

## TYPE E SINGLE-FREQUENCY SIGNALING SYSTEM

### GENERAL DESCRIPTIVE INFORMATION

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**1. GENERAL**

**1.01** This section provides a general description of the E-Type Single-Frequency Signaling System and operation of a typical E-type unit. It also provides a general description of the different plug-in units presently available. Detailed operational information is available in the individual circuit descriptions.

**1.02** This section is reissued for the following reasons:

- To delete reference to Section 310-325-100 in paragraph 7.01.

- To change the reference from Section 975-115-100 to Section 975-120-100 in paragraph 7.01.
- To change reference from Section 179-101-101 to Section 179-701-101 in paragraph 7.01.
- To delete reference in Table F to Class 4 office in USE column for E1A unit.

Change arrows have been used in Part 7 to indicate changes, except where deletions have occurred.

**A. System Description**

**1.03** The E-Type Single-Frequency (SF) Signaling System consists of plug-in units and common bay equipment designed to provide a means of transmitting address and supervisory information for telephone switching systems over transmission facilities on an ac, inband basis. Basically, the signaling system converts dc signals from connecting trunk equipments into a voice-frequency tone that shares the transmission path with speech. Signaling equipment is required only at the end terminals. The SF units convert signals, as required, to initiate and terminate telephone connections. This signal conversion includes connect (seizure), delay dialing, start dialing, wink-start pulsing, dial pulsing, revertive pulsing, ringing, answer, disconnect, ring forward and ringback.

**B. Application**

**1.04** In general, the E-Type SF Signaling System provides a means for converting dc signals to 2600-Hz tone at one end of a trunk and reconversion to the original dc state at the opposite end. A 2-state signal of tone-on/tone-off in each direction corresponds to on-hook/off-hook signals of the connected equipments. Generally, the normal speech transmission paths of a carrier or 4-wire voice-frequency line facility are used for the tone signals.

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**1.05** Differences in signaling methods used by the various switching systems require a diversity of plug-in E-type signaling units. Some special applications require the use of frequencies such as 2000 and 2400 Hz as well as 2600 Hz. Tables A through E provide information on signaling conditions during operation of the various SF signaling units. These conditions include E and M lead control, revertive pulsing, loop-reverse battery signaling, and subscriber loop signaling. Table F provides a ready reference to the application of the various SF signaling units. Additional descriptive information on the various units is given in 3.02 through 3.22.

## 2. OPERATIONAL REQUIREMENTS

**2.01** The E-Type SF Signaling System is designed to operate with carrier or 4-wire line facilities having +7 and -16 dB transmission level points. The facility should not introduce a frequency shift of more than  $\pm 10$  Hz.

**2.02** Tone transmitted from the SF signaling unit must not deviate by more than  $\pm 5$  Hz from nominal frequency.

**2.03** Tone transmitted from the SF signaling unit is nominally -20 dBm0 except upon initial application (transition from off-hook to on-hook), when it is -8 dBm0 for approximately one-half second.

**2.04** To allow for random variations in the signal power, the receiver portion of the SF unit is designed to operate on a signal of -29.5 dBm0. Although this provides a steady-state margin of 9.5 dB, facility variation cannot exceed  $\pm 6$  dB at 2600 Hz without affecting performance.

**2.05** Originating SF units should be equipped with a pulse corrector to ensure the passage of dial pulses to the terminating SF unit when the source of dial pulses is a station dial or a sender exceeding prescribed limits. Terminating dial pulse SF units have built-in pulse correction so that, for each SF pulse received, an acceptable dc pulse is delivered to the connecting central office equipment. In some cases, where the terminating office is a step-by-step office, an external pulse corrector must be provided on the equipment side of the terminating SF unit.

**2.06** Lead resistance is limited depending on the SF unit and its application. T and R loop limits lie between 100 and 2400 ohms. However, the M-lead resistance should not exceed 25 ohms, nor should the ground potential difference be more than  $\pm 1$  volt if the E and M SF unit and the connecting circuits are served from different battery supplies.

**2.07** The cabling loss between the carrier and SF unit, at 2600 Hz, is limited to 0.8 dB.

## 3. UNIT DESCRIPTIONS

### General

**3.01** Some SF units are equipped with a 4-wire terminating set. Examples of these are E1A, E1C, E1D, E1E, E1F, E1L, and E1S units. Other SF units are designed without internal terminating sets but may be used for 2-wire applications if external terminating sets are provided. These include the E1B, E2B, E3B, E4B, and E1J units.

**3.02** *E1A 2600-Hz Signaling Unit:* This unit, rated Manufacture Discontinued (MD), was designed for application on 2-wire, E and M, DP or MF exchange or toll connecting trunks using 4-wire line facilities. A separate repeat coil is always required to pass the dc current required by the connecting trunk.

**3.03** *E1B 2600-Hz Signaling Unit:* This unit (MD) was designed for application on any E and M, DP or MF, 4-wire trunk using 4-wire line facilities. This unit, with an external 4-wire terminating set, can be used on 2-wire trunks.

**3.04** *E2B (MD) and E3B (MD) 2400- or 2600-Hz Signaling Units:* Both the E2B and the E3B units were designed for application on any E and M, DP or MF, 4-wire office trunk using 2- or 4-wire line facilities. These units, with external 4-wire terminating sets, can be used on any 2-wire trunk using 2- or 4-wire line facilities. When 2-wire line facilities are used, the SF unit at one end of the circuit is arranged to receive 2400 Hz and send 2600 Hz, while the SF unit at the distant end is arranged to send 2400 Hz and receive 2600 Hz. A 2-wire network is required in the 4-wire line receive path of each SF unit. This network prevents the transmit portion of a unit from interfering with its own receiver. The

TABLE A

## SF SIGNALS USED IN E AND M LEAD SIGNALING

TYPE E1A, E1B, E2B, E3B (CALLING END)				TYPE E1A, E1B, E2B, E3B (CALLED END)			
SIGNAL OR STATE	M LEAD	E LEAD	SF TONE <sup>2</sup>	SF TONE <sup>2</sup>	E LEAD	M LEAD	SIGNAL OR STATE
Idle	Ground	Open	On	On	Open	Ground	Idle
Connect <sup>1</sup>	Batt	Open	Off	On	Ground	Ground	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	Open	On	On	Open	Ground	Dial Pulsing
	Batt		Off		Ground		
Off-Hook	Batt	Ground	Off	Off	Ground	Batt	Off-Hook <sup>1</sup> (Answer)
Ring Forward <sup>1</sup>	Ground	Ground	On	Off	Open	Batt	Ring Forward
	Batt		Off		Ground		
Ringback	Batt	Open	Off	On	Ground	Ground	Ringback <sup>1</sup>
		Ground		Off		Batt	
Flashing	Batt	Open	Off	On	Ground	Ground	Flashing
		Ground		Off		Batt	
On-Hook	Batt	Open	Off	On	Ground	Ground	On-Hook <sup>1</sup>
Disconnect <sup>1</sup>	Ground	Open	On	On	Open	Ground	Disconnect

*Note 1:* Terminal originating signal.

*Note 2:* E2B and E3B will use 2400- and 2600-Hz SF tone at opposite ends of 2-wire line facilities. All units listed will use 2600-Hz SF tone at both ends of 4-wire line facilities.

