E1E 2000- AND 2600-CYCLE SINGLE-FREQUENCY SIGNALING AND 4-WIRE TERMINATING UNIT REVERSE BATTERY SUPERVISION — REVERTIVE PULSING ORIGINATING OFFICE END COMMON SYSTEMS

1. GENERAL

1.01 The E1E single-frequency (SF) signaling unit is made for the originating end of one-way trunks with loop reverse battery supervision and revertive pulsing. Its 4-wire terminating set is suitable for exchange, tandem, and toll connecting trunks that use carrier channels for line facilities. DC loop supervisory signals (loop closures) from the office side are converted to 2600-cycle signals for transmission over the line facility to an E1F unit at the distant terminal. Conversely, it receives 2600-cycle signals from the line facility (which are originated by the SF unit at the far end), and converts them to dc supervisory signals (battery reversals) on the office side. In addition, it receives pulses of 2000-cycle tone from the terminating end, which represent the revertive pulses. These, in turn, are converted to a "no-current" condition on the 2-wire "T" and "R" leads for the count down of revertive pulses by the originating sender or register.

1.02 Audible tone and flashing signals are passed without distortion over a maximum of three SF signaling links in tandem providing none of these links transmit the flashing signals with an E2B unit. The E1E must be used with a complementary E1F unit at the terminating end of the trunk. It will not function with any other unit in the E series nor will it function with an electron tube 2600-cycle unit. Conversion from 2-wire office to 4-wire line facility is accomplished by a 4-wire terminating circuit which is an integral part of the E1E.

2. APPLICATION

2.01 This unit will function with N-, O-, or ON-type carrier systems. Office transmission levels for the transmitter and receiver are −16 db and +7 db, respectively. Nominal 2600-cycle supervisory tone (in the idle condition) is −20 dbm referred to zero transmission level. This level is increased 13 db for approximately the first 40 milliseconds whenever it is applied to the line. The 2000-cycle revertive pulsing tone is nominally received at 0 dbm referred to zero transmission level.

2.02 Seven leads are required to insert the signaling transmitter-receiver between the office terminal and line facility. These leads may be cabled to an intermediate distributing frame for cross connection. Fig. 1 shows a typical circuit layout with an E1E at the left terminal, and a complementary E1F unit at the right terminal.

2.03 The 2-wire side of the 4-wire terminating circuit is designed for a nominal 900ω and 2-mf impedance. The 4-wire side matches 600ω facilities. A group of five building-out capacitors is included with the compromise network in the terminating circuit for use as required to balance the capacitance of the 2-wire office cabling. The terminating circuit has a 10:1 impedance ratio between the net and 2-wire side instead of the usual 1:1 ratio. This was done to reduce transmission loss in the receive path (4-wire to 2-wire) as much as possible without exceeding 16 db loss in the transmit path (2-wire to 4-wire). Nominal receive and transmit losses are 2 db and 15.8 db, respectively.

2.04 The maximum allowable frequency shift is ±10 cycles, and the transmission variation should be within ±6 db at the signaling frequencies in the 4-wire facility. The conductor loop resistance on the 2-wire side cannot exceed 100ω. The E1E will function with district or office selectors, trunk or office link frame, or outgoing revertive pulsing trunk circuit.

© American Telephone and Telegraph Company, 1959
Printed in U.S.A.

3. OPERATIONAL PRINCIPLES

3.01 A block diagram showing the basic elements of the E1E circuit appears in Fig. 2. The transmitter converts dc loop supervisory signals on the 2-wire "T" and "R" leads into the absence or presence of 2600-cycle tone on the "T" and "R" line transmit leads. It consists of C1A, C1B, C2, and M relays, a 13-db pad, and the line transmitting portion of the 4-wire terminating circuit. Battery through transfer contacts on the R relay, and ground in series with the M relay winding through transfer contacts on both the R and RP relays are supplied to the 2-wire "T" and "R" leads. The M relay operates upon loop closures on the 2-wire "T" and "R" leads and causes 2600-cycle tone to be removed from the line transmit "T" and "R" leads toward the terminating office. While operated, it also charges a capacitor timing circuit which on the subsequent release of the M relay short-circuits the 13-db pad for approximately 40 milliseconds. This initial pulse of high-level tone increases the signal to noise ratio and insures proper operation of the terminating office receiver. The M relay in conjunction with the R relay in the receiver controls a conditioning circuit consisting of C1A, C1B, and C2 relays. After revertive pulsing has been completed and the call has progressed beyond "Incoming Advance," C2 relay operates and closes through the talking path in preparation for speech transmission. Switching transients which might be developed in the office equipment and/or the SF unit are thereby blocked until the critical revertive pulsing portion of the call has taken place.

