

**FUA SIGNALING CONVERTER CIRCUIT**  
**DESCRIPTION**  
**TYPE F SIGNALING SYSTEM**

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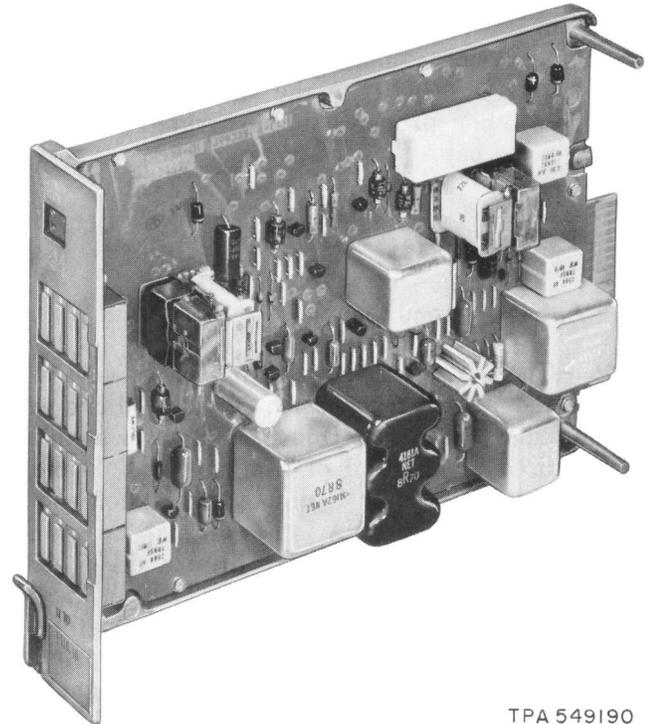
**1. GENERAL**

**1.01** This section describes the FUA single-frequency (SF) signaling circuit, SD-1C226-01 (Fig. 1) which is a component part of type F signaling system.

**A. System and Unit Description**

**1.02** The FUA (Fig. 1) is a plug-in device which is used, in conjunction with an auxiliary, to convert DC signals to AC tone signals and vice versa. Six FUA's plus six auxiliaries can be plugged into a 23-inch diecast shelf. A maximum of 12 shelves can be mounted on an 11-foot 6-inch bay, 10 shelves on a 10-foot 6-inch bay, 8 shelves on a 9-foot bay, and 6 shelves on a 7-foot bay. Space is also provided in each of these bays for two 2600-Hz tone supplies and their associated transfer

circuit, a fuse and alarm circuit, and a plug-in carrier group alarm control circuit. In the 11-foot 6-inch bay and the 10-foot 6-inch bay, space is provided for three DC to DC power converters while in the 9-foot and 7-foot bay, space is provided for only two DC to DC power converters.



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**Fig. 1—FUA Unit**

**1.03** The FUA is placed in service by inserting it into the guides on the shelf and sliding it toward the rear of the bay. A locking device on the face of the unit, locks the module in place when sufficient contact with the bay mounting is made. The FUA is removed by releasing the locking device and withdrawing the unit.

**1.04** Components of the FUA are mounted on a printed wiring board. The board is held in a die cast aluminum frame approximately 10 1/2 inches by 7 inches by 1 1/2 inches. All interconnections between the bay and the SF module is 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.

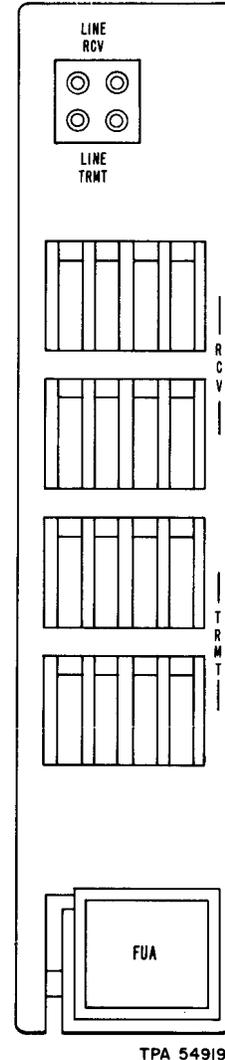
**1.05** The FUA provides a zero loss 4-wire transmission path to the auxiliaries and includes pads which allow adjustment for the transmission level. These pads are adjusted with 16 slide switches on the front of the unit. (See Fig. 2.) These pads permit the introduction of attenuation in the transmit or receive path over a range of 0 to 16.5 dB in 0.1 dB steps. An external echo suppressor, equalizer, or other voice equipment can be inserted between the signaling circuit and the pad, when proper cabling arrangements are made in the bay.

