NOTES ON THE NETWORK

SECTION 5

SIGNALING

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1. GENERAL

1.01 Interoffice signaling for operator and customer dialing is described in this section. Full dial operation is assumed; therefore, ringdown and straightforward methods are not discussed.

1.02 The names given for the different signals are those which are well established by general use. A few alternative terms having considerable use are shown in parentheses in Fig. 1. The direction of each signal, the indication given to the customer or operator, and the on- or off-hook classification of the signal are shown where applicable.

1.03 Applications of several of these signals are listed in Fig. 2 for a dialed connection switched through three intermediate offices in addition to the originating and terminating end offices. Calls can, of course, be switched through more or fewer offices. The number of offices shown should suffice to illustrate the use of signals.

1.04 This section will describe on- and off-hook signaling from the technical viewpoint as well as how they are used in signaling systems. The requirements for sender and register timing intervals are also included in this section.

1.05 The signaling, carrier, and switching systems referred to in this section are of Bell System manufacture. There are many systems of other manufacture in use throughout the industry. Some of these differ appreciably in design but, for network applications, they should be compatible with the equipment described in this section.

1.06 With the introduction of Electronic Switching Systems (ESSs) and Stored Program Control (SPC) in crossbar switching systems, a new type signaling system, known as Common Channel Interoffice Signaling (CCIS), has been developed for Bell System use. In this system, the signaling information for a number of interoffice trunks is encoded and transmitted over a separate data-link network. Between ESS and crossbar offices with SPC, the CCIS system permits eliminating all per-trunk signaling equipment. CCIS is covered in Section 6.

1.07 Signaling on international circuits to points outside the contiguous North American Network uses systems different from those in domestic service. At present, most such circuits terminating in the United States use the International Telegraph and Telephone Consultative Committee (CCITT) Signaling System No. 5. A new system known as CCITT No. 6 and similar in many respects to the CCIS system mentioned in the previous paragraph is also in use. Reference should be made to paragraphs 8.41, 8.42, and Section 10 for additional details concerning the signaling systems used in international dialing.

1.08 Signaling to and from the Traffic Service Position System (TSPS) is different in some ways from the signaling associated with toll cordboard operation. This has been taken into account at appropriate locations in this section.

1.09 The Pulse Code Modulation (PCM) carrier system (eg, T1) has an integral signaling system which makes use of one of the code bits associated with each channel for conveying the signaling state of the channel. The PCM systems can interconnect with E&M lead, loop reverse battery, and foreign exchange (FX) signaling. The signaling delay of PCM signaling is discussed in paragraph 7.41.

2. ON- AND OFF-HOOK SIGNALS

2.01 A number of interoffice signals are classified as on-hook, off-hook, or a sequential combination of the two. The terms were derived from the position of an old-fashioned telephone set receiver in relation to the mounting (hook) provided for it. If the station is on-hook, the conductor loop between the station and local central office is open and no current is flowing. For off-hook conditions, there is a dc shunt across the line and current is flowing in the loop.

2.02 These terms have also been found convenient to designate the two signaling conditions of a trunk. Usually, if a trunk is not in use, it is signaling on-hook toward both ends. Seizure of the trunk at the calling end initiates an off-hook signal transmitted toward the called end. Also, if a trunk is in the condition of awaiting an answer from the called end, the called end is signaling

NAME OF SIGNAL	ON-HOOK	OFF-HOOK	DIRECTION: CALLING END	DIRECTION: CALLED END	USE OR MEANING	INDICATION: TO CUSTOMER	INDICATION: TO OPERATOR	SEE NOTE
Connect (Seizure)		√	—	→	Requests service and holds connection.			
Dial Tone			←	—	Equipment is ready for dialing.	Steady tone	Steady tone	
Disconnect	√		—	→	No service is desired. Message is completed. Release connection.		Calling supervisory lamp lighted	
Answer (Off-Hook)		√	←	—	Called party has answered. Charge timing begins and depends on this signal.		Called supervisory lamp dark	
Hang Up	√		←	—	Called party releases. Message is completed.			
Delay-Dial (Delay Pulsing)		√	←	—	Called end is not ready for digits.		Start-dial or KP forward lamp dark	1
Wink		√	←	—	Called end is not ready for digits.		Start-dial or KP forward lamp dark	1
Start-Dial (Start Pulsing)	√		←	—	Called end is ready for digits.		Start-dial or KP forwarded lamp lighted	1
Stop		√	←	—	Some digits have been received. Called end is not ready for further digits.		Start-dial lamp changes to dark	1
Go	√		←	—	Called end is ready for further digits.		Start-dial lamp changes to lighted	1
Dial Pulsing (DP)	√	√	—	→	Indicates called number.			
TOUCH-TONE (Pushbutton)			—	→	Indicates called number.			
Multifrequency Pulsing (MFP)								
Keypulse (KP)			—	→	Prepares receiving circuit for digits.			
Digits			—	→	Indicates called number.			
Start Pulse (ST)			—	→	Indicates that all necessary digits have been sent.			
Start Identification (Automatic Number Identification [ANI])		√	←	—	Indicates that Centralized Automatic Message Accounting (CAMA) sender is ready to receive calling number.			
ANI Outpulsing (MF)								
Keypulse (KP)			—	→	Prepares CAMA sender for digits.			
Identification Digit			—	→	Indicates if service observed, whether automatic or operator identification, identification failure, hotel-motel, mobile, and coinless public telephone.			
Digits			—	→	Indicates calling number if sent.			
Start Pulse (ST)			—	→	Indicates all digits sent.			1
Line Busy Tone			←	—	Called line is busy.	60-IPM tone	60-IPM tone	5
Reorder Tone and No Circuit ATB			←	—	All paths are busy. All trunks are busy. Indicates blockage in equipment. Indicates incomplete registration of digits.	120-IPM tone	120-IPM tone	2, 5

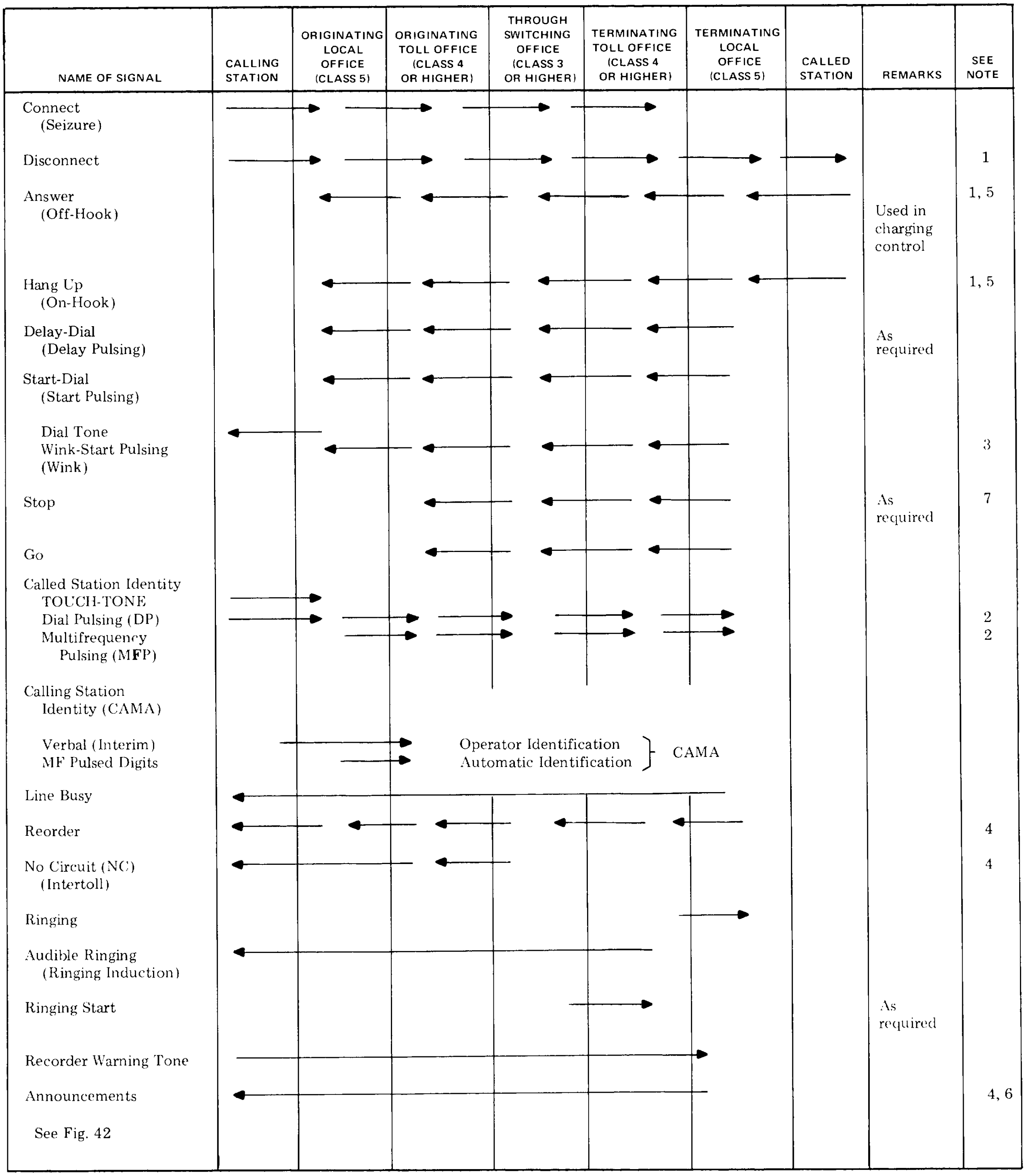
Fig. 1—Signals Required in Dialing Through the Network

NAME OF SIGNAL	ON-HOOK	OFF-HOOK	DIRECTION: CALLING END	DIRECTION: CALLED END	USE OR MEANING	INDICATION: TO CUSTOMER	INDICATION: TO OPERATOR	SEE NOTE
Ringing			———	→	Alerts called customer to an incoming call.	Bell rings or other alerting signal.		3
Audible Ringing			←	———	Called station is being rung or awaiting operator answer.	Ringing tone		
Ring Forward (Timed Wink)	√		———	→	Recalls operator forward to the connection.		Steady or flashing lamp	7
Ringback (Untimed)	√		←	———	Recalls operator backward to the connection.		Lighted lamp for duration of ring	
Ringing Start			———	→	Starts ringing when terminating equipment is of controlled ringing type.			
Wink-Off	√		←	———	Releases customer from operator trunk.			
Reverse Make-Busy		√	←	———	Make busy from far end of trunk.			
Coin Collect			←	———	To collect coins deposited in coin box.			
ABC Tone			←	———	Indicates that caller may dial billing number.	60 ms of 941 + 1477 Hz (number tone) and 940 ms of 440 + 350 Hz (dial tone). This signal decays exponentially with a time constant of 200 ms.		
Coin Collect Tone			←	→	Indicates that coin collect signal is being sent to coin box.		Low tone or no tone	
Coin Return			←	———	To return coins deposited in coin box.			
Coin Return Tone			←	→	Indicates that coin return signal is being sent to coin box.		High tone or no tone.	
Coin Denomination Tones			———	→	Indicates number and denomination of coins deposited in coin box.	Tones from gongs or oscillator in coin box		
Class-of-Service Tone			———	→	Indicates to operator the class of service of the calling customer's line.		High, low, or no tone	
Recorder Warning Tone			←	→	Indicates telephone conversation is being recorded.	1400-Hz tone of 0.5-second duration applied every 15 seconds		
Alerting Tone			←	———	Indicates that an operator has come on the line (emergency interrupt on a busy line — verification call)	440 Hz tone for 2 seconds followed by 1/2 second of tone every 10 seconds.		
Recall (Customer Flashing)	√	√	←	→	Manually recalls operator to connection.		Flashing lamp	6

Notes:

1. In cordboard operation, the start-dial, delay-dial, stop, and go signals are sometimes indicated to the operator on the calling cord lamp instead of the start-dial lamp. In Traffic Service Position (TSP) operation, these signals are indicated on KP and ST lamps.
2. It will be observed that conditions producing a 120-IPM tone signal apply to facilities that are relatively liberally engineered; hence, the probability of an immediate subsequent attempt succeeding is reasonably good.
3. Ringing of the called station should be started automatically upon seizure of the called terminal.
4. An ST pulse may not be sent on calls by multiparty customers or if there is an identification failure.
5. Some offices may still be returning flashes in synchronism with tone. Flashing signals should be eliminated and only audible tone signals used.
6. With TSP operation, the effect of flashing can depend upon the circumstances, but in most instances, a flashing supervisory lamp will result.
7. No effect, unless inward operator is at terminating end of the connection.