TABLE B

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

TYPE E1C (CALLING END)				TYPE E1D (CALLED END)			
SIGNAL OR STATE	OFFICE T AND R TO SF UNIT	SF UNIT TO OFFICE T AND R	2600 SF TONE	2600 SF TONE	SF UNIT TO OFFICE T AND R	OFFICE T AND R TO SF UNIT	SIGNAL OR STATE
Idle	Open	Batt	On	On	Open	Batt	Idle
Connect <sup>1</sup>	Closure	Batt	Off	On	Closure	Batt	Connect
Stop Dialing	Closure	Rev Batt	Off	Off	Closure	Rev Batt	Stop Dialing <sup>1</sup>
Start Dialing	Closure	Batt	Off	On	Closure	Batt	Start Dialing <sup>1</sup>
Dial Pulsing <sup>1</sup>	Open	Batt	On	On	Open	Batt	Dial Pulsing
	Closure		Off		Closure		
Off-Hook	Closure	Rev Batt	Off	Off	Closure	Rev Batt	Off-Hook <sup>1</sup> (Answer)
Ring Forward <sup>1</sup>	Open	Rev Batt	On	Off	Open	Rev Batt	Ring Forward
	Closure		Off		Closure		
Ringback	Closure	Batt	Off	On	Batt	Ringback <sup>1</sup>	
		Rev Batt		Off			Rev Batt
Flashing	Closure	Batt	Off	On	Batt	Flashing <sup>1</sup>	
		Rev Batt		Off			Rev Batt
On-Hook	Closure	Batt	Off	On	Closure	Batt	On-Hook <sup>1</sup>
Disconnect <sup>1</sup>	Open	Batt	On	On	Open	Batt	Disconnect

Note 1: Terminal originating signal.

TABLE C

## SF SIGNALS USED IN REVERTIVE PULSE T AND R LOOP SIGNALING

TYPE E1E (CALLING END)				TYPE E1F (CALLED END)				
SIGNAL OR STATE	OFFICE T AND R TO SF UNIT	SF UNIT TO OFFICE T AND R	2600 SF TONE	2000 SF TONE	2600 SF TONE	SF UNIT TO OFFICE T AND R	OFFICE T AND R TO SF UNIT	SIGNAL OR STATE
Idle	Open	Batt	On	Off	On	Open <sup>2</sup>	Batt	Idle
TG test <sup>1</sup>	16,500Ω Closure	Batt	On	Off	On	Open <sup>2</sup>	Batt	TG test
Seizure <sup>1</sup>	165Ω Closure	Batt	Off	Off	On	Closure <sup>3</sup>	Batt	Seizure
Revertive pulse selections	165Ω Closure	No current Batt	Off	On Off	On	Closure <sup>3</sup>	No current Batt	Revertive pulse selections <sup>1</sup>
Stop <sup>1</sup>	Open	Batt	On	Off	On	Open <sup>2</sup>	Batt	Stop
Cable Discharge	Open	No current	Off	On	On	Open <sup>2</sup>	Short	Cable Discharge
Incoming advance	165Ω Closure	Rev Batt	Off	Off	Off	Closure	Rev Batt	Incoming advance <sup>1</sup>
Bypass	Closure	No current	Off	On	On	Closure	Open	Bypass <sup>1</sup>
Open between sender and dist <sup>1</sup>	Open	Batt	On	Off	On	Open	Batt	Open between sender and dist
Cable charge	Open	Batt	On	Off	On	Open	Batt	Cable charge <sup>1</sup>
District closure <sup>1</sup>	Closure	Batt	Off	Off	On	Closure	Batt	District closure
Flashing	Closure	Batt Rev Batt	Off	Off	On Off	Closure	Batt Rev Batt	Flashing <sup>1</sup>
Off-Hook	Closure	Rev Batt	Off	Off	Off	Closure	Rev Batt	Off-Hook <sup>1</sup>
Disconnect <sup>1</sup>	Open	Batt	On	Off	On	Open	Batt	Disconnect

Note 1: Terminal originating signal.

Note 2: High resistance.

Note 3: Low resistance.

TABLE D

## SF SIGNALS USED FOR RINGING AND LOOP-START SIGNALING

TYPE E2L (CALLING END)				TYPE E2L (CALLED END)			
SIGNAL OR STATE	OFFICE T AND R TO SF UNIT	SF UNIT TO OFFICE T AND R	2600-HZ SF TONE (CO TO STA)	2600-HZ SF TONE (STA TO CO)	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
Ringing <sup>1, 2</sup>	Grd/Batt and 20 Hz <sup>2</sup>	Open	On-Off <sup>2</sup>	On	Grd/Batt and 20 Hz <sup>2</sup>	Open	Ringing
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)

Note 1: Terminal originating signal.

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

TABLE D (Contd)  
SF SIGNALS USED FOR RINGING AND LOOP-START SIGNALING

SIGNAL OR STATE	TYPE E2S (CALLING END)				TYPE E2L (CALLED END)				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	2600-HZ SF TONE (CO UNIT TO STA UNIT)	OFFICE T AND R TO SF UNIT		
Idle	Open	Grd/Batt	Off	Off	On	Grd/Batt	Grd/Batt	Idle	
Off-Hook <sup>1</sup> (Seizure)	Closure	Grd/Batt	Off	Off	Off	Grd/Batt	Grd/Batt	Seizure	
Start Dial	Closure	Dial Tone and Grd/Batt	Off	Off	Off	Dial Tone and Grd/Batt	Dial Tone and Grd/Batt	Start Dial <sup>1</sup>	
Dial Pulsing <sup>1</sup>	Open-Closure	Grd/Batt	On-Off	Off	Off	Grd/Batt	Grd/Batt	Dial Pulsing	
Waiting Answer	Closure	Audible Ring and Grd/Batt	Off	Off	Off	Audible Ring and Grd/Batt	Audible Ring and Grd/Batt	Waiting Answer <sup>1</sup>	
Off-Hook (Talk)	Closure	Grd/Batt	Off	Off	Off	Grd/Batt	Grd/Batt	Off-Hook <sup>1</sup> (Answered)	
On-Hook <sup>1</sup> (Disc.)	Open	Grd/Batt Closure	Off	Off	Off	Grd/Batt Closure	Grd/Batt	On-Hook (Disc.) Off-Hook	

Note 1: Terminal originating signal.

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

TABLE E

## SF SIGNALS USED FOR RINGING AND GROUND-START SIGNALING

TYPE E2L AND E2LA (CALLING END), NO. 5 CSBR OFFICE			TYPE E2S AND E2SA (CALLED END)				
SIGNAL OR STATE	OFFICE T AND R TO SF UNIT	SF UNIT TO OFFICE T AND R	2600-HZ SF TONE (CO TO STA)	2600-HZ SF TONE (STA TO CO)	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	Off	On	Grd/Batt	Note 3	Make-Busy <sup>3</sup>
Ringling <sup>1</sup>	Grd/Batt and 20 Hz	Open	On and 20 Hz <sup>2</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.



TABLE E (Contd)  
SF SIGNALS USED FOR RINGING AND GROUND-START SIGNALING

SIGNAL	TYPE E2S AND E2SA (CALLING END)				TYPE E2L AND E2LA (CALLED END), NO. 5 CSBR OFFICE			
	STATION T AND R TO, SF UNIT	SF UNIT TO STATION T AND R	2600-HZ SF TONE (STA TO CO)	2600-HZ SF TONE (CO TO STA)	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>	Grd <sup>3</sup>	Open/Batt	Off	On	Batt/Grd	Open/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 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	On	On	Batt/Batt	Open/Batt	On-Hook <sup>1</sup> (Disc.)	
On-Hook <sup>1</sup> (Disc.)	Note 3	Closure	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

