 MS apart. Remains cut 625±150 MS after last incoming on-off transition	Not Cut	Switched in after 13±8 MS. Remains in circuit until 50±5 MS after last incoming on-off transition
14a. Near End Answers—Free Call	On	Off	Not Cut	—	Not Cut	Out of circuit
14b. Near End Answers—Pay Call	On-Off Transition	Off	Not Cut	Cut 125±50 MS	Not Cut	Out of circuit
15. Talking—Pay Call	Off	Off	Not Cut	—	Not Cut	Out of circuit
16. Far End Hangs Up First	Off	Off-On Transition	Not Cut	—	Not Cut	Switched in after 13±8 MS
17. Near End Hangs Up Later	Off-On Transition	On	Not cut	Precut 8±7 MS, then cut	Cut	In circuit
18. Idle	On	On	Cut	—	Cut	In circuit

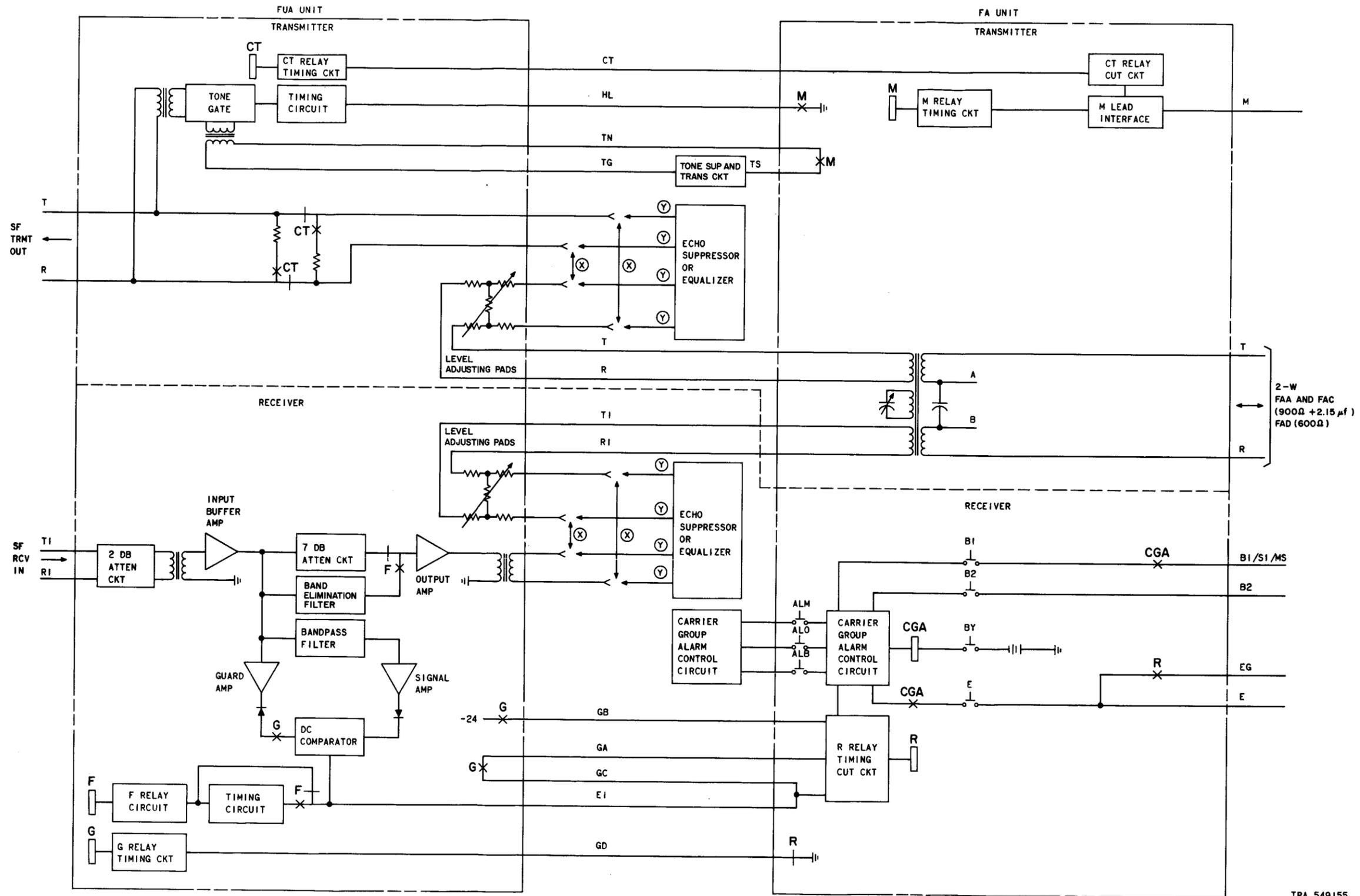
TABLE F
GGA TRUNK-RELEASE AND DELAY MAKE-BUSY ARRANGEMENTS

AUX UNIT	TYPE OF APPLICATION	FEATURE	SCREW SWITCHES TO TIGHTEN DOWN		LEADS USED
			WITHOUT FYG CONTROL	WITH FYG CONTROL	
FAA, FAB, FBB	2-Way or 1-Way Outgoing- With Circuit Patchbay (Excluding ESS Offices)	Circuit Release — Delayed Make Busy	—	ALM or ALO, E, ALB	ALM or ALO, ALB
	1-Way Incoming	Circuit Release	—	ALM or ALO	ALM or ALO
	No. 1 or No. 2 ESS Offices	Circuit Release	—	ALM or ALO	ALM or ALO
	No. 1 Crossbar or Cross- bar Tandem — 2-Way or 1-Way Outgoing — With- out Circuit Patchbay	Circuit Release Make Busy	—	ALM or ALO, B1, BY	ALM or ALO, S1
	No. 4 Crossbar — 2-Way or 1-Way Outgoing — With- out Circuit Patchbay	Circuit Release Make Busy	—	ALM or ALO, B1, BY	ALM or ALO, MS
	No. 5 Crossbar — 2-Way or 1-Way Outgoing — Without Circuit Patchbay	Circuit Release Make Busy	—	ALM or ALO, B2, BY	ALM or ALO, B1, B2
FCA	Step-by-Step — With Trunk Circuits	Circuit Release — Delayed Make Busy	F, G	B, E, F, G, H	ALM, W(), S, S2
	Step-by-Step Selector Mul- tiple — Without Trunk Circuit	Circuit Release — Delayed Make Busy	C	A, C, H	ALM, W(), S
	No. 1 Crossbar, or Cross- bar Tandem	Circuit Release Make Busy	G	C, E, G, H	ALM, S or S1
	No. 5 Crossbar	Circuit Release Make Busy	G	D, E, G, H	ALM, B1, B2
	No. 1 or No. 2 ESS	Circuit Release	—	H	ALM
FDA, FDB	All Switching Offices	Circuit Release	—	ALM	



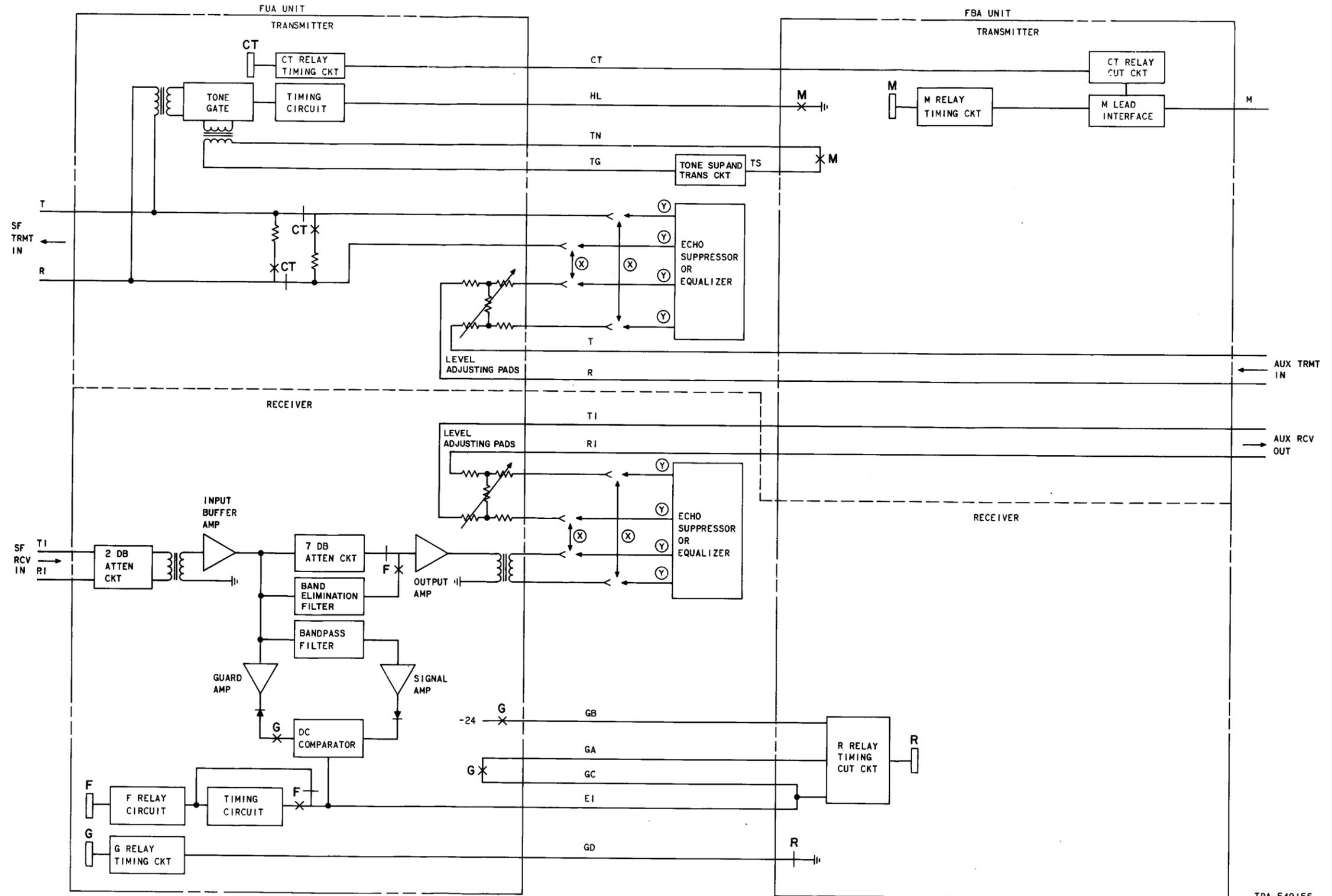
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Fig. 3—Simplified Application Schematic of the FUA Unit Plus the Auxiliary Unit