Fig. 1—Signals Required in Dialing Through the Network (Contd)



Notes:

1. This signal is simply relayed from office to office.
2. Connection must be established before remaining or regenerated digits are sent ahead.
3. Second dial tone is used in some cases but is not satisfactory in ultimate.
4. May originate at any one of the indicated offices.
5. Answer supervision must be returned to the office where charging control is centered. It is desirable to return real or simulated answer supervision to the originating office in all cases if feasible.
6. Announcement may be by operator or by machine (recorded announcement).
7. Stop is returned when selector cuts in on the level having trunks which require this signal.

Fig. 2—Use of Signals With Calls Dialed Through the Network

on-hook toward the calling end. Answer of the call results in the sending of an off-hook signal back toward the calling end. However, it should be noted that trunks using delay-dial operation with loop reverse battery signaling can use off-hook toward the originating office when idle.

2.03 Both off- and on-hook signals, when not used to convey address information, are often referred to as supervisory signals or simply as "supervision." A sequence of alternating on- and off-hook signals (dial pulses) occurring within a specific time duration is used to convey address information.

2.04 The various on- or off-hook signals are shown in Fig. 1. The direction of transmission of each signal is also shown. One or more of the following factors help in determining the significance of a signal in addition to the information given in Fig. 1:

(a) ***Duration:*** The on-hook interval of a dial pulse is relatively short and is distinguishable from an on-hook disconnect signal which is transmitted in the same direction but for a longer duration.

(b) ***Relative Time of Occurrence:*** A delay-dial, off-hook signal occurs before any digits have been sent while the answer off-hook signal occurs after all digits have been sent. Although both signals are transmitted in the same direction and both are off-hook, they are distinguished by the relative time of their occurrence.

CONNECT (SEIZURE)

2.05 A connect signal is a sustained off-hook signal transmitted toward the called end of a trunk following its seizure. This signal is the means by which the calling end indicates a request for service. It continues as long as the connection is held. Momentary interruptions in the connect signal caused by dial pulses or the ring forward signal are ignored as far as the connect and disconnect functions are concerned. To avoid double seizures (ie, simultaneous seizure from both ends), a connect signal must be sent immediately upon seizure of a 2-way trunk in order to make it busy at the other end. The simultaneous seizure of a 2-way trunk at both ends is called "glare." (See paragraphs 2.25 through 2.44.)

ANSWER (OFF-HOOK)

A. Charge Delay

2.06 When the called customer answers, an off-hook signal is transmitted toward the calling end to the office where automatic charging control takes place. For charging purposes, the answer off-hook signal is distinguished from off-hook signals of shorter duration by the requirement that it must be continuous for a minimum interval which ranges from 2 to 5 seconds. The 1975 issue of ***Notes on Distance Dialing*** indicated that the minimum continuous off-hook signal (charge delay feature) that should be considered an answer for charging purposes is 0.6 second. However, study has shown that many spurious off-hook signals last longer than 0.6 second. As a result, the present recommended minimum off-hook signal that should be recognized as an answer signal for charging purposes is 2 seconds.

2.07 Most trunks when idle and all trunks when awaiting the customer's answer transmit an on-hook signal from the called end to the calling end. Most trunks return to the on-hook state when the called station hangs up. Some 1-way loop signaling trunks are arranged to signal off-hook toward the calling end when idle.

B. Answer Signals on Calls to Directory Assistance

2.08 Direct-dialed directory assistance calls to 555-1212 and NPA + 555-1212 trunks originally did not return answer supervision. This prevented the use of Automatic Message Accounting-Centralized Automatic Message Accounting (AMA-CAMA) tape analysis for network completion studies on calls to directory assistance. Consequently, to improve the effectiveness of the network completion studies, it has been recommended that answer supervision should be returned on all 555-1212 and NPA + 555-1212 calls.

2.09 Where operator directory assistance (131) trunks are used jointly to complete customer-dialed 555 calls and operator-placed 131 calls, these trunks should also be arranged to return answer supervision. Where the 131 trunks handle only operator-dialed traffic, the return of answer supervision is optional.

C. Cross-Office Transfer Time for Answer Signals

2.10 Since individual switching offices contribute directly to network effects, it is important to establish performance objectives which recognize those parameters to which the network is most sensitive. Cross-office delay in transfer of the answer signal is one such parameter. In the recent past, the controlling consideration in placing an objective figure on this function was the desire to avoid a transmission clip at the time of verbal response following call answer. The widespread use of inband single-frequency (SF) signaling on intertoll trunks was the principal factor in causing this clip. Today the growing use of T Carrier and CCIS has shifted this concern, while not eliminating it. It now appears that long-term priorities should seek to avoid undue loss of revenue attributable to slow transfer of the answer signal that governs the start of charging.

2.11 Where little or no penalty is attached to prompt return of an answer signal, it is clear that this task should be performed with dispatch. Figures ranging from 5 to 25 milliseconds are being achieved and are preferred. It is also clear that forward-looking signaling arrangements should seek higher standards. Thus CCIS-to-CCIS connections should tend to produce improved performance. This subject remains under study and further advice may be expected. In the absence of economic options to achieve higher speeds, figures on the order of 50 milliseconds (average) for normal class 4 offices appear acceptable. This is reasonably consistent with the allowed split of class 4 and class 4X offices in the switching hierarchy for which figures in the order of 25 milliseconds per office have been published.

CONTROL OF DISCONNECT

A. Calling Customer Control of Disconnect

2.12 Calling customer control of disconnect, also known as forward control of disconnect, forward disconnect, or calling party control, is the means by which the calling end notifies the called end that the established connection is no longer needed and should be released. Forward disconnect is an on-hook signal which is transmitted toward the called end at the conclusion of the call. As long as the customer remains off-hook, the connection will remain up. When the calling customer goes on-hook for a period longer than the disconnect time, the connection is released. This method allows the calling customer to disconnect at any time by hanging up.

2.13 To distinguish an off-hook signal intended as a disconnect signal from other off-hook signal indications, such as a ring forward signal, the forward disconnect signal should exceed a minimum of 300 to 800 milliseconds for step-by-step trunk circuits and about 150 to 400 milliseconds for other types of trunk circuits. To ensure that ring forward signals do not cause false disconnections, incoming trunk equipments to inward and/or through operators must not release during a minimum on-hook interval of 140 milliseconds (a maximum 130-millisecond ring forward pulse plus a 10-millisecond safety margin). In general, any trunk circuit connected to inband signaling equipment must also be arranged so that it will not release during an on-hook interval of less than 140 milliseconds.

2.14 Calling customer control is usually modified by the local central office to prevent connecting the called party to dial tone as soon as the calling party goes on-hook and to prevent locking the called party to the connection as long as the calling party is off-hook. Table A lists disconnect timing that occurs in various types of telephone connections when the ***calling*** party hangs up and the called party remains off-hook. Table B lists similar information for conditions where the ***called*** party hangs up and the calling party remains off-hook.

B. Calling Customer Control of Disconnect With Forced Disconnect

2.15 In addition to the features discussed above, calling customer control of disconnect can include a forced disconnect feature. The addition of a forced disconnect feature is a distinguishing characteristic of all (except No. 5 crossbar) outgoing CAMA (paragraphs 8.26 through 8.30 and 8.36 through 8.39) and Automatic Intercept System (AIS) (paragraph 9.01) local central office trunk circuits. The calling customer may disconnect at any time but is automatically disconnected (winked off*) when an on-hook signal is received from the CAMA or AIS. The timing of partial dial, permanent signal, and other disconnect sequences is performed by the CAMA or AIS trunk. The forced disconnect feature ensures that "dial 1 for slumber" does not hold high revenue earning CAMA trunks out of service. If the terminating end reverts back to off-hook, the outgoing trunk circuit is automatically made busy (reverse make-busy).

* Wink off and winked off are popular terms for a forced disconnect from a CAMA, AIS, or TSPS. Actually the off- to on-hook transition causes the disconnect—not a wink.

TABLE A

DISCONNECT TIMING (NOTE 1)
(CALLING PARTY HANGS UP, CALLED PARTY HOLDS)

TERMINATING CENTRAL OFFICE SWITCHING SYSTEM	TIMED DELAY IN TERMINATING CENTRAL OFFICE FROM INCOMING DISCONNECT TO RESTORAL OF CALLED LINE TO IDLE STATE
No. 1 crossbar	2 to 4 minutes (Note 2)
No. 5 crossbar	13 to 32 seconds (Note 2)
No. 5 crossbar centrex, phases I and II	2 to 5 seconds
No. 5 crossbar centrex, phase III	1.2 to 1.6 seconds
Step-by-step	Immediate—calling party control
No. 1/1A ESS	2 to 3 seconds—ground start
	10 to 11 seconds—loop start
No. 2/2B ESS	10 to 11 seconds
No. 3 ESS	10 to 11 seconds

Notes:

1. Noncoin, direct-dialed calls; no operator handling.
2. Timing of incoming trunk is terminated if the corresponding outgoing trunk is seized by originating office for a new call.

2.16 The forced disconnect described in the previous paragraph is a timed disconnect (Table B) of 13 to 32 seconds in No. 5 crossbar and 10 seconds in No. 4 ESS.

C. Operator Control of Disconnect

2.17 Operator control of disconnect is used on outgoing trunks to the TSPS. (See paragraphs 8.31 through 8.35 and 8.40.) The local central office trunks are designed to have calling customer control of disconnect until the TSPS office returns off-hook supervision (Automatic Number Identification [ANI] request) to the local central office to indicate that the TSPS is ready to receive the calling number. This off-hook signal remains for the duration of the call, locking the calling customer to the TSPS. At the end of the call, the TSPS, recognizing an on-hook from the calling (or called) party, provides necessary timing and then reverts to on-hook toward the local central office. This causes a forced disconnect of the calling customer. If the terminating end reverts back to off-hook, the trunk circuit is automatically made busy.

D. Joint Hold Control of Disconnect

2.18 In situations where recording-completing switchboard trunk circuits are used, joint

TABLE B

DISCONNECT TIMING (NOTE 1)
(CALLED PARTY HANGS UP, CALLING PARTY HOLDS)

ORIGINATING CENTRAL OFFICE SWITCHING SYSTEM	TIMED DELAY IN ORIGINATING CENTRAL OFFICE FROM INCOMING DISCONNECT TO RESTORAL OF CALLING LINE TO IDLE STATE
No. 1 crossbar	2 to 4 minutes (Note 2)
	14 to 29 seconds—LAMA calls (Note 3)
No. 5 crossbar	13 to 32 seconds (Note 4)
Step-by-step	Indefinite—without connector time-out on non-CAMA interoffice calls
	—CAMA calls 13-32 seconds (Note 5)
	12 to 37 seconds—with connector time-out on intraoffice calls
No. 1/1A ESS	Immediate—ground-start outgoing trunk
	10 to 11 seconds—loop-start—non-FX
No. 2/2B ESS	10 to 11 seconds
No. 3 ESS	10 to 11 seconds

Notes:

1. Noncoin, direct-dialed calls; no operator handling.
2. From 1 to 2 minutes in some offices; indefinite on noncharge calls.
3. Plus interval for AMA entry but not more than 2 to 5 seconds additional.
4. Indefinite on noncharge calls; on LAMA calls, additional time is allowed for the AMA entry but not more than 1.7 to 6.7 seconds.
5. Also on calls from step-by-step common control via extended area service-multifrequency outgoing trunk (13 to 19 seconds).

hold is the method of control utilized. This means the customer is not disconnected until both the customer and operator are on-hook. If the calling customer fails to hang up, release is not forced by on-hook supervision from the operator and a permanent signal will remain on the switchboard.