E-TYPE SIGNALING UNIT APPLICATIONS

UNIT	LINE FACILITY		4-WIRE TERM. SET		TRUNK SIGNALING		CUSTOMER LINE		PULSING <sup>1</sup>			USE
	2-W	4-W	INTERNAL	EXTERNAL	E & M	REVERSE BATTERY	LOOP-START	GROUND-START	DP <sup>6</sup>	MF	RP	
E1A		X	X		X					X		Class 5 Offices
E1B		X		X	X					X		Classes 1 to 5 Offices
E2B	X	X		X	X					X		Classes 1 to 5 Offices
E3B	X	X		X	X	X <sup>4</sup>	X <sup>5</sup>			X		Classes 1 to 5 Offices
E4B		X		X	X	X <sup>4</sup>	X <sup>5</sup>			X		Classes 1 to 5 Offices
E1C		X	X			X				X		Class 5 Office Originating
E2C		X	X			X				X		Class 5 Office Originating
E3C		X	X			X			X <sup>7</sup>	X		CAMA Originating Class 5 Office
E4C		X	X			X			X	X		Class 5 Office CAMA Originating
E1D		X	X			X			X	X		Class 4 or 5 Offices Terminating
E2D		X	X			X			X			Class 4 or 5 Offices Terminating
E3D		X	X			X				X		Class 4 or 5 Offices Terminating
E4D		X	X			X			X	X		Class 4 Office CAMA Terminating
E1E		X	X			X					X	Class 4 or 5 Offices Originating

TABLE F (Contd)  
E-TYPE SIGNALING UNIT APPLICATIONS

UNIT	LINE FACILITY		4-WIRE TERM. SET		TRUNK SIGNALING		CUSTOMER LINE		PULSING <sup>1</sup>			USE
	2-W	4-W	INTERNAL	EXTERNAL	E & M	REVERSE BATTERY	LOOP-START	GROUND-START	DP <sup>6</sup>	MF	RP	
E1F		X	X			X					X	Class 5 Office Terminating
E1J		X		X	X					X		Classes 1 to 5 Offices
E1L		X	X				X		X			Cust Line, Office End
E2L		X	X				X		X			Cust Line, Office End
E2LA <sup>2</sup>								X				Cust Line, Office End
E1S		X	X				X		X			Cust Line, Station End
E2S		X	X				X		X			Cust Line, Station End
E2SA <sup>3</sup>								X				Cust Line, Station End

*Note 1:* All units but E2C pass ac signals such as multifrequency, TOUCH-TONE, and frequency-shift pulsing.

*Note 2:* Functions only with E1L or E2L unit to provide ground-start operation.

*Note 3:* Functions only with E1S or E2S unit to provide ground-start operation.

*Note 4:* When proper converter is provided.

*Note 5:* When used with SD-96252-01 at station end.

*Note 6:* Originating pulse correction may be required for marginal pulsing.

*Note 7:* Without originating pulse correction.

*Note 8:* Use with loop or E and M unit at the originating end on MF trunks with approximately 140 msec disconnect time.

network is automatically inserted or removed by the SF unit, as required.

**3.05 E4B 2600-Hz Unit:** This unit replaces the E3B unit for applications on E and M lead, DP or MF trunks using 4-wire facilities.

**3.06 E1C 2600-Hz Signaling Unit:** This unit is suitable for application at the originating end of one-way, 2-wire, loop-reverse battery, MF, exchange, tandem or toll connecting trunks using 4-wire line facilities. Ringback capability is optional.

**3.07 E2C 2600-Hz Signaling Unit:** This unit is similar to the E1C unit but is for DP applications only. It includes a transmitting dial pulse corrector circuit.

**3.08 E3C 2600-Hz Signaling Unit:** Similar to the E1C unit, this unit is designed for use on MF trunks for CAMA or ANI applications. It may be used for DP from closely adjusted senders of common control offices. The unit includes additional talk-off-control and ability to transfer 3 dB of gain.

**3.09 E4C 2600-Hz Signaling Unit:** Similar to the E3C unit, this unit is designed for use in DP, CAMA, or DP ANI applications. It includes a transmitting pulse corrector.

**3.10 E1D 2600-Hz Signaling Unit:** This unit was designed for application at the terminating end of one-way, 2-wire, loop-reverse battery, DP or MF, exchange, tandem or toll connecting trunks, using 4-wire line facilities. A special E1D unit is available for application on MF trunks which have disconnect times in the order of 140 msec.

**3.11 E2D 2600-Hz Signaling Unit:** Designed for DP application, similar to the E1D, this unit includes a transmit path cut circuit.

**3.12 E3D 2600-Hz Signaling Unit:** Designed for MF application, similar to the E1D, this unit includes a transmit path cut circuit.

**3.13 E4D 2600-Hz Signaling Unit:** Similar to the E2D unit, this unit is designed for use on CAMA or ANI applications. This unit includes reverse make-busy and improved return loss and transfers 3 dB of gain.

**3.14 E1E 2000- and 2600-Hz Signaling Unit:** This unit was designed for application at the originating end of one-way, 2-wire, reveritive pulsing, exchange, tandem, or toll connecting trunks using 4-wire line facilities. This unit transmits 2600-Hz signals and receives 2600- and 2000-Hz signals. The E1E SF unit will function only with the E1F SF terminating unit.

**3.15 E1F 2000- and 2600-Hz Signaling Unit:** This unit was designed for application at the terminating end of one-way, 2-wire, reveritive pulsing, exchange, tandem or toll connecting trunks using 4-wire line facilities. This unit transmits 2000- and 2600-Hz signals and receives 2600-Hz signals. The E1F SF unit will function only with the E1E SF originating unit.

**3.16 E1J 2600-Hz Signaling Unit:** This unit was designed for use on AUTOVON trunks over 4-wire facilities using MF signaling and requiring wink signal distortion to be at a minimum. The unit with an external 4-wire terminating set may be used for 2-wire office trunks using MF signaling.

**3.17 E1S 2600-Hz Signaling Unit:** This unit was designed for use at the station end of loop-start, DP, or TOUCH-TONE® calling customer lines using 4-wire line facilities. This unit converts station loop signals into 2600-Hz tone toward the central office. It connects a local 20-Hz ringing source toward the station when 2600-Hz tone is received. Circuit options allow this unit to be used with an auxiliary unit for ground-start lines.

**3.18 E2S 2600-Hz Signaling Unit:** Designed for foreign exchange station lines, this unit includes pulse correction for operation with station dialing. This unit also includes circuit options for use with auxiliary equipment for ground-start lines.

**3.19 E1L 2600-Hz Signaling Unit:** This unit was designed for use at the switching end of loop-start, DP, or TOUCH-TONE calling DTWX lines using 4-wire line facilities. This unit converts received 2600-Hz tone signals into loop signals toward the central office. It converts 20-Hz ringing from the central office into 2600-Hz tone toward the station. Circuit options allow this unit to be used for ground-start operation.

**3.20 E2L 2600-Hz Signaling Unit:** This unit is designed for applications similar to those of the E1L but is used in foreign exchange service. Circuit options allow this unit to be used for ground-start operation.

**3.21 E2S-A Auxiliary Unit:** This unit is designed to be mounted adjacent to and function with an E2S SF unit for ground-start, DP, or TOUCH-TONE calling customer lines using 4-wire line facilities.

**3.22 E2L-A Auxiliary Unit:** This unit was designed to be mounted adjacent to and function with an E2L SF unit for DP or TOUCH-TONE calling customer lines using 4-wire line facilities.

#### 4. TYPICAL SIGNALING UNIT OPERATION

**4.01** Basically, all E-type signaling units are similar in operating principles. Individual SF signaling units contain features which adapt them to particular circuit applications. All SF units must receive dc signals from the central office and convert these signals into voice-frequency tones which are applied to the transmission line toward an SF signaling unit at the distant office. Receiving portions of an SF signaling unit must determine when a signal is present at the incoming line and convert the signal to the appropriate dc condition. Signals used for the various SF signaling units are listed in Tables A through E and applications of the various units are listed in Table F.

**4.02** An E3B signaling unit is described in this section, since the operating principles of this unit are representative of most E-type units. Fig. 1 shows a typical circuit arrangement using E and M signaling. A 4-wire transmission facility terminating into both a 4-wire switching office and a 2-wire switching office.

**4.03** The signaling unit is associated with the office trunk relay circuit and the line facility by office cross-connections. All connecting leads may be cabled to a distribution frame.