## B. Application and Compatibility

**1.06** The FUA provides two interfaces, one with the 4-wire transmission facility and one with the auxiliary (Fig. 3). One FUA and an auxiliary is required at one end of a signaling link and a compatible type E or F unit at the other end is also required. The FUA is designed to be applied to 4-wire facilities with  $-16$  dBm and  $+7$  dBm voice transmission level points (TLP). The SF units must be within 3 dB of these nominal TLPs as measured at 2600 Hz. These units provide signaling for 2-wire and 4-wire E & M lead signaling, loop, reverse-battery signaling, and special access type signaling.

**1.07** Table A lists the auxiliaries and each unit function, application, and comparable type E unit.

**1.08** These type F units are compatible with all present type E equipment except E1E and E1F revertive pulsing signaling units. There is no provision for revertive pulsing with switching circuits within the type F system. For compatibility with switching circuits see SD-99421-06, with other signaling units see SD-1C240-02 or descriptive BSPs on the auxiliaries.



**Fig. 2—FUA Unit Faceplate**

## 2. OPERATIONAL PRINCIPLES

### A. Transmitter

**2.01** The transmitter portion of the FUA (Fig. 4), provides both signaling and speech functions. This circuit can be divided into three main divisions: (1) tone level timing circuit, (2) CT relay control circuit, and (3) transmission path.

**2.02** 2600-Hz signal tone coming from the common oscillator is controlled by the auxiliary and sent into the FUA through the TN and TG leads. It then passes through the tone level gate and timing circuit and is applied to the line transmit

TABLE A

**TYPE F AUXILIARY AND MISCELLANEOUS SIGNALING UNITS  
GENERAL INFORMATION AND APPLICATION**

CODE	SECTION	FUNCTIONAL DESCRIPTION	GENERAL APPLICATION	SPECIFIC USE	E TYPE SF UNITS REPLACED
FA ( )	179-364-101	600- or 900-Ohm 2W E&M Lead	2-Way Trunks	2-Wire Switching	E1A or E-B + Term. Set
FB ( )	179-364-101	4-W E&M Lead	2-Way Trunks	4-Wire Switching DP or MF	E-B + "P" Pads
FC ( )	179-364-101	Loop Reverse Battery Originating	1-Way Trunks	DP or MF 2W-900 Ohm	E3C, E4C, E5C
FD ( )	179-364-101	Loop Reverse Battery, Terminating	1-Way Trunks	DP or MF 2W-900 Ohm	E3D, E4D, E5D
FL ( )	179-365-101	Special Access CO End	Special Access Loop-Start or Ground-Start	2W-600 or 900 Ohm	E2L — E2LA E1P + Term. Set
FP ( )	179-365-101	Special Access CO End	Special Access Loop-Start or Ground-Start	4-Wire Extension	E1P + 4182 Type Network
FR ( )	179-365-101	Special Access Station End	Special Access Loop-Start or Ground-Start	4-Wire Extension	E1R + 4182 Type Network
FS ( )	179-365-101	Special Access Station End	Special Access Loop-Start or Ground-Start	2W-600 or 900 Ohm	E2S — E2SA E1R Term. Set
FM ( )	179-366-101	Nonsignaling By-Pass	Nonsignaling By-Pass	Nonsignaling By-Pass	—

path through T5, a high impedance transformer. The tone level timing circuit, controlled by the auxiliary on the HL lead, allows for two output levels 12 dB apart which is controlled by the timing circuit. In the off-hook condition, 2600-Hz tone is off. When the on-hook condition occurs, tone is applied at the high level (–24 dB at the –16 TLP) for a period of 350 milliseconds after which time it goes to the low level (–36 dB at the –16 TLP). During pulsing operations, the timing circuit holds the tone at a high level.