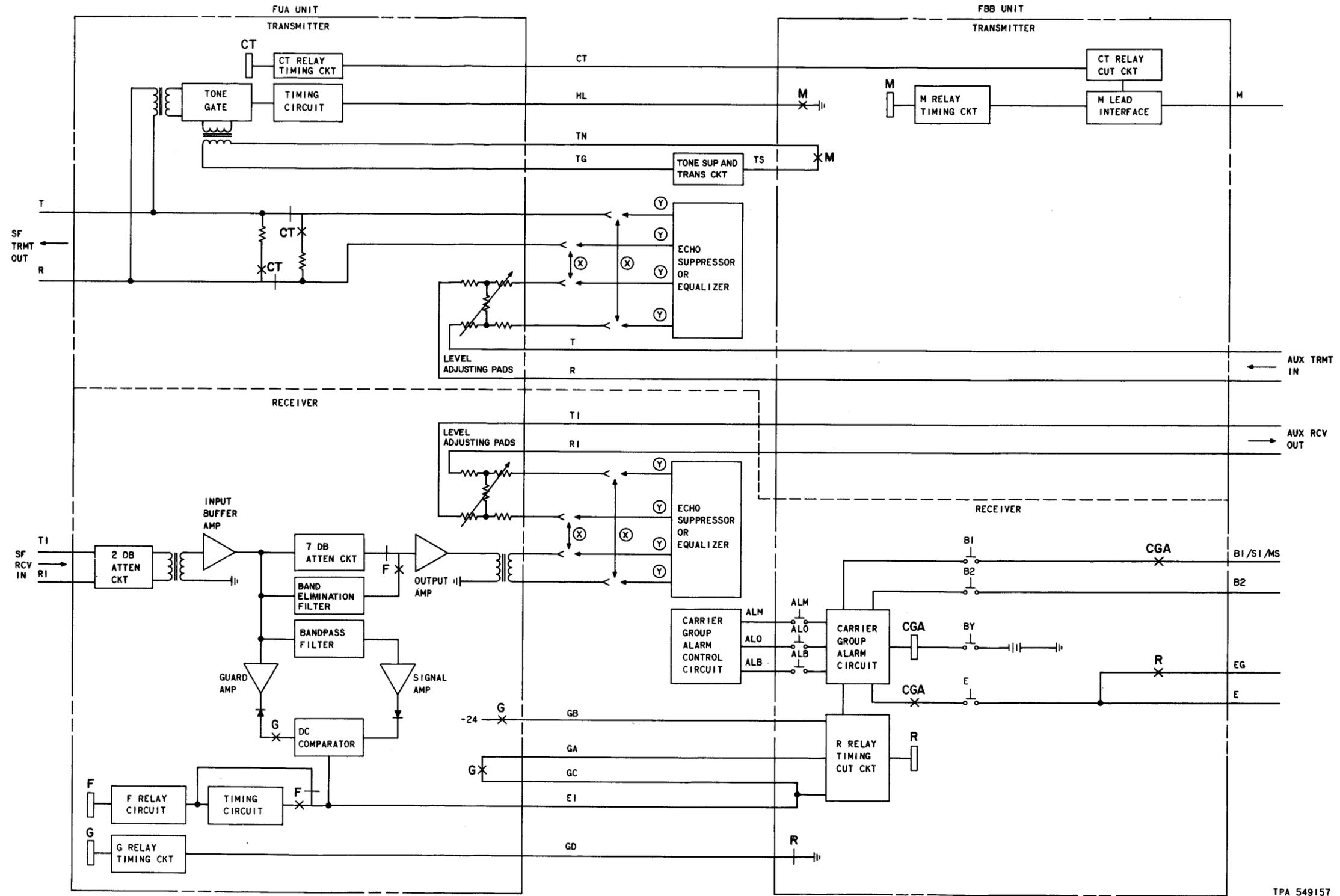
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Fig. 4—FUA Plus FA Units



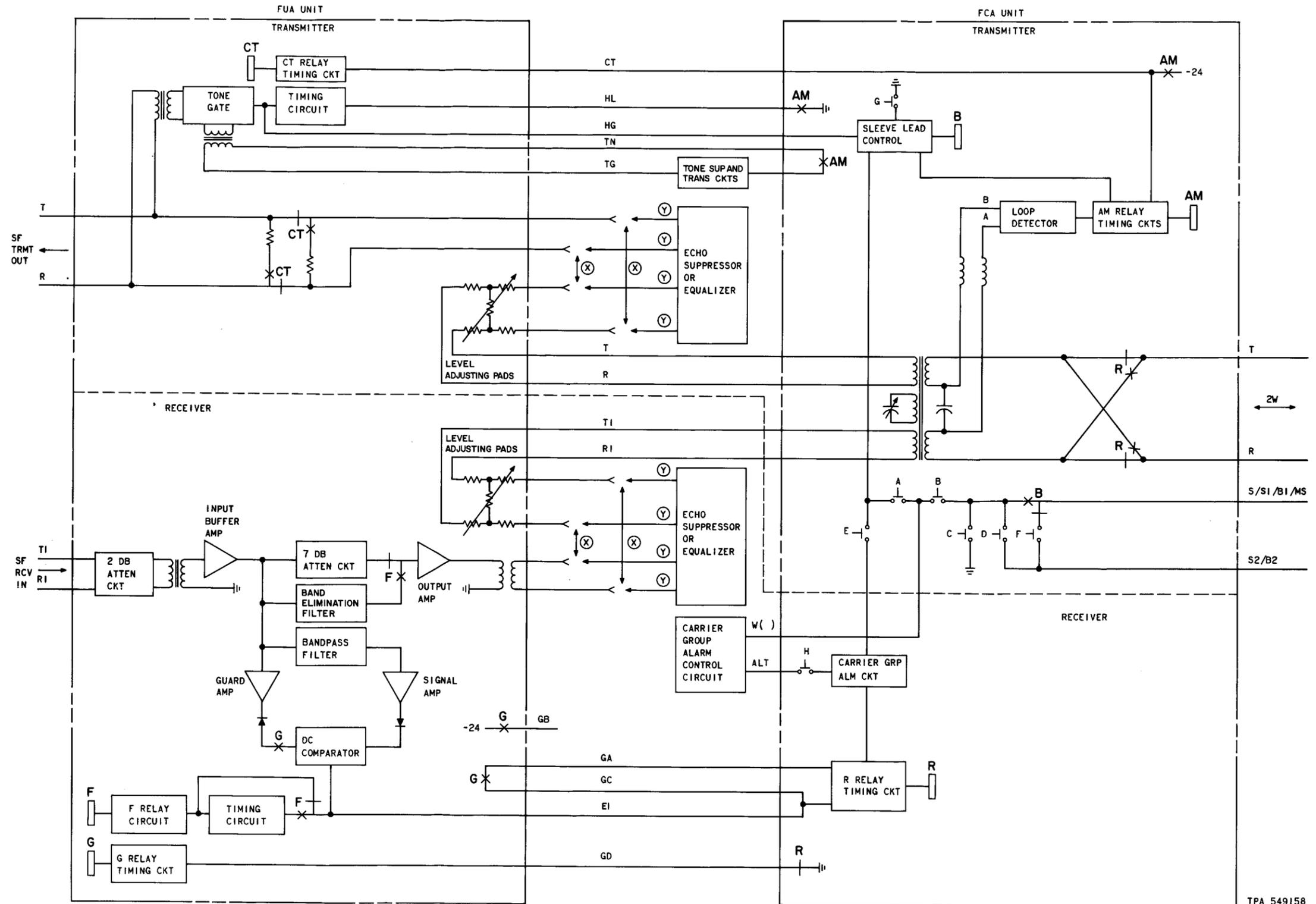
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Fig. 5—FUA Plus FBA Units



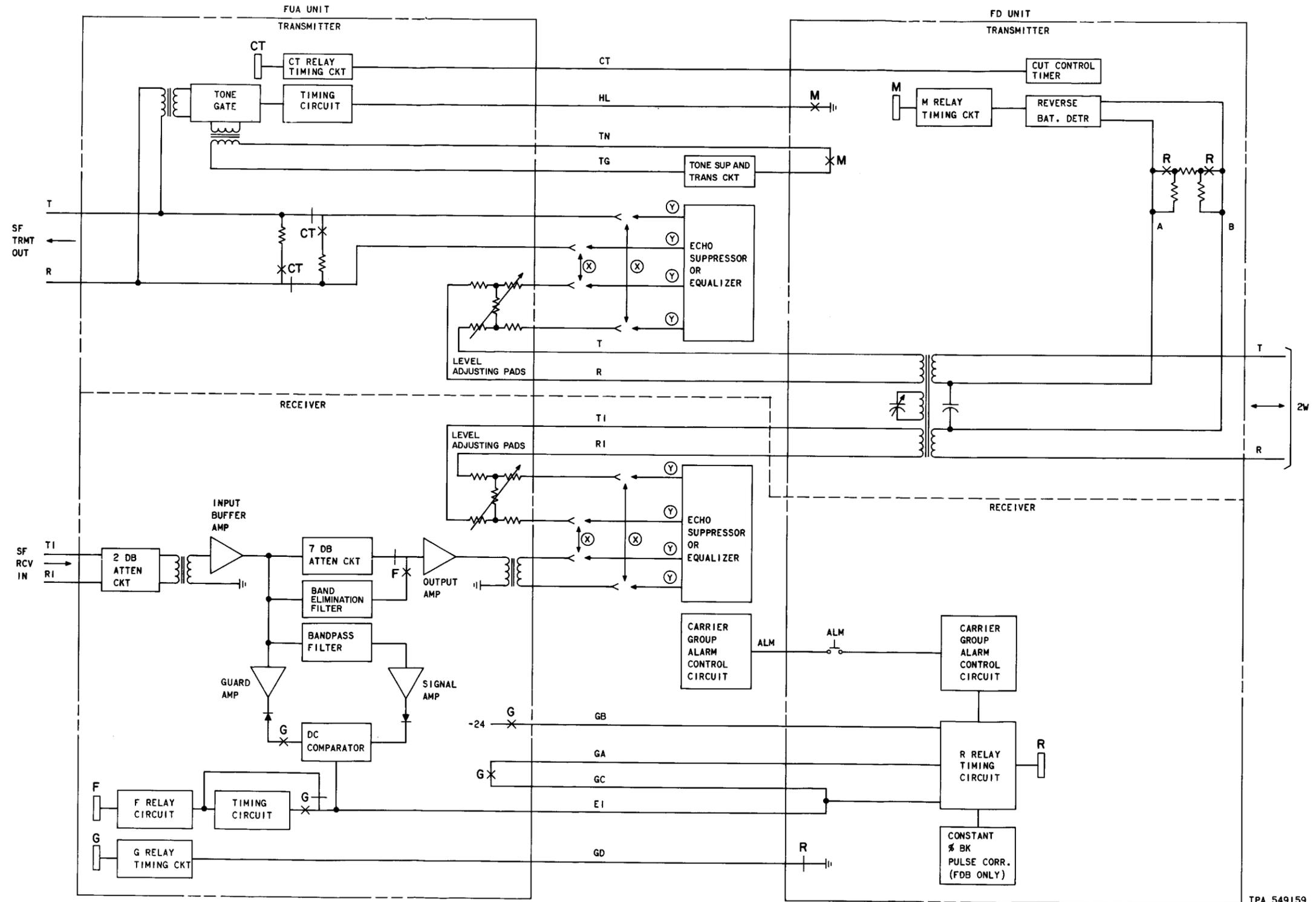
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Fig. 6—FUA Plus FBB Units