GUARD TIME

2.19 Generally, two methods are used to guarantee the minimum disconnect interval necessary between calls. In the first method, the trunk is held busy at the calling end for an interval after its release. This prevents a new connect signal from being sent forward until sufficient time has elapsed to effect the release of the equipment at the called end. The second method permits the trunk to be reseized immediately; but the sending of the connect signal is delayed by common control equipment either for a measured interval or until a test of the trunk indicates that disconnection has taken effect. The second method saves trunk equipment but cannot be used for 2-way trunks because, as explained in paragraph 2.05, the connect signal must be sent immediately.

2.20 The timed interval used to ensure trunk release before reseizure is called "guard time." The disconnect time averages 360 milliseconds for calls to a common control office and about 500 milliseconds for calls to a step-by-step office. Therefore, typical guard times are 700 milliseconds for common control offices and 1000 milliseconds for step-by-step offices. Minimum guard times for common control senders are chosen to be longer than the average disconnect times plus round trip signaling time for the incoming office but generally not as long as the maximum possible disconnect interval. A guard time less than the maximum possible disconnect interval is used to save sender holding time. This can be done without an appreciable effect on service because trunks do not usually take the maximum time to release, a new call is not usually connected in the minimum time, and signaling distortion is not normally at its most adverse limit. Actual guard times for the various switching systems are as follows:

SWITCHING SYSTEM	MILLISECONDS
Step-by-step	Not available
No. 1 crossbar	Not available
No. 4 crossbar	Not available
No. 5 crossbar	620 to 1650
Crossbar tandem	Not available
No. 1/1A ESS	800 to 1000
No. 2/2B ESS	Not available
No. 3 ESS	Not available
No. 4 ESS	1050 to 1200

2.21 The above guard times are for terrestrial facilities and include delays introduced by trunk and signaling equipment. When satellite facilities (routed through an earth satellite repeater) are used, the round trip time and, consequently, the trunk guard times must be longer. At present, only the No. 4 crossbar system, No. 1/1A ESS, No. 1/1A ESS HILO, and No. 4 ESS have options to operate with satellite facilities. The No. 4 crossbar system uses a guard time of 1050 to 1250 milliseconds. The No. 1/1A ESS and No. 1/1A ESS HILO use a guard time of 1600 to 1800 milliseconds. The No. 4 ESS uses the same guard time for terrestrial or satellite facilities (1050 to 1200 milliseconds).

2.22 The No. 5 crossbar is not presently used in the public network with satellite facilities but can be made compatible for use with satellite facilities and is used in private line applications. In these applications, the guard time is 1050 to 1250 milliseconds; however, this will be changed to 1600 to 1800 milliseconds in the near future.

2.23 An important factor in establishing a compatible guard time is the interval required to restore the incoming trunk circuit to the idle condition (force an on-hook toward the calling end if the called end is still off-hook) after the trunk disconnect timing has elapsed. The electromechanical switching systems, in general, have short intervals that do not change with traffic load. The ESSs, in general, have longer intervals that can become very long for heavy traffic conditions. The time required to restore the trunk circuit to idle after the disconnect timing has elapsed is as follows:

SYSTEM	LIGHT TRAFFIC (MILLISECONDS)	HEAVY TRAFFIC (MILLISECONDS)
No. 4 crossbar	Not available	
No. 5 crossbar	140 to 450	140 to 450
Crossbar tandem	Not available	
No. 1/1A ESS	175 to 275	450
No. 2/2B ESS	Not available	
No. 3 ESS	Not available	
No. 4 ESS	0 to 30	110 to 150

2.24 The delay introduced by various switching systems from receipt of a seizure (connect) signal to the return of a delay-dial or wink-start signal is as follows:

	DELAY IN MILLISECONDS FROM CONNECT SIGNAL TO:	
SYSTEM	WINK	DELAY-DIAL
No. 4 crossbar	Not available	
No. 5 crossbar	100 to 200	10 to 20
Crossbar tandem	Not available	
No. 1/1A ESS	Not available	
No. 2/2B ESS	Not available	
No. 3 ESS	Not available	
No. 4 ESS	Not available	

GLARE

2.25 Two-way trunks are subject to occasional simultaneous seizures at both ends because of the unguarded interval between the seizure of the trunk at one end and the consequent making busy of the trunk at the other end. This is called "glare." These simultaneous seizures cause each end of the trunk to receive a sustained off-hook signal.

2.26 Equipment at each end should be arranged to: (1) prevent the off-hook signal from reaching the charging control equipment and (2) disengage from this mutually blocking condition.

2.27 Historically, glare on trunks between common control offices was generally handled by lengthy sender or transmitter time-out intervals of up to 40 seconds followed by reorder tone. These long time-out intervals are a disadvantage in that the customer assumes a no-ring, no-answer condition and hangs up before the time-out is completed. The customer satisfaction would not be improved significantly by waiting the full time-out period for a reorder signal to be returned. It is clear that any attempt to salvage the calls now lost in glare conditions must be made within seconds rather than the long historic time-out intervals.

2.28 Dependent upon the types of switching systems involved, various techniques are used in the Bell System to reduce ineffective attempts and long time-out intervals due to glare. The results are as follows:

(a) The No. 1/1A, 2/2B, 3, and 4 ESSs use a method to detect and resolve glare on both wink-start and delay-dial controlled outpulsing conditions that saves both calls. To accomplish this, only one ESS office is required. The office at the opposite end can be either electronic or electromechanical.

(b) The No. 4A and 4M crossbar systems have a glare detection and retrial scheme that saves the call from the No. 4 crossbar office. In a glare condition between two No. 4 crossbar offices, both calls could be saved. When only one No. 4 crossbar office is involved, and the other office is an electromechanical office (other than No. 4 crossbar), only the call from the No. 4 crossbar office would be saved.

(c) The No. 5 crossbar and crossbar tandem systems recognize any off-hook from the far end of the circuit as a glare condition if it occurs within the minimum round trip signaling transit interval for the facility. It is also available for No. 5 crossbar trunk circuits used to provide Common Control Switching Arrangements (CCSAs). However, this feature does not cover the full range of relevant No. 5 crossbar trunk circuits used to provide toll service.

A. Glare Resolution in ESSs

2.29 The ESSs detect glare by timing the incoming wink-start or delay-dial signal. Where the maximum time for the appropriate controlled outpulsing signal is exceeded, glare is assumed. The office detecting the glare condition holds the off-hook toward the other office until the office detecting glare can back out of the connection, attach a register to the connection, and go on-hook toward the other office as a start-dial signal. The call incoming to the office detecting glare will be completed on the original trunk. The call outgoing from the office detecting glare will be retried on another trunk. This method saves both calls as long as one or both ends have ESSs.

2.30 Any wink-start signal over 350 milliseconds should be treated as glare. The actual glare detection times for the various ESSs are as follows:

(a) No. 1/1A ESS, 500 to 600 milliseconds

(b) No. 2/2B ESS, 450 to 550 milliseconds

(c) No. 3 ESS, not available

(d) No. 4 ESS, 350 to 500 milliseconds.

2.31 Delay-dial to start-dial intervals that exceed 4 seconds may be considered glare. The No. 1/1A ESS has two different maximum times for glare detection: 4-second detection time used on trunks shared with the No. 4 crossbar as explained in paragraphs 2.33 through 2.39 and 6-second timing used on trunks with other types of switching systems. The shorter time permits the No. 1/1A ESS to detect and resolve the glare before the No. 4 crossbar can detect the glare. The actual glare detection times when expecting delay-dial for the various ESSs are as follows:

(a) No. 1/1A ESS:

(1) 4 ±0.1 seconds with 4- to 8-second overall timing

(2) 6 ±0.1 seconds with 16- to 20-second overall timing.

(b) No. 2/2B ESS (glare resolution with wink-start only).

(c) No. 3 ESS, not available.

(d) No. 4 ESS:

(1) 4 ±0.1 seconds, intertoll

(2) 5 ±0.1 seconds, toll connect

(3) 10 seconds, second trial, intertoll and toll connect.

In all systems, a failure on a retried call will route the call to reorder.

2.32 Wink-start is the preferred controlled outpulsing method on 2-way trunks where at least one of the offices is an ESS and the second is something other than a No. 4 crossbar. (See Table C.) Wink-start permits less expensive trunk circuits in the ESSs when hardware is used to generate the delay-dial signal and quicker detection of glare for either hardware or software generated delay-dial. Where electromechanical switching systems and ESSs are at opposite ends of a trunk, the electronic system should be optioned to back out of glare situations in favor of the electromechanical system. Where two ESSs are involved, the following protocols should be observed:

(a) The lower ranked office should back out (give up control) of glare situations in favor of the higher ranked office, thereby allowing the greatest chance of completion to a call that has traversed the network and is descending in the hierarchy rather than one which is just starting.

(b) If of equal rank, the A office should be assigned to maintain control of the trunk. The Z office should be assigned to release. The A and Z designations should be determined by using the Common Language Equipment Identification codes.

B. Glare Resolution in No. 4 Crossbar

2.33 The No. 4A and 4M crossbar systems have intertoll trunks and toll connecting trunks that operate differently. Since there are no 2-way toll connecting trunks, this discussion is limited to intertoll trunks.

2.34 Delay-dial is still the required method of controlled outpulsing for outgoing intertoll or 2-way intertoll trunks connected to No. 4A and 4M crossbar offices. The requirements for delay-dial

TABLE C

CONTROLLED OUTPULSING METHODS AVAILABLE
IN BELL SYSTEM SWITCHING SYSTEMS

SWITCHING SYSTEM	TYPE OF CALL	DELAY-DIAL		DELAY-DIAL WITH INTEGRITY CHECK	WINK-START	
		EXPECT	SENT	EXPECT	EXPECT	SENT
Step-by-step	Local	—	—	—	—	—
	Toll completing — with integrity check	—	X	—	—	X
	Toll completing — without integrity check	—	—	—	—	—
	Toll connecting — outgoing	—	—	—	—	—
	CAMA — outgoing	—	—	—	—	—
Step-by-step (Common Control)	Local — outgoing	—	—	XX	XX	—
	Local — incoming	—	—	—	—	—
	Toll completing — with integrity check	—	X	—	—	X
	Toll completing — without integrity check	—	—	—	—	—
	Toll connecting — outgoing	—	—	XX	XX	—
	CAMA — outgoing	—	—	XX	XX	—
Step-by-step (CAMA)	Incoming	—	—	—	—	XX
	Outgoing	—	—	XX	—	—
Step-by-step (Toll)	Intertoll — outgoing	XXX	—	—	—	—
	Intertoll — incoming	—	—	—	—	X
	Toll completing — outgoing	XXX	—	—	—	—

LEGEND:

X — Design capability
XX — Always available
XXX — Preferred method

TABLE C (Contd)

CONTROLLED OUTPULSING METHODS AVAILABLE IN BELL SYSTEM SWITCHING SYSTEMS

SWITCHING SYSTEM	TYPE OF CALL	DELAY-DIAL		DELAY-DIAL WITH INTEGRITY CHECK	WINK-START	
		EXPECT	SENT	EXPECT	EXPECT	SENT
No. 1 crossbar	Local — loop outgoing	XX	—	X	X	—
	Local — loop incoming	—	—	—	—	X
	Toll completing — incoming	—	—	—	—	XX
Crossbar tandem	Intertoll	XX	XX	X	X	X
	Toll connecting — incoming	—	XX	—	—	X
	Toll connecting — outgoing	XX	—	X	X	—
	CAMA	—	—	XX	XX	—
No. 4 crossbar	Intertoll	XX	XX	X	—	—
	Toll connecting — incoming	—	XX	—	—	—
	Toll connecting — outgoing	XX	—	X	X	—
	CAMA	—	—	—	—	XX
No. 5 crossbar (Local)	Local — MF	XX	XX	XX	XX	XX
	Local — DP	XX	XX	X	X	X
	Toll completing — incoming	—	XX	—	—	XX
	Line link pulsing — DP outgoing	XX	—	X	X	—
	CAMA — outgoing	—	—	XX	XXX	—

TABLE C (Contd)