**4.04** A functional diagram in Fig. 2 indicates the elements of the E3B signaling unit. The signaling unit may be divided into four parts: (1) signal transmitter, (2) signal receiver, (3) control circuit, and (4) voice amplifier.

#### Signal Transmitter

**4.05** The transmitter consists of a voice path, a means to apply two levels of tone, and an ability to cut the voice path momentarily upon receipt of a change in the signal. These actions are initiated by an M lead change of state, and are required to ensure tone detection at the distant SF unit by removing voice from the tone path and increasing tone level for short periods. Transmitting functions are controlled by relays M, HL, and CO.

**4.06** The transmitting portion of the signaling unit is controlled by dc signals on the M lead. An off-hook signal from the central office equipment will cause the transmitter to remove tone from the line and cut the voice path. After a short period, the transmission path is connected through to the central office equipment. Should dial pulsing be passed to the SF unit, the voice path would remain cut for the full pulse train.

**4.07** An on-hook signal from the central office equipment causes the SF unit to apply a higher level tone (approximately 12 dB) for about one-half second. The voice path is cut for the initial part of this signal. If the unit is receiving tone when an on-hook signal is received, the voice path is cut until the next signal change to off-hook is received from either direction.

#### Signal Receiver

**4.08** The receiver is bridged on the incoming transmission path and continuously compares signal energy against guard energy. When a signal tone is present, the SF unit will detect the tone and indicate an on-hook signal to connecting equipment via the E lead. The receiver contains band-shaping networks; an amplifier-limiter stage; signal and guard frequency detectors; a rectifier and comparator; a pulse correction network; and R, RG, and G relays.

**4.09** The receiver controls its own input bandwidth and the bandwidth utilized by the signal network. The guard network is shunted in degrees so that energy outside the signal bandwidth is weighted according to the state of the SF unit.

**4.10** To allow for aging of components, the receiver sensitivity and signal timing are

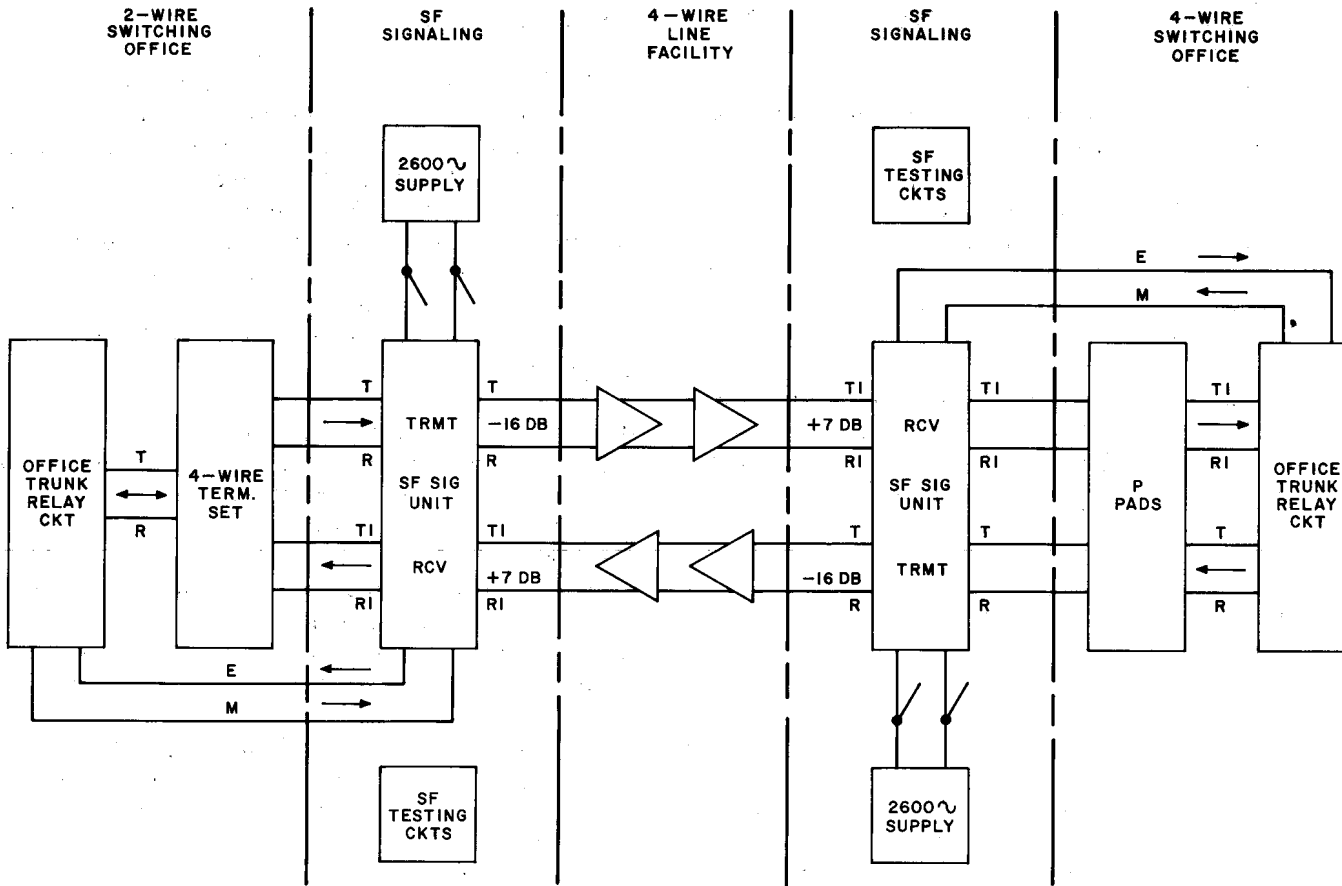


Fig. 1—Single-Frequency Signaling (E & M Type) on 4-Wire Line Facilities

adjustable to permit proper setting of receiver operate levels.

4.11 After comparing the received signal energy against the guard energy and having detected a signal, the receiver relay R and its slave relay RG are operated. This in turn produces an on-hook signal (open) on the E lead.

4.12 A pulse correcting feature is employed to properly shape the E-lead opens and closures, when a series of pulses is received, so that connecting central office equipment will function. After answer supervision is received by the terminating SF signaling unit, additional delay is introduced by the receiver to inhibit short voice-simulated signals but still retain ability to pass a ring-forward signal.

4.13 The operation of the receiver causes the voice amplifier to be blocked momentarily,

until the receive relays are operated, to effectively confine the signaling tone within one switching link. The receiver relays insert band-elimination filters to continue to confine the signal to one link. The electronic cut is released to allow all other frequencies to continue on the transmission path while a signal is present.

#### Control Circuit

4.14 Signal bandwidth is controlled by the RG and G relays, while guard effectiveness is controlled by the M and G relays. Table G indicates the different states of signal bandwidth and guard control for normal steady-state conditions. Broadband energy is normally received from the line when the RG relay is released. Operation of the RG relay inserts filters to limit energy from the line to a bandwidth that is peaked approximately at the signal frequency. The G relay controls the

