

## TYPE F SINGLE FREQUENCY SIGNALING SYSTEM

### GENERAL DESCRIPTION

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**1. GENERAL**

**1.01** This section provides a general description of the Type F Single Frequency (SF) Signaling System. Detailed information on individual plug-in units can be found in the 179 Division of Bell System Practices. This section supersedes Section 975-260-100, Issue 2.

**1.02** This section is reissued to include the FLC-L2 and FXA F- to G-signaling adapter units. Change arrows are used to indicate these changes. The Equipment Test List is not affected.

**1.03** The Type F SF Signaling System is mainly comprised of plug-in units, which can be categorized as follows: (1) common bay equipment,

and (2) SF units. The common bay equipment, as arranged in the application schematic and bay wiring (see SD-1C240-01 or -02), consists of (1) Fuse and Alarm Circuit SD-1C239-01 or -02, (2) Carrier Group Alarm Control Circuit SD-1C284-01, (3) Tone Supply and Transfer Circuit SD-1C224-01 or -02 and (4) -48 to -24V de-to-dc Power Converter SD-81868-01. The SF units are plug-in type units which contain the circuitry to provide an interface between a 4-wire carrier or metallic facility and office, station, or duplex (DX) signaling equipment. The SF unit which is to be used depends upon: (1) the particular function desired, (2) compatibility with SF unit at distant end, (3) the office side interface, and (4) the bay arrangement. Individual SF units are described in Part 2.

**1.04** The Type F SF Signaling System supersedes the E-type signaling system in all applications except revertive pulsing but will not directly replace E-type SF units because of differences in physical design. However, the Type F signaling units are compatible with most of the E-type units working at the distant end of a specified circuit. (See Table A.) The circuitry of the Type F units has been substantially improved over the E-type units. These improvements provide better signaling and transmission performance, better operating stability, and better component reliability.

**1.05** The Type F signaling system provides a means of transmitting address and supervisory information for telephone switching systems over transmission facilities on an ac inband (within voice frequency range) basis. Basically, the system converts dc signals from connecting trunk or station equipment into a 2600-Hz tone that shares the transmission path with the speech. The Type F signaling units convert signals, as required, to initiate and terminate telephone connections. These converted signals are for connect (seizure), stop dialing, start dialing, wink, start pulsing, dial pulsing, ringing, answer, disconnect, ringforward, and ringback.

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**SECTION 179-360-100**

**1.06** Direct current (DC) signals are converted to 2600-Hz tone signals at one end of a trunk and reconverted into dc signals at the other end of the trunk. A 2-state signal of tone on/tone off in each direction of transmission corresponds to on-hook/off-hook signals, respectively, and is received by the connecting equipment. Generally, the normal speech transmission path of a carrier or 4-wire metallic facility is used for the transmission of the tone and speech signals. 20-Hz ringing signals are converted to 2600-Hz tone on signals except, when in ground-start operation, the 2600-Hz ringing signals are converted to 2600 Hz modulated at 20-Hz rate.

**1.07** Optional circuit conditions can be selected and provided through the use of screw-type switches which are usually located on the faceplates of the SF units. Most of the options, such as build-out resistance, build-out capacitance, carrier group alarm features, loop-start or ground-start features, simplex (SX) inductors, etc, can be switched in or out while the Type F SF unit is in its in-service position. The SF units, including most of the common bay equipment, can be placed into and removed from service with ease. Simply loosen the locking device on the face of the unit before extracting it from the bay position, or slide the unit forward until the locking device locks when inserting it into its bay position.

**1.08** A shorthand, three-letter, coded system has been developed to identify the major system components of the Type F signaling system. The first letter identifies the component as being part of the Type F signaling system, the second letter identifies the component as being within a particular family group, and the third letter identifies the particular unit within the family group. The family groups can be identified as follows:

FAMILY GROUP	TYPE OF UNIT
FA—	2-wire E&M auxiliary units
FB—	4-wire E&M auxiliary units
FC—	Loop originating auxiliary units
FD—	Loop terminating auxiliary units
FG—	2-wire DX and 20-Hz ringdown auxiliary units

FAMILY GROUP	TYPE OF UNIT
FH—	4-wire DX and 20-Hz ringdown auxiliary units
FL—	2-wire special access CO end auxiliary units
FM—	Miscellaneous signaling units
FP—	4-wire special access auxiliary units located toward or at CO end
FR—	4-wire special access auxiliary units located toward or at station end
FS—	2-wire special access station end auxiliary units
FT—	Test equipment
FU—	2600-Hz signal converters (required with auxiliary units)
FW—	4-wire E&M signaling units (single-module unit, FU_ not required)
FY—	Miscellaneous units other than signaling units.

**2. EQUIPMENT**

**A. Bay Arrangements**

**2.01** There are two basic bay arrangements provided for in the Type F signaling system, each of which is available in four different ceiling heights. The bay which accommodates FWA, FWB, or FWC SF units is one arrangement (single module), and the bay which accommodates an FU( ) converter unit in conjunction with an auxiliary SF unit is the other arrangement (double module). The single-module bay arrangements are intended to be used in offices which require a large number of 4-wire E and M lead SF units. The double-module bay arrangement, which utilizes the FU( ) converter units in conjunction with auxiliary SF units, is an arrangement in which any or all of the available auxiliary SF unit applications can be used. These bay configurations cannot be mixed,

that is, the entire bay must be either single or double module.

**2.02** There are several other bay arrangements using Type F signaling equipment. Most of these are consolidated and unitized arrangements. When practical, the consolidated (J98624) and unitized (J98626 or J98629) arrangements are more desirable because of the following features:

- Significant reductions in the amount of cabling and distributing frame cross-connection
- Related transmission equipment located in same bay for easy access
- Includes maintenance features [such as Switched Maintenance Access System (SMAS)].

The consolidated and unitized bay arrangements are not covered in this section. Refer to the 332 Division of Bell System Practices for information on these bay arrangements.

#### **Single-Module Bay Arrangements (J99335)**

**2.03** The single-module bays are available in four different sizes. An 11-foot 6-inch bay has mountings for 132 SF units, a 10-foot 6-inch bay has mountings for 108 SF units, a 9-foot bay has mountings for 96 SF units, and a 7-foot bay has mountings for 60 SF units. In each case, the bay has two tone supplies and associated transfer circuit, and a fuse and alarm panel. The bay will also contain a number of -48 volt dc to -24 volt dc power converter units. The bay will be equipped with a power converter unit for each 18 to 24 SF units, but not less than two such power converters per bay.

**2.04** For small central office (CO) or private branch exchanges (PBX) installations, framework, apparatus, wiring (for one tone supply), one -48 volt dc to -24 volt dc regulated power converter, and mountings for either 8 or 20 FWA, FWB, or FWC SF units are available. This combined package can be mounted in any bay which accepts standard 23-inch mounting plates.

#### **Double-Module Bay Arrangements (J99335)**

**2.05** The double-module bays are available in four different sizes. An 11-foot 6-inch bay has mountings for 72 signaling circuits (FUA unit plus

an auxiliary SF unit), a 10-foot 6-inch bay has mountings for 60 signaling circuits, a 9-foot bay has mountings for 48 signaling circuits, and a 7-foot bay has mountings for 36 signaling circuits. In each case, the bay has two tone supplies and associated transfer circuit, and a fuse and alarm panel. The bay will also contain a number of -48 volt dc to -24 volt dc power converter units. The bay will be equipped with a power converter unit for each 9 through 12 signaling circuit, but not less than two such power converter units per bay. The bay arrangements to be equipped with auxiliary SF units, which utilize looped signaling leads, have an additional resistor wired to pin 26 of the auxiliary SF unit mounting to provide the SB lead battery for the looped M lead.

**2.06** Figure 1 shows an 11-foot 6-inch double-module bay arrangement.

**2.07** For small CO or PBX installations, framework, apparatus, wiring (for one tone supply) and mountings for either 6 or 12 signaling circuits [FU( ) unit plus an auxiliary SF unit] are available. This combined package can be mounted in any bay which accepts standard 23-inch mounting plates.

**2.08** Figure 2 shows a bay arrangement for 12 signaling circuits.

### **B. Common Bay Equipment**

#### **Tone Supply and Transfer Circuit**

**2.09** The tone supply and transfer unit (FYA), which provides steady 2600-Hz tone to the signaling units, is shown in Fig. 3. The FYA unit is supplied in pairs for all full bay arrangements. Normally, the bay load is divided between the two units. If one of the units encounters a trouble condition, its load is automatically transferred to the other unit.

**2.10** The tone supply and transfer circuit is contained in a die cast aluminum frame which is approximately 2 inches high by 8 inches wide by 10-1/2 inches deep. Two tone supply and transfer units occupy the space of one standard 23-inch mounting plate.

**2.11** The source of the 2600-Hz tone is a stable tuned reed selector consisting of a coil magnetically coupled to a reed that is tuned to 2600 Hz. The tone supply circuit utilizes automatic

gain control (AGC) circuitry for regulating its output. A dc output voltage is supplied to the transfer circuit for monitoring purposes.

**2.12** The transfer circuit consists of a balanced dc bridge which controls operation of a transfer relay. The balanced bridge monitors the dc output from the tone supply. An unbalanced condition of the bridge causes the transfer relay to operate which in turn transfers the load to the good tone supply and activates audible and visual alarm conditions.

**-48 Volt dc to -24 Volt dc Power Converter (J98703A,L1)**

**2.13** The -48 volt dc to -24 volt dc power converter, hereby referred to as the power converter, is shown in Fig. 4. The power converter provides regulated -24 volts dc power to the Type F signaling units and the tone supply and transfer circuit in the bay. The power converter reduces the effect of -48 volt office battery noise and limits variations in voltage. The power converter also helps to isolate the 2600-Hz signal tone from the office -48 volt dc supply.

**2.14** The number of power converters that are required in a bay arrangement depends upon the type and size of the bay. (See paragraphs 2.03 and 2.05.) A power converter unit is approximately 8 inches high by 3-1/2 inches wide by 10-1/2 inches deep. Six power converter units occupy approximately 10 inches of vertical space in a standard 23-inch bay.

**2.15** Five test jacks are mounted on the face of the power converter unit (J1-J5). These test jacks provide access for measuring the input and output voltages of the power converter. The -48 volt dc input can be checked using test points J1 and J2 and the -24 volt dc output can be checked using test points J3 and J4. The regulating circuit of the power converter can be monitored by using test point J5.

**Carrier Group Alarm Control Circuit**

**2.16** The carrier group alarm control (FYG and FYH) units provide a means of activating the trunk processing features of the auxiliary units, which include the stopping of charges on a call and preventing further trunk seizures. It also returns the trunk circuit to service when the carrier

has been restored. This unit will not be used in conjunction with single-module FWA, FWB, or FWC SF unit applications. The SD-5G423-01 carrier group alarm trunk release and make-busy circuit is used with the single-module FW\_ units. The 5G423-01 unit is 2 inches high and 23 inches wide, and is designed for use in the standard bay. The 5G423-01 unit operates basically the same as the FYG and FYH.

**2.17** The FYG or FYH unit receives a ground on the SA lead when the associated carrier alarm circuit is activated. It responds to the ground condition and grounds the ALM, ALO, and W1-12 leads (associated with the auxiliary SF units) as a trunk release and make-busy signal. Approximately 10 seconds later (2.5 seconds for FYH and 5G423-01) battery is applied to the ALB lead toward the auxiliary SF units as a delayed make-busy indication. If the W1-12 leads are being used in step-by-step offices with sleeve lead control, ground is momentarily removed from the W\_ leads (wink) allowing the switching equipment to release. The FYH unit has a set of break contacts for connection to the ESS remote master scanner.

**2.18** The FYG and FYH units are approximately 8 inches high by 2 inches wide by 10-1/2 inches deep. The FYG is shown in Fig. 5. The FYG and FYH units are used only in double-module bay arrangements. The maximum number of FYG or FYH units required ranges from six for the 11-foot 6-inch bay to three for the 7-foot bay. One FYG or FYH unit is required for each group of twelve 2-module signaling units.

**Fuse and Alarm Panel**

**2.19** The fuse and alarm panel provides means for distributing and fusing -48 volt dc battery power for the dc power converters, for the auxiliary units, and to the SB lead resistors. The -24 volt dc output from the power converters is also distributed and fused by this circuit. The -24 volts is required by the tone supplies and the signaling units. The fuse and alarm circuit will also detect a blown fuse and activate either a major or minor alarm (depending upon fuse that is blown). The alarm portion of the circuit will also detect a failure from the power converters.