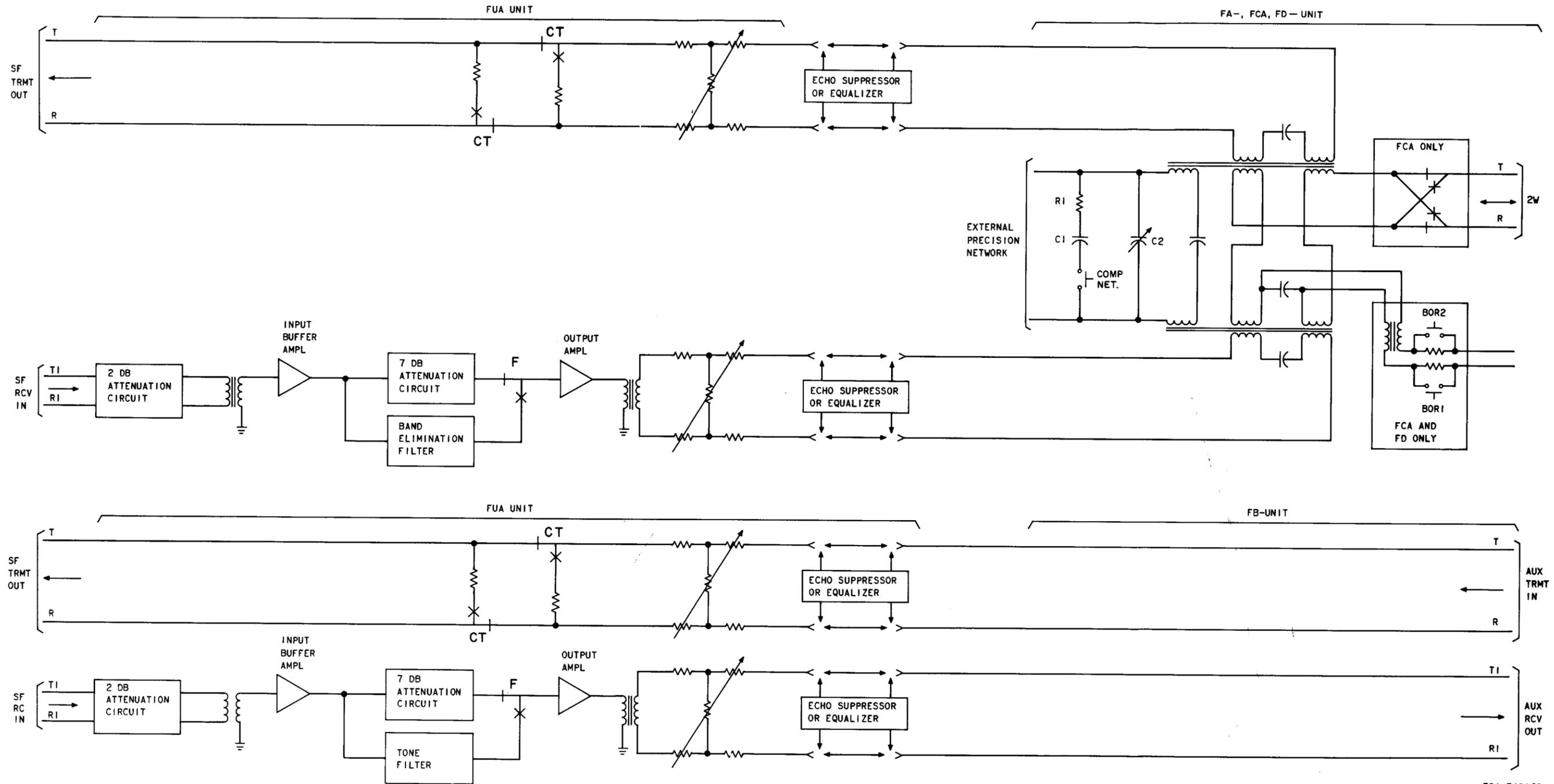
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Fig. 7—FUA Plus FCA Units



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Fig. 8—FUA Plus FD Units



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Fig. 9—Transmit and Receive Paths

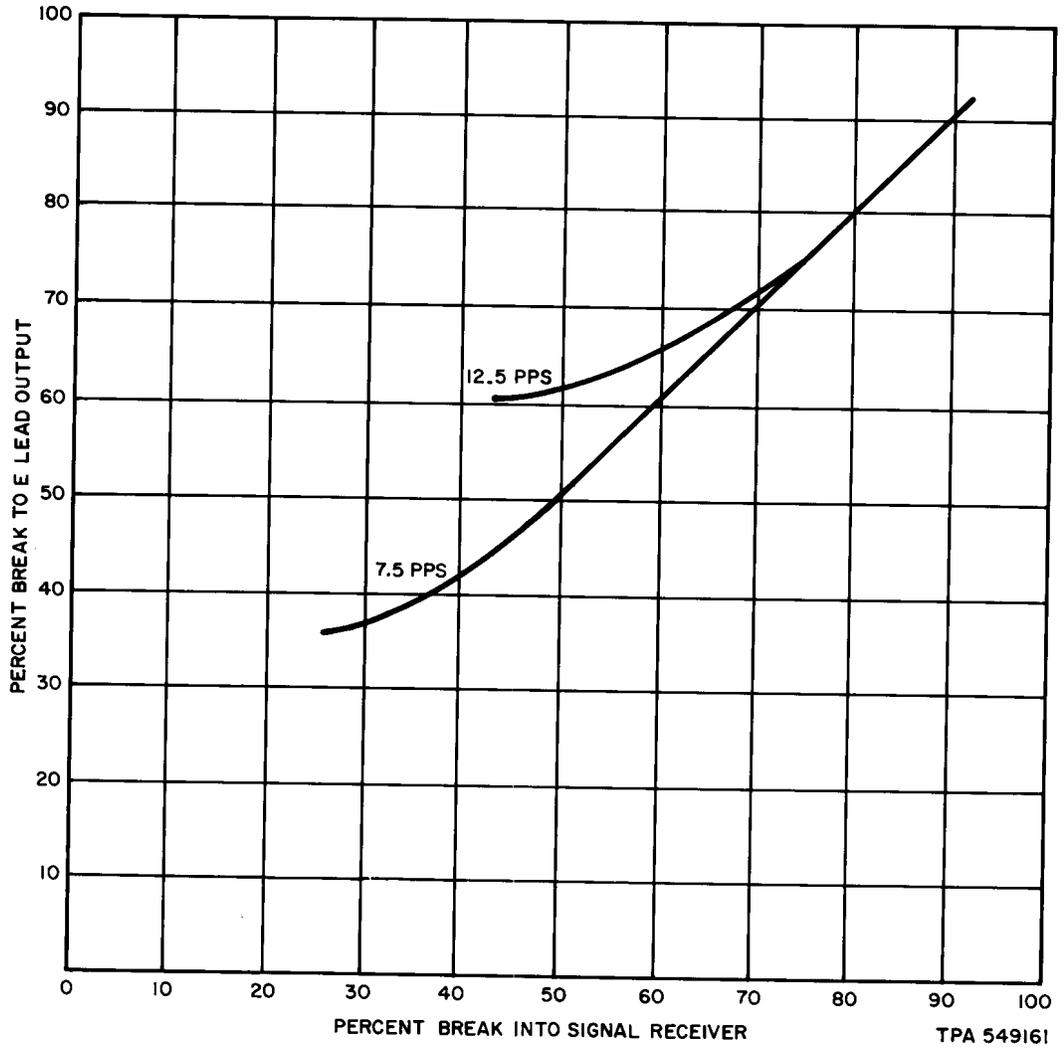


Fig. 10—Receiver Pulse Correction For the FA₁, FB₁, and FDA Units Plus the FUA Unit