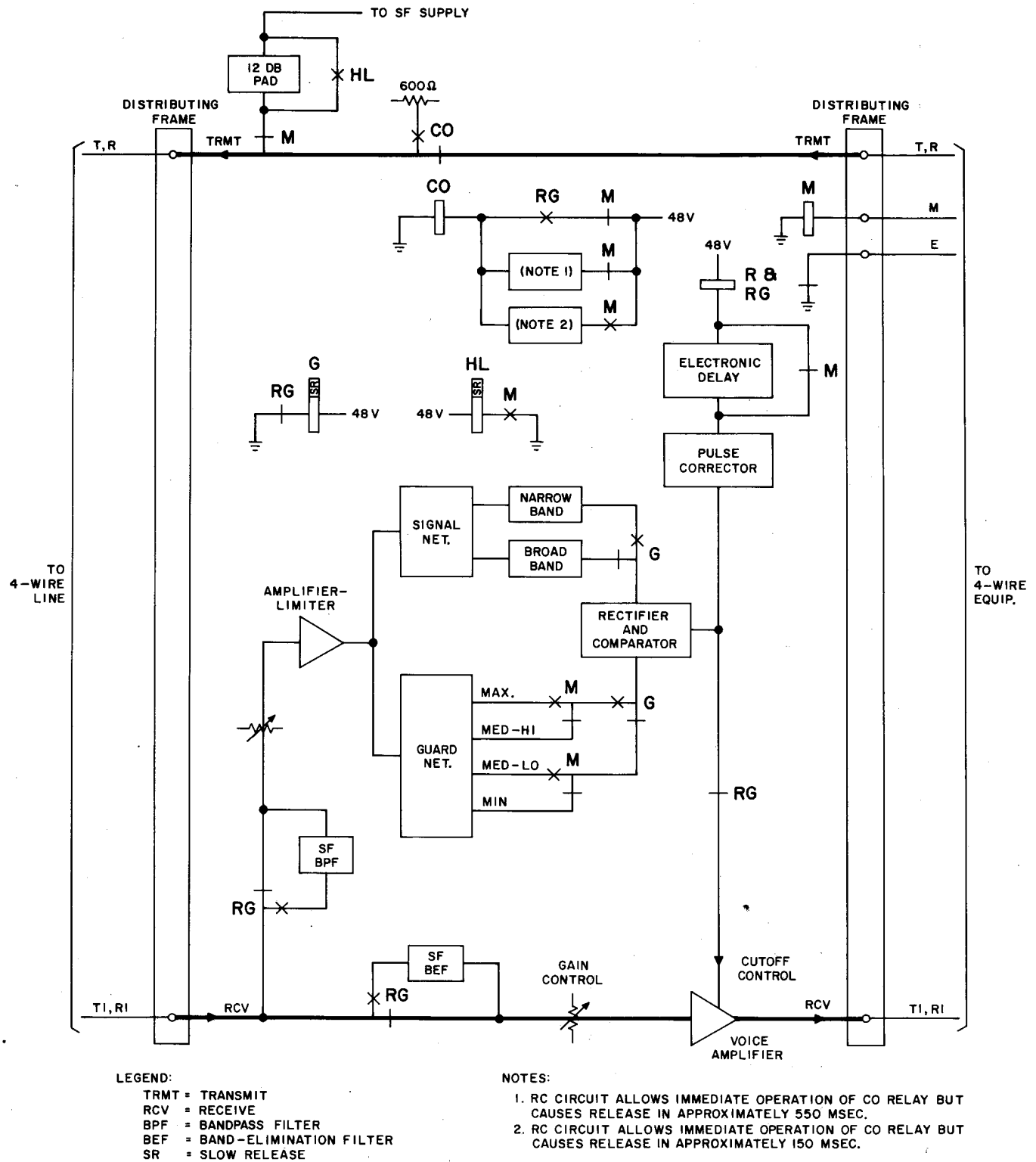


Fig. 2—E3B-20 Single-Frequency Signaling Unit—Functional Diagram

TABLE G

TYPICAL STEADY STATE CONTROL FUNCTIONS (E3B-20)

CONDITION	SWITCHHOOK SIGNAL		CONTROL RELAYS			RECEIVER INPUT BANDWIDTH	SIGNAL NETWORK BANDWIDTH	GUARD NETWORK SHUNT	GUARD OUTPUT	ELECTRONIC DELAY
	E LEAD	M LEAD	RG	G	M					
Idle	On-Hook	On-Hook	O	R	R	Narrow	Broad	Max.	Min	Out
Seized (Term. Unit)	Off-Hook	On-Hook	R	O	R	Broad	Narrow	Med-Low	Med-High	Out
Seizing (Orig Unit)	On-Hook	Off-Hook	O	R	O	Narrow	Broad	Med-High	Med-Low	In
Talk	Off-Hook	Off-Hook	R	O	O	Broad	Narrow	None	Max.	In

Legend: O = Operated

R = Released



amount of bandwidth used to produce an output from the signal network.

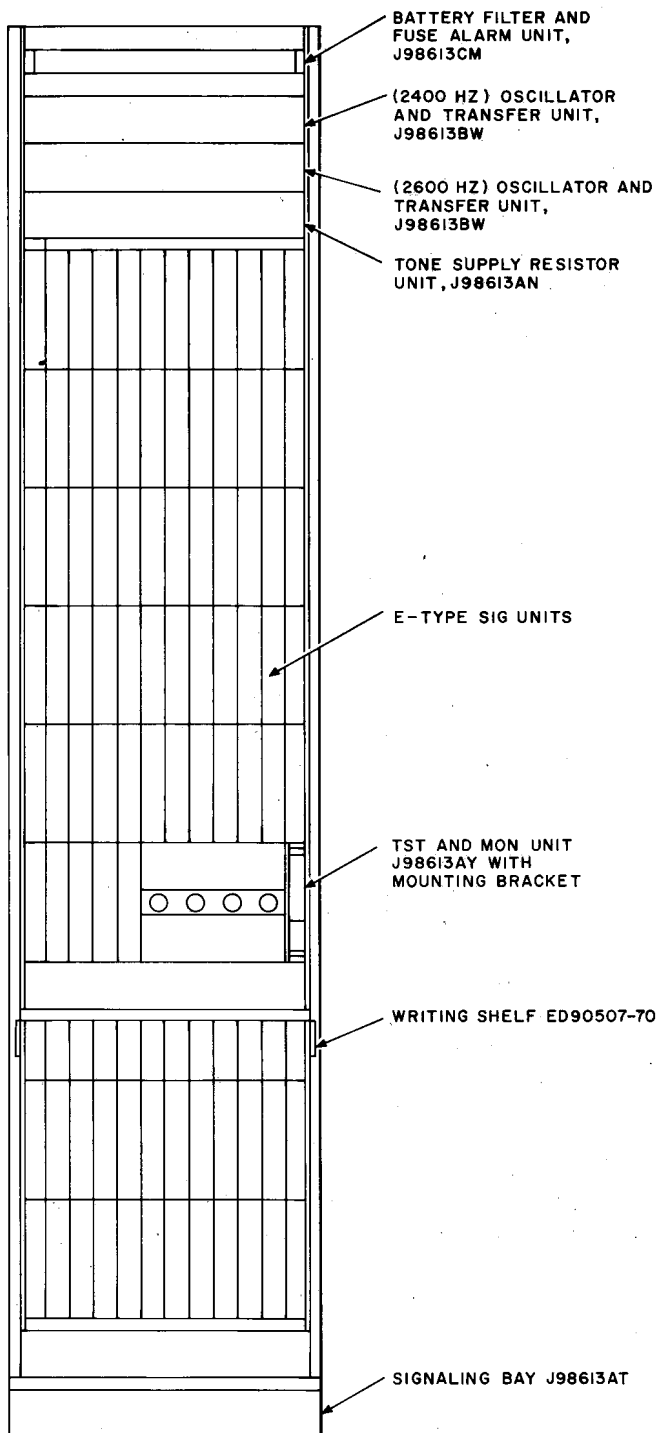


Fig. 3—Typical J98613 Signaling Bay, Arrangement for Central Office

4.15 Guard energy is derived from voice, line noise, or as a product of the amplifier-limiter of the SF unit. The amount of guard energy used by the comparator is dependent on the condition of the unit. For example, in the talking condition the M and G relays are operated. This results in the maximum use of whatever guard energy is present outside the narrow signal bandwidth to reduce voice simulation of signals.