**2.20** The fuse and alarm panel occupies 4 inches of vertical space in the signaling bay. The fuse and alarm can be seen in Fig. 1.

### C. SF Units

**2.21** A number of SF signaling units have been designed to provide a wide variety of services. An SF unit is approximately 1-1/2 inches wide by 8 inches high by 10-1/2 inches deep. All circuit components are mounted on a printed board and are contained in a die cast aluminum frame. Figure 6 shows a mated pair of SF units. Table A provides a list of the SF units and corresponding features. The SF units, which are listed in Table A, are grouped and described briefly in paragraphs 2.22 through 2.28.

**2.22 FA\_ and FB\_ Units:** These units are 2- or 4-wire, 600- or 900-ohm, E and M lead, auxiliary signaling SF units. They can be used at either the originating or terminating end, or both, of a signaling link or at an intermediate point when more than one signaling link is used. These units can be used for either DP (dial pulse) or MF (multifrequency) signaling applications.

**2.23 FC\_ and FD\_ Units:** These units are 2-wire, 900-ohm, loop signaling auxiliary SF units. The FC\_ units are used at the originating end of the interoffice trunks, whereas the FD\_ units are used at the terminating end of interoffice trunks. DP or MF signals can be used.

**2.24 FG\_ and FH\_ Units:** These units are 2- or 4-wire, 600- or 900-ohm, DX or 20-Hz signaling auxiliary SF units. The DX units (FGA and FHA) are used on applications which require conversion from DX to SF signaling (and vice versa). The 20-Hz ringdown units (FGM, FGN, FHM, and FHN) are primarily intended for use on private line applications which require conversion from 20-Hz ringing to SF signaling (and vice versa). The 20-Hz ringdown units have switches which allow for code selection of the ringing signal.

**2.25 FL\_, FP\_, FR\_, and FS\_ Units:** These units are 2- or 4-wire, 600- or 900-ohm, special access, auxiliary SF units. The FP\_ and FR\_ units can operate on either an E and M lead or loop signaling basis. The FL\_ and FS\_ units can only operate on a loop signaling basis. The FL\_ and FP\_ units are used at the central office end, and the FR\_ and FS\_ units are used at the station end of special line or trunk applications. ♦The FLC unit has been modified to FLC-L2 to provide an improved impedance match for the ESS office associated with the Remote Switching System

(RSS) application. This modification consists of an additional compromise network which can be switched in and out of the circuit by means of a slide switch. Another feature of the modification is the alarm make-busy (ALB) function which when activated operates the R relay. Operation of the R relay makes the trunk appear on-hook for approximately 2.5 seconds and then permanently busy to new calls.♦ The FPD unit is used at the CO end of the analog carrier and the FRD is used at the station end of the analog carrier. The FPD and FRD units connect directly to D-Tandem channel units. Figures 7 and 8 illustrate typical applications of FPD and FRD units.

**2.26 FM\_ Units:** These units are nonsignaling auxiliary SF units. They provide a transmission interface to the associated office or station equipment, and are used on applications where no signaling is required.

**2.27 FU\_ Units:** The FUA and FUD units are SF signaling converters which convert dc pulses to ac signals and vice versa. These units interface between the 4-wire transmission facility and auxiliary signaling unit. The FUA has active components and the FUD has integrated circuits. The FUD has a built-in gain transfer and line balancing network which allows for elimination of external repeaters and range extenders.

**2.28 FW\_ Units:** These units are 4-wire, 600-ohm, E and M lead signaling SF units. They are used in single-module bay applications. They can be used at either the originating or terminating end, or both, of a trunk or at an intermediate point when more than one signaling link is used.

**2.29** All 2-wire units, except the FAA and FGA units, have inductors in series with the A and B leads for the following reasons:

- Low frequency return loss is improved as the induction appears as high impedance, preventing the A and B lead resistance from shunting the midpoint capacitor.
- This induction also prevents fast rise time current pulses in the loop, reducing crosstalk due to current transients such as dial pulse currents.

- Any electrical noise (above 20 Hz) in the A and B leads or CO battery-ground leads, is blocked from entering the voice paths.

All 2-wire units have a switchable compromise network and adjustable building out capacitors and are arranged for the connection of an external precision network if required.

**2.30** When 2-wire E and M lead signaling units are used (FA<sub>1</sub>), the A and B leads are extended to the office equipment for the option of removing the 1- $\mu$ F capacitor in the 2-wire terminating set. This is the only function of the A and B leads for these units.

#### D. Test Extenders

**2.31** Two test extenders have been provided to facilitate the testing of the SF units and their associated interface equipment: (1) the FTA extender accommodates FW<sub>1</sub> SF units, and (2) the FTB extender accommodates FW<sub>1</sub> or FUA plus auxiliary SF units. The FTB test extender is shown in Fig. 9.

**2.32** The test extender consists of a test stand with a number of jacks and keys and a cable extender that connects from the test stand to the bay mounting. The test extender provides access to the transmission and signaling ports associated with the particular SF unit under test while allowing the SF unit to remain electrically connected to the circuit. The connections which are required to place the SF unit in a test condition are shown in Fig. 10.

#### E. F- to G-Signaling Adapter

**2.33** The F- to G-signaling adapter unit which is designated as FXA unit provides the electrical and mechanical interface required for a G-signaling unit to plug into a double-module shelf (FU<sub>1</sub> + F-AUX).

**2.34** The FXA adapter unit converts the -24 and -48 volts dc supplied to the F-signaling units to +12, +5, and -12 volts which are required for the G-signaling units. If either one of these voltages varies out of limits, a visual alarm on the faceplate of the adapter is displayed. (See Fig. 11.) The adapter also converts F-signaling carrier group alarms (CGA) into G-signaling CGA and connects signaling features between the two systems which

are identical and do not require signal conversion. There is a switch on the faceplate which is operated to either 2-wire or 4-wire position depending on the type of operation.

### 3. APPLICATIONS

**3.01** Type F signaling units are available for a large variety of applications. Although the SF units are primarily intended to be used on carrier facilities, they may also be used on 4-wire metallic facilities when V4 repeaters are used at SF signaling unit locations. Signaling units are available for most all applications requiring conversion from loop signaling, E and M lead signaling, DX signaling, or 20-Hz ringing to 2600-Hz tone (SF) signaling. Figures 12 through 18 illustrate typical applications of Type F units.

**3.02** Most of the Type F signaling units are compatible with each other. In addition, they are also compatible with a large number of the SF units within the E-type signaling system. Compatibility information for Type F units can be found in the sections which are referenced in Part 7 of this section.

### 4. OPERATIONAL REQUIREMENTS

#### Transmission Units

**4.01** The Type F signaling units are designed to function over the voice paths of 4-wire broadband J, K, and L carrier, various radio transmission systems, N or O carrier systems, and T carrier systems. On any facility which is used, -16 dBm and +7 dBm transmission level points (TLP) must be used. The SF units should not be removed from the +7 and -16 TLPs by more than 5 dB overall combined net loss at 2600 Hz. This loss may be evenly divided between the transmitting and receiving ends, or may be all at one end or the other.

**4.02** The transmission facility should not introduce a frequency shift greater than 10 Hz and should be held to within  $\pm 5$  dB at 2600 Hz.

**4.03** The 2600-Hz tone from the tone supply and transfer unit shall be within 5 Hz of the 2600-Hz frequency. The 2600-Hz tone is supplied to the individual SF signaling units at a fixed voltage of .246 volt ac (approximately -10 dBm). Reduction to -36 dBm (low level tone) and -24

dBm (high level tone) takes place in the SF signaling units for transmission at a -16 TLP.

**4.04** The operating voltage, which is obtained from the -48 volt dc to -24 volt dc power converter, shall be held to within -24  $\pm$ 1.2 volts dc.

**4.05** Loss through the receive path band-elimination filter shall be at least 35 dB at 2600 Hz  $\pm$ 10 Hz.

**4.06** The losses at 1000 Hz through the transmit path are 0.1  $\pm$ 0.1 dB and  $\pm$ 0.25 dB through the receive path.

**4.07** Message circuit noise must not exceed 50 dBm0 for noncompanded channels, 60 dBm0 for companded channels, and voice frequencies must not exceed +10 dBm0.

#### **E and M Lead Units**

**4.08** E and M lead units are designed to function with circuits that furnish -48 volt battery through a 13A resistance lamp or through 500 ohms on the M lead to the SF unit as an off-hook signal, and ground or open as an on-hook signal. The E and M lead unit furnishes ground or closed circuit condition on the E lead as an off-hook signal, and an open circuit as an on-hook signal.

**4.09** The M lead earth potential difference when separate batteries are involved shall not exceed  $\pm$ 3.0 volts, and the external resistance on the M lead loop shall not exceed 1000 ohms.

**4.10** Current through the E lead must not exceed 1/3 ampere. External contact protection must be provided when inductive (relay) loads are connected to the E lead.

#### **DX Units**

**4.11** The maximum amount of resistance on the DX loop shall not exceed 5000 ohms and the minimum amount of insulation resistance shall be 100,000 ohms.

**4.12** The maximum amount of dc earth potential is  $\pm$ 30 volts and the maximum amount of induced longitudinal voltage shall not exceed 35 volts ac (RMS).

**4.13** The D relay pulse distortion shall be within  $\pm$ 2 percent break (both office talk batteries equal).

#### **20-Hz Ringdown Units**

**4.14** The 20-Hz ringdown unit, when combined with an FU( ) 2600-Hz converter unit, changes dc signals or ac ringing signals to 2600 Hz, which is transmitted over the carrier.

**4.15** The ac ringing voltage shall be no less than 84 Vrms and no greater than 110 Vrms at 17 through 35 Hz. The duration of the ring should be no less than 450 milliseconds.

**4.16** The dc signal voltage applied to the S1 lead will be negative and should not exceed -43 volts.

**4.17** When in the CODE and NO CODE modes, the ringdown durations from a distant station to a near station are a minimum of 1.40 seconds and maximum of 2.50 seconds.

**4.18** In the EXT CODE mode where ac ringdown from the distant station is employed, the minimum ringdown toward the near station will be 350 ms shorter than that sent from the distant station. When ringdown from the distant station exceeds 1.75 seconds, the duration of the ringdown toward the near station will be a minimum of 1.40 seconds.

**4.19** In the EXT CODE mode where the dc interface is used at the distant station, the minimum ringdown toward the near station will be 300 milliseconds shorter than the dc signals applied to the distant unit. When dc signals applied to the distant station exceed 1.7 seconds, the minimum ringdown toward the near station is 1.40 seconds.

**4.20** The insulation resistance across the 2-wire loop or between any conductor and ground must be greater than 30,000 ohms.

**4.21** The maximum absolute value of superimposed direct current is 53 volts.

**4.22** The maximum 60-Hz longitudinal induced noise is 40 Vrms.

**Units Employing A and B Leads**

**4.23** Build-out resistors (BOR) must be inserted when the external conductor loop resistance on the A and B leads is less than 520 ohms (for loop terminating and special access units only).

**Special Access Units**

**4.24** The ringing supply associated with special access units should have the following characteristics:

- (a) Maximum negative superimposed dc voltages—  
-53 volts
- (b) RMS ac voltage—60-120 volts
- (c) Frequency:  
  
Loop start—17-35 Hz  
Ground start—17-23 Hz
- (d) Ringing detector requires grounded ringing source.

**5. TYPICAL SF UNIT OPERATION**

**5.01** All Type F signaling units are similar in operating principles. Individual SF signaling units contain features which adapt to particular circuit applications. All SF units receive dc (ac for ringing) signals from office equipment and convert these signals into 2600-Hz tone signals which are applied to the transmission line toward an SF signaling unit at the distant end of the transmission facility. Receiving portions of an SF signaling unit must determine when a 2600-Hz signal is present at the incoming line and convert the signal to the appropriate dc (ac for ringing) signal. Signals used for the various signaling units are listed in Tables B through H.

**5.02** An FBA SF unit used in conjunction with an FUA SF unit is described in this part of the section, since the operating principles of this unit are representative of most Type F units. Figure 12 shows a typical circuit arrangement—a 4-wire transmission facility terminating into a 2-wire switching office on one end and a 4-wire switching office on the other end.