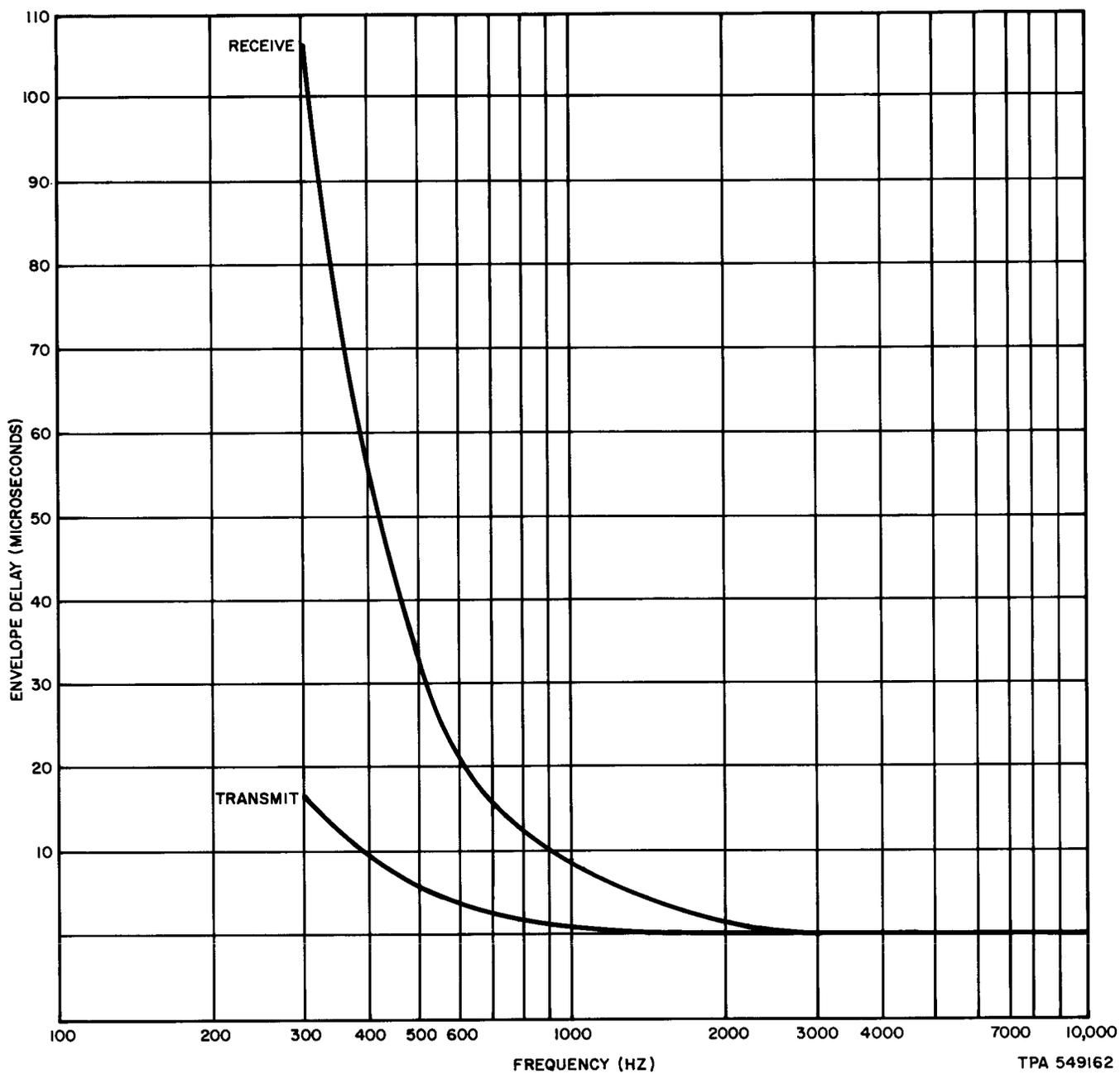


Fig. 11—Nominal Envelope Delay for the FB_ Units Plus the FUA Unit

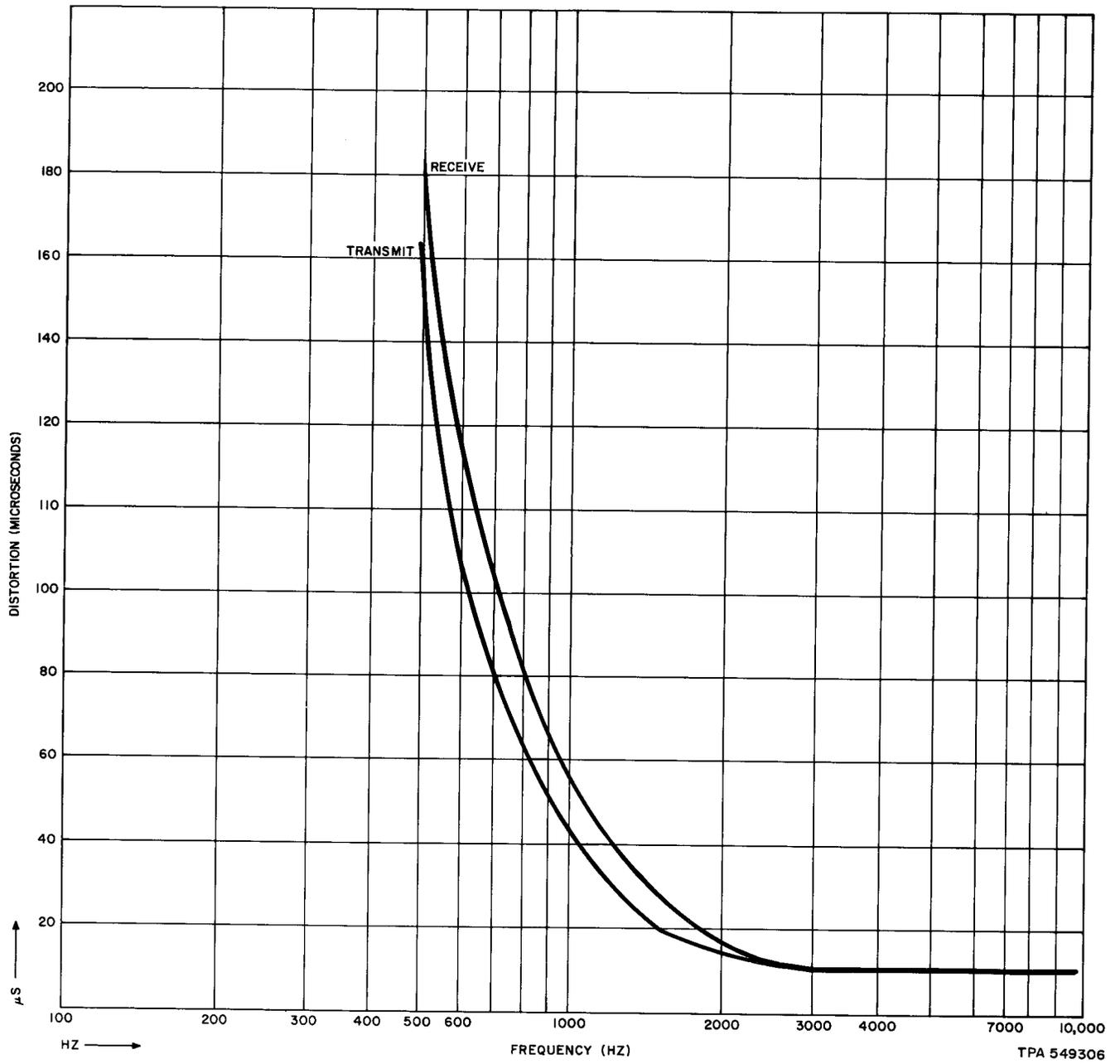


Fig. 12—Delay Envelope Distortion For the FA_ FCA, and FD_ Units Plus the FUA Unit