4.16 Transmitting pulse correction is controlled by the receiver (RG) relay, a guard (G) relay, and the transmitter (M) relay. In the talking condition (M relay operated), an electronic delay is introduced to inhibit operation on short bursts of voice-simulated signal, yet retain the ability to pass a ring-forward signal without undue distortion. If, in the pulse receiving condition (M relay released and G relay operated) a signal is detected, the pulse corrector acts to provide an acceptable pulse (within normal pulsing limits) to connecting central office equipment. Operate and release time adjustments are provided to assure proper pulsing while protecting against operation on spurious signals.

#### Voice Amplifier

4.17 The voice amplifier compensates for the small insertion loss of the receiver and provides a high-loss path in the backward direction. Loss in the backward direction is necessary to prevent noise or speech originating in the central office from reaching and interfering with the signal receiver. Voice amplification is adjustable to allow for component variation and aging. Normal adjustment would require no loss at 1000 Hz between the input and output of the receive path.

## 5. EQUIPMENT

### A. Mounting Arrangements

5.01 A typical 11-foot 6-inch by 23-inch signaling bay used in a central office is shown in Fig. 3. This arrangement contains 84 signaling units, a testing and monitoring unit, and required common equipment. This bay will mount 90 signaling units without a testing and monitoring unit. A special bay is available to mount the revertive-terminating units, since an additional oscillator and different tone distribution is required. Other arrangements in single 9-foot and double 7-foot bays are available. Signaling units are also

mounted in combination with other equipments. Fig. 4 and 5 show typical arrangements of signaling units in carrier equipment bays.

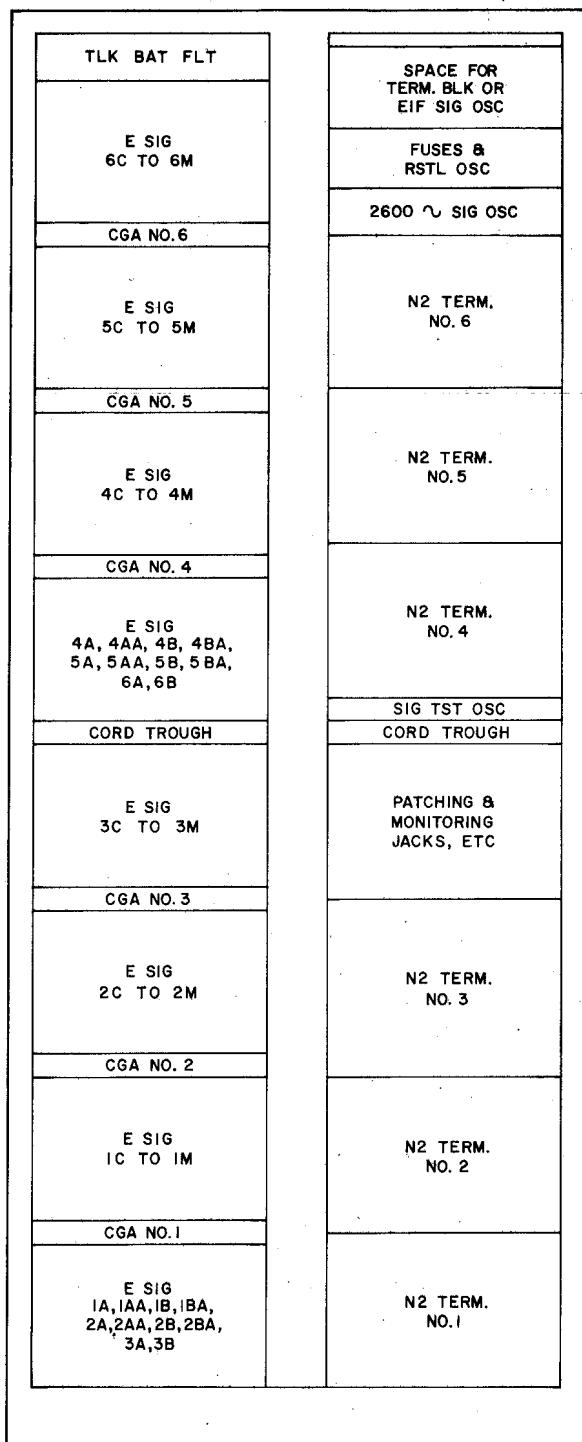


Fig. 4—J99285B N2 Carrier 72-Channel Packaged Terminal Frame (11 Feet 6 Inches High) With E-Type Signaling Units

5.02 When 23-inch racks are not available, signaling units may be mounted in 19-inch racks on special mounting shelves. In this case, common equipment must be installed elsewhere, possibly in 16-type apparatus mountings secured to a wall.

5.03 Plug-in signaling units are arranged in rows of ten and mounted on shelves vertically spaced at 12-inch intervals. Signaling units are secured to the mounting shelves by screw-type fasteners. Plug-in connectors allow for easy removal for test and maintenance. A typical signaling unit is shown in Fig. 6.

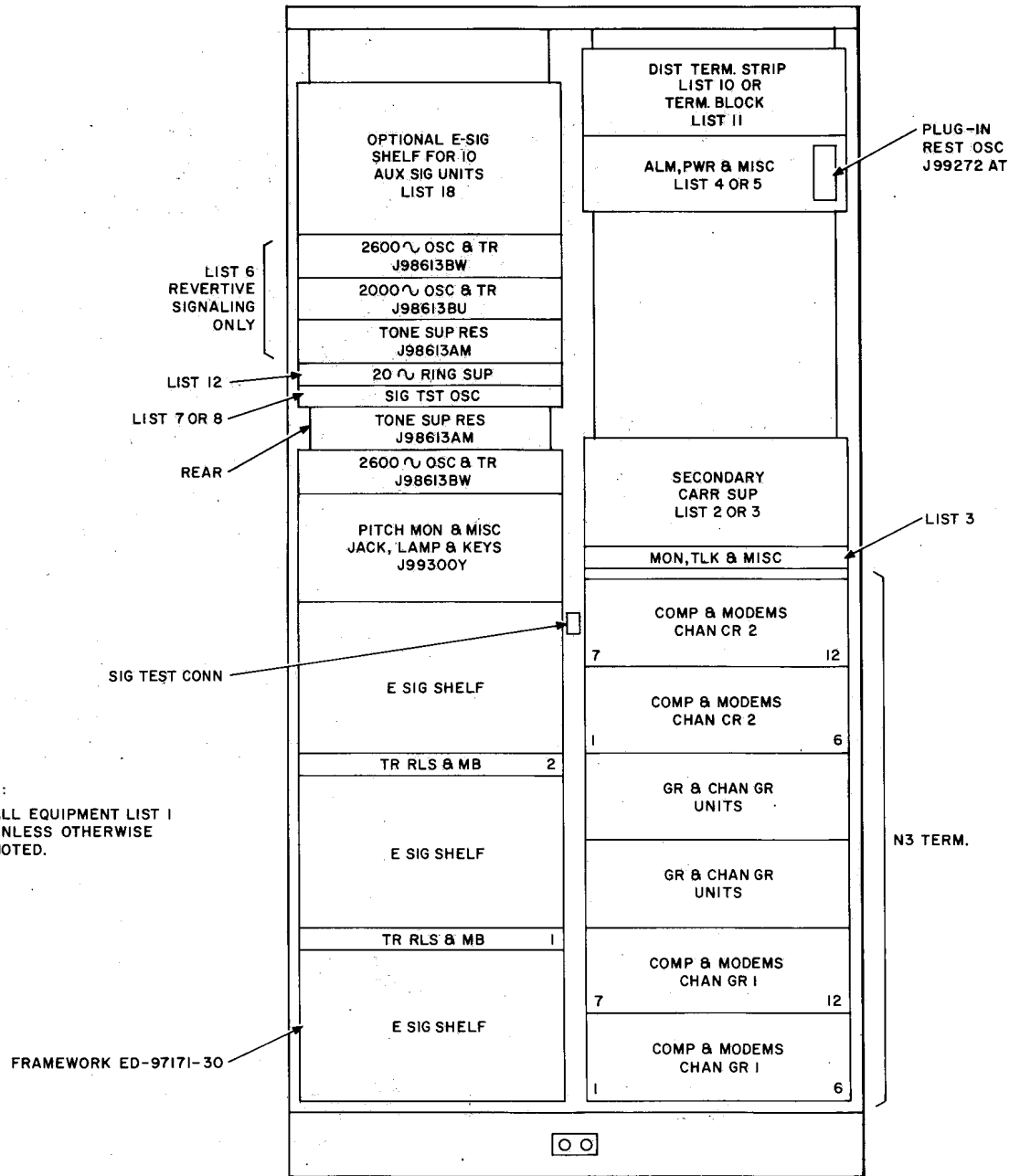
5.04 No signaling unit position should be separated from a monitoring unit, or a testing unit by more than two bays unless a connector is provided for a portable monitoring or portable testing unit.