CONTROLLED OUTPULSING METHODS AVAILABLE IN BELL SYSTEM SWITCHING SYSTEMS

SWITCHING SYSTEM	TYPE OF CALL	DELAY-DIAL		DELAY-DIAL WITH INTEGRITY CHECK	WINK-START	
		EXPECT	SENT	EXPECT	EXPECT	SENT
No. 5 crossbar (Toll)	Intertoll — DP	XX	XX	X	X	XX
	Intertoll — MF	XX	XX	XX	XX	XX
	CAMA — incoming	—	—	—	—	XX
	Toll connecting — DP outgoing	XX	—	X	X	—
	Toll connecting — MF outgoing	XX	—	XX	XX	—
	Line link pulsing — DP (2-wire, 2-way)	XX	XX	X	X	—
	LUNK — DP (4-wire)	XX	XX	X	X	X
TSPS	Incoming	—	—	—	—	XXX
	Outgoing	—	—	XX	XX	—
No. 1/1A ESS (Local)	Local	—	X	XX	XX	XXX
	Toll connecting — outgoing	—	XX	—	XXX	—
	Toll connecting — incoming	—	—	XX	—	XXX
	CAMA — outgoing	—	—	XX	XX	—
No. 1/1A ESS (Toll)	Intertoll	—	X	XX	XX	XXX
	Toll connecting — incoming	—	X	—	—	XXX
	Toll connecting — outgoing	—	—	XX	XX	—
	CAMA	—	—	XX	XX	—

TABLE C (Contd)

CONTROLLED OUTPULSING METHODS AVAILABLE
IN BELL SYSTEM SWITCHING SYSTEMS

SWITCHING SYSTEM	TYPE OF CALL	DELAY-DIAL		DELAY-DIAL WITH INTEGRITY CHECK	WINK-START	
		EXPECT	SENT	EXPECT	EXPECT	SENT
No. 1/1A ESS HILO	Intertoll	—	—	XX	XX	XXX
	Toll connecting — incoming	—	—	—	—	XXX
	Toll connecting — outgoing	—	—	XX	XX	—
	CAMA — incoming	—	—	—	—	XXX
No. 2/2B ESS (Local)	Local — incoming	—	X	—	—	XXX
	Local — outgoing	—	—	XX	XX	—
	Toll connecting — incoming	—	—	—	—	XXX
	Toll connecting — outgoing	—	—	XX	XX	—
	CAMA — outgoing	—	—	XX	XX	—
No. 2/2B ESS (Toll)	Intertoll	—	X	XX	XX	XXX
	CAMA — incoming	—	—	—	—	XXX
No. 3 ESS	Local — incoming	—	—	—	—	XXX
	Local — outgoing	—	—	XX	XX	—
	Toll connecting — incoming	—	—	—	—	XXX
	Toll connecting — outgoing	—	—	XX	XX	—
	CAMA — outgoing	—	—	XX	XX	—
No. 4 ESS	Intertoll	—	—	XX	XX	XXX
	Toll connecting — incoming	—	—	—	—	XXX
	Toll connecting — outgoing	—	—	XX	XX	—
	CAMA	—	—	—	—	XXX

have been modified from the historic requirements by the introduction of retrial features and features to permit operation with trunks using facilities via a synchronous satellite. The changes (if installed) permit the return of the delay-dial signal to be delayed as much as 5 seconds after seizure.

2.35 When either multifrequency (MF) or dial pulsing (DP) address signaling is used with No. 4A and 4M crossbar system intertoll trunks, the terminating office must return a delay-dial signal to the No. 4A or 4M crossbar office. It is not possible to distinguish no sender ahead from glare when delay-dial is used. Therefore, in the following paragraphs on glare resolution when the delay-dial method is used, no sender ahead will be included with glare.

2.36 With retrial features in the No. 4A and 4M crossbar systems, the off-hook, delay-dial signal must be returned within 5 seconds of seizure or the sender will lock out the trunk and retry the call on another trunk. If the office returning the delay-dial signal to the No. 4 crossbar had been incorrectly optioned to return a wink-start signal, a no sender ahead condition would cause the trunk to be falsely locked out. If the delay-dial signal is returned, the start-dial signal must be returned within 5 seconds of the delay-dial signal on first attempt. Today in most No. 4A and 4M crossbar offices, the retrial period is 8 seconds. However, there are some No. 4A and 4M offices which operate with a 20- to 30-second retrial interval. In heavy traffic, retrial is canceled. The sender, register, or link attachment requirements are given in Fig. 3.

2.37 When the start-dial signal is not received in time, the sender causes the trunk to send a signaling sequence which is used to stop outpulsing and return reorder at the distant office. This signaling sequence is a 100- to 200-millisecond on-hook followed by a minimum of 220-millisecond off-hook and then a 750- to 1000-millisecond on-hook signal (trunk guard time) before the trunk circuit can be selected again. This signaling sequence from the No. 4A crossbar would cause the crossbar tandem to retry the call. Usually, the ESSs would not be exposed to this signaling sequence since the electronic offices would time out and resolve the glare before the No. 4A crossbar times out.

2.38 The timer used for the 5- and 8-second timing mentioned above is held to close tolerances. The 5-second time is adjusted to +0.05 -0 second. While age and voltage variations are expected to widen this timing range, it is expected that the timing periods will remain within ±0.5 second throughout the service life of the equipment.

2.39 It is important that any switching system depending on the No. 4 crossbar system for glare detection and resolution delay outpulsing for at least 200 milliseconds. This permits the on-hook, off-hook, on-hook signaling sequence used by the No. 4 crossbar to be recognized as an unexpected stop to block outpulsing or start retrial in the other office.

C. Glare Resolution in No. 5 Crossbar and Crossbar Tandem

2.40 Crossbar tandem systems have a feature that detects some but not all glare conditions. This feature is usable with either the wink-start or delay-dial method of controlled outpulsing. A similar feature is being developed for No. 5 crossbar, but is not available for all applications. The No. 5 crossbar CCSA trunks using wire spring markers and wire spring trunk link connectors have this feature. One intertoll trunk circuit is available with this feature when using wire spring trunk link connectors. However, this feature is not presently available for all 2-way trunk circuits and for flat spring markers and trunk link connectors.

2.41 This feature takes advantage of the fact that the time from the initial seizure signal to the return of the delay-dial or wink-start to the originating office requires a minimum total interval. Any off-hook seen by the originating office from the time of seizure until the minimum time for the return of a delay-dial or wink-start signal must be glare. This method detects many but not all glare situations. In either No. 5 crossbar or crossbar tandem, any off-hook received during the first 100 milliseconds after trunk seizure is detected as glare.

2.42 When glare is detected, the office detecting glare backs out (possibility both offices) of the connection, maintains a delay-dial signal (off-hook) toward the distant office, attaches a signaling receiver to the trunk, and sends a start-dial (on-hook) signal toward the terminating office. The originating office then selects a new trunk for the completion of the call.

			4A AND 4M		4A AND 4M CAMA		CROSSBAR TANDEM (INCL CAMA)	NO. 5 CROSSBAR (INCL CAMA)		SXS CAMA	NO. 1 ESS
			RETRIAL (NOTE 3)	NO RETRIAL (NOTE 1)	RETRIAL (NOTE 3)	NO RETRIAL (NOTE 1)		DP	MF		
Sender or register in distant office must be attached in less than _ seconds or originating sender in indicated system may time out.	Normal Traffic	First Trial	5	30-40	5	20-30	20	19	13	19	16
		Second Trial	8 (Note 2)	—	8 (Note 2)	—					
	Heavy Traffic	—	5	5	5	5	3, 5, or 8	4.4	4.4	4.6	4
Line finder in distant office must be attached in less than _ seconds or originating sender in indicated system may time out.	Normal Traffic	—	—	20-30	—	20-30	20	19	—	19	16
	Heavy Traffic	—	—	20-30	—	20-30	3, 5, or 8	4.4	—	4.6	4

Notes:

1. Without the retrial feature, timing starts with sender seizure.
2. Some offices are still operating with a 20- to 30-second retrial interval.
3. With the retrial feature, the sender will wait as long as 5 seconds after seizure for return of the delay-dial signal from the distant office. With the retrial feature, timing starts when the delay-dial signal is returned from the distant office.

Fig. 3—Sender, Register, or Line Finder Attachment Timing Requirements

2.43 To use this method of glare detection, the round trip delay time must be at least 100 milliseconds. The option to use this type of glare detection is sometimes called "option for use with single frequency signaling" because the option can be used with SF signaling but cannot be used with physical facilities or with digital (T) carrier facilities.

D. Trunk Hunting—Method to Minimize Glare

2.44 The strategy of selecting idle trunks, as well as the number of seizures per trunk per unit of time, has an effect on glare. Opposite order trunk hunting gives lowest glare. In this method, one office selects from low- to high-numbered trunks while the other office selects from high- to low-numbered trunks. In this selection method, glare is possible only when all but one trunk in the group is busy. The greater the number of seizures per trunk per unit of time, the greater the glare problem. When glare is a problem, consideration should be given to adding more trunks to the group or to replacing a single group of 2-way trunks with two groups of 1-way trunks.

IMMEDIATE-DIAL

2.45 Trunk groups employing common receiving equipment (such as senders or registers) may be equipped at the called end with fast links (or bylinks) with both the links and the common receiving equipment liberally engineered to minimize delays. Such groups are normally ready to receive pulsing in about 120 milliseconds after receipt of the connect signal. Immediate-dial is used with these trunks and is required for direct-dialed CAMA traffic from nonsenderized step-by-step offices to avoid the use of second dial tone. In addition, dial pulsing trunks from common control offices to direct control switching systems which are ready to accept digits immediately after seizure need not employ delay-dial. Some advantage is realized, however, if delay-dial is employed for signaling integrity check purposes.

2.46 Most trunks, in order to direct control switching systems, are ready to receive digits without delay and are normally in the start-dial, on-hook condition. However, senders should delay the first dial pulse a minimum of 150 milliseconds after trunk closure to allow time for operating the A relay and soaking the B relay of the distant selector or equivalent circuit. Senders are informed by classmarks whether they are operating with this type of trunk or with trunks requiring either a delay-dial or wink-start signal prior to the start-dial indication.

2.47 The minimum delay of 150 milliseconds in the previous paragraph was 70 milliseconds in the 1975 issue of ***Notes on Distance Dialing***. The 70 milliseconds, given in ***Notes on Distance Dialing***, provide a 5-millisecond margin for distortion in the signaling and trunk relay equipment. Tests show that the 5-millisecond margin is not nearly large enough. Loop signaling circuits with F-type SF signaling require a minimum of 90 milliseconds sent to guarantee 65 milliseconds at the distant step-by-step selector. When E&M lead signaling and a pulse corrector are used at the step-by-step office, the minimum time increases to 150 milliseconds. When E&M lead signaling is used and there is no pulse corrector at the step-by-step office, the minimum again increases to 150 milliseconds. As a result, the Bell System plans to use 150 milliseconds as a minimum interval between seizure and outpulsing on all immediate-dial circuits. The No. 1/1A ESS has elected to use 170 milliseconds and the No. 4 ESS has elected to use 210 milliseconds as the minimum for this time interval.

SIGNALING INTEGRITY CHECK

2.48 Signaling integrity check is a per-call test made by a common control office during the initial call setup. It is used as an indication of the ability of the trunk to transmit signals. It is associated with detection, identification, and recording of trunk/facility troubles as well as with a second attempt at call completion if the switching system has this capability. The ability to detect trunk/facility troubles lessens the probability that customers will be left high and dry, and it improves the call completion rate when the switching system has second attempt capability. The ability to identify and record trunk/facility troubles greatly assists the maintenance force. Therefore, the integrity check feature is recommended on intertoll and toll connecting trunks using carrier derived facilities whenever possible.

2.49 The exact nature of the check varies from switching system to switching system. However, there are two general types of signaling integrity checks. The first and most complete check requires a signaling response from the incoming office in the form of a delay-dial or wink-start signal. This check is known as integrity check.

The second check requires circuit continuity and the correct polarity on the tip and ring of the trunk which is known as continuity and polarity check.