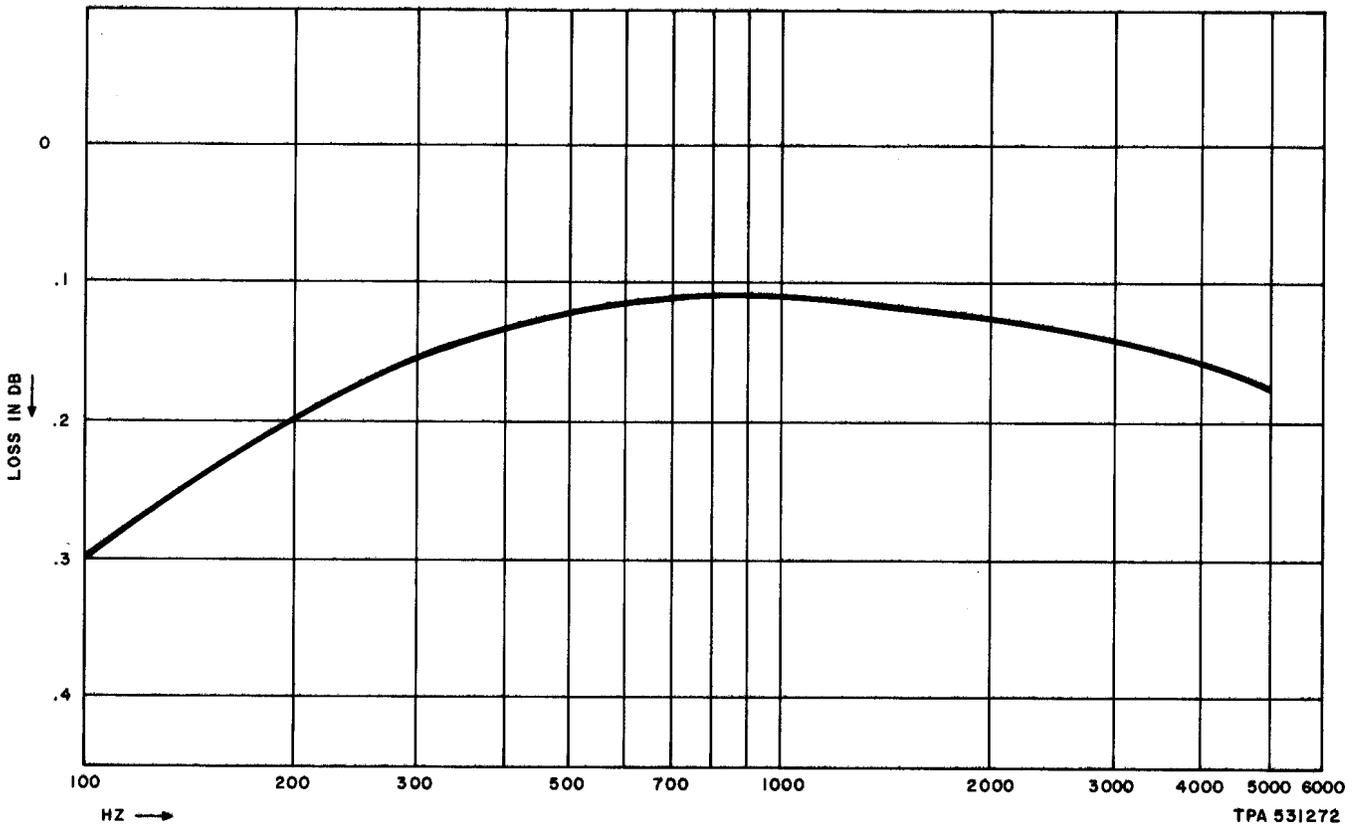


Fig. 13—Transmit Circuit Insertion Loss For the FB Units Plus the FUA Unit

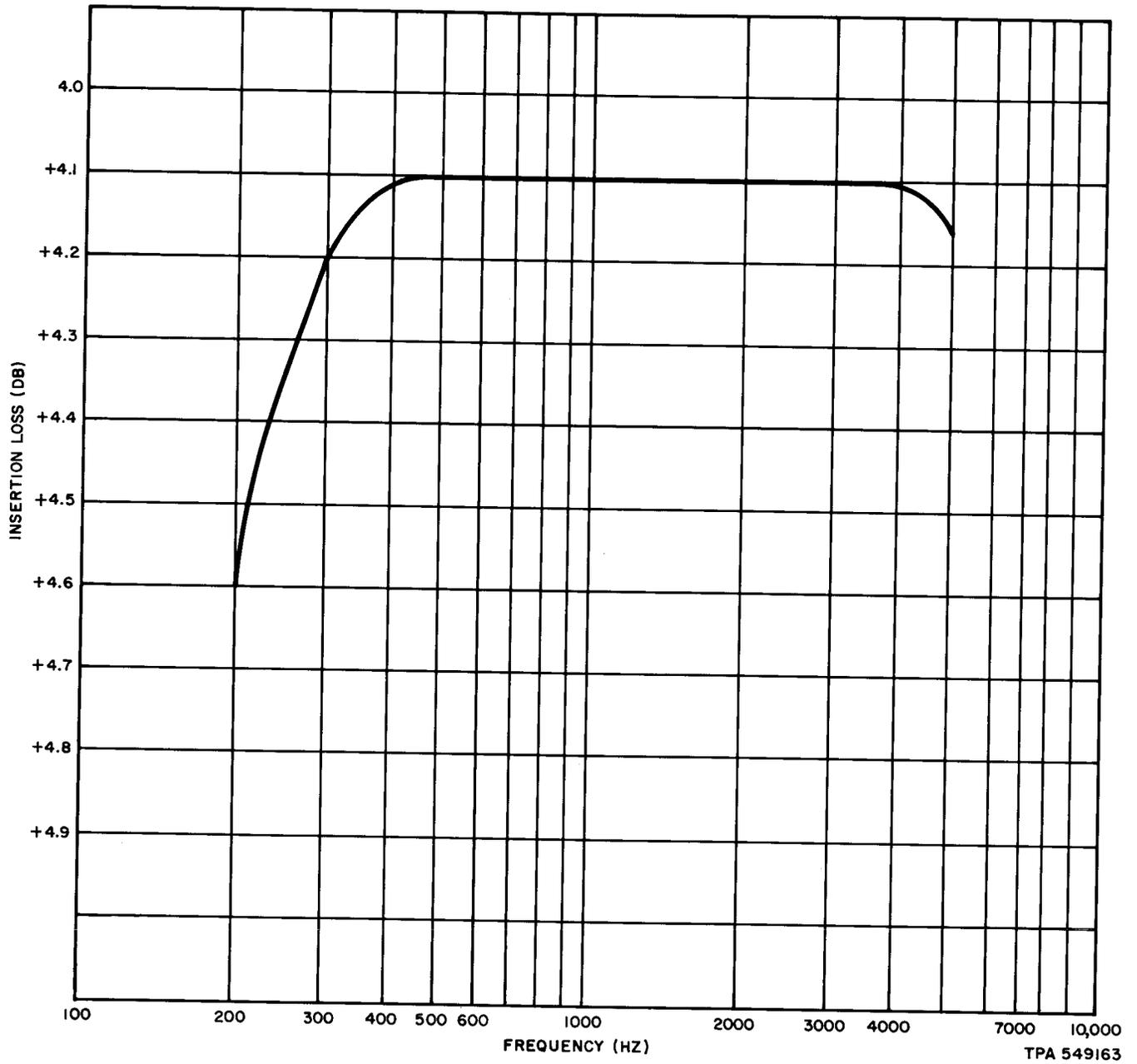


Fig. 14—Nominal Transmit Circuit Insertion Loss for the FAA, FAC, FCA, and FD_ Units Plus the FUA Unit

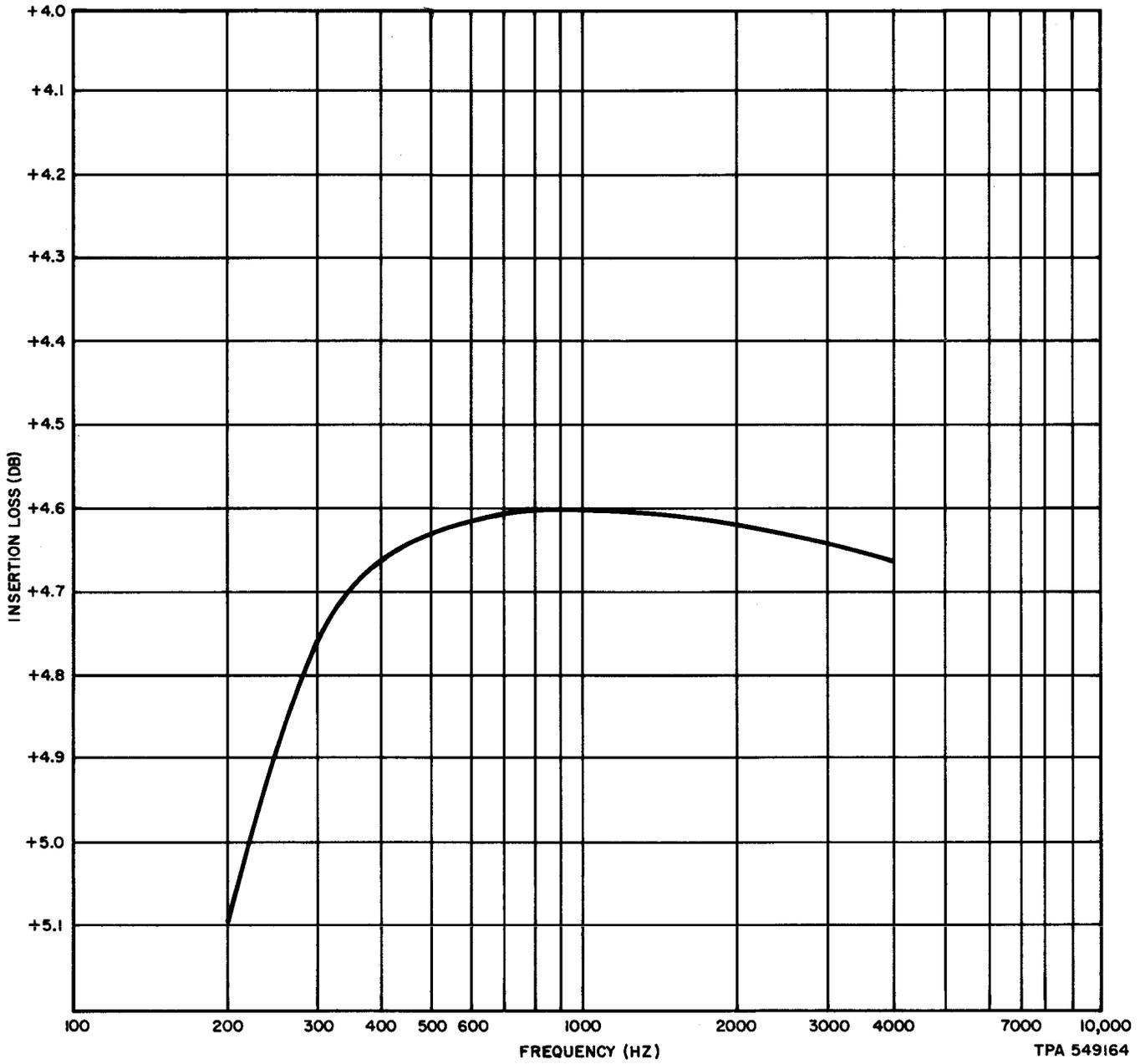
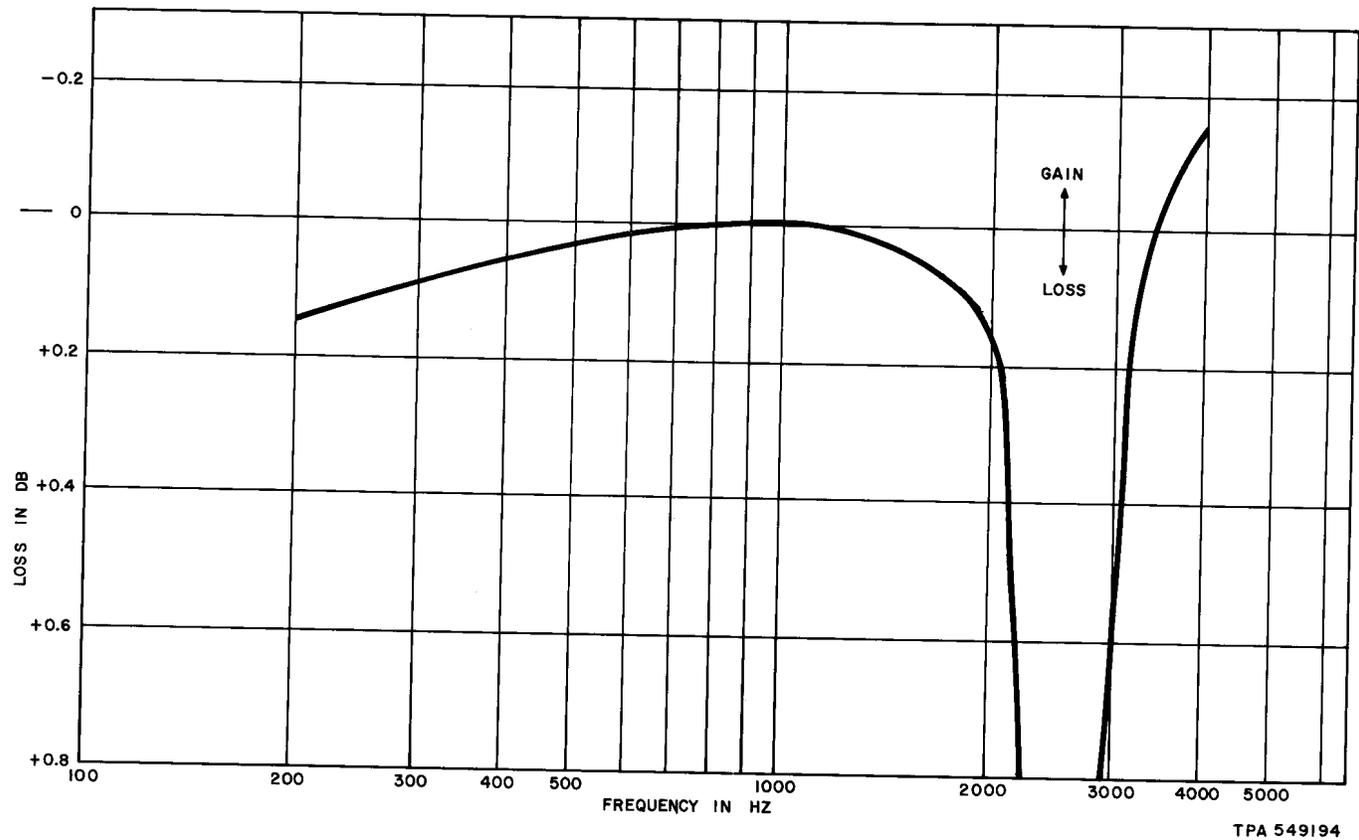