**2.03** The CT relay control circuit provides a balanced cut and termination of the transmission path during idle circuit conditions, during change or states (on-hook to off-hook and vice versa) and during pulsing to prevent transients from the central office switching equipment from interfering with the 2600-Hz tone. When the circuit

is in the seized condition, the CT relay releases and provides a through path for transmission. The CT relay is operated when a negative voltage from the auxiliary is applied to the CT lead. This negative voltage on the CT lead ceases when an off-hook condition occurs but the relay does not release immediately because of a delay (125 ms) in the CT relay timing circuit. When the relay releases, it provides a through path for transmission. A precut condition is simulated by delaying the 2600-Hz tone until after the CT relay is operated. From off-hook to on-hook, the transmission path is not cut instantaneously because of the delay in the operation of the CT relay.

#### **B. Receiver**

**2.04** The receive portion of the circuit (Fig. 4) provides both signaling and speech functions.

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This circuit can be divided into three main divisions: (1) voice transmission circuit, (2) signal and guard detector circuits, and (3) timing circuit.

**2.05** The voice transmission path consists of input amplifier, an output amplifier for obtaining essentially zero gain and a band elimination filter which is inserted when the F relay is activated. When an input is received by this unit, it passes through the amplifier stages and is inserted into the signal and guard detector circuits. The band elimination filter may or may not be inserted, depending upon what the frequency of the input is. If it is other than pure 2600 Hz it will pass on through the output amplifier with little loss or distortion.

**2.06** The signal and guard detector circuit consists of signal and guard amplifiers, detectors and a dc comparator. When a signal is present at the output of the input amplifier a portion of it is fed into the signal and guard amplifiers. The output of each amplifier is fed into its respective rectifiers and the output of the rectifiers are fed into the dc comparator. When a 2600-Hz signal is received, the output of the signal rectifier is positive and greater than the negative output of the guard rectifier. These outputs (the guard being connected through a make contact of the G relay which is operated when 2600-Hz tone is absent and for a period after tone is applied) are fed into a dc comparator where they are recognized as a turn-on signal. This results in the operation of the F relay. Two conditions, broadband or narrowband, may exist as a result of the absence or presence of a 2600-Hz signal. When the on-hook condition occurs, a 2600-Hz signal is on the line and the broadband condition exists. This means that the receiver will be held operated even if the frequency is changed by as much as  $\pm 500$  Hz.

**2.07** The dc comparator is preset to operate when a ratio of the signal to guard power is at least 10 dBm. As mentioned in 2.06, the positive output causes the comparator to operate the F relay. A command sent on the E1 lead tells the auxiliary to apply ground to the GD lead causing the normally operative G relay to release. The release of the G relay removes the guard amplifier from the circuit and thus the broadband condition exists. The narrowband condition exists when the G relay is operated and the guard amplifier is in the circuit. This condition exists during the off-hook state and also during pulsing since the G relay

timing circuit, controlled by the auxiliary, delays its release. This narrowbanding reduces false operation by speech simulated signals when in the talking mode. The broadband condition is invoked for long duration signals such as start dial or free call conditions, to eliminate the possibility of false release of the receiver by noise or speech interference. In the absence of guard energy a nominal level of  $-13 \pm 6$  dBm 2600-Hz tone will operate the unit.

**2.08** The purpose of the timing circuit is to keep the F relay operated when the 2600-Hz signal is removed for short periods of time, such as when dialing. When no signal tone is applied, the F relay is released and the voice transmission path is connected through the buffer amplifiers and matching pad. When 2600-Hz tone is applied, the F relay operates and the voice transmission path is through the amplifiers and the band elimination filter. The nominal band width of the 2600-Hz filter is 75 Hz. The timing circuit is also placed into the circuit when 2600-Hz tone is applied. The timing circuit keeps the F relay operated during pulse trains to minimize the noise generated in the voice path by short filter insertions.

### 3. PULSING CHARACTERISTICS

**3.01** This circuit in conjunction with an appropriate auxiliary is capable of transmitting and receiving dial pulses and supervisory signals. MF signals will be passed through either the transmit or receive transmission paths without distortion.

**3.02** The FUA converts the 2600-Hz tone to dc, but pulse correction if any is provided by the auxiliary. Graphs and tables concerning the pulsing characteristics for the auxiliary plus the FUA are given in the descriptive section on each particular auxiliary.

### 4. TRANSMISSION CHARACTERISTICS

**4.01** Transmission characteristic can be found in individual auxiliary BSP sections.

#### A. Transmitting

**4.02** Since the transmit path has a balanced cut, no repeat coils are necessary between the carrier and SF unit to eliminate longitudinal noise.