**5.03** A functional diagram of an FBA SF unit being used in conjunction with an FUA SF

unit is shown in Fig. 19. Together, the two units comprise a complete signaling circuit. The complete signaling circuit (FBA unit plus FUA unit) can be divided into three parts: (1) signal transmitter, (2) signal receiver, and (3) timing circuit.

**Signal Transmitter**

**5.04** The signal transmitter, which is controlled by the condition of the M lead, controls operation of the M relay. In the idle condition (on-hook) the M lead is grounded, causing the M relay to be operated. The M relay applies low level (-36 dBm) 2600-Hz tone to the line toward the distant SF unit. When the switching machine seizes the trunk, -48 volt battery is applied to the M lead causing the M relay to release, thus removing 2600-Hz tone from the line.

**5.05** When dialing, ground or open and battery pulses are applied to the M lead which pulses the M relay, which in turn applies high level (-24 dBm) tone pulses to the line. A cut control circuit is activated during pulsing which terminates the line facility and connecting equipment with 600 ohms. This prevents noise or speech from interfering with the tone signals. The M relay has operate and release timing circuits associated with it to improve the pulses which are received on the M lead. A pulse shaper circuit is also provided to guarantee a minimum interval between repetitive pulses and shorten long single pulses.

**5.06** At the end of pulsing, the M relay is released and the transmission path is cut through. With exception to the level adjusting pads in the FUA SF unit, the 1000-Hz loss through the transmit path is approximately 0.1 dB.

**5.07** The tone gate and timing circuit consists of an amplifier, a diode switching gate (for high and low level tone control), and a timer. The M relay contacts provide tone control. With the M relay operated, the tone gate is closed and tone is applied to the line facility. High and low level tone control is provided by a diode switching gate. The high level tone is applied to the line during pulsing and ringing. Low level tone is transmitted during the idle condition.

**Signal Receiver**

**5.08** The signal receiver is controlled by the condition of 2600-Hz tone received at the

receive port from the line facility. In the idle condition (on-hook) 2600-Hz tone is present at the line receive port, causing -24 volts dc to be applied to the E1 lead of the FBA SF unit and keeping the R relay released. When the trunk is seized by the switching machine at the distant end, the tone is removed from the line causing the R relay to operate. With the R relay operated, the loop between the E and EG leads is closed.

**5.09** When dialing at the distant end, 2600-Hz tone pulses (at the dialing rate) are received at the line port. These tone pulses are detected and converted into dc pulses causing the R relay to pulse. Operate, release, and minimum break timing circuitry is provided for pulse correction. The FBA SF unit is limited to receiving tone pulses in the range of 7.5 through 12.5 pulses per second. A minimum tone pulse of 38 milliseconds is required to operate the receiver. If the tone pulses are within the input limits, an output closure between the E and EG leads of at least 47 milliseconds break is guaranteed.

**5.10** When 2600-Hz tone is being received, the R relay is released, grounding the GD lead toward the FUA SF unit and keeping the G relay released. With the G relay released, the guard amplifier in the FUA unit is disconnected from the dc comparator. This is known as the broadband condition. The G relay is slow to release (180 milliseconds) and, therefore, holds operated during pulsing. With the G relay operated, the narrowband condition exists. The narrowband condition reduces false operation of the R relay operate timer (caused by speech interference).

#### **Voice Amplifier**

**5.11** The transmission path through the receive circuit is directed through a voice amplifier. Voice signals are dropped 2 dB before entering the amplifier. The first amplifier stage is provided for impedance matching and does not provide any gain. Voice signals are attenuated another 7 dB before entering the output amplifying stage which provides 9 dB of gain. The output level of the receiving circuit is within  $\pm 0.25$  dB of the input signal at 1000 Hz.

**5.12** The 2600-Hz tone which is received at the receive circuit (of the voice amplifier) is directed through two separate paths. One path is via a bandpass filter, signal amplifier, rectifier,

and on to a dc comparator. The other path is via a guard amplifier, a rectifier and on to the dc comparator. The dc comparator is preset to operate when the ratio between the signal and guard amplifier energy is 8 dB. This ratio will only be correct for 2600-Hz tone signals which are within the limits stated in Part 4.

**5.13** When SF tone is received, the F relay is operated and two filters are inserted into the transmission path. A 2600-Hz bandpass filter directs signal tone to a signal amplifier and filters out speech and noise signals. A band-elimination filter is inserted between amplifier stages in the speech path causing high losses at and close to the 2600-Hz frequency. The band-elimination filter, therefore, allows speech to pass through but blocks signal tone (2600 Hz).

## **6. MAINTENANCE**

**6.01** There are no field adjustments to be made on the various units of the Type F signaling system other than pad selection and screw switch operation for build-out resistance and capacitance and carrier group alarm function. Units not meeting circuit requirements should be replaced with spare units and defective units should be sent to Western Electric Company repair centers for repair.

**6.02** Type F signaling test extenders are provided to gain access to transmission and signaling ports of the Type F signaling units. The Type F signaling unit remains electrically connected to the signaling link when the test extender is used. The FTA test extender accommodates FWA, FWB, or FWC SF units, and the FTB test extender accommodates an FUA SF unit plus its associated auxiliary SF unit or FWA, FWB, or FWC SF units. The test extender provides jack access to all transmission and signaling ports of the Type F units with the exception of the echo suppressor, delay equalizer, or P-pad leads.

**6.03** When using the FTA or FTB test extenders, the signaling unit under test is removed from its in-service position and placed in the test extender receptacle. A cable connects the test extender to the in-service position of the SF unit. With this arrangement, the SF unit can remain electrically connected to its assigned circuit, yet it is removed from the bay and located at a convenient working position.

**SECTION 179-360-100**

**6.04** Overall pulsing tests for Type F signaling units are described in Section 179-302-501 and Section 179-302-502. These tests provide a method for checking the pulsing requirements for the signaling links. Each of these sections provides originating and terminating end procedures.

**7. REFERENCES**

**7.01** The following is a list of sections containing information on component units of the Type F signaling system.

SECTION	TITLE
179-360-101	Type F Signaling—2600-Hz Tone Supply and Transfer Circuit SD-1C224-01—Description
179-361-101	Signaling Test Extender for Use With Type F Signaling Units—Description
179-362-101	2600-Hz FWA, FWB, and FWC Single-Frequency Signaling Units SD-1C225 and SD-1C583-01—Description
179-363-101	Signaling Converter Unit—Description—Type F Signaling System
179-364-101	E and M Loop Auxiliary Units—Description—Type F Signaling System
179-365-101	Special Access Auxiliary Units—Description—Type F Signaling System
179-366-101	Signaling By-Pass Auxiliary Units—Description—Type F Signaling System
179-367-101	DX Auxiliary Units—Description—Type F Signaling System
179-368-101	FGN, FHN Auxiliary Signaling Circuit With Built-In Code Selection for 2-Way 20-Hz Ringdown

Application—Type F Signaling System

**7.02** The following is a list of sections providing signaling tests or adjustments for the Type F signaling units:

SECTION	TITLE
179-302-501	Signaling Tests—Type E and F—Using 2B Signaling Test Set
179-302-502	Signaling Tests—Type E and F—Using 4A Signaling Test Set
179-360-501	2600-Hz Tone Supply and Transfer Circuit—Tests—Type F Signaling System
179-363-301	Adjustment Procedures for FUD Signaling Converter Unit

**7.03** The following is a list of sections related to the Type F signaling system:

SECTION	TITLE
179-701-101	DC Signaling Systems
179-702-101	CX and SX Signaling Systems
310-325-100	Foreign Exchange Message Telephone Arrangements
951-920-100	TOUCH-TONE® Calling—General Description
975-110-100	Local Subscriber Loop Signals and Signaling Systems
975-115-100	Signals and Signaling Systems—Between Offices
975-210-100	MF Pulsing Systems
975-215-100	2400-/2600-Hz Signal System, Toll Systems
975-230-100	DX Signaling Systems
975-240-100	Type E Single Frequency Signaling System

TABLE A

CODE OF AUX MODULE	DRAWING SD-1C-1-01	SWITCHING					SIGNALING						CGA TRUNK CONDITIONING	LINE BUILDOUT RESISTANCE	LIGHTNING PROTECTION	NEAREST TYPE E SIGNALING UNIT	NOTES
		PRINCIPAL TYPE OF SERVICE	CIRCUIT END	CONDUCTORS IN SPEECH PATH	IMPEDANCE OHMS	SUPERVISORY	ADDRESS				PULSING TOWARD OFF-HOOK						
							TRANSMIT TO FAR END		RECEIVE FROM FAR END								
							TYPE OF PULSING	PULSE CORRECTION	TYPE OF PULSING	PULSE CORRECTION							
FAA	227	MSG	O, T	2	900	EM	DP, MF	PS	DP, MF	Timer	Yes	Yes	—	No	E1A	1	
FAB	227	MSG	O, T	2	600	EM	DP, MF	PS	DP, MF	Timer	Yes	Yes	—	No	E1A	1	
FAC	227	MSG	O, T	2	900	EM	DP, MF	PS	DP, MF	Timer	Yes	Yes	—	No	E1A	1, 6, 7	
FAD	227	MSG	O, T	2	600	EM	DP, MF	PS	DP, MF	Timer	Yes	Yes	—	No	E1A	1, 6	
FBA	227	MSG	O, T	4	600	EM	DP, MF	PS	DP, MF	Timer	Yes	No	—	No	E4B	1	
FBB	227	MSG	O, T	4	600	EM	DP, MF	PS	DP, MF	Timer	Yes	Yes	—	No	E4B	1	
FBM	227	MSG	O, T	4	600	EM	DP, MF	PS	DP, MF	Timer	Yes	Yes	—	No	E4B	1	
FBN	227	MSG	O, T	4	600	EM	DP, MF	PS	DP, MF	Timer	Yes	Yes	—	No	E4B	1	
FCA	228	MSG*	O	2	900	LP	DP, MF	PS	—	Timer	Yes	Yes	No	Yes	E4C	2	
FDA	229	MSG*	T	2	900	LP	—	—	DP, MF	Timer	Yes	Yes	Yes	Yes	E4D	2	
FDB	229	MSG*	T	2	900	LP	—	—	DP, MF	CPB	Yes	Yes	Yes	Yes	E4D	2	
FGA	373	PVT	INT	2	900	DX	DX	Timer	DX	Timer	Yes	Yes	—	Yes	None	2, 3	
FGM	153	PVT	O, T	2	900	LP	RD	—	RD	—	—	—	—	Yes	None	2	
FGN	153	PVT	O, T	2	900	LP	RD	—	RD	—	—	—	—	Yes	None	2	
FHA	373	PVT	INT	4	600	DX	DX	Timer	DX	Timer	Yes	Yes	—	Yes	None	1, 3	
FHM	153	PVT	O, T	4	600	LP	RD	—	RD	—	—	—	—	Yes	None	1	
FHN	153	PVT	O, T	4	600	LP	RD	—	RD	—	—	—	—	Yes	None	1	
FLA	231	SA	CO	2	900	LP	—	—	DP	CPB	No	Yes	Yes	Yes	E2L/LA	2	
FLB	231	SA	CO	2	600	LP	—	—	DP	CPB	No	Yes	Yes	Yes	E2L/LA	2	

Legend:

AVN	Autovon Network	MF	Multifrequency Pulse
CO	Central Office	MSG	Intertoll, Toll Connecting and Other Trunks
CPB	Constant Percent Break	O	Originating
CUS	Customer	PS	Pulse Shaper
DP	Dial Pulse	SA	Special Access Lines and Trunks
DX	As in DX Signal Transmission System	T	Terminating
EM	E- and M- Lead Signaling	*	Suitable Loop Signaling Trunk Circuits may not be Available for Intertoll Applications
LP	Loop	RD	Ringdown
INT	Located at Intermediate Central Office	PVT	Private

Notes:

1. Must be associated with FUA signaling converter.
2. Must be associated with FUA or FUD signaling converter.
3. Used to extend signaling on metallic facilities, by means of DX signal transmission, from a carrier terminal situated at an intermediate location on a circuit.
4. Must be associated with FMB, FMC, FMD, or FME to maintain continuity in absence of signaling functions.
5. Used with FMA or FMB to maintain circuit continuity when signaling function is not desired.
6. Has screw switch for connecting or disconnecting the 1-μF capacitor across the A and B leads.
7. Has 3-μF capacitor which may be connected, by means of a screw switch, in parallel with the fixed 1-μF capacitor which is in series with the balancing windings of the hybrid.
8. E and M lead supervisory only available for loop-start applications.