Fig. 15—Nominal Transmit Circuit Insertion Loss For the FAD Unit Plus the FUA Unit



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Fig. 16—Nominal Receive Circuit Insertion Loss With Band Elimination Filter in For the FB Units Plus the FUA Unit

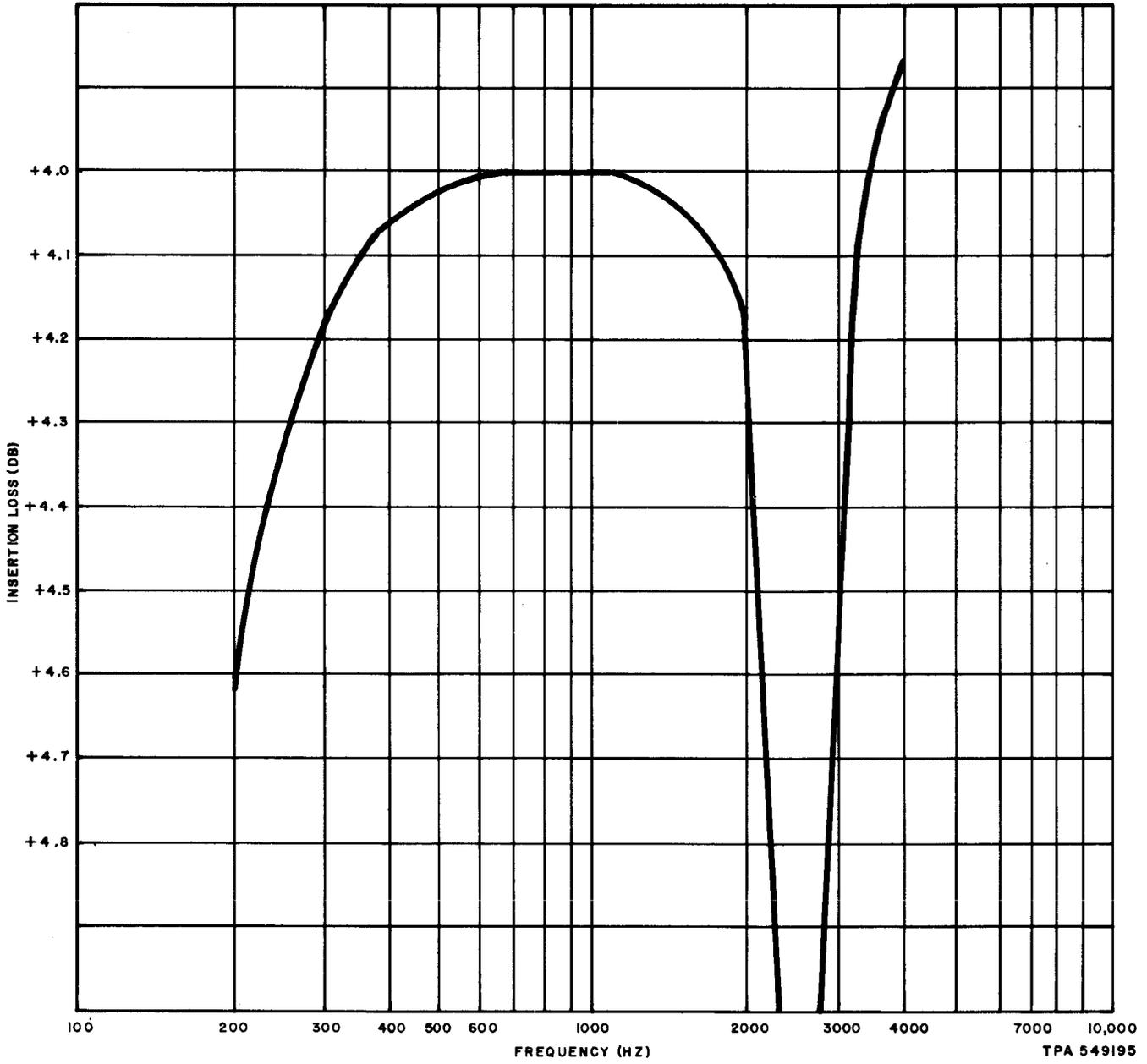


Fig. 17—Nominal Receive Circuit Insertion Loss With Band Elimination Filter In For The FAA, FAC, FCA, and FD_ Units Plus the FUA Unit

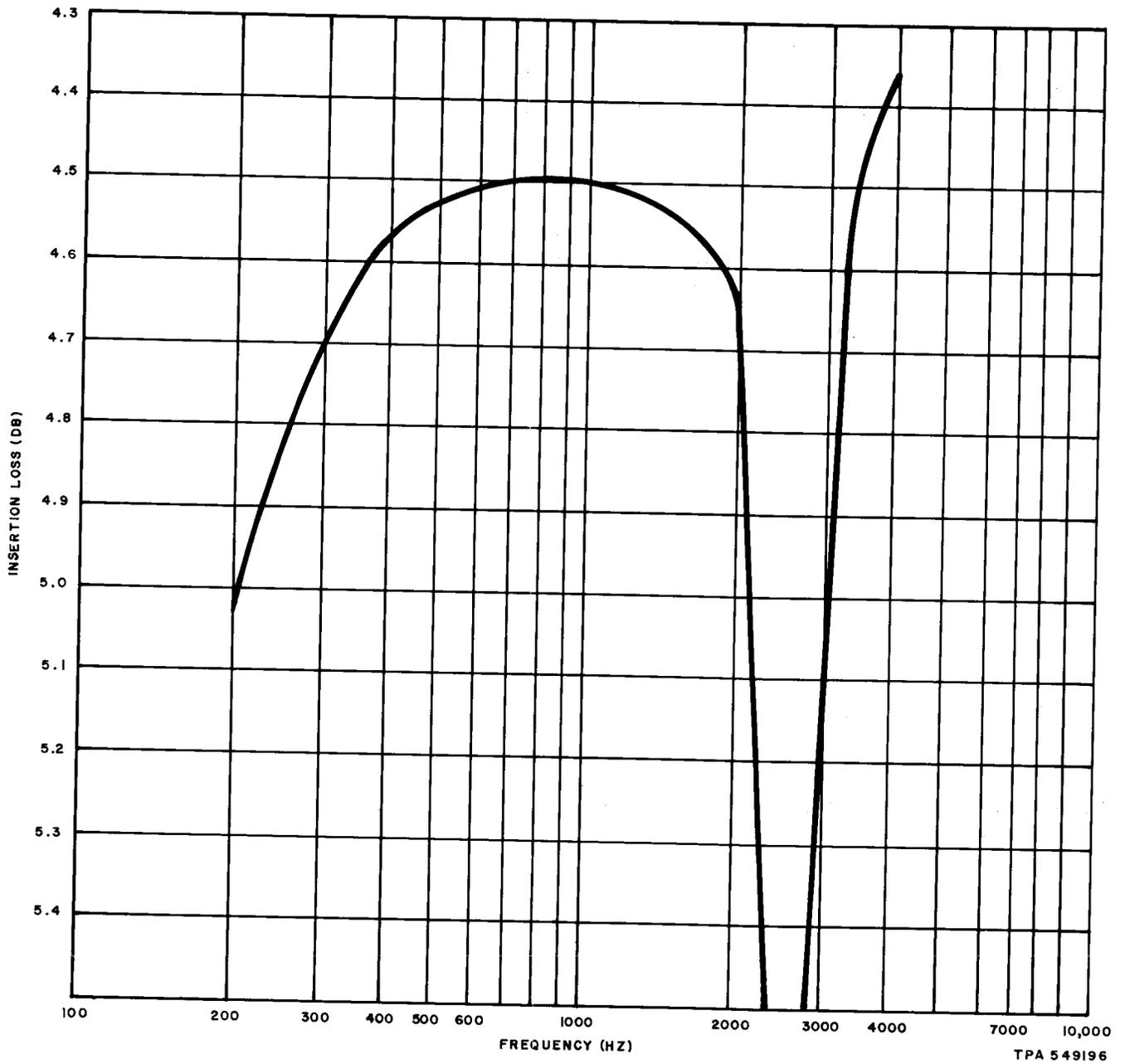


Fig. 18—Nominal Receive Circuit Insertion Loss With Band Elimination Filter In For the FAD Plus the FUA Unit

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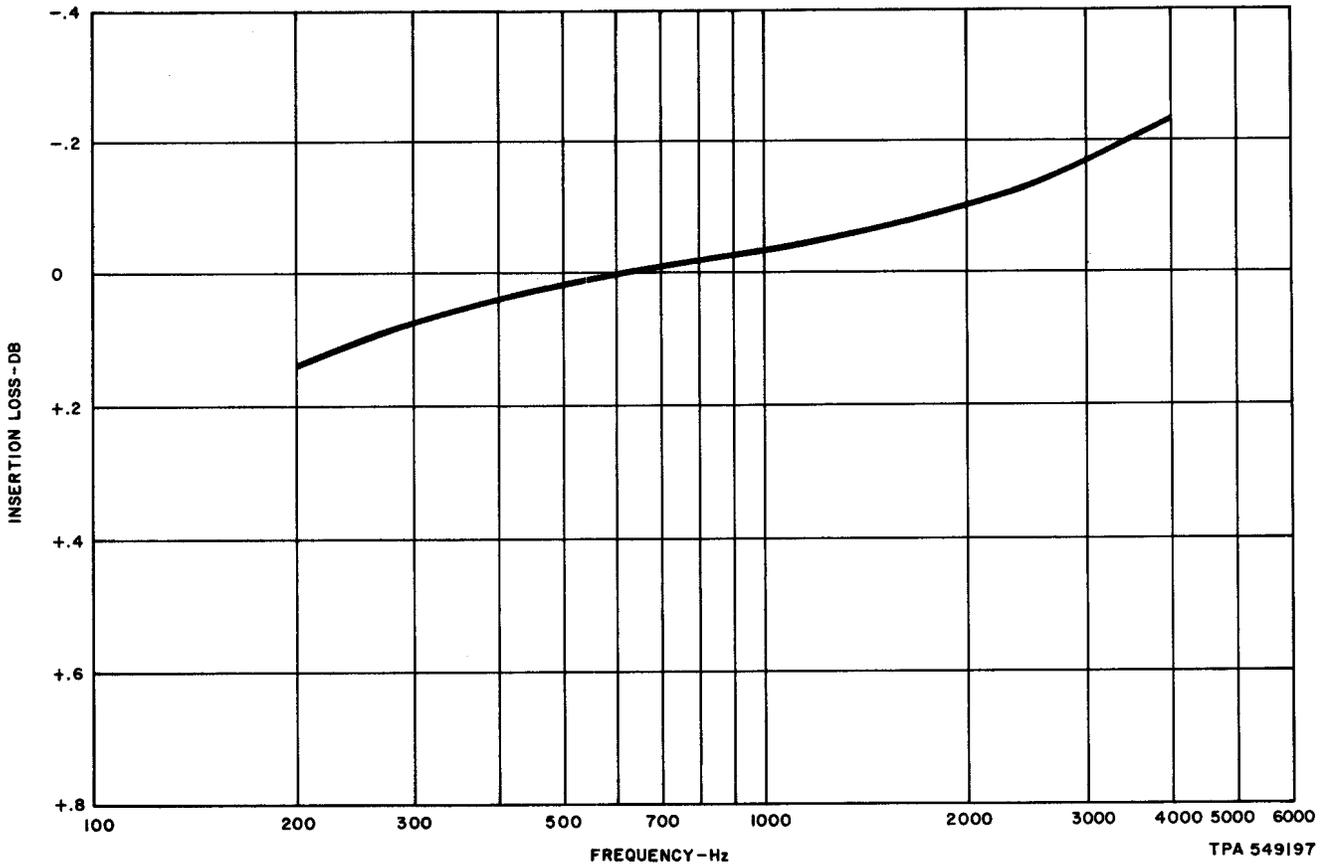