3.02 In Fig. 2, the voice amplifier is shown as part of the receiver although technically it is a separate circuit. The amplifier's primary function is to provide a high-loss path in a backward direction to prevent noise or speech originating in the office equipment from reaching the receiver (over the T1, R1 leads) and interfering with its operation. In addition, it makes up for the insertion loss of the receiver, and by means of its associated potentiometer allows the required trunk net loss to be established.

3.03 The 2600-cycle portion of the receiver consists of (1) an amplifier-limiter input stage, (2) a signal and guard frequency network plus separate half-wave rectifiers, (3) a dc amplifier, (4) R and RF relays, and (5) a signal elimination network. The 2000-cycle portion consists of (1) an amplifier, (2) a full-wave rectifier, and (3) RP relay.

3.04 The amplifier-limiter stage receives 2600 cycles from the line through either a third winding on the input transformer or the signal elimination network depending on whether the RF relay is released or operated. A potentiometer at the input of this stage permits setting the receiver operate sensitivity of −28 dbm referred to zero transmission level. Since nominal 2600-cycle signal power is −20 dbm (at OTL), an 8-db operate margin is obtained. This allows for variations in the sending power at the distant terminal, loss variation in the line facility, and sensitivity drift in the receiver itself. At low input levels, the amplifier-limiter produces maximum gain, while at higher input levels limiting takes place and gain is reduced. An output transformer and capacitor arrangement forms a low-pass filter to sharply attenuate harmonics of the signal frequency that might be generated as a result of limiting. These harmonics, if not suppressed, would produce an excess amount of guard voltage which might prevent proper receiver operation, as described below.

3.05 The amplifier-limiter output voltages are applied to the signal-guard network where they are separated into signal and guard components. The signal portion develops ac voltages proportional to incoming 2600-cycle tone and/or signaling frequency appearing in speech. The guard portion develops ac voltages proportional to all frequencies except 2600-cycle tone and/or speech simulated signaling frequency. These components are individually rectified, combined in opposing polarity, and are then fed to the dc amplifier for control of the receiving RF relay. The RF relay in turn controls the R relay.

3.06 The signal-guard relationship determines the operate time of the receiver. A high signal-guard ratio produces fast operate time; low signal-ratio, a slow operate time. This ratio is established by the RF relay which controls the bandpass characteristic of the signal channel, the efficiency of the guard channel, and the signal elimination network. Whenever the RF relay is operated, the signal elimination network, consisting of two individual tuned circuits, is inserted into the 4-wire receive leg. One circuit is used to feed the receiver input and has maximum response at 2600 cycles. The

second circuit has maximum attenuation at 2600 cycles and is inserted in series with the voice amplifier input to prevent received 2600-cycle tone from reaching the office equipment. When the trunk is idle (RF relay operated), the guard channel is at its lowest efficiency and the signal channel is broad band. The resultant signal-guard ratio is maximum, and the receiver should not be released falsely by line noise. In the talking condition (RF relay released), the guard channel is at its maximum efficiency and the signal channel is narrow-band. Signal-guard ratio is now minimum and any 2600-cycle frequencies appearing in speech should not cause false operation of the receiver.

3.07 Release of the RF relay operates the R relay which furnishes dc supervisory signals to the office equipment on the 2-wire "T" and "R" leads. When the R relay is released, −48-volt battery is applied to the "R" lead and ground to the "T" lead. Operation of the R relay reverses the battery and ground.

3.08 When 2000-cycle tone pulses are received, 2600-cycle supervisory tone is also being received. The input of the 2000-cycle amplifier is therefore bridged across the 4-wire receive leg after the signal elimination net to protect the 2000-cycle amplifier from 2600-cycle tone. The combined effect of the signal elimination net and the low sensitivity of the 2000-cycle amplifier insures its response only to spurts of high level revertive pulse tone. A potentiometer at the amplifier input allows for adjusting maximum amplifier sensitivity to −8 dbm referred to OTL. Nominal 2000-cycle tone is 0 dbm at OTL giving an 8-db operate margin. The rectified 2000-cycle signals are used to operate RP relay which converts the revertive pulses back to "no-current" conditions by inserting a high series resistance in the 2-wire loop.

3.09 When C2 relay operates after "Incoming Advance" (3.01), it short-circuits the RP relay winding. High level 2000-cycle signals appearing in speech might otherwise cause false operations of the RP relay which would create excessive noise in the speech path.

4. MISCELLANEOUS

4.01 The E1E unit is 2 inches wide by 12 inches high. Ten units mounted side by side require the space taken by six 2- by 23-inch mounting plates. For 19-inch relay rack bays, eight units use approximately the same amount of space as seven 1-3/4 by 19-inch mounting plates. Fig. 3 is a view of the unit.