TABLE A (Contd)

CODE OF AUX MODULE	DRAWING SD-1C --- -01 +SD-7C --- -01	SWITCHING					SIGNALLING					CCA TRUNK CONDITIONING	LINE BUILDOUT RESISTANCE	LIGHTNING PROTECTION	NEAREST TYPE E SIGNALING UNIT	NOTES
		PRINCIPAL TYPE OF SERVICE	CIRCUIT END	CONDUCTORS IN SPEECH PATH	IMPEDANCE OHMS	SUPERVISORY	ADDRESS				PULSING TOWARD OFF-HOOK					
							TRANSMIT TO FAR END		RECEIVE FROM FAR END							
							TYPE OF PULSING	PULSE CORRECTION	TYPE OF PULSING	PULSE CORRECTION						
FLC	231	SA	CO	2	900	LP	—	—	DP	CPB	No	Yes	Yes	Yes	E2L/LA	2
FLD	231	SA	CO	2	600	LP	—	—	DP	CPB	No	Yes	Yes	Yes	E2L/LA	2
FMA	296	Replaces FU where only adjustable transmission loss and echo suppressor access are required.														
FMB	296	Replaces FUA or AUX when fixed 4-wire zero trans. loss and no echo supp. access are required.														
FMC	296	Replaces AUX module when a 4-wire extension network with adjustable equalization is required.														
FMD	296	Replaces AUX module when a 900-ohm 4-wire circuit is required.														
FME	296	Replaces AUX module when a 600-ohm 4-wire circuit is required.														
FFA	231	SA	CO	4	600	EM, LP	—	—	DP	CPB	No	Yes	Yes	Yes	E1P	1, 8
FPD	039*	SA	Note 10	4	600	Note 11	—	—	DP	CPB	No	Yes	—	Yes	—	10, 11
FRA	230	SA	CUS	4	600	EM, LP	DP	PS	—	—	No	Yes	No	Yes	E1R	1, 8
FRD	040*	SA	Note 10	4	600	Note 11	DP	PS	—	—	No	Yes	—	Yes	—	10, 11
FSA	230	SA	CUS	2	900	LP	DP	PS	—	—	No	Yes	No	Yes	E2S/SA	2
FSB	230	SA	CUS	2	600	LP	DP	PS	—	—	No	Yes	No	Yes	E2S/SA	2
FSC	230	SA	CUS	2	900	LP	DP	PS	—	—	No	Yes	No	Yes	E2S/SA	2
FSD	230	SA	CUS	2	600	LP	DP	PS	—	—	No	Yes	No	Yes	E2S/SA	2
FWA	225	MSG	O, T	4	600	EM	DP, MF	PS	DP, MF	Timer	Yes	No	—	No	E4B	
FWB	225	AVN	O, T	4	600	EM	DP, MF	PS	MF	Timer	Yes	No	—	No	E1J	
FWC	583	MSG	O, T	4	600	EM	MF	PS	MF	Timer	Yes	No	—	No	E4B	9

Legend:

AVN	Autovon Network	MF	Multifrequency Pulse
CO	Central Office	MSG	Intertoll, Toll Connecting and Other Trunks
CPB	Constant Percent Break	O	Originating
CUS	Customer	PS	Pulse Shaper
DP	Dial Pulse	SA	Special Access Lines and Trunks
DX	As in DX Signal Transmission System	T	Terminating
EM	E- and M-Lead Signaling	*	Suitable Loop Signaling Trunk Circuits may not be Available for Intertoll Applications
LP	Loop	RD	Ringdown
INT	Located at Intermediate Central Office	PVT	Private

Notes:

1. Must be associated with FUA signaling converter.
2. Must be associated with FUA or FUD signaling converter.
3. Used to extend signaling on metallic facilities, by means of DX signal transmission, from a carrier terminal situated at an intermediate location on a circuit.
4. Must be associated with FMB, FMC, FMD, or FME to maintain continuity in absence of signaling functions.
5. Used with FMA or FMB to maintain circuit continuity when signaling function is not desired.
6. Has screw switch for connecting or disconnecting the 1-μF capacitor across the A and B leads.
7. Has 3-μF capacitor which may be connected, by means of a screw switch, in parallel with the fixed 1-μF capacitor which is in series with the balancing windings of the hybrid.
8. E- and M- lead supervisory only available for loop-start applications.
9. Must be used with noncompandored facility in same building only.
10. For use in tandem analog carrier (T1 carrier).
11. 2-state to 3-state conversion.