Fig. 19—Nominal Receive Circuit Insertion Loss With Band Elimination Filter Out For the FB_ Units Plus the FUA Unit

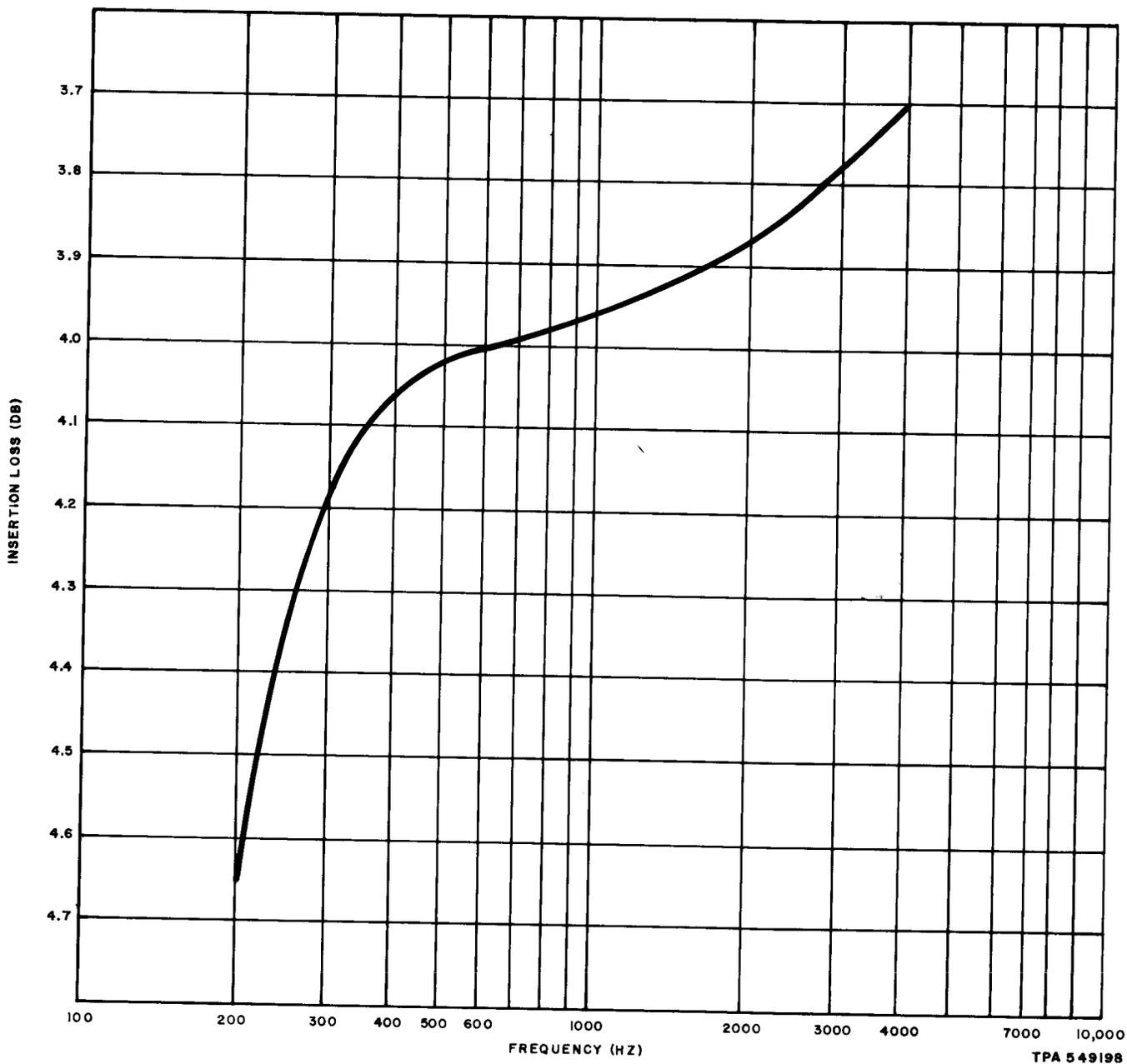


Fig. 20—Nominal Receive Circuit Insertion Loss With Band Elimination Filter Out For the FAA, FCA, and FD Units Plus the FUA Unit

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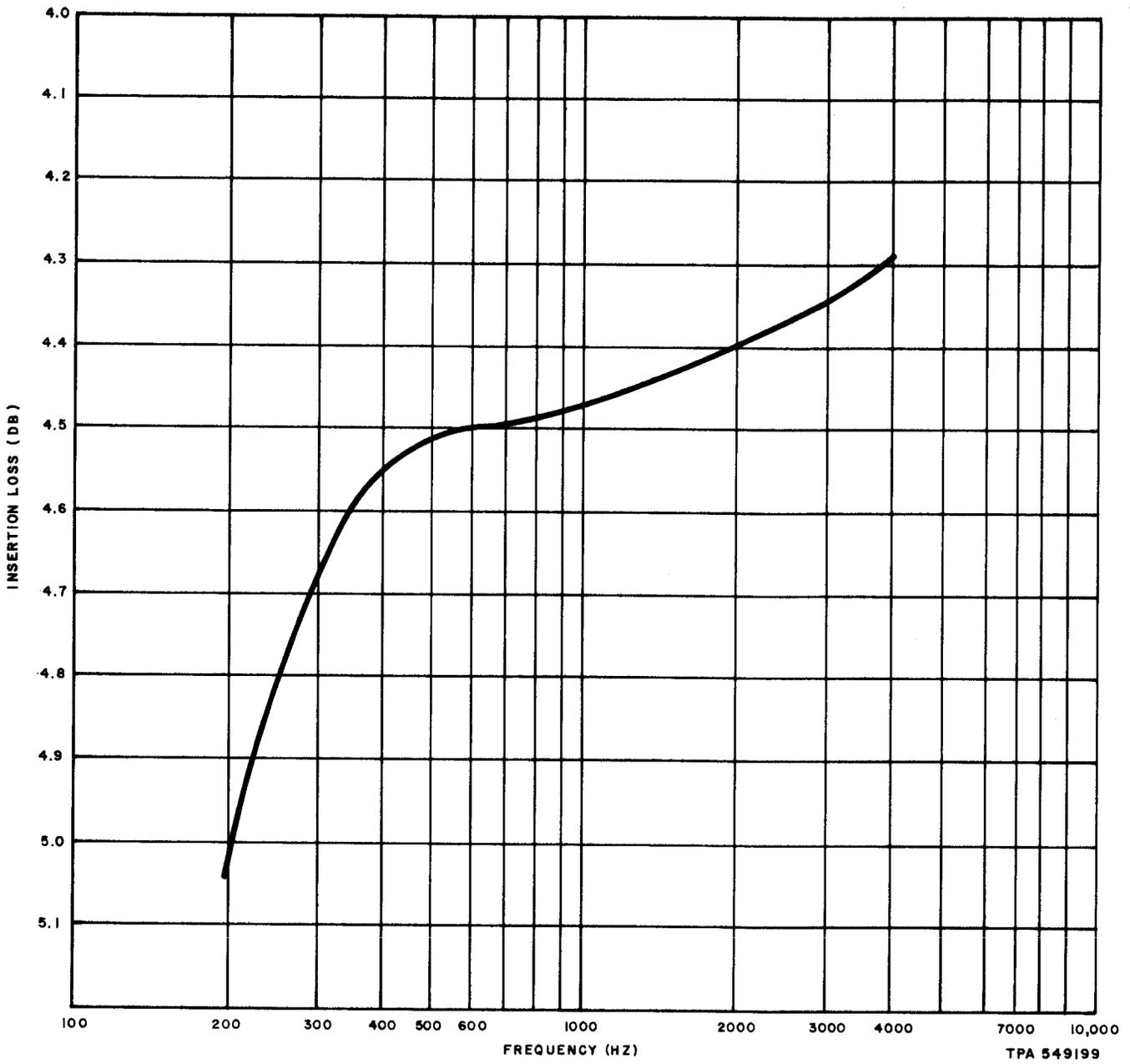


Fig. 21—Nominal Receive Circuit Insertion Loss With Band Elimination Filter Out for the FAB Unit Plus the FUA Unit