#### B. Common Bay Equipment

5.05 Fuse panels are available for various combinations of numbers of units and types of offices served. Panels are available with and without battery filter and/or 20-Hz ringing supplies. Bays with testing units and bays intended to mount the foreign exchange customer line station units require connection to 20-Hz ringing. If the monitoring or testing unit provided is fully transistorized and the signaling test set is provided with an ac power pack, the +130 volt supply is not required. One -48 volt fuse supplies five signal unit positions. To reduce battery noise a bay filter should always be used.

5.06 Oscillators and transfer units are available for the 2000-, 2400-, or 2600-Hz supplies. Normally, each of two oscillators furnished will serve one-half of the bay positions, on an even-odd basis. If one oscillator fails, the entire load is automatically (or manually) transferred to the good oscillator, and office and local alarms are operated. Manual transfer keys, alarm cutoff keys, and testing jacks are provided. Each unit will supply a maximum of 120 E-type signaling units. A typical panel for this unit is shown in Fig. 7.

5.07 Tone distribution units are available for regular and small installations. A special panel is available for revertive pulsing units. These units distribute tone to units within a bay, while providing isolation for individual circuits. Group strapping is possible so that one unit may be used for both 2400- and 2600-Hz tone distribution.



NOTE:  
ALL EQUIPMENT LIST 1  
UNLESS OTHERWISE  
NOTED.

Fig. 5—J99300C N3 Carrier 24-Channel Packaged Terminal Frame (9 Feet High) With E-Type Signaling Units

C. Associated Equipment

5.08 Use of external associated equipment such as the 4-wire terminating set, 2-wire line network, repeating coil, or pulse corrector depends on the signaling unit and facility connecting to trunk equipments.

6. MAINTENANCE

6.01 In-service checks of E-type signaling units are made using a monitoring unit (see Fig. 8). Rack-mounted and portable models of this unit are available. The circuit contains a monitor amplifier and jacks for monitoring and test equipment. Connection to the signaling unit being checked is

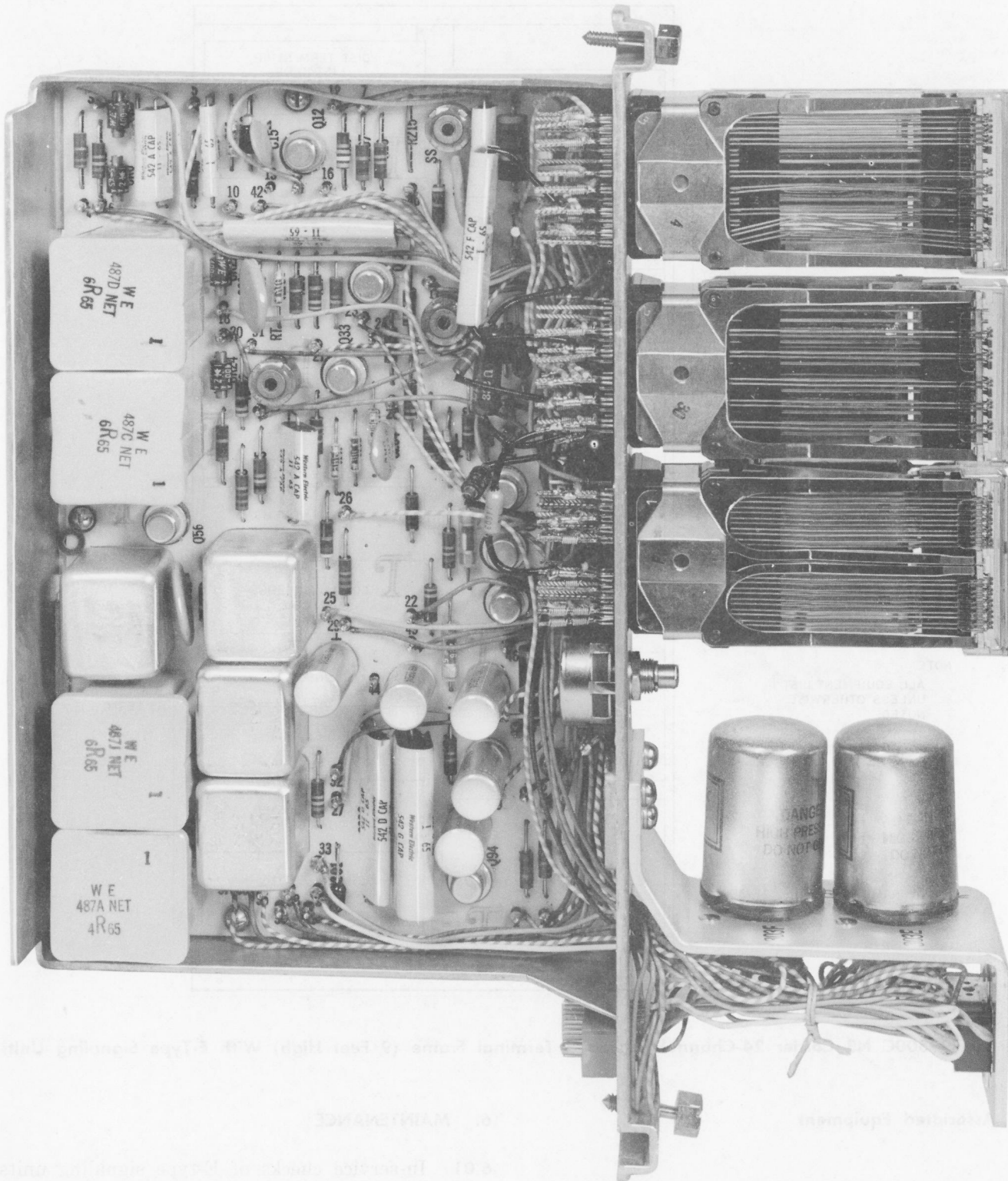


Fig. 6—Typical Signaling Unit (E3B)