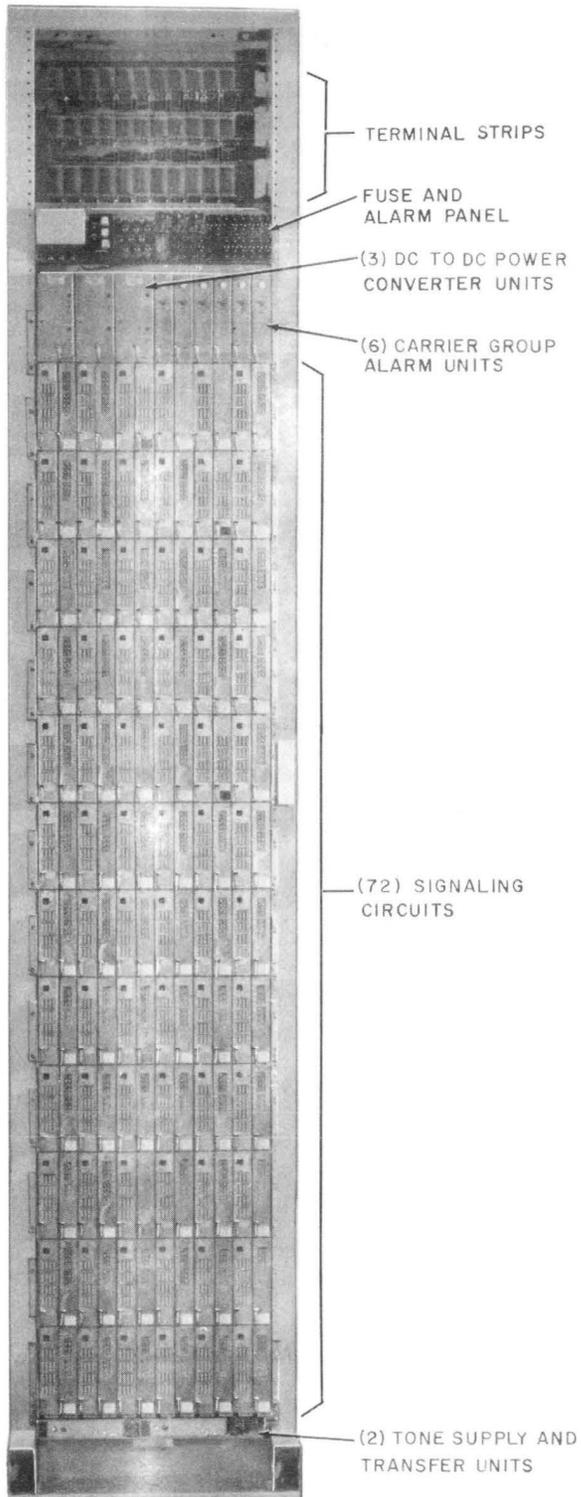


Fig. 1—Double-Module Bay

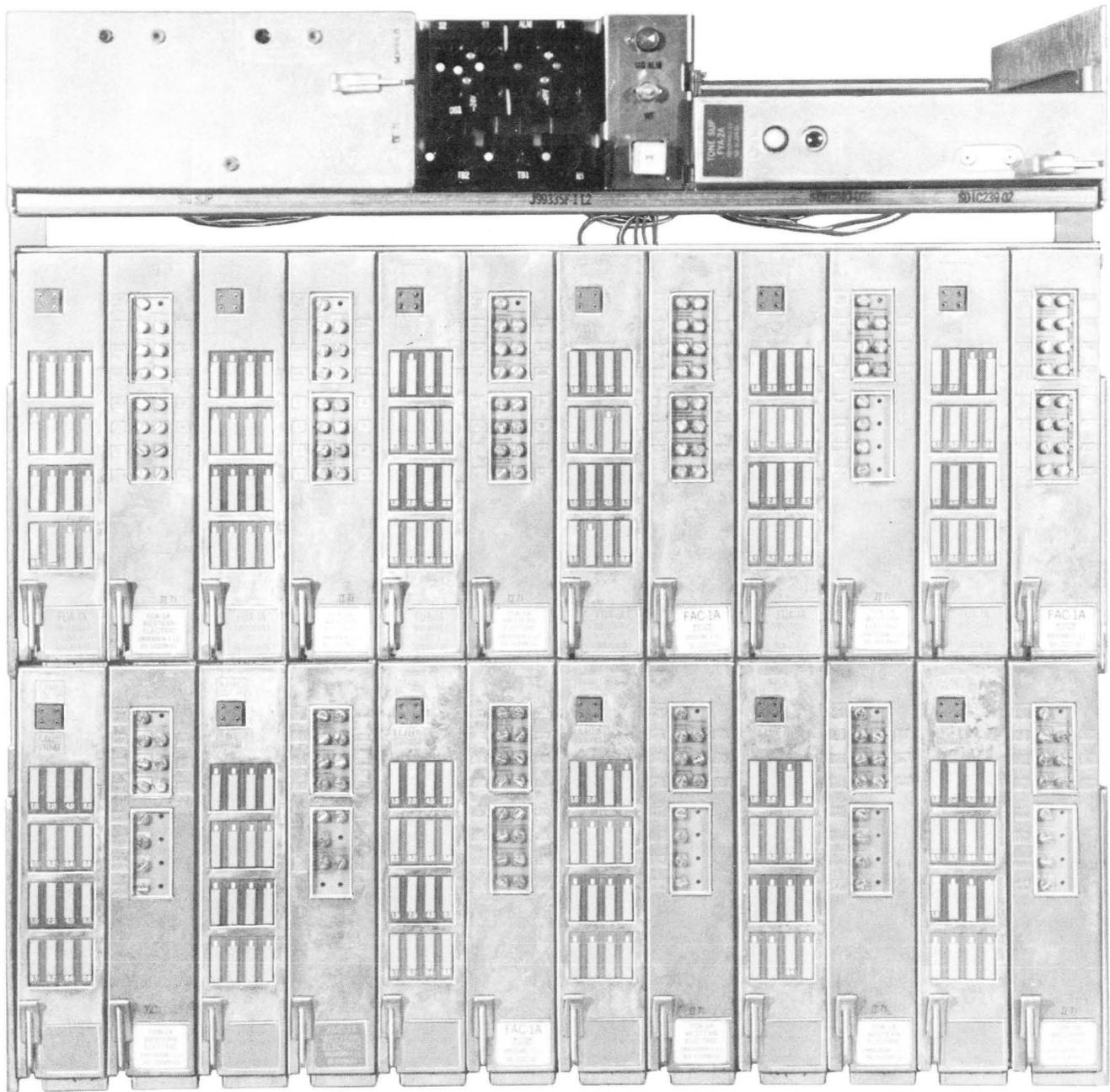


Fig. 2—Small Double-Module Arrangement



Fig. 3—2600-Hz Tone Supply and Transfer Unit

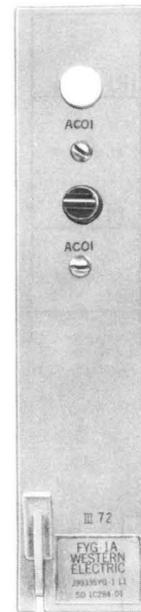


Fig. 5—Carrier Group Alarm Unit

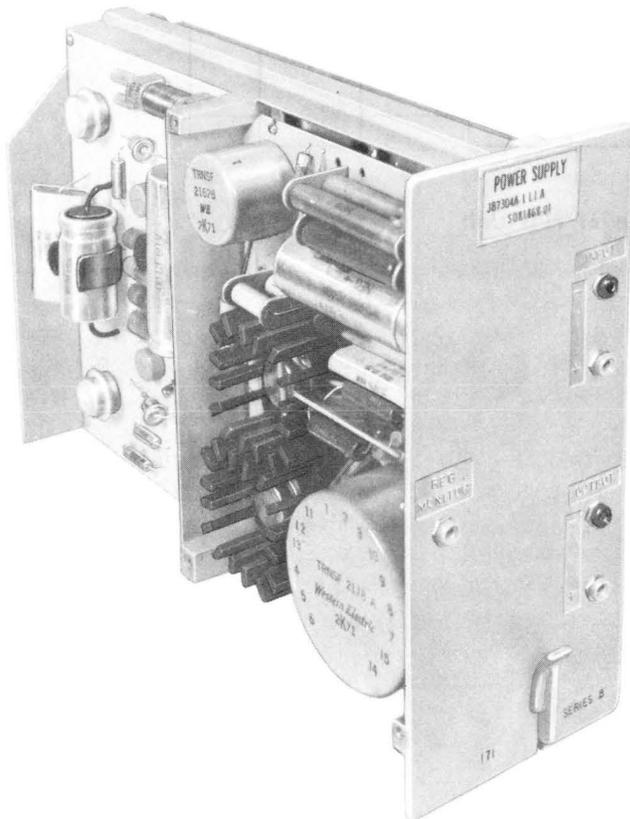


Fig. 4—DC-to-DC Power Converter

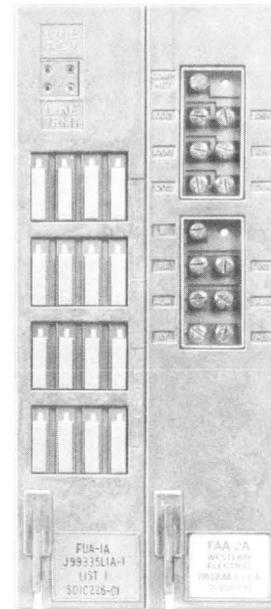


Fig. 6—Mated Pair of SF Units

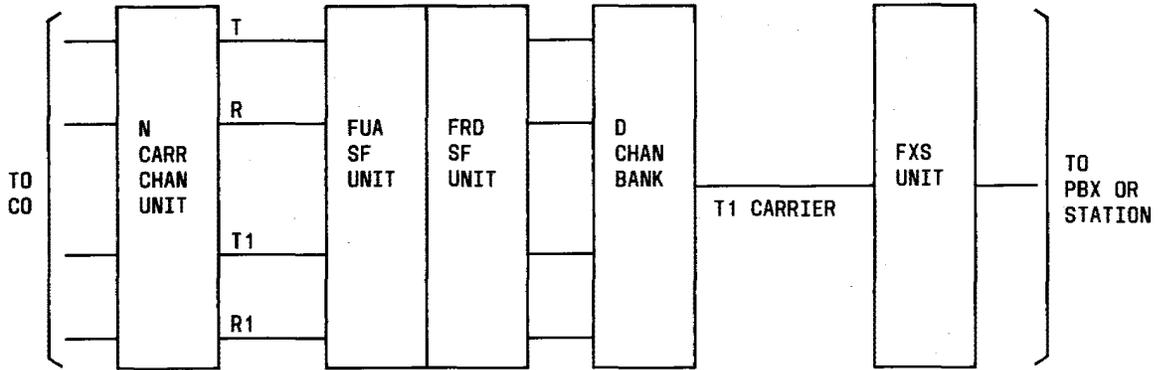


Fig. 7—Typical Application of FRD Unit

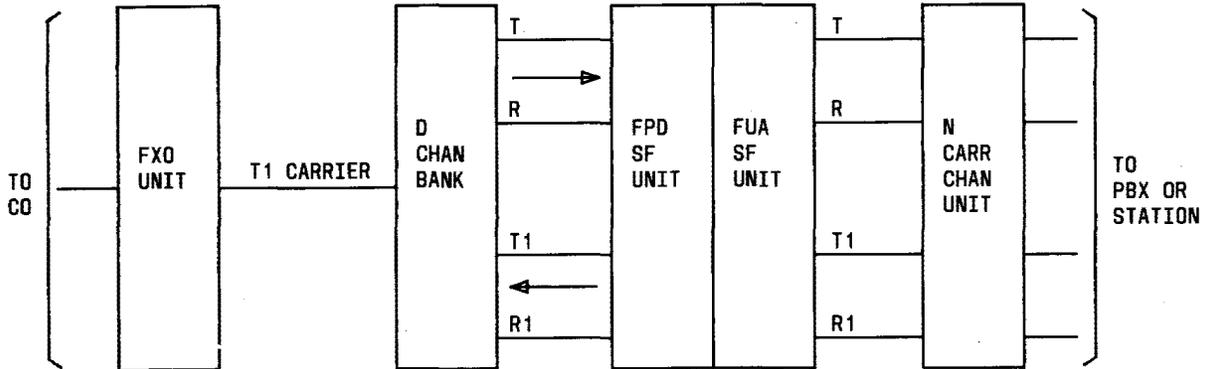


Fig. 8—Typical Application of FPD Unit

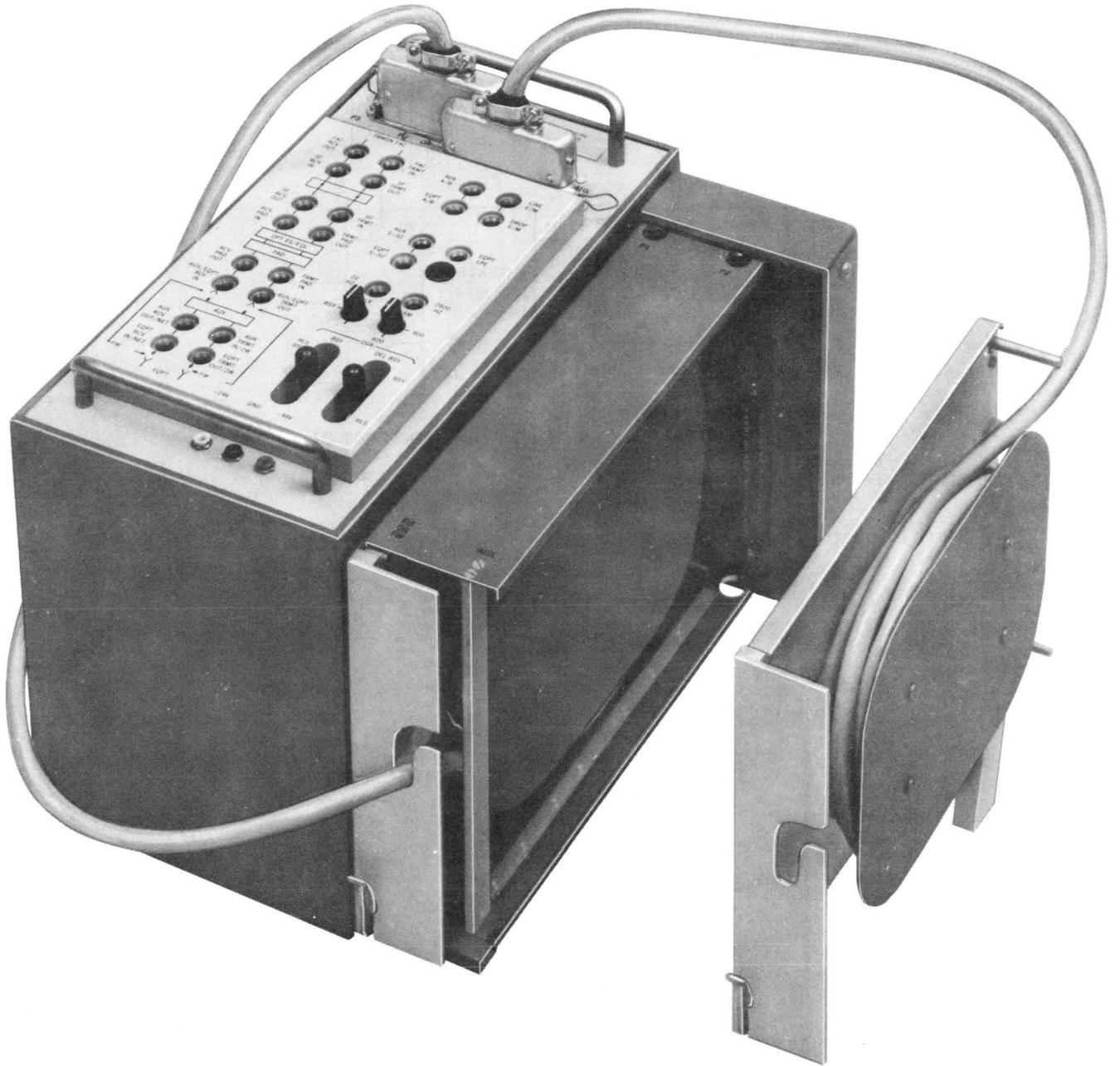


Fig. 9—FTB Test Extender With Cable Extenders Attached

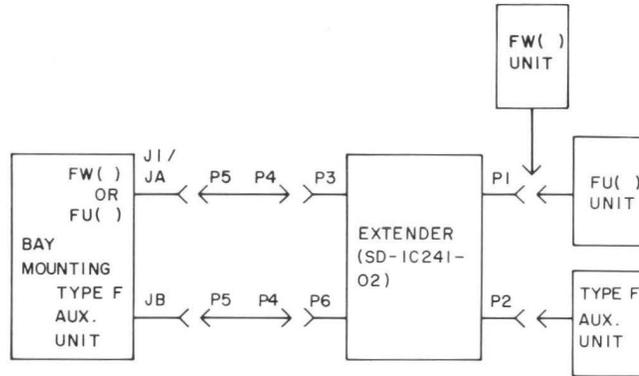


Fig. 10—FTB Test Extender in Use (SD-1C241-02)