2.50 The No. 4 crossbar, No. 5 crossbar, crossbar tandem, step-by-step CAMA, No. 4 ESS, and No. 1/1A ESS provide the continuity and polarity test check on immediate-dial calls to progressive control offices over physical facilities using loop reverse battery supervision. No change in the progressive control office is necessary for this operation. However, it does not provide as complete a check as would be possible if E&M lead supervision were used and the trunk circuits in the progressive (direct) control office were equipped to return a stop-dial/start-dial signal. The signal sent by the progressive control office as an integrity check signal is a timed off-hook signal that meets the requirements for either delay-dial or wink-start operation. As a result, the originating office can use either delay-dial or wink-start expected. The signal sent is called wink-start by some and delay-dial by others.

2.51 Trunks using immediate-dial (not equipped for integrity check) over carrier do not have any form of signaling integrity check. Under these circumstances, the common control switching machine outpulses blindly on the trunk. If there is a trunk trouble, it generally goes undetected by the equipment (no trouble record) and the customer usually ends up high and dry.

2.52 The No. 4 crossbar, crossbar tandem, No. 5 crossbar, step-by-step CAMA, No. 4 ESS, and No. 1/1A ESS can provide signaling integrity check on all outgoing calls using the delay-dial or wink-start method of operation with MF pulsing and loop reverse battery or E&M lead supervision to common control offices. This method can also be employed with dial pulsing and E&M lead supervision to common control or progressive control offices, provided the progressive (direct) control office uses an incoming trunk circuit that will return a stop-dial/start-dial signal.

FLASHING

2.53 Flashing signals were once transmitted between offices in the network to flash supervisory lamps in the operator's cord circuit. Sixty flashes per minute indicated line busy and 120 flashes per minute indicated no circuit or reorder. With the advent of customer dialing of toll calls, tone was added to the flash signal to provide both the customer and operator with identifiable signals. Every effort should be made to eliminate flashing signals between offices where they still exist.

REVERSE MAKE-BUSY (OFF-HOOK MAKE-BUSY)

2.54 Outgoing trunk make-busy by means of off-hook supervision received from the terminating end is a feature of outgoing CAMA, TSPS, and AIS trunks in all local switching systems. Other types of outgoing trunks, especially loop signaling trunks with customer control of disconnect, require an applique circuit to automatically make the trunk appear busy when idle and while receiving off-hook supervision from the terminating end.

2.55 Provisions for off-hook make-busy for trunks other than operator, TSPS, and AIS when an outgoing trunk circuit is used, or other techniques that accomplish the same result with or without an outgoing trunk circuit, are summarized for the various switching systems in Table D.

3. CONTROLLED OUTPULSING

3.01 Controlled outpulsing, which is used between common control offices and between operators and common control offices, requires less common equipment than if immediate-dial operation is used. Controlled outpulsing permits the use of slower links and results in a more efficient use of registers. With controlled outpulsing, the originating office seizes the trunk and sends a connect signal to the terminating office just as in immediate-dial outpulsing. However, if the idle state of the called office is an on-hook indication, the terminating office returns an immediate off-hook signal (or is off-hook idle) followed by an on-hook signal to the originating office. The exact timing of the on-hook, off-hook, on-hook (or off-hook, on-hook) signaling sequence constitutes the differences between the delay-dial and wink-start methods of controlled outpulsing. These differences are described in paragraphs 3.06 through 3.26. Whether delay-dial or wink-start, the originating office will wait a short period after receiving the on-hook, off-hook, on-hook (or off-hook, on-hook) signaling sequence and then begin outpulsing. Either dial pulse or MF address signaling can use controlled outpulsing. There are many applications where a common control office uses controlled outpulsing with dial pulse signaling to step-by-step offices to obtain the maintenance advantages of integrity check. (See paragraph 2.48.)

TABLE D

OFF-HOOK MAKE-BUSY PROVISIONS
(For trunks other than operator, TSPS, and AIS)

OFFICE	SUPERVISION	OFF-HOOK MAKE-BUSY	PROVISION
Step-by-step	Loop, E&M	No	None available
No. 1 crossbar	Loop	No	None available
No. 1 crossbar (MF)	Loop	No	Make-busy circuit
No. 4 crossbar	Loop, E&M	Yes	Some 1-way outgoing intertoll
No. 5 crossbar	Loop	No	Make-busy circuit
	E&M	No	Substitute 2-way trunk circuit
Crossbar tandem	Loop	No	Make-busy circuit
	E&M	No	Substitute way trunk circuit
No. 1/1A ESS	Loop	No	None available
	E&M	No	Substitute 2-way trunk circuit
No. 2/2B ESS	Loop	No	Substitute 2-way trunk circuit
	E&M	No	
No. 3 ESS	E&M	Yes	
No. 4 ESS	E&M	No	Substitute 2-way trunk circuit

3.02 Originally, the only method of controlled outpulsing was delay-dial. Switchboards and the No. 4 crossbar system have used this method of controlled outpulsing since the start of toll dialing. Consequently, the vast majority of intertoll trunks were arranged for the delay-dial method of controlled outpulsing. However, the introduction of the No. 1/1A ESS, No. 1/1A ESS HILO, and No. 4 ESS as toll switching systems and the TSPS that all use the wink-start method of controlled outpulsing have greatly reduced the number of intertoll trunks that require the delay-dial method of controlled outpulsing. Essentially all new trunks being added to the network that require controlled outpulsing use the wink-start signal. (Many other new trunks use CCIS.)

3.03 The No. 4 crossbar design was modified to provide the maintenance advantages of integrity check (paragraph 2.48) on both toll connecting (1-way outgoing) trunks and on intertoll trunks. In addition, it permits the use of intertoll trunks over synchronous satellite-derived facilities. The signal delay inherent in synchronous satellite-derived facilities precludes the use of the historic delay-dial operation with these facilities. With these changes, toll connecting trunks will accept either a delay-dial or wink-start signal from the terminating office. No. 4 crossbar intertoll trunks expect a delay-dial signal from the terminating office. The delay-dial signal, rather than a wink-start signal, is necessary for the proper operation of the No. 4 crossbar retrial feature described in paragraph 2.36.

3.04 The No. 5 crossbar and crossbar tandem systems also have design changes to permit wink-start operation. However, it should be remembered that the No. 4 crossbar, No. 5 crossbar, and crossbar tandem systems originally were designed for delay-dial operation. The design changes to permit wink-start operation may or may not be present in a given office. On the other hand, the ability to use delay-dial operation is always present in these offices.

3.05 To properly describe the operation of the various switching systems for signaling compatibility purposes, it is necessary to define the signal ***sent*** by the terminating office and the signal ***expected*** by the originating office. Generally, the signal ***sent*** by the terminating office is the same as the signal ***expected*** by the originating office. However, this may not always be the case. In addition, in specific situations, there are advantages in not having the ***sent*** and ***expected*** signals identical. For example, glare resolution in the No. 1/1A ESS (paragraphs 2.29 through 2.32) uses different ***sent*** and ***expected*** signals to resolve the glare in the "wink-start mode." When two No. 1/1A ESS offices interconnect, both can ***send*** wink-start but both do not ***expect*** wink-start. The office selected to back out of the connection (glare situation) ***expects*** a wink-start signal and, therefore, times the wink. Any wink-start signal over 500 milliseconds is detected as glare. The office selected to remain on the trunk ***expects*** delay-dial and does not time the signal received (other than the 18- to 20-second overall timing) and, therefore, remains in control of the trunk. Another factor is the difference in the definition used by the various systems for delay-dial and wink-start. A No. 4 crossbar can send a delay-dial signal and the No. 5 crossbar originating office can expect a wink-start signal with compatible operation. Table C covers the design capabilities of the various systems and their ability to use the various methods and the preferred method of controlled outpulsing for each of the Bell System switching systems.

DELAY-DIAL WITHOUT SIGNALING INTEGRITY CHECK

3.06 Delay-dial without signaling integrity check is the oldest method of controlled outpulsing. It is also the most unsatisfactory method from a maintenance standpoint. Consequently, it should be used only when wink-start or delay-dial with integrity check is not available.

3.07 In the delay-dial without signaling integrity check method, the originating office seizes the trunk circuit which sends a connect signal toward the called office. After a timing interval of at least 300 milliseconds on some trunks and 75 milliseconds on others, the calling office then looks at the supervision from the called office. If the supervision is on-hook, the originating office starts the outpulsing procedure. If the supervision is off-hook, the calling office will wait until the supervision from the called office goes on-hook (start-dial) and then start the outpulsing procedure. The called office sends a delay-dial (off-hook) signal from the incoming trunk circuit as soon as the connect signal is recognized. In Bell System electromechanical switching systems, the delay-dial signal is generated by the individual incoming trunk circuit. In electronic switching systems, such as the No. 4 ESS, the delay-dial signal is generated by common control equipment which controls the trunk circuit. The trunk circuit sends the delay-dial signal. The delay-dial signal is maintained until a register is attached to the incoming trunk. When the register is attached and ready to receive pulses, the start-dial (on-hook) signal is sent to the calling office.

3.08 In this method of controlled outpulsing, there is no minimum time requirement for the delay-dial (off-hook) signal. In fact, no delay-dial signal is needed if the called office is ready to receive pulses.

3.09 If the called office is not ready to receive pulses, the speed with which the called office returns the delay-dial signal is especially important in the delay-dial method of operation. Where signaling integrity check is not used, the failure to receive a delay-dial signal may permit the sender to outpulse before the register or sender is attached at the called end. This can cause the call to be routed to reorder or left high and dry depending on the exact conditions involved.

3.10 The trunk circuits that use E&M leads for signaling in the delay-dial method of operation are on-hook at both ends when in the idle condition. E&M lead signaling trunks should receive the delay-dial signal less than 300 milliseconds after seizure; otherwise, the originating end will interpret the on-hook signal (or lack of off-hook signal) as a start-dial signal and begin outpulsing prematurely. The 300 milliseconds must include all signaling delays in signaling units and transmission delays as well as the delay within the terminating trunk circuit. These conditions obviously preclude using transmission facilities derived from a synchronous satellite which has a round trip transmission time of over 300 milliseconds.

3.11 Some loop signaling trunks using the delay-dial method of controlled outpulsing must receive the delay-dial signal within 75 milliseconds of trunk seizure. With this method of operation, the incoming trunk is in the off-hook state when idle to meet the timing requirements. Other loop signaling trunks using the delay-dial method must receive the signal in less than 300 milliseconds after seizure. With this operation, the incoming trunks can be either off-hook or on-hook when idle. The off-hook when idle trunk circuits could be used with synchronous satellite-derived facilities; however, the use of such trunks on satellite-derived facilities is remote since the 2-wire loop trunk circuits are generally used for toll connecting and there is no suitable signaling unit to interface with the 4-wire loop trunk circuits.

3.12 When the originating office ***expects*** a delay-dial signal (without integrity check), the terminating office must ***send*** a delay-dial signal. The No. 4 crossbar, No. 5 crossbar, and crossbar tandem systems may ***expect*** a delay-dial signal (without integrity check). The No. 4 crossbar, No. 5 crossbar, crossbar tandem, No. 1/1A ESS, No. 1/1A ESS HILO, No. 2/2B ESS, No. 4 ESS, step-by-step (common control), and step-by-step (with integrity check) systems can ***send*** a delay-dial signal. The No. 3 ESS and TSPS ***cannot send*** a delay-dial signal. The No. 1/1A ESS, No. 1/1A ESS HILO, No. 2/2B ESS, No. 3 ESS, No. 4 ESS, and TSPS never operate in the ***expect*** delay-dial (without integrity check) mode.

3.13 Delay-dial is often referred to as an off-hook, on-hook signaling sequence. The delay-dial signal is the off-hook interval and the start-dial is the on-hook interval. Bell System switching systems do not check for an on-hook before the delay-dial signal.

DELAY-DIAL WITH INTEGRITY CHECK

3.14 With integrity check, the originating office will not outpulse until a delay-dial (off-hook) signal followed by a start-dial (on-hook) signal has been recorded at the originating office. This method is very much like wink-start operation. In fact, with No. 4 crossbar toll connecting, crossbar tandem, and No. 5 crossbar trunks, delay-dial ***expected*** and wink-start ***expected*** are identical. No. 4 crossbar intertoll trunks always ***expect*** delay-dial as explained in paragraphs 2.34 through 2.39. The ESSs do have differences between delay-dial ***expected*** and wink-start ***expected*** which will be explained in paragraph 3.26.