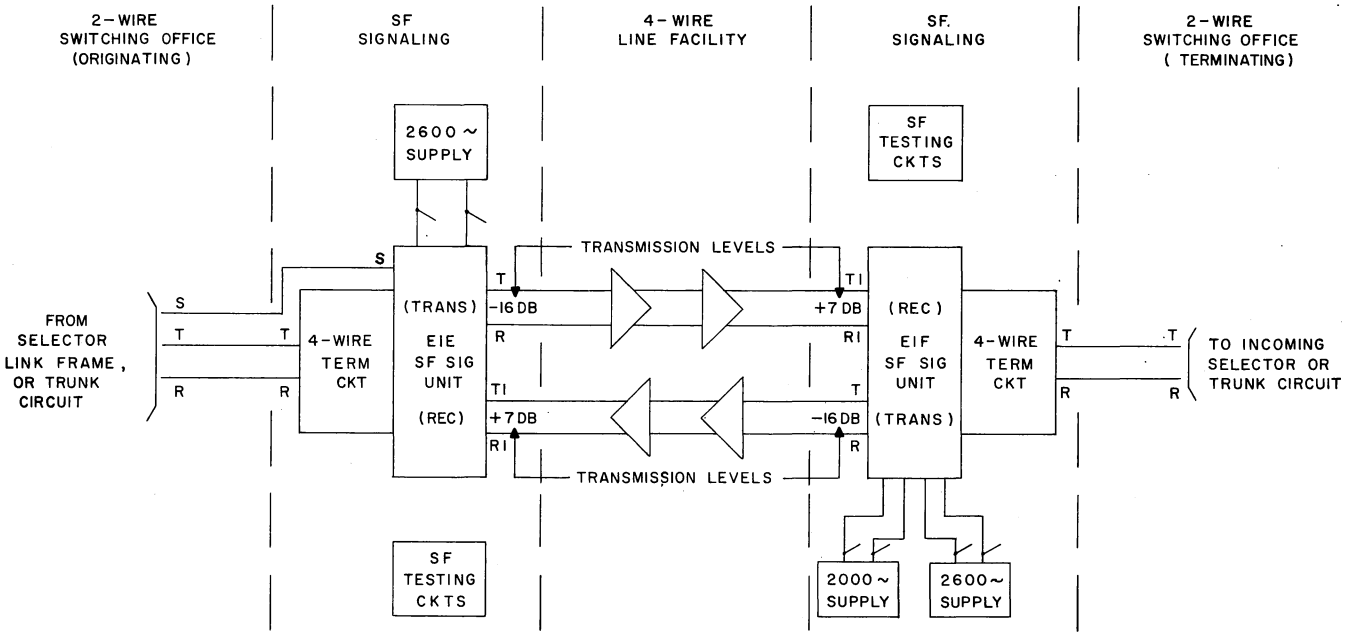

Fig. 1 – Circuit Layout Using E1E SF Signaling Unit

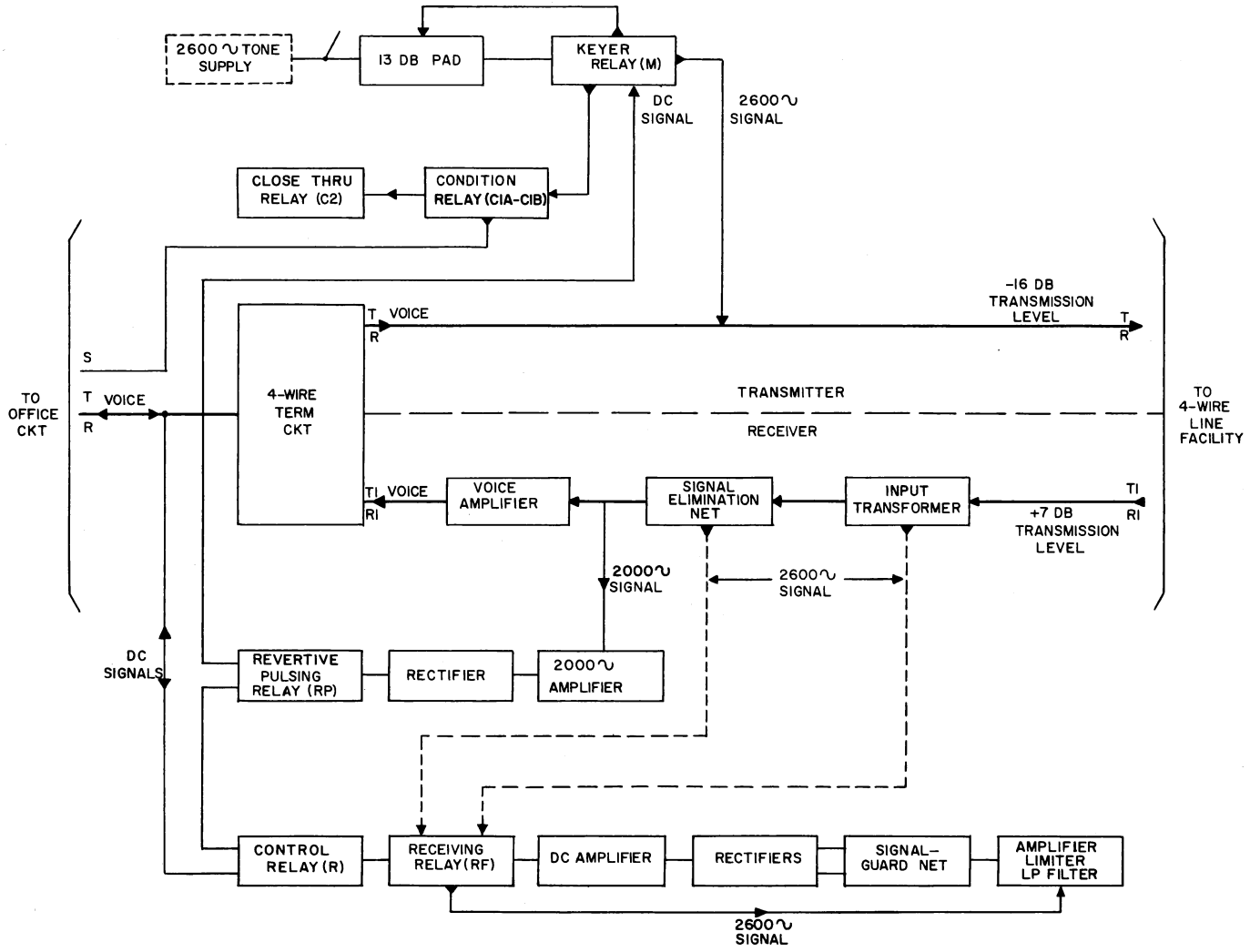