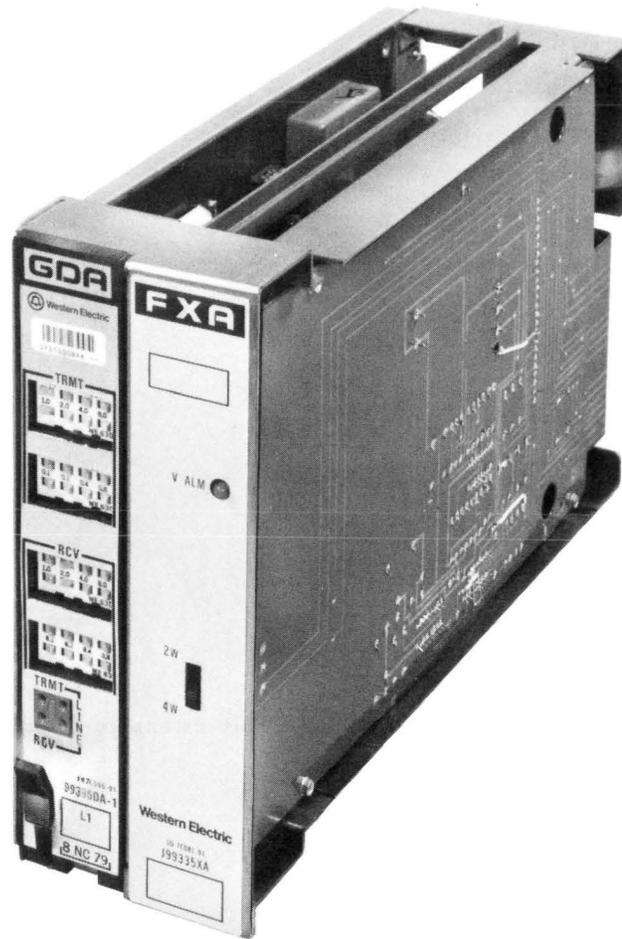


Fig. 11—F- to G-Signaling Adapter

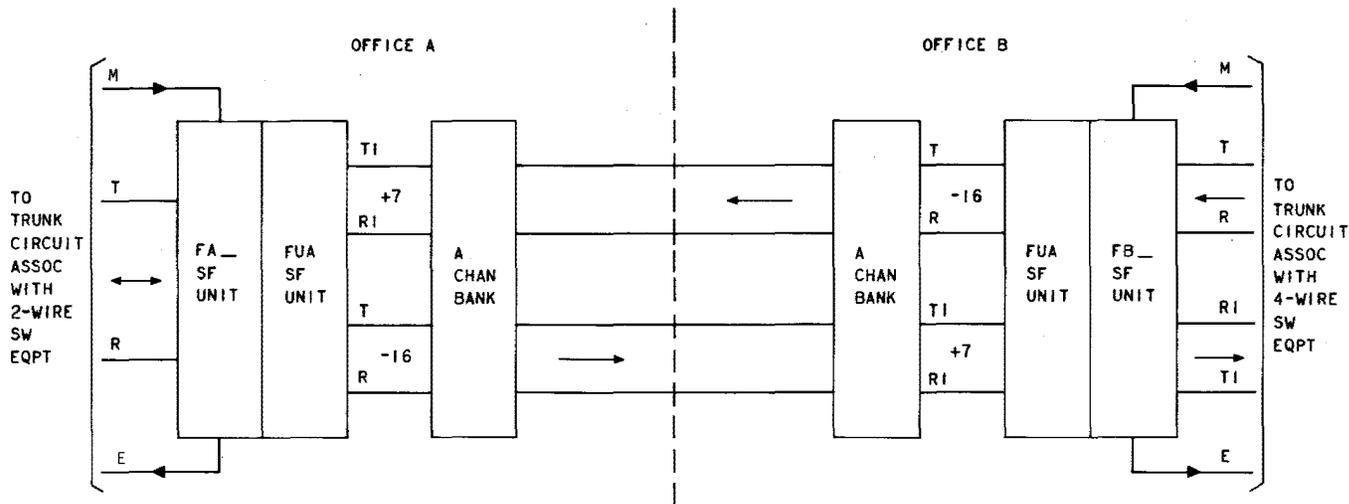


Fig. 12—Typical Application of FA\_ and FB\_ SF Units

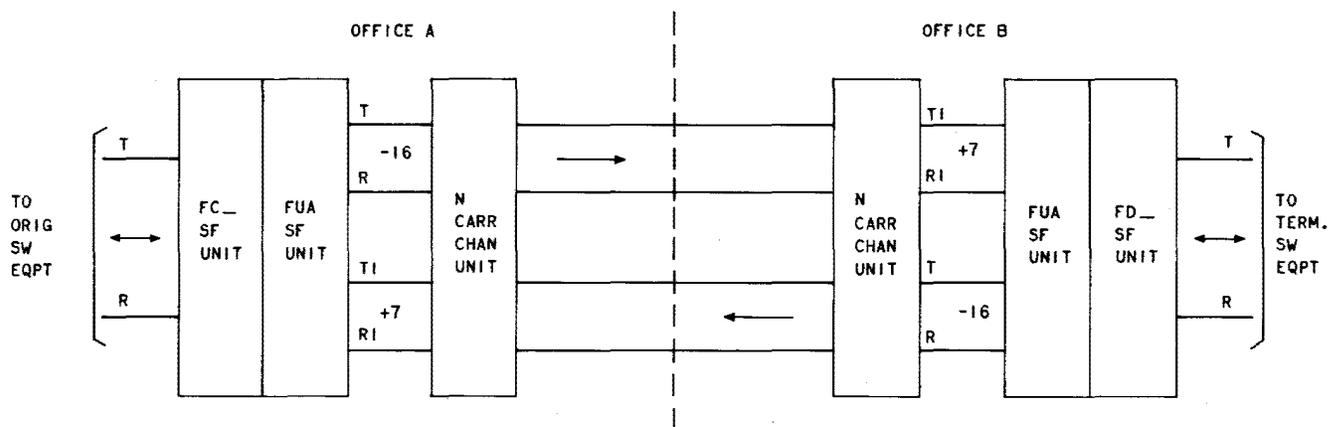


Fig. 13—Typical Application of FC\_ and FD\_ Units

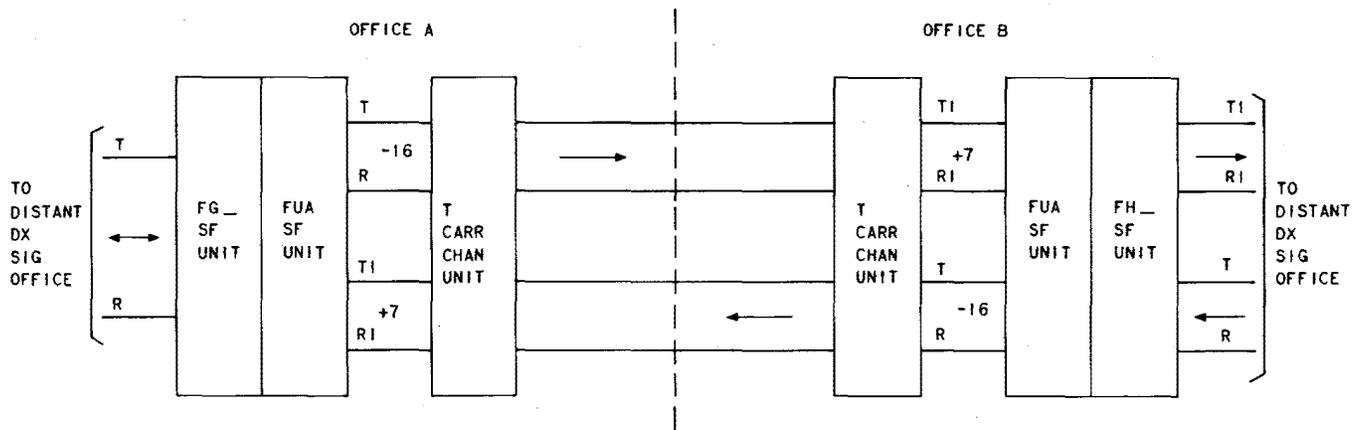


Fig. 14—Typical Application of FG\_ and FH\_SF Units

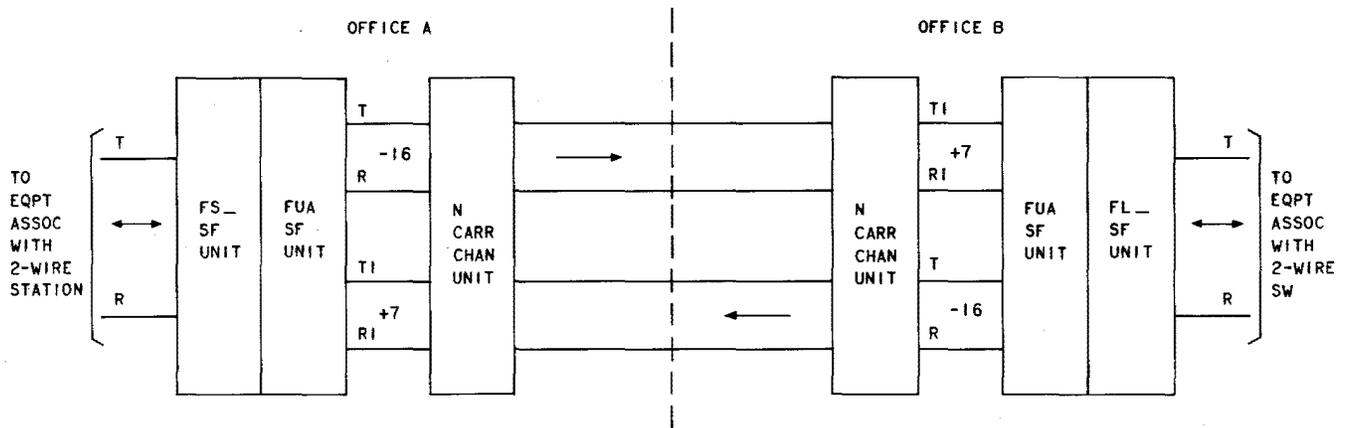


Fig. 15—Typical Application of FL\_ and FS\_SF Units

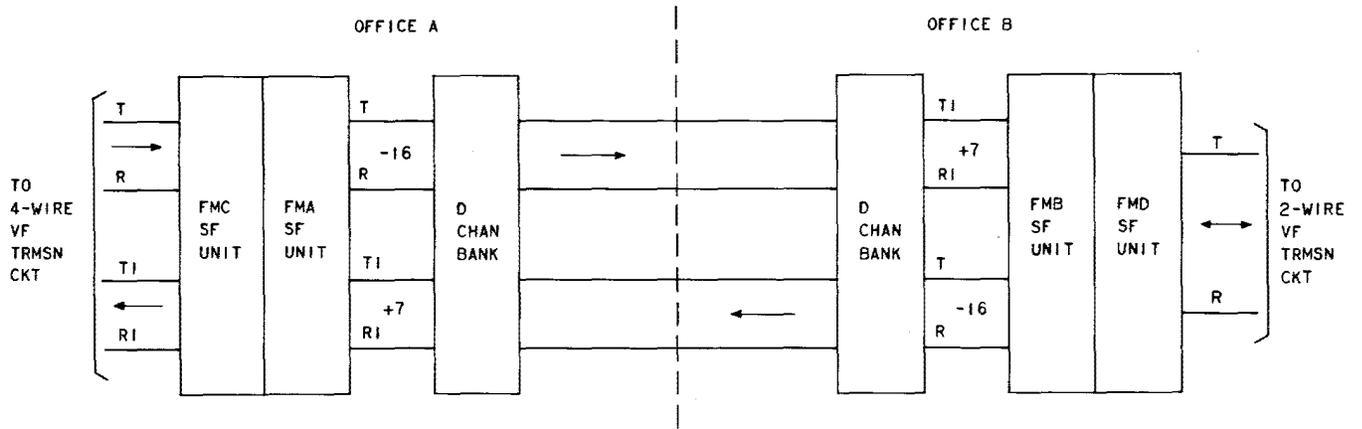


Fig. 16—Typical Application of FM Units

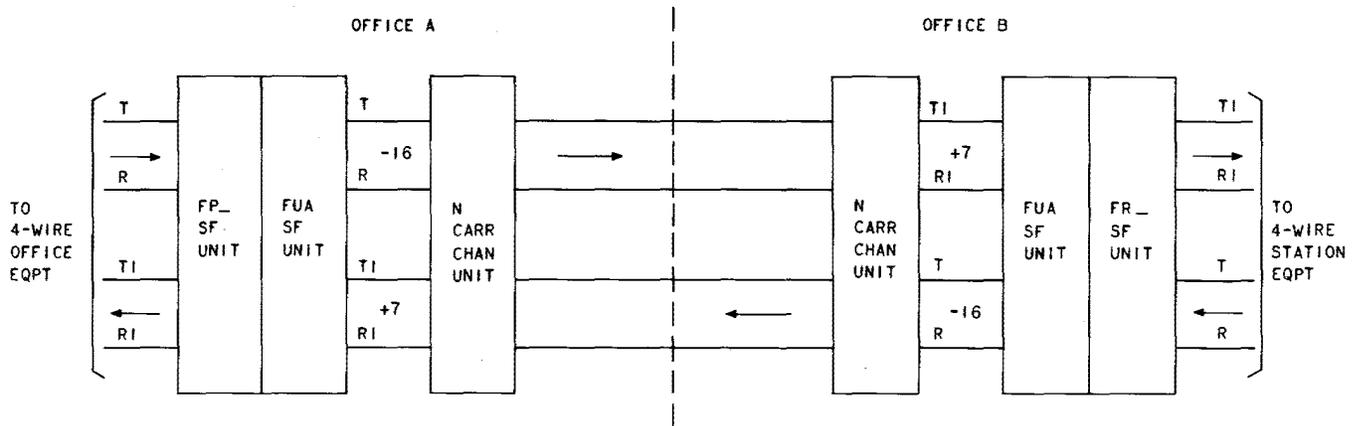


Fig. 17—Typical Application of FP and FR Units

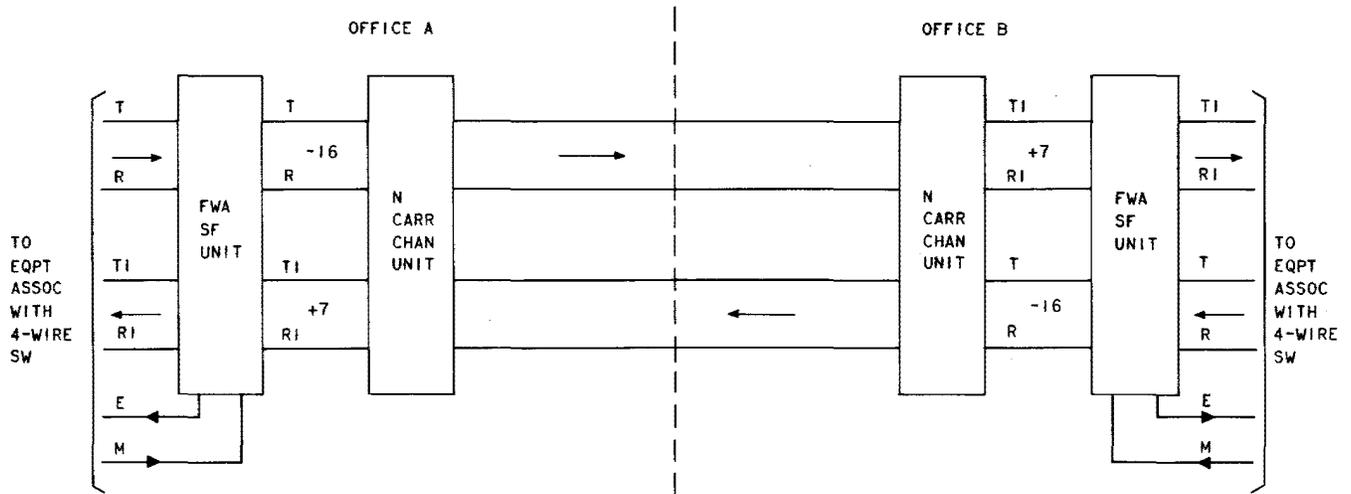


Fig. 18—Typical Application of FWA SF Units—For DP or MF, Use FWB for MF

TABLE B

SF SIGNALS USED IN E AND M LEAD SIGNALING

FW_, FA_, OR FB_ SF UNIT (CALLING END)				FW_, FA_, OR FB_ SF UNIT (CALLED END)			
SIGNAL OR STATE	M LEAD	E LEAD	2600-HZ TONE	2600-HZ TONE	E LEAD	M LEAD	SIGNAL OR STATE
Idle	Ground <sup>3</sup>	Open	On	On	Open	Ground <sup>3</sup>	Idle
Connect <sup>1</sup>	Batt	Open	Off	On	Ground	Ground <sup>3</sup>	Connect
Stop Dialing	Batt	Ground	Off	Off	Ground	Batt	Stop Dialing <sup>1</sup>
Start Dialing	Batt	Open	Off	On	Ground	Ground	Start Dialing <sup>1</sup>
Dial Pulsing <sup>1</sup>	Ground <sup>3</sup> Batt	Open	On Off	On	Open Ground	Ground <sup>3</sup>	Dial Pulsing <sup>2</sup>
Off-Hook	Batt	Ground	Off	Off	Ground	Batt	Off-Hook <sup>1</sup> (Answer)
Ring Forward <sup>1</sup>	Ground <sup>3</sup> Batt	Ground	On Off	Off	Open Ground	Batt	Ring Forward
Ringback	Batt	Open Ground	Off	On Off	Ground	Ground <sup>3</sup> Batt	Ringback <sup>1</sup>
Flashing	Batt	Open Ground	Off	On Off	Ground	Ground <sup>3</sup> Batt	Flashing
On-Hook	Batt	Open	Off	On	Ground	Ground <sup>3</sup>	On-Hook <sup>1</sup>
Disconnect <sup>1</sup>	Ground <sup>3</sup>	Open	On	On	Open	Ground <sup>3</sup>	Disconnect

Note 1: Terminal originating signal.

Note 2: Does not apply to FWB SF units.

Note 3: Or open.

TABLE C

## SF SIGNALS USED IN REVERSE BATTERY T AND R LOOP SIGNALING

FC_ UNIT (CALLING END)				FD_ UNIT (CALLED END)			
SIGNAL OR STATE	OFFICE T AND R TO SF UNIT	SF UNIT TO OFFICE T AND R	2600-HZ SF TONE	2600-HZ SF TONE	SF UNIT TO OFFICE T AND R	OFFICE T AND R TO SF UNIT	SIGNAL OR STATE
Idle	Open	Batt-Grd	On	On	Open	Batt-Grd	Idle
Connect <sup>1</sup>	Closure	Batt-Grd	Off	On	Closure	Batt-Grd	Connect
Stop Dialing	Closure	Rev Batt-Grd	Off	Off	Closure	Rev Batt-Grd	Stop Dialing <sup>1</sup>
Start Dialing	Closure	Batt-Grd	Off	On	Closure	Batt-Grd	Start Dialing <sup>1</sup>
Dial Pulsing <sup>1</sup>	Open Closure	Batt-Grd	On Off	On	Open Closure	Batt-Grd	Dial Pulsing
Off-Hook	Closure	Rev Batt-Grd	Off	Off	Closure	Rev Batt-Grd	Off-Hook <sup>1</sup> (Answer)
Ring Forward <sup>1</sup>	Open Closure	Rev Batt-Grd	On Off	Off	Open Closure	Rev Batt-Grd	Ring Forward
Ringback	Closure	Batt-Grd Rev Batt-Grd	Off	On Off	Closure	Batt-Grd Rev Batt-Grd	Ringback <sup>1</sup>
Flashing	Closure	Batt-Grd Rev Batt-Grd	Off	On Off	Closure	Batt-Grd Rev Batt-Grd	Flashing <sup>1</sup>
On-Hook	Closure	Batt-Grd	Off	On	Closure	Batt-Grd	On-Hook <sup>1</sup>
Disconnect <sup>1</sup>	Open	Batt-Grd	On	On	Open	Batt-Grd	Disconnect

Note 1: Terminal originating signal.

TABLE D

## SF SIGNALS USED FOR RINGING AND LOOP-START SIGNALING USING T &amp; R LEADS

CALL ORIGINATING AT CENTRAL OFFICE END							
FL_SF UNIT				FS_SF UNIT			
SIGNAL OR STATE	OFFICE T AND R TO SF UNIT	SF UNIT TO OFFICE T AND R	2600-HZ SF TONE	2600-HZ SF TONE	SF UNIT TO STATION T AND R	STATION T AND R TO SF UNIT	SIGNAL OR STATE
Idle	Grd/Batt	Open	Off	On	Grd/Batt	Open	Idle
Seizure <sup>1</sup>	Grd/Batt	Open	Off	On	Grd/Batt	Open	Idle