**4.03** The transmit circuit consists of a straight through connection with transformer T5

bridged across it. Contacts of the CT relay are also in the path and control the closure of the T and R leads in the talking conditions. When the circuit is idle and also during dialing, the CT relay cuts the transmission path and applies a 600-ohm termination on each side of the cut. There is only a negligible amount of loss in the transmit path (excluding the P-pads) of the FUA. Since the loss is negligible, no amplification is required in the transmit circuit.

## B. Receiving

**4.04** The transmission path through the receive circuit is via input transformer T1, an input buffer amplifier, an attenuation circuit, an output amplifier, and output transformer T2. A band-elimination filter is also bridged across the receiving circuits transmission path. The output level of the receiving circuits transmission path is within 0.4 dB of the input signal level between 300 and 3000 Hz. A sharp drop-off between 2200 and 2800 Hz is provided by the band-elimination filter. Insertion of the filter prevents 2600 Hz from being passed through the transmission path to another link.

**4.05** Voice frequencies entering the receive circuit pass through the input buffer amplifier, the band elimination filter, and the output amplifier. This circuit provides zero dB loss at 1000 Hz.

**4.06** The harmonic distortion performance of the voice path is shown in Fig. 5. Most of the distortion is caused by the second harmonic. It can be concluded that for signals entering the receive circuit below +5 dBm, the total harmonic distortion will be at least 55 dB below the input

signal level. Internal noise of the receive circuit which includes battery noise is below 20 dBm.

**4.07** The FUA provides high return loss and longitudinal balance characteristics. For an input between 250 and 4000 Hz, return loss measurements against 600 ohms, exceed 30 dB with a minimum longitudinal balance of 65 dB. A minimum of 60 dB of longitudinal balance exists at the output, for frequencies between 200 and 3000-Hz.

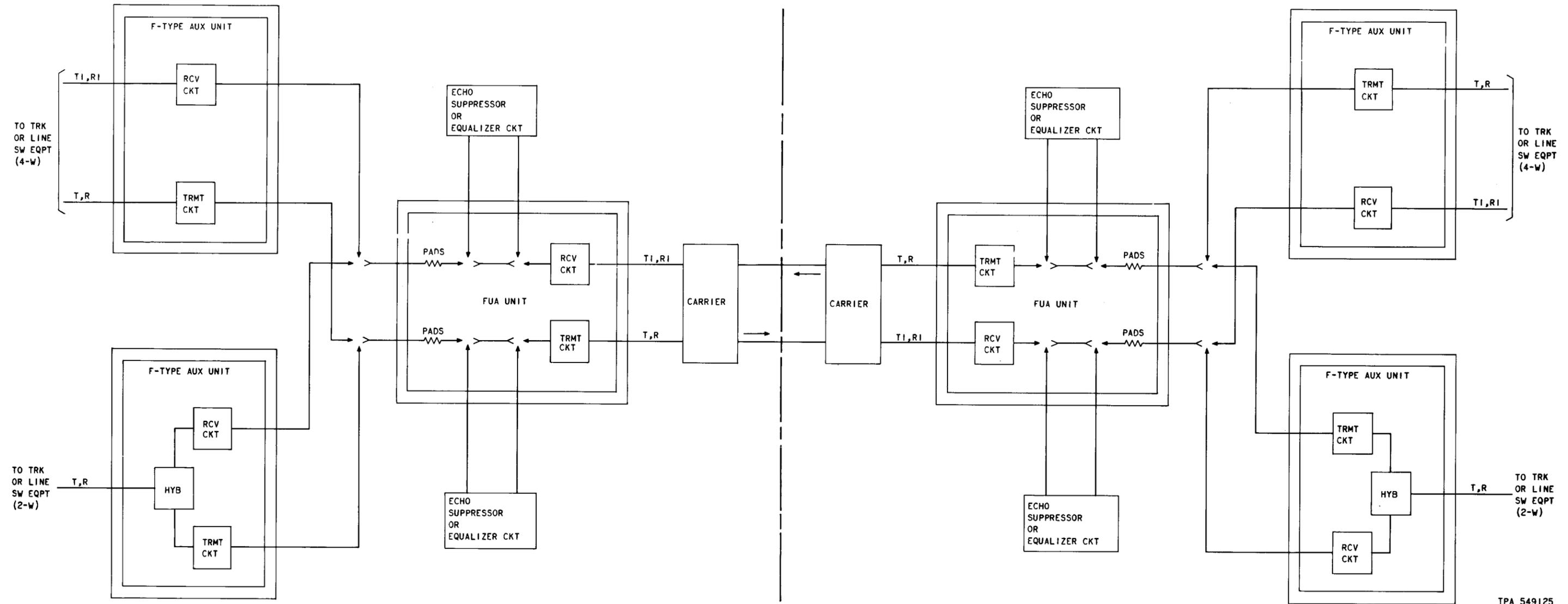
**4.08** The band-elimination filter is switched in the receive circuit under control of the F relay. With F relay operated, the band-elimination filter is connected to the output amplifier stage. When F relay is released a resistive termination is provided in place of the filter in the voice transmission path.