Fig. 2 – Basic Elements of E1E Circuit

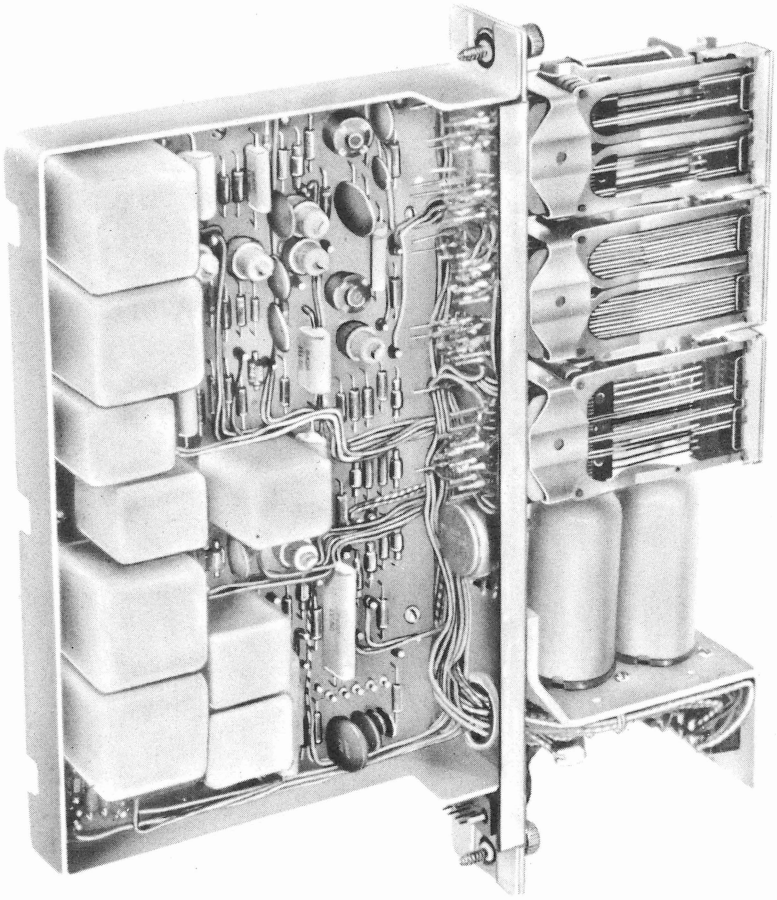

Fig. 3 – E1E SF Signaling Unit