3.15 In the delay-dial with integrity check method of controlled outpulsing, seizure of the trunk by the originating office causes the distant office to return a delay-dial signal. However, the delay-dial signal does not have to be returned within a given interval (ie, 300 milliseconds). It can be delayed for a longer period since the originating office will not begin outpulsing until it has received an off-hook (delay-dial) signal followed by an on-hook (start-dial) signal. It is the performance of this positive signaling sequence from on-hook to off-hook to on-hook that verifies the "integrity" of the trunk.

3.16 The delay-dial signal in this method of controlled outpulsing must meet the following requirements:

(a) The off-hook must be a minimum of 140 milliseconds in duration.

(b) The off-hook to on-hook transition (start-dial) must not occur until:

(1) 210 milliseconds after the connect signal is received, and

(2) The register or sender is attached and ready to receive pulses.

It is desirable to minimize the post dialing delay by sending the off-hook to on-hook transition as soon as possible after the above requirements are met. The signaling system used with the transmission facility will distort the off-hook (delay-dial) signal as it is transmitted between offices. As a result, the originating office must recognize an off-hook as short as 100 milliseconds as a delay-dial signal.

3.17 The 210-millisecond delay from the reception of the connect signal at the terminating office to the sending of the start-dial signal (by the terminating office) was not included in the 1975 issue of ***Notes on Distance Dialing.*** It was not necessary to specify this delay because it was inherent to the operation of the electromechanical switching systems and to the No. 1 ESS. However, with the advent of faster ESSs, it would be possible to complete sending the 140-millisecond minimum delay-dial signal before the originating office was in a position to receive the delay-dial signal. For example, to minimize glare (paragraphs 2.25 through 2.44) in electromechanical switching systems, the marker causes the trunk to send a connect signal to the terminating office before a sender is attached. With a short delay signaling system such as used in T Carrier, the minimum delay-dial signal could be over before the sender is attached and ready to receive a delay-dial signal. In the No. 5 crossbar system, the sequence of sending the connect signal to attaching a sender and detecting a wink-start or delay-dial signal is between 100 and 210 milliseconds. A minimum length delay-dial or wink-start signal (140 milliseconds) can be missed if the start-dial signal reaches the originating No. 5 crossbar office less than 210 milliseconds after the connect signal. In addition, there is a period of time after the No. 1/1A ESS sends the connect signal forward on a 1- or 2-way trunk that the system is blind to signaling from the far end. A start-dial signal occurring within 210 milliseconds of the connect signal can be missed.

3.18 All Bell System common control switching systems, as well as the step-by-step system (with integrity check), can ***send*** signals that will meet the requirements for delay-dial with integrity check. In many cases, the signal ***sent*** also meets the requirements for wink-start and is actually called wink-start by the terminating office.

3.19 The majority of No. 4 crossbar, crossbar tandem, and No. 5 crossbar switching systems can ***expect*** delay-dial with integrity check. As indicated above, it is identical to wink-start ***expected*** in No. 5 crossbar and crossbar tandem. The No. 4 crossbar using delay-dial with signaling integrity check will consider any delay-dial signal over 5 seconds to be glare (paragraphs 2.25 through 2.44) on 2-way trunks.

3.20 At least one No. 5 crossbar 2-way Line Link Pulsing (LLP) circuit fails if the delay-dial or wink-start signal is received within 100 milliseconds of seizure. A complete survey of circuits has not been made; therefore, other LLP or trunk circuits may have the same operating characteristics. Whenever a long delay signaling system such as SF signaling is used, the necessary delay is provided in the signaling system.

3.21 All the electronic switching systems (No. 1/1A ESS, No. 1/1A ESS HILO, No. 2/2B ESS, No. 3 ESS, and No. 4 ESS) can ***expect*** delay-dial with integrity check. Unlike the electromechanical systems, there is a difference between ***expect*** wink-start and ***expect*** delay-dial with integrity check. ***Expect*** delay-dial with integrity check operation has no time limit in most systems for the delay-dial signal except a 4-second limit when glare detection is used (paragraphs 2.25 through 2.44), while wink-start has a shorter time-out interval of 500 to 600 milliseconds for No. 1/1A ESSs. See paragraph 2.30 for the time-out interval for other systems. The No. 2/2B ESS times

8 seconds (±10 percent) for an off-hook and after the off-hook is received up to 16 seconds (±10 percent) for an on-hook.

3.22 Delay-dial with integrity check can be an on-hook, off-hook, on-hook like wink-start or an off-hook, on-hook signaling sequence like delay-dial. All E&M lead trunks are on-hook when idle. The loop trunks can be off- or on-hook when idle per paragraph 3.11. The originating office would have to restrict interconnection to on-hook, off-hook, on-hook sequence trunks to make use of all three signaling intervals. However, Bell System offices do not detect the original on-hook.

WINK-START

3.23 With wink-start operation, the trunk equipments signal on-hook toward each end when in the idle condition. On receipt of a connect signal, the called office initiates a request for register (or sender), but the called office does not immediately return an off-hook (delay-dial) signal to the calling office. The idle condition on-hook signal to the calling office is maintained until the register (or sender) is attached at the called office, at which time a wink-start signal is sent by the called office. The wink-start signal is an off-hook signal that must meet the following requirements:

(a) The off-hook must be a minimum of 140 milliseconds and a maximum of 290 milliseconds in duration.

(b) The off-hook to on-hook transition (start-dial) must not occur until 210 milliseconds after the connect signal is received.

It is desirable to minimize the post dialing delay by sending the off-hook transition as soon as possible after the above requirements are met. The nominal wink-start signal is about 200 milliseconds for electromechanical offices, 150 milliseconds for No. 1/1A ESS offices, and 250 milliseconds for No. 4 ESS offices. Electromechanical and No. 1/1A ESS offices delay returning the wink-start signal for slightly more than 100 milliseconds. This is the minimum time required to attach a register/receiver to the incoming trunk after the connect signal is received. The No. 4 ESS usually returns the wink-start signal within a few milliseconds of the receipt of the connect signal. The transitions from on-hook to off-hook to on-hook, with the duration of off-hook constrained as indicated, constitute the wink.

3.24 The signal transmission system will generally distort the wink-start as it is transmitted between offices. As a result, the calling office must recognize an off-hook signal in the range of 100 to 350 milliseconds as a wink-start signal. Off-hook signals exceeding 350 milliseconds can be treated as glare on 2-way, wink-start trunks (paragraphs 2.25 through 2.44). All wink-start trunks operate in the same manner, whether E&M lead or loop reverse battery signaling.

3.25 The 210-millisecond minimum delay between reception of the connect signal and completion of the wink-start signal was not included in the 1975 issue of ***Notes on Distance Dialing***. It was not necessary to specify this delay because it was inherent to the operation of the electromechanical switching systems and to the No. 1 ESS. Additional details concerning this subject are provided in paragraph 3.17.

3.26 The capability of various switching systems to ***expect*** or ***send*** wink-start is covered in Table C. In the case of ***expect*** wink-start, the ESSs time the received off-hook signal. On No. 1/1A ESS 2-way trunks, an off-hook, wink-start signal longer than 500 to 600 milliseconds is interpreted as a glare condition and initiates the start of the glare resolution sequence. On No. 1/1A ESS 1-way trunks, a 500- to 600-millisecond, wink-start signal causes the call to be routed to reorder and maintenance activity started. All present CAMA systems and TSPSs ***send*** wink-start.

FALSE OFF-HOOK

3.27 The No. 5 crossbar system is known to generate a false off-hook that can cause pumping on a 2-way LLP circuit with either delay-dial or wink-start operation. When a 2-wire No. 5 crossbar 2-way LLP circuit is used on a call originating in a PBX and the call is abandoned by the PBX party before the completion of dialing (call abandoned in the originating register), a false off-hook pulse is sent back toward the PBX. The false off-hook pulse can start any time from 200 to 570 milliseconds after receipt of on-hook from the PBX. The duration of the false pulse is 160 to 250 milliseconds.

START-DIAL (START-PULSING)

3.28 Start-dial is an on-hook signal transmitted from the called office to the calling office occurring when the receiving office is ready to accept digits. However, a momentary delay of a minimum of 70 milliseconds after receipt of the start-dial signal should be introduced before dial pulsing is started. This delay is necessary because dial pulsing receiving circuits are sometimes momentarily disabled at the instant of the sending of the start-dial signal to prevent the registration of a false reflected pulse. In the No. 5 crossbar offices, dial pulsing is delayed 55 milliseconds instead of the recommended 70 milliseconds. Good practice also suggests that dial pulse registration circuits at the called end be disabled (desensitized) for a minimum of 30 milliseconds and a maximum of 70 milliseconds after the start-dial signal is sent. In the No. 4A crossbar system, a nominal 200-millisecond delay is introduced after receipt of the start-dial signal and before MF outpulsing. This delay was introduced to prevent false stop-dial signals occurring with the use of the older type SF signaling equipment. It also facilitates proper sender retrial operation (when such features are provided) during simultaneous seizures of 2-way intertoll trunks. There is no standard delay between the start-dial signal and MF outpulsing. The delay can be 0 to 200 milliseconds depending on the MF sender used in the various switching systems.

3.29 Experimental data indicate that the start-dial signal generates transient noise at the sending central office that lasts for about 50 milliseconds in electromechanical offices and about 20 milliseconds in electronic offices. This transient can mask the KP signal long enough to prevent recognition by the MF receiver, thereby causing a call failure. No Bell System switching system will accept an MF-pulsed address signal unless it starts with KP (and ends with ST [start]). The nominal transmitted KP signal is from 90 to 120 milliseconds and the MF receiver will recognize a KP signal of 55 milliseconds minimum. It is easy to see that call failures could occur on MF-pulsed calls between electromechanical offices. As a result, design changes are being introduced in the crossbar tandem system to provide a 50-millisecond delay between the reception of the start-dial signal and the transmission of the KP signal. Similar changes are being considered for the No. 5 crossbar system. It is good practice to introduce a minimum delay of 50 milliseconds between the receipt of the start-dial signal and the beginning of outpulsing to permit the transients associated with the start-dial signal to dissipate before the first MF pulse is sent. Actual delays introduced between the reception of the start-dial signal and the beginning of the KP signal are as follows:

SYSTEM	DELAY (MILLISECONDS)
No. 1 crossbar	Not available
No. 4 crossbar	200
No. 5 crossbar:	
MF senders	0
DP senders	55
DP senders converted to MF operation	55
No. 1/1A ESS	100 - 150
No. 2/2B ESS	Not available
No. 3 ESS	Not available
No. 4 ESS	20, 80, or 200 (selectable per trunk group)

STOP-GO

3.30 The stop-go method of operation is used where a step-by-step intertoll office is a tandem between two common control offices or a common control office and a link-type Community Dial Office (CDO) not equipped for immediate-dial. The originating common control office dial pulses the address information. An off-hook signal returned to the originating office within the interdigital interval stops outpulsing until the supervisory condition returns to on-hook. The off-hook signal sent toward the originating end to stop outpulsing is known as a stop signal. The on-hook that signals to resume pulsing is the go signal.

3.31 In stop-go operation, the step-by-step intertoll office uses one, two, or three digits to route the call to the proper outgoing trunk. After the last pulse is registered and as the selector begins to rotate, a stop signal is sent by the step-by-step selector circuit toward the originating end of the connection. The stop signal is a timed off-hook signal of about 330 milliseconds.

3.32 The terminating office sends a delay-dial signal on stop-go trunks as soon as it receives the initial seizure signal or off-hook. The delay-dial signal from the terminating office overlaps the stop signal at the step-by-step outgoing trunk circuit preventing outpulsing until the terminating office is ready to receive pulses. A start-dial, on-hook signal from the terminating office is the go signal to resume pulsing. After receipt of the go signal, the originating office should delay outpulsing a minimum of 70 milliseconds. Stop-go operation cannot be used with local step-by-step tandems because local step-by-step circuits are not normally equipped to return a stop signal.

UNEXPECTED STOP

3.33 An unexpected stop is a spurious off-hook (stop) signal detected by the sender before or during outpulsing. It can be an off-hook (stop) signal on a circuit not arranged for stop-go operation or a second off-hook signal on a circuit arranged for stop-go operation. The detection of an unexpected stop signal is used as a trouble condition. However, prudent use of this test is required because it is possible for many circuits to produce unexpected stop signals when there is no trouble. To prevent taking unnecessary trouble records and falsely sending calls to reorder, the various Bell System switching machines use different methods to avoid detecting nonproductive unexpected stop signals.