## 5. MAINTENANCE

**5.01** There are no field adjustments provided on the FUA (excluding the P-pads). SF units not meeting circuit requirements should be sent to Western Electric Co. for repair. Defective units should be replaced with spare units.

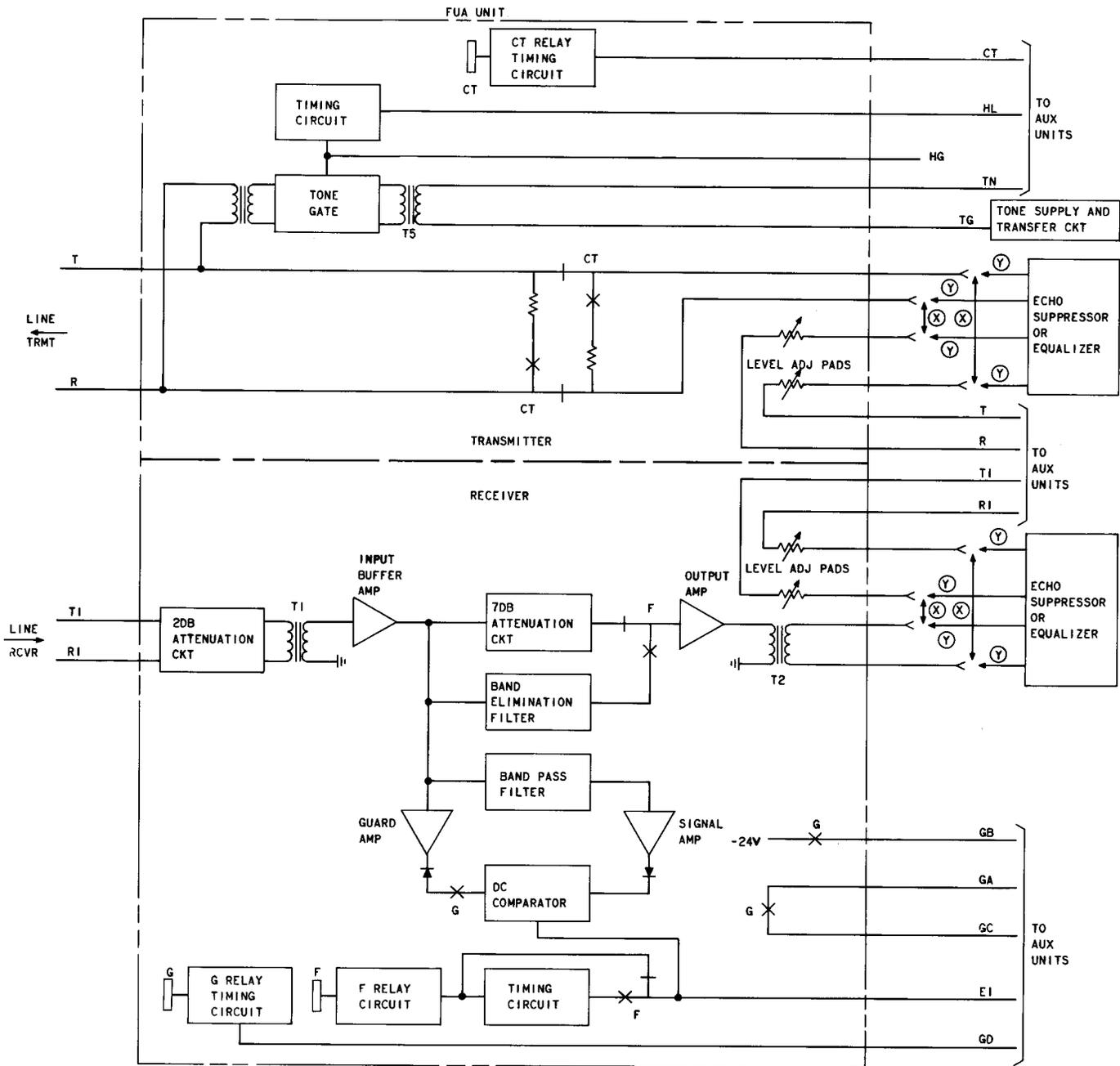
**5.02** The Type F Test Extender SD-1C241-02 is provided to gain access to the transmission and signaling ports. Use of the test extender will necessitate the removal of the SF units from the bay. The test extender provides jack access to all transmission and signaling ports of the SF units.