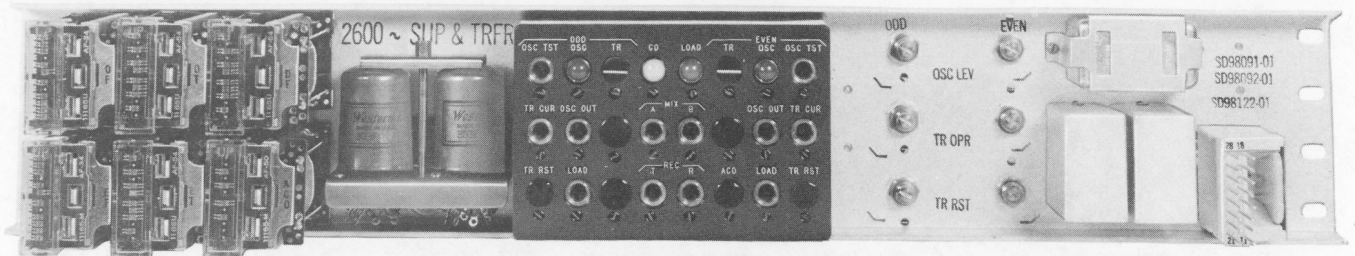


Fig. 7—2400/2600-Hz Supply and Transfer Unit

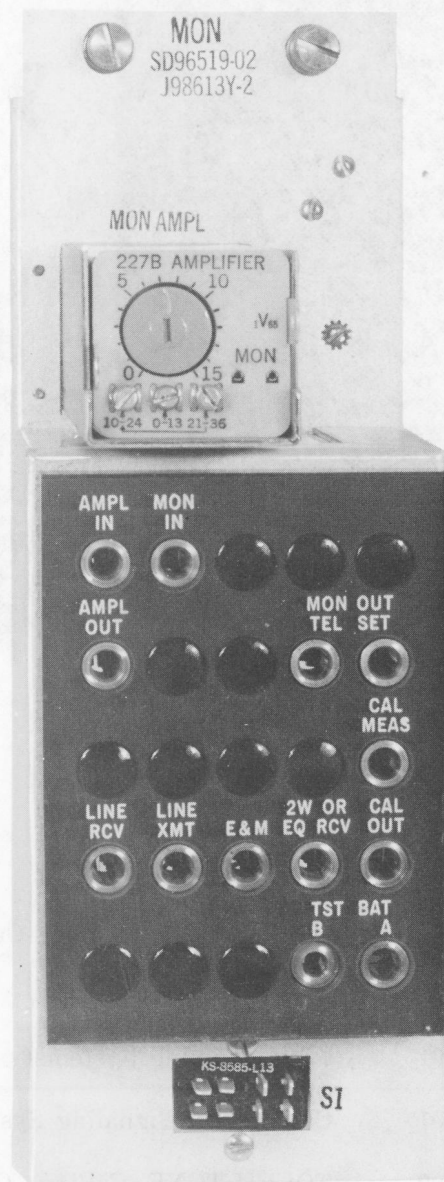


Fig. 8—Monitoring Unit

made by patching the SF unit S jack to the S1 jack of the monitoring unit. Checks of line transmit level, line receive level, receiver sensitivity, and status of dc signals toward the central office equipment can be made.

**6.02** In-service checks and out-of-service tests are made using a testing and monitoring unit (see Fig. 9). Rack-mounted and portable models of this unit are available. In-service checks are made as described in 6.01. Signaling units to be tested, however, are removed from their service positions and mounted in the test bracket furnished with this unit. Connections are made through the normal P connector of the SF unit. Necessary testing and monitoring jacks and control keys are provided to connect recommended test equipment. All signaling operations may be tested through the use of two multiposition switches that establish the various testing conditions. Tests and adjustments of the E-type SF units are included in other sections listed under Part 7, REFERENCES.

## 7. REFERENCES

**7.01** The following is a list of sections containing related information on Single-Frequency Signaling Systems.

SECTION	TITLE
179-314-501—E1A, B, C, D, L, S	SF Signaling— In-Service Tests
179-324-504—E1E	
179-326-502—E1F	
179-316-502—E1B, 2B, 3B, 4B	SF Signaling—Out- of-Service Tests
179-318-502—E1A	

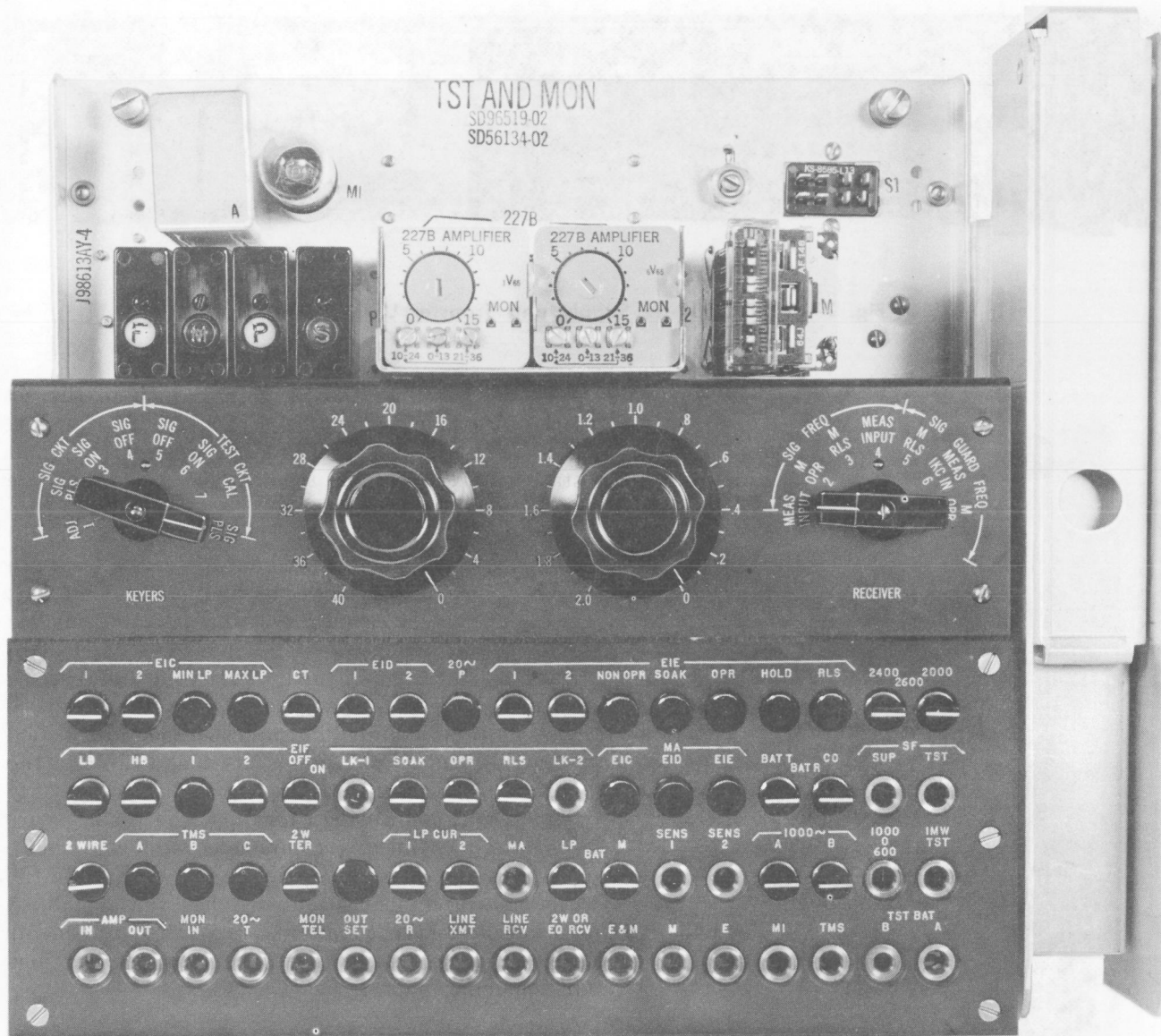


Fig. 9—Testing and Monitoring Unit

179-320-502—E1C, 2C	} SF Signaling—Out-of-Service Tests	179-330-501—E1S, 2S	} SF Signaling—Out-of-Service Tests	
179-322-502—E1D, 2D, 3D		179-353-501—E3C, E4C		
179-324-501—E1E		179-354-501—E4D		
179-326-501—E1F		179-701-101		◆DC Signaling Systems◆
179-327-501—E1J		179-102-101		CX and SX Signaling Systems
179-328-501—E1L, 2L		951-920-100		TOUCH-TONE Calling—General Description

SECTION	TITLE	SECTION	TITLE
975-110-100	Customer Loop Signaling and Signaling Systems	975-210-100	MF Pulsing Systems
975-120-100	Interoffice Signaling and Signaling Systems	975-215-100	2400/2600-Hertz SF Signaling System, Toll Systems
		975-230-100	DX Signaling System