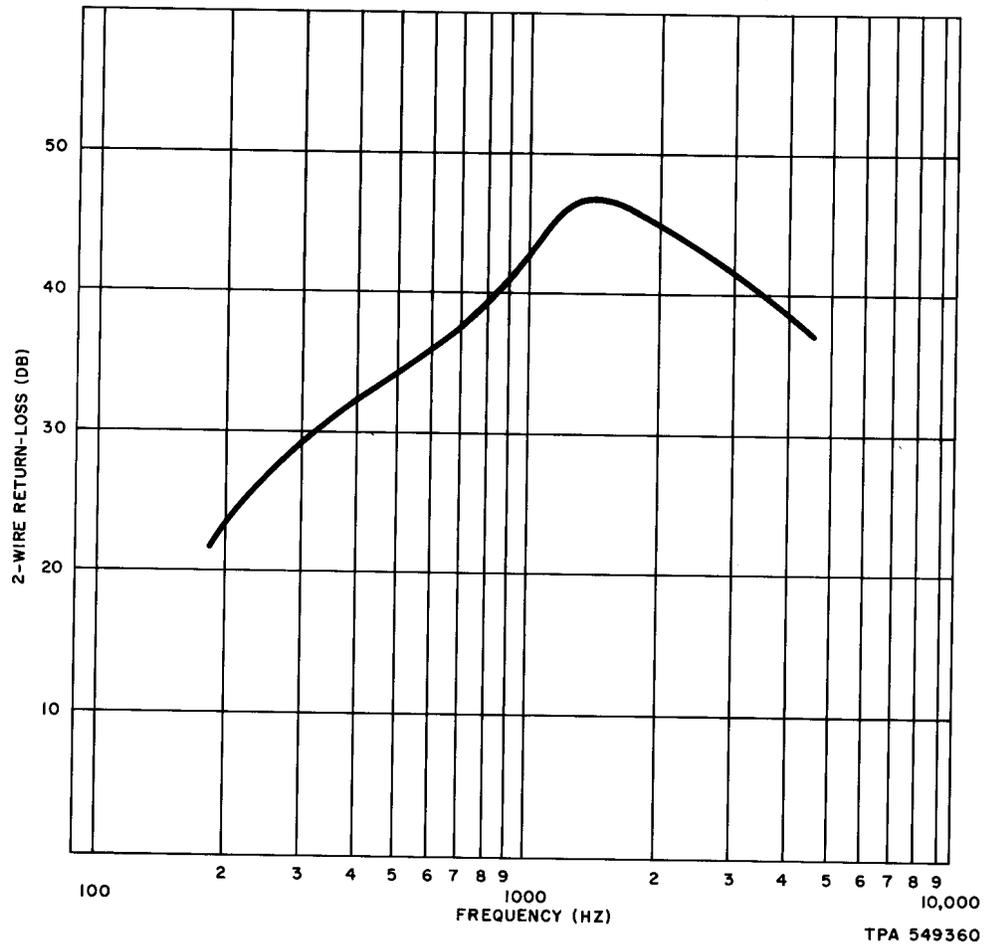


Fig. 22—Nominal FAA, FAC, FCA, and FD_Units—Return Loss-Frequency Characteristics—2-Wire Side Against 900 Ohms Plus 2.15 μ F

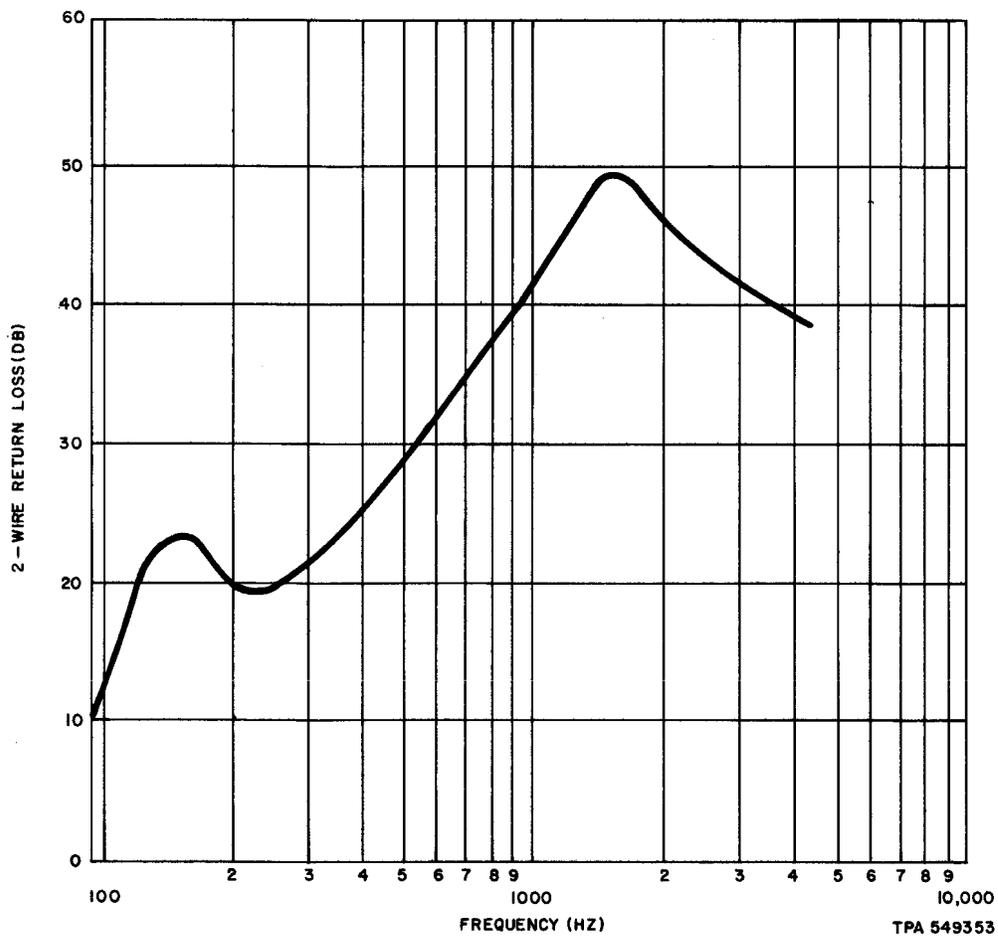


Fig. 23—Nominal FAD Unit—Return Loss-Frequency Characteristics—2-Wire Side Against 600 Ohms Plus 2.15 μF

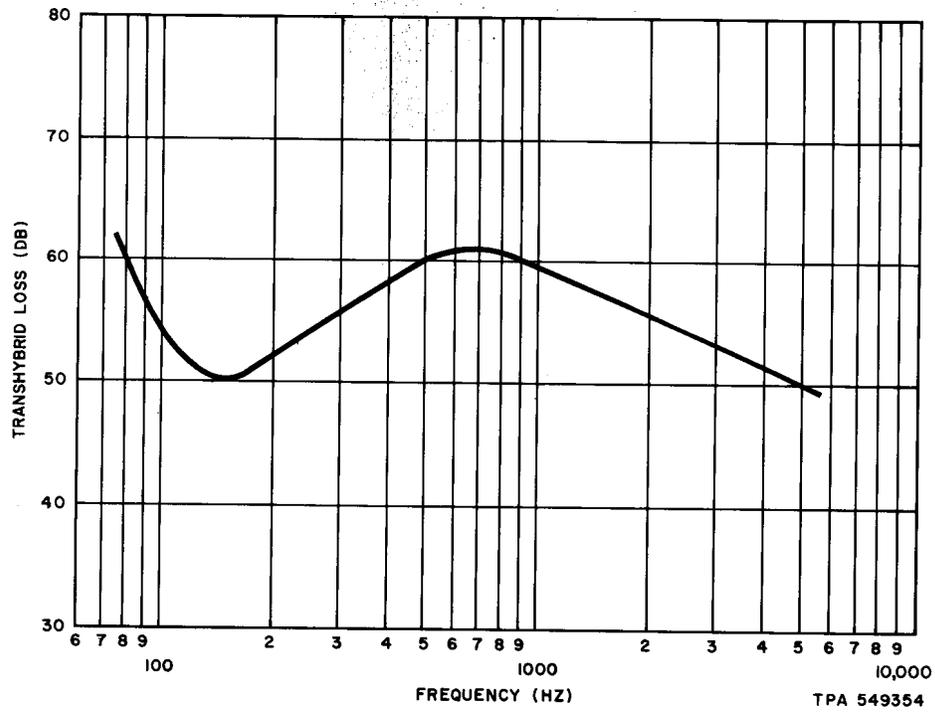


Fig. 24—Nominal FAA, FAC, FCA, and FD_ Units—Transhybrid Loss

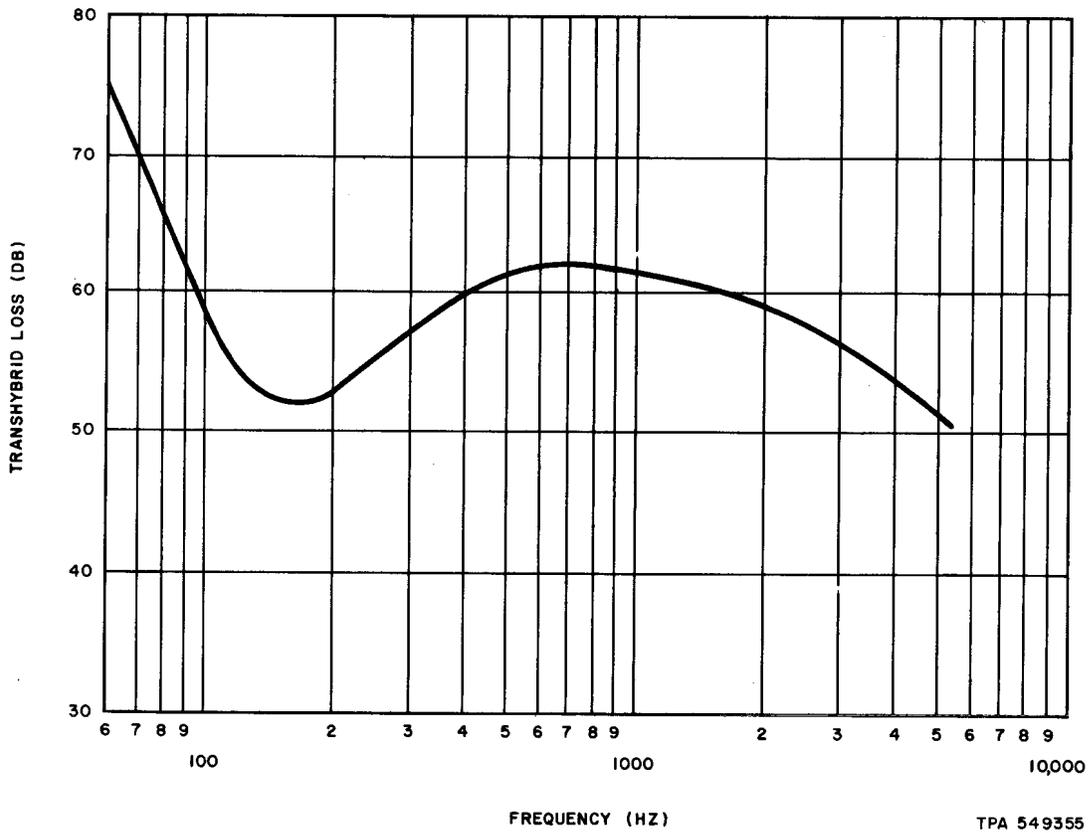


Fig. 25—Nominal FAB Unit—Transhybrid Loss