**5.03** 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.



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



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Fig. 4—Block Diagram of FUA Unit

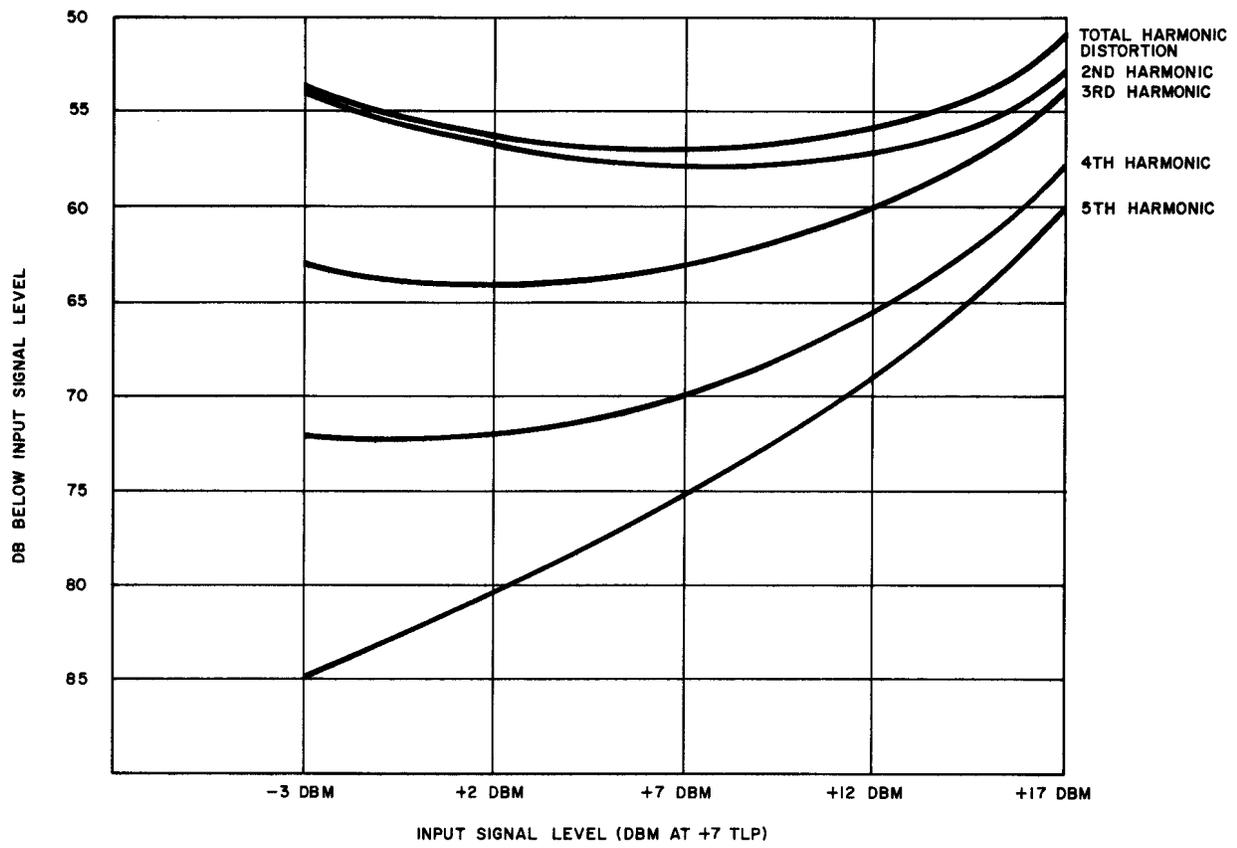


Fig. 5—Receive Harmonic Distortion Affect