Ring <sup>1,2</sup>	Grd/Batt and 20 Hz <sup>2</sup>	Open	On-Off <sup>3</sup>	On	Grd/Batt and 20 Hz <sup>2</sup>	Open	Ring <sup>1</sup>
Off-Hook Ring-Trip and Talk	Grd/Batt	Closure	Off	Off	Grd/Batt	Closure	Off-Hook <sup>1</sup> Ring-Trip and Answer
On-Hook <sup>1</sup> (Disc.)	Grd/Batt	Closure	Off	Off	Grd/Batt	Closure	Off-Hook
On-Hook (Hang-Up)	Grd/Batt	Open	Off	On	Grd/Batt	Open	On-Hook <sup>1</sup> (Hang-Up)
CALL ORIGINATING AT STATION END							
FS_SF UNIT				FL_SF UNIT			
SIGNAL OR STATE	STATION T AND R TO SF UNIT	SF UNIT TO OFFICE T AND R	2600-HZ SF TONE (STA UNIT TO CO UNIT)	2600-HZ SF TONE (CO UNIT TO STA UNIT)	SF UNIT TO OFFICE T AND R	OFFICE T AND R TO SF UNIT	SIGNAL OR STATE
Idle	Open	Grd/Batt	On	Off	Open	Grd/Batt	Idle
Off-Hook <sup>1</sup> (Seizure)	Closure	Grd/Batt	Off	Off	Closure	Grd/Batt	Seizure
Start Dial	Closure	Dial Tone and Grd/Batt	Off	Off	Closure	Dial Tone and Grd/Batt	Start Dial <sup>1</sup>
Dial-Pulsing <sup>1</sup>	Open-Closure	Grd/Batt	On-Off	Off	Open-Closure	Grd/Batt	Dial Pulsing
Waiting Answer	Closure	Audible Ring and Grd/Batt	Off	Off	Closure	Audible Ring and Grd/Batt	Waiting Answer <sup>1</sup>
Off-Hook (Talk)	Closure	Grd/Batt	Off	Off	Closure	Grd/Batt	Off-Hook <sup>1</sup> (Answered)
On-Hook <sup>1</sup> (Disc.)	Open	Grd/Batt	On	Off	Open	Grd/Batt	On-Hook (Disc.) Off-Hook

Note 1: Terminal originating signal.

Note 2: 20-Hz ringing (2 sec on, 4 sec off).

Note 3: 2600 Hz (2 sec on, 4 sec off).

TABLE E

## SF SIGNALS USED FOR RINGING AND GROUND-START SIGNALING USING T &amp; R LEADS

CALL ORIGINATED AT CENTRAL OFFICE END							
FL_SF UNIT					FS_SF UNIT		
SIGNAL OR STATE	OFFICE T AND R TO SF UNIT	SF UNIT TO OFFICE T AND R	2600-HZ SF TONE	2600-HZ SF TONE	SF UNIT TO STATION T AND R	STATION T AND R TO SF UNIT	SIGNAL OR STATE
Idle	Open/Batt	Batt/Batt	On	On	Open/Batt	Note 3	Idle
Seizure <sup>1</sup>	Grd/Batt	Open	On	On	Grd/Batt	Note 3	Make-Busy <sup>3</sup>
Ringling <sup>1</sup>	Grd/Batt and 20 Hz	Open	Note 4	On	Grd/Batt and 20 Hz <sup>2</sup>	Open	Ringling
Off-Hook Ring-Trip and Talk	Grd/Batt	Closure	Off	Off	Grd/Batt	Closure	Off-Hook <sup>1</sup> Ring-Trip and Answered
On-Hook <sup>1</sup> (Disc.)	Open/Batt	Closure	On	Off	Open/Batt	Closure	On-Hook
On-Hook (Hang-Up)	Grd/Batt	Open	Off	On	Grd/Batt	Open	On-Hook <sup>1</sup> (Hang-Up)

*Note 1:* Terminal originating signal.

*Note 2:* 20-Hz ringing (2 sec on, 4 sec off).

*Note 3:* Function of connecting station equipment.

*Note 4:* 2600 Hz modulated at 20-Hz rate (2 sec on, 4 sec off).

TABLE E (Contd)

SF SIGNALS USED FOR RINGING AND GROUND-START SIGNALING USING T & R LEADS

CALL ORIGINATED AT STATION END							
FS_SF UNIT					FL_SF UNIT		
SIGNAL	STATION T AND R TO SF UNIT	SF UNIT TO STATION T AND R	2600-HZ SF TONE	2600-HZ SF TONE	SF UNIT TO OFFICE T AND R	OFFICE T AND R TO SF UNIT	SIGNAL
Idle	Note 3	Open/Batt	On	On	Batt/Batt	Open/Batt	Idle
Off-Hook <sup>1</sup>	Closure and Grd on Ring <sup>3</sup>	Open/Batt	Off	On	Batt/Grd	Open/Batt	Seizure
Start-Dial	Closure	Grd/Batt and Dial Tone	Off	Off	Closure	Grd/Batt and Dial Tone	Start Dial <sup>1</sup>
Dial-Pulsing <sup>1</sup>	Open-Closure	Grd/Batt	On-Off	Off	Open-Closure	Grd/Batt	Dial Pulsing
Waiting Ans.	Closure	Audible Ring and Grd/Batt	Off	Off	Closure	Audible Ring and Grd/Batt	Waiting Ans. <sup>1</sup>
Off-Hook (Talk)	Closure	Grd/Batt	Off	Off	Closure	Grd/Batt	Off-Hook <sup>1</sup> (Answered)
Off-Hook	Closure	Open/Batt	Off	On	Batt/Batt	Open/Batt	On-Hook <sup>1</sup> (Disc.)
On-Hook <sup>1</sup> (Disc.)	Open <sup>3</sup>	Grd/Batt	On	Off	Open/Batt	Open/Batt	On-Hook

Note 1: Terminal originating signal.

Note 2: 20-Hz ringing (2 sec on, 4 sec off).

Note 3: Function of connecting station equipment.