3.34 Toll switching systems can look for unexpected stops during MF outpulsing on intertoll circuits. However, no Bell System switching system looks for unexpected stops after outpulsing is completed, ie, after the last dial pulse when dial pulsing or after the ST pulse when MF pulsing. The No. 5 crossbar system, for example, often produces a short off-hook signal in the process of transferring call control from the incoming register back to the trunk circuit. This off-hook signal would be detected as an unexpected stop if a switching system looked for unexpected stops after outpulsing was completed. The step-by-step and No. 1 crossbar systems are known to produce short off-hook signals during and after the units digit. Consequently, Bell System switching systems do not look for unexpected stops after the start of the units digit on toll completing or local calls.

3.35 The Bell System switching systems test for unexpected stops during MF outpulsing as follows:

(a) The crossbar tandem system looks for an unexpected stop during MF outpulsing until the completion of the ST pulse on 2-way trunks and until outpulsing the tens digit on 1-way trunks.

(b) The No. 4 crossbar system looks for an unexpected stop during MF outpulsing until the completion of the ST pulse on intertoll trunks and until outpulsing the units digit on toll connecting trunks.

(c) The No. 5 crossbar system looks for an unexpected stop during DP outpulsing in the interdigital intervals until after outpulsing the tens digit on intertoll, toll connecting, and local trunks. The No. 5 crossbar system looks for an unexpected stop during MF outpulsing from the start of the KP signal until the end of the tens digit on intertoll, toll connecting, and local trunks.

(d) The No. 1/1A ESS looks for an unexpected stop before MF outpulsing and in an interval between the tens and units digits on intertoll, toll connecting, and local trunks.

(e) The No. 4 ESS looks for an unexpected stop after receipt of the start-dial indication to the completion of the ST pulse on intertoll calls and on toll connecting calls before MF outpulsing starts to the hundreds digit for 10-digit outpulsing, to the ST pulse on 7-digit outpulsing, to the tens digit on 5-digit outpulsing, and to the units digit on 4-digit outpulsing.

SENDER TIMING

3.36 Normally in a No. 4 crossbar or crossbar tandem switching system, senders wait as long as 20 to 40 seconds for a sender to be attached in the distant office. If a distant sender cannot be attached within this time interval, the "home" sender times out and routes the call to an overload announcement. When all "home" senders in the same sender group become busy, the time-out interval is automatically reduced from 20 to 40 seconds to 5 to 8 seconds. There are instances when this short sender timing interval may not be appropriate and network management personnel may elect to cancel it and return the sender waiting time to the regular 20- to 40-second interval. For this reason, an indication is given to network management when short sender timing is in effect so that manual cancellation can be activated if desired. These signal indications are a part of the Dynamic Overload Control (DOC) equipment.

3.37 The DOC equipment is also available for use in ESS offices and is used to send signals to distant offices, requesting that they limit the amount of traffic sent to the ESS office. The DOC signals are sent from ESS offices because of a shortage of real time, a shortage of receivers, or a lack of capability to switch calls. The DOC control console at the ESS office contains various lamps indicating the type signals being sent. It is also Network Management's practice to limit traffic in expected overload situations (eg, Mother's Day).

4. DIAL PULSING

4.01 Dial pulsing is a means of transmitting digital information from a customer's dial to the central office equipment. Pulses from a customer's dial are momentary openings of the loop which are followed at the switching equipment by release of a relay. In nonsenderized step-by-step systems, the pulses from the customer's dial are used to actuate the switching equipment directly in the local central office. On trunked step-by-step calls, the dial pulses for the distant selectors are relayed forward by an outgoing dial pulse repeater. At the terminating office, the relayed pulses may either operate the switching equipment directly or may again be relayed by an incoming dial pulse repeater. Senders which accept dial pulses from trunks are available as well as senders which will dial pulse outward.

4.02 With dial pulsing, the numerical value of each digit is represented by the number of on-hook intervals in a train of pulses. The on-hook intervals of each digit are separated by short off-hook intervals while the digits themselves are separated by relatively long off-hook intervals. The on-hook signals are not interpreted as disconnect signals since they are considerably less than the minimum disconnect times given in Tables A and B. The off-hook interval between digits is distinguished from the off-hook between pulses by the timing of a slow release relay or by other means. In step-by-step systems, the end of a digit is recognized when the off-hook signal exceeds 90 to 295 milliseconds. In common control systems, the range is in the order of 75 to 210 milliseconds. When the end of a digit is recognized, additional operations must be performed before the next digit can be received.

4.03 Dial pulse signaling in the Bell System is originated at a "pulsing speed" of approximately 10 pulses per second (PPS) at approximately 61 percent break (BK). Pulsing speed is maintained as close to the nominal 10 PPS as economic considerations warrant. The break ratio is deliberately changed away from 50 percent BK in order to compensate for the characteristics of relays, switches, and signal transmission systems, which differ substantially, and in order to make the most advantageous use of circuit conditions occurring during the break and make time intervals.

4.04 Figure 4 illustrates dial pulsing. Figure 4(A) shows typical pulsing contacts (which may be the cam-operated contact in a rotary dial or the "make" contact of a pulse-repeating relay in a signaling circuit as shown); these contacts open and close a dc circuit a number of times equal to the digit being dialed together with relays which are intended to respond accordingly. Figure 4(B) illustrates some of the terms employed in describing dial pulse signaling circuits.

LOOP AND LEAK

4.05 Series resistance in the circuit connecting the pulsing contact with the relay winding reduces the maximum current that can flow and the rate at which the current increases from zero to maximum. The net effect of adding series resistance is the same as increasing the percent break at the pulsing contact. Shunt capacitance and shunt resistance have the opposite effect. Instead of ceasing to flow abruptly when the pulsing contact is opened, relay winding current continues flowing at a steady rate through the shunt resistance and then at an exponentially decreasing rate until the capacitance is charged to the signaling voltage. The net effect of adding shunt capacitance or shunt resistance is the same as decreasing the percent break at the pulsing contact.

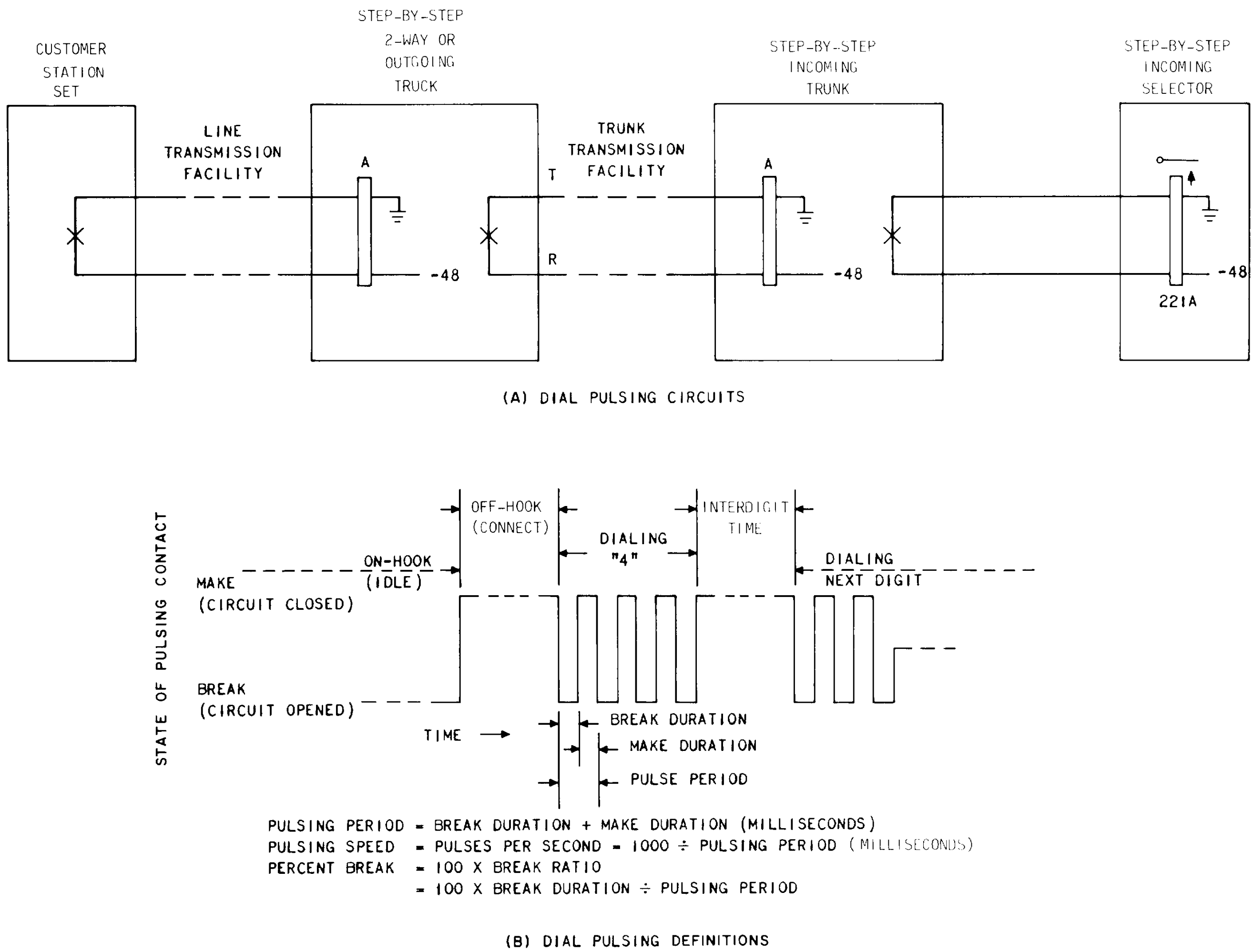
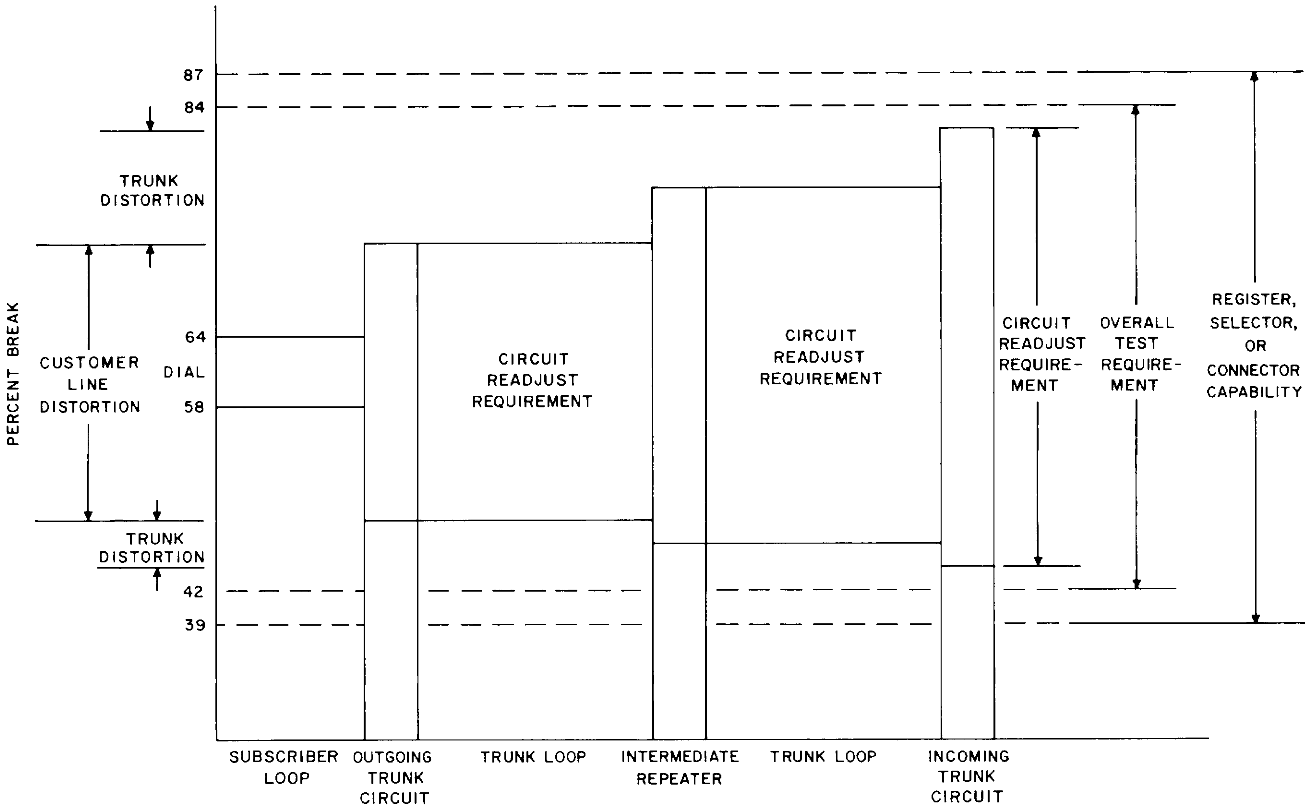
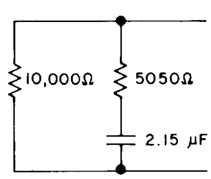


Fig. 4—Dial Pulse Signaling

4.06 In certain pulsing tests, series resistance is added to roughly simulate the effect of a long loop in increasing the break ratio. The test condition is then known as the ***loop*** condition and the amount of resistance is usually stated. Various standardized combinations of resistance and capacitance are often shunted across the test circuit to simulate the tendency of ringers, ringing bridges, and other apparatus and equipments to reduce the break ratio. The conditions are known as ***leak*** conditions and the combinations are designated ***leak A, leak B, leak D1,*** etc. Figure 5(B) shows the circuit of the ***leak A*** condition.