TABLE F

SF SIGNALS USED FOR RINGING AND LOOP-START SIGNALING ON SX LEADS

CALL ORIGINATING AT CENTRAL OFFICE END							
FP_ OR FL_ SF UNIT				FR_ OR FS_ SF UNIT			
SIGNAL OR STATE	OFFICE A AND B TO SF UNIT	SF UNIT TO OFFICE A AND B	2600-HZ SF TONE	2600-HZ SF TONE	SF UNIT TO STATION A AND B	STATION A AND B TO SF UNIT	SIGNAL OR STATE
Idle	Grd/Batt	Open	Off	On	Grd/Batt	Open	Idle
Seizure <sup>1</sup>	Grd/Batt	Open	Off	On	Grd/Batt	Open	Idle
Ringin <sup>1, 2</sup>	Grd/Batt and 20 Hz <sup>2</sup>	Open	On-Off <sup>3</sup>	On	Grd/Batt and 20 Hz <sup>2</sup>	Open	Ringin
Off-Hook Ring-Trip and Talk	Grd/Batt	Closure	Off	Off	Grd/Batt	Closure	Off-Hook <sup>1</sup> Ring-Trip and Answer
On-Hook <sup>1</sup> (Disc.)	Grd/Batt	Closure	Off	Off	Grd/Batt	Closure	Off-Hook
On-Hook (Hang-Up)	Grd/Batt	Open	Off	On	Grd/Batt	Open	On-Hook <sup>1</sup> (Hang-Up)
CALL ORIGINATING AT STATION END							
FR_ OR FS_ SF UNIT				FL_ OR FP_ SF UNIT			
SIGNAL OR STATE	STATION A AND B TO SF UNIT	SF UNIT TO OFFICE A AND B	2600-HZ SF TONE (STA UNIT TO CO UNIT)	2600-HZ SF TONE (CO UNIT TO STA UNIT)	SF UNIT TO OFFICE A AND B	OFFICE A AND B TO SF UNIT	SIGNAL OR STATE
Idle	Open	Grd/Batt	On	Off	Open	Grd/Batt	Idle
Off-Hook <sup>1</sup> (Seizure)	Closure	Grd/Batt	Off	Off	Closure	Grd/Batt	Seizure
Start Dial	Closure	Dial Tone and Grd/Batt	Off	Off	Closure	Dial Tone and Grd/Batt	Start Dial <sup>1</sup>
Dial Pulsing <sup>1</sup>	Open-Closure	Grd/Batt	On-Off	Off	Open-Closure	Grd/Batt	Dial Pulsing
Waiting Answer	Closure	Audible Ring and Grd/Batt	Off	Off	Closure	Audible Ring and Grd/Batt	Waiting Answer <sup>1</sup>
Off-Hook (Talk)	Closure	Grd/Batt	Off	Off	Closure	Grd/Batt	Off-Hook <sup>1</sup> (Answered)
On-Hook <sup>1</sup> (Disc.)	Open	Grd/Batt Closure	On	Off	Open	Grd/Batt	On-Hook (Disc.) Off-Hook

Note 1: Terminal originating signal.

Note 2: 20-Hz ringing (2 sec on, 4 sec off).

Note 3: 2600 Hz (2 sec on, 4 sec off).

TABLE G

SF SIGNALS USED FOR RINGING AND GROUND-START SIGNALING ON SX LEADS

CALL ORIGINATED AT CENTRAL OFFICE END							
FL_ OR FP_ SF UNIT				FR_ OR FS_ SF UNIT			
SIGNAL OR STATE	OFFICE A AND B TO SF UNIT	SF UNIT TO OFFICE A AND B	2600-HZ SF TONE	2600-HZ SF TONE	SF UNIT TO STATION A AND B	STATION A AND B TO SF UNIT	SIGNAL OR STATE
Idle	Open/Batt	Batt/Batt	On	On	Open/Batt	Note 3	Idle
Seizure <sup>1</sup>	Grd/Batt	Open	Off	On	Grd/Batt	Note 3	Make-Busy <sup>3</sup>
Ringling <sup>1</sup>	Grd/Batt and 20 Hz	Open	Modulated at 20 Hz <sup>4</sup>	On	Grd/Batt and 20 Hz <sup>2</sup>	Open	Ringling
Off-Hook Ring-Trip and Talk	Grd/Batt	Closure	Off	Off	Grd/Batt	Closure	Off-Hook <sup>1</sup> Ring-Trip and Answered
On-Hook <sup>1</sup> (Disc.)	Open/Batt	Closure	On	Off	Open/Batt	Closure	On-Hook
On-Hook (Hang-Up)	Grd/Batt	Open	Off	On	Grd/Batt	Open	On-Hook <sup>1</sup> (Hang-Up)

*Note 1:* Terminal originating signal.

*Note 2:* 20-Hz ringing (2 sec on, 4 sec off).

*Note 3:* Function of connecting station equipment.

*Note 4:* 2600 Hz modulated at 20-Hz rate (2 sec on, 4 sec off).

TABLE G (Contd)

## SF SIGNALS USED FOR RINGING AND GROUND-START SIGNALING ON SX LEADS

CALL ORIGINATED AT STATION END							
FR _ OR FS _ SF UNIT				FP _ OR FL _ SF UNIT			
SIGNAL	STATION A AND B TO SF UNIT	SF UNIT TO STATION A AND B	2600-HZ SF TONE	2600-HZ SF TONE	SF UNIT TO OFFICE A AND B	OFFICE A AND B TO SF UNIT	SIGNAL
Idle	Note 3	Open/Batt	On	On	Batt/Batt	Open/Batt	Idle
Off-Hook <sup>1</sup>	Closure and Grd on Ring <sup>3</sup>	Open/Batt	Off	On	Batt/Grd	Open/Batt	Seizure
Start-Dial	Closure	Grd/Batt and Dial Tone	Off	Off	Closure	Grd/Batt and Dial Tone	Start Dial <sup>1</sup>
Dial-Pulsing <sup>1</sup>	Open-Closure	Grd/Batt	On-Off	Off	Open-Closure	Grd/Batt	Dial Pulsing
Waiting Ans.	Closure	Audible Ring and Grd/Batt	Off	Off	Closure	Audible Ring and Grd/Batt	Waiting Ans. <sup>1</sup>
Off-Hook (Talk)	Closure	Grd/Batt	Off	Off	Closure	Grd/Batt	Off-Hook <sup>1</sup> (Answered)
Off-Hook	Closure	Open/Batt	Off	On	Batt/Batt	Open/Batt	On-Hook <sup>1</sup> (Disc.)
On-Hook <sup>1</sup> (Disc.)	Open <sup>3</sup>	Grd/Batt	On	Off	Open/Batt	Open/Batt	On-Hook

*Note 1:* Terminal originating signal.

*Note 2:* 20-Hz ringing (2 sec on, 4 sec off).

*Note 3:* Function of connecting station equipment.

TABLE H  
SF SIGNALS USED IN DX SIGNALING

FG_ OR FH_ SF UNIT (CALLING END)				FG_ OR FH_ SF UNIT (CALLED END)			
SIGNAL OR STATE	T LEAD (FG_ UNIT) OR T&R LEADS (FH_ UNIT) FROM DISTANT DX UNIT	T LEAD (FG_ UNIT) OR T&R LEADS (FH_ UNIT) TO DISTANT DX UNIT	2600-HZ TONE	2600-HZ TONE	T LEAD (FG_ UNIT) OR T&R LEADS (FH_ UNIT) TO DISTANT DX UNIT	T LEAD (FG_ UNIT) OR T&R LEADS (FH_ UNIT) FROM DISTANT DX UNIT	SIGNAL OR STATE
Idle	Ground	Ground	On	On	Ground	Ground	Idle
Connect	Battery	Ground	Off	On	Ground	Ground	Connect
Stop Dialing	Battery	Battery	Off	Off	Battery	Battery	Stop Dialing <sup>1</sup>
Start Dialing	Battery	Ground	Off	On	Battery	Ground	Start Dialing <sup>1</sup>
Dial Pulsing <sup>1</sup>	Ground Battery	Ground	On Off	On	Ground Battery	Ground	Dial Pulsing
Off-Hook	Battery	Battery	Off	Off	Battery	Battery	Off-Hook <sup>1</sup>
Ring Forward <sup>1</sup>	Ground Battery	Ground	Off On	Off	Ground Battery	Ground	Ring Forward
Ringback	Battery	Ground Battery	Off	Off On	Battery	Ground Battery	Ringback <sup>1</sup>
Flashing	Battery	Ground Battery	Off	On Off	Battery	Ground Battery	Flashing <sup>1</sup>
On-Hook	Battery	Ground	Off	On	Battery	Ground	On-Hook <sup>1</sup>
Disconnect <sup>1</sup>	Ground	Ground	On	On	Ground	Ground	Disconnect <sup>1</sup>

Note 1: Terminal originating signal.

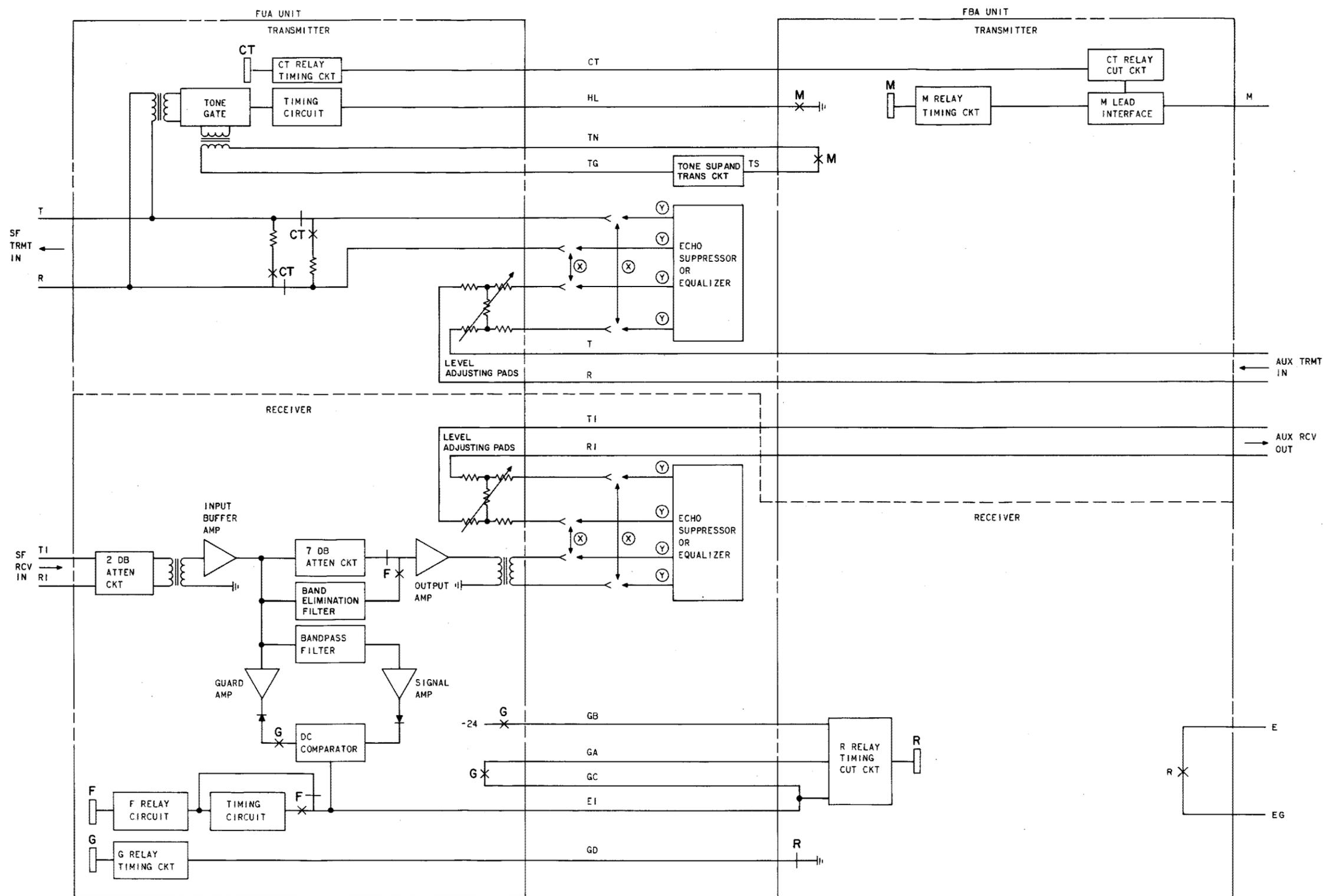


Fig. 19—FUA Plus FBA Units