(A) DIAL-PULSE PERCENT-BREAK DISTORTION



(B) LEAK A

Fig. 5—Circuit Requirements for Loop Conditions

4.07 In a purely nonreactive dc circuit, the flow of current would correspond exactly to the changing state of the pulsing contact. In practice, however, circuits do have considerable inductance and capacitance, so that the flow of current in the relay winding does not correspond exactly to the instantaneous state of the pulsing contact. Furthermore, relays cannot exactly translate change of current in their windings into changes of state of their own contacts. The important consideration, however, is the state of the contact upon which all subsequent activity in the circuit depends. For this reason, the terms and definitions in Fig. 4 refer to states of the pulsing contact and not to current flow or any other feature of the circuit. The terms "break ratio" and "percent break" always imply the presence of a switch or relay contact at the point where the break ratio is specified. They have no meaning apart from such a contact.

4.08 In most cases, the contact of the signaling circuit at which a break ratio is specified is accessible for the connection of a signaling test set. Where it is not accessible, a relay furnished as part of the test set is substituted in place of the regular relay solely for the purpose of providing an accessible contact for testing. The relay is a specific type representative of relays generally used to terminate dial pulse signaling circuits. Pulsing test measurements and requirements are then identified with the test relay and not with the relay in the signaling circuit for which it is substituted.

4.09 Modern customer dials are designed to a break ratio of 58 to 64 percent, manufactured with an objective accuracy of 10 ±0.5 PPS, and operated under normal service conditions between 8 and 11 PPS during any portion of the rundown. Older dials were manufactured to somewhat wider tolerances and may be expected to vary in service from 7.5 to 12 PPS and from 59.5 to 67.5 percent BK. The difference between new and old dials is partly reflected in changes over the years in average loop lengths and estimated central office range capabilities.

DIAL PULSING LIMITS

4.10 Modern 10-PPS switchboard dials are held to a requirement of 10 ±0.3 PPS, 62 to 66 percent BK. Older 10-PPS switchboard dials, still in service, can vary over the range 10 ±0.5 PPS, 59.5 to 67.5 percent BK. Twenty-PPS dials are provided on some switchboards for use over certain metallic trunks. The limit for modern 20-PPS dials is 17 to 21 PPS, 62 to 66 percent BK. While present applications of 20-PPS dials will continue, no new circuits will be designed for 20 PPS. There will be no requirement to operate with 20-PPS dials. Some existing Bell System switching systems are not compatible with a 20-PPS dial, eg, No. 2/2B ESS and No. 10A Remote Switching System.

The objective output for modern senders is:

E&M pulsing	10±0.2 PPS	60.0±2 percent BK
Loop pulsing	10±0.2 PPS	60.0±2 percent BK
Battery and ground	10±0.2 PPS	60.0±2 percent BK

The majority of senders in service will outpulse within the following limits:

E&M pulsing	10±1 PPS	56.0 to 60.0 percent BK
Loop pulsing	10±1 PPS	59.5 to 67.5 percent BK
Battery and ground	10±1 PPS	48.5 to 66.0 percent BK

4.11 The nominal dial pulsing speed in the various signaling, trunk, and pulse repeater circuits used in network dialing is 10 PPS. Percent break requirements for these circuits differ since the percent break may be shifted in passing through various circuits.

4.12 Signaling circuits are usually designed to shift the break ratio of received dial pulses, if necessary, to a value better suited to the requirements of the circuit to which they deliver those pulses. For example, a switchboard dial or loop sender operates at 64 percent BK because the connected trunk circuit works best with this break ratio on its input loop; however, the composite (CX) interoffice signal transmission system (to which the trunk circuit is assumed to be connected) functions best with 58 percent BK on its M lead. Therefore, the trunk circuit is designed to convert the loop pulsing it receives from the dial to M lead pulsing for interoffice transmission and also to change 64 percent BK incoming to 58 percent BK outgoing. With 58 percent incoming on its M lead, the CX system operates best when it delivers 59 percent BK on its E lead at the other end.

4.13 At the receiving end of the CX system, the E lead is connected to a trunk circuit which, in turn, may be connected to an AB toll transmission selector. In this case, the A relay of the trunk circuit and its associated circuitry change the 59 percent BK received on the E lead to 62 percent BK, which is optimum for the A relay in the selector for driving the vertical stepping mechanism. Further examples of the percent break of a signal and typical shifts in percent break are given in Table E. These examples are illustrative only and are not meant to be all-inclusive. For types not listed, other literature should be consulted.

4.14 In general, the various dial pulse receivers, such as step-by-step selectors and the senders or registers of other switching systems, must have capabilities broader than the requirements of the dial pulse generators and the transmitting and repeating devices to provide a margin for normal variations in break ratio and pulsing speed. However, short on-hook signals are generated by Bell System switching systems that could be mistaken for dial pulses. These short on-hook signals occur before the start of pulsing, during the interdigital interval, and shortly after the completion of outpulsing. As a result, it is recommended that dial pulse receivers ignore on-hook signals shorter than 10 milliseconds and accept on-hook signals greater than 25 milliseconds.

4.15 Figure 5 shows the limiting conditions on loop pulsing. The circuit diagram for this arrangement is shown in Fig. 4. The percent break limits for a dial are shown on the left in Fig. 5. The distortion these pulses experience from the customer's line, the originating office, the intermediate office, and the terminating office is shown from left to right. The capability of selector or connector is shown on the far right. The diagram shows loop pulsing through three repetitions

TABLE E

PERCENT BREAK SHIFT IN OUTGOING TRUNKS

TYPE OF TRUNK (BELL SYSTEM)	AVERAGE PERCENT BREAK TESTED AT 12 PPS		
	INPUT	OUTPUT	SHIFT
Outgoing intertoll trunks from switchboard	64*	58	−6
CX signaling circuit	58	59	+1
Four-wire trunk circuit to toll intermediate selector or intertoll transmission selector	59	59	0
Trunk circuit to AB train	59	62	+3
Trunk circuit to loop toll train	59	64	+5
Operator office trunk circuit — loop signaling†	59	62	+3
Operator office trunk — CX signaling†	59	58	−1
Selector appearance of intertoll trunk	59	58	−1

*From 10-PPS operator dial.
†Repeating relay used from intertoll selector appearance.

to drive a register, selector, or connector. However, when pulse distortion exceeds the capability of the register, selector, or connector, pulse correction must be provided, usually at the terminating office. The percent break ranges shown in Fig. 5 are for pulsing over a customer's loop of 1500 ohms and no ***leak*** in one test and pulsing with ***leak A*** and no ***loop*** in another.

4.16 The 1500-ohm loop test is made with the highest dial percent break of 64 percent. This test will give the highest percent break because the current in the pulsing relay is at the lowest possible value during the make interval and zero during the break interval. The ***leak*** test is with zero loop and is made with the lowest dial percent break of 58 percent. This test will give the lowest percent break because the current through the pulsing relay is highest during the make interval and continues to flow at a decreasing rate during the break interval. The current in the break interval is made up of two components. The first is the current that flows until the capacitance in the ***leak*** circuit is charged to the signaling voltage; the second is the current that flows through the dc leakage.

4.17 The ***leak*** test represents a test on a customer's line with zero loop resistance, maximum number of ringers, and maximum permissible leakage. The percent breaks shown in Fig. 5 are measured at the repeater or incoming trunk circuit on the contacts of the pulsing relay. If this relay is not accessible, another pulsing relay should be substituted. A 221A relay is used for this purpose in the Bell System. The tests are made at the highest dial pulsing speed (12 PPS) encountered in practice because the higher the pulsing speed, the higher the distortion.

INTERDIGITAL TIME

4.18 The interdigital time is the interval from the end of the last on-hook pulse of one digit train of dial pulses to the beginning of the first on-hook pulse of the next digit train. A slow release relay, or equivalent device, which ignores the digit pulses but releases between pulse trains, is used to advance or condition the receiving equipment for the next digit. For customer dialing and operator keying or dialing, the interdigital time is under human control. (See Fig. 4.)

4.19 The interdigital time delivered by a sender depends on the availability of the succeeding digit. When the next digit is immediately available, the sender must control the minimum interdigital interval. The requirements for the minimum interval are:

(a) Three hundred milliseconds when pulsing into senders or registers of systems other than step-by-step.

(b) Six hundred milliseconds was the recommended interdigital interval in the past for pulsing into step-by-step selectors or equivalent. The nominal time for all actions necessary, including a 10-step hunt of the selector, is 534 milliseconds. This is well within the 600 milliseconds recommended. However, the maximum time for selector action can be as high as 695 milliseconds. Field evidence is available that shows the 600-millisecond interdigital time is causing occasional call failures. As a result, 700 milliseconds is the new recommended interdigital interval. Six hundred milliseconds should only be used where no higher interdigital time is available.

4.20 A breakdown of the interdigital interval in step-by-step offices is as follows:

TIME IN MILLISECONDS			
MINIMUM	AVERAGE	MAXIMUM	
58	100	155	Release C relay
250	325	400	Hunt 10 terminals
40	57	75	Operate D relay
8	10	15	Operate A relay
15	22	30	Operate B relay
20	20	20	Soak B
391	534	695	Total Interdigital Time in Milliseconds

4.21 The No. 5 crossbar system, No. 1/1A ESS, No. 2/2B ESS, and No. 3 ESS have always had the ability to transmit a 700-millisecond interdigital interval. The ability to use a 700-millisecond interdigital interval has been added to the No. 4 crossbar system, the crossbar tandem system, and the No. 4 ESS. These offices may or may not have added the necessary changes to use the increased interval. The No. 1/1A ESS has an office option for an interdigital interval of 600 to 1000 milliseconds. The default value is 600 milliseconds.

4.22 Although senders and registers are capable of recognizing interdigital intervals as short as 300 milliseconds, Bell System senders have not in the past used interdigital intervals of less than 500 milliseconds when outpulsing; shorter intervals approaching the 300-millisecond minimum may be used in the future. An accuracy of ±5 percent is considered satisfactory for timing this interval.

4.23 In step-by-step systems, three functions must be completed during the interdigital interval as follows:

(a) Recognize the end of a digit by the release of the digit pulse train detector C (or equivalent) slow release relay.

(b) Trunk-hunt over as many as ten terminals.

(c) Test idle terminal, cut-through, operate A relay, and soak B relay of next switch or equivalent relay circuit.

4.24 A sender must receive a stop-dial signal 65 milliseconds before the termination of the interdigital interval to allow time for the sender to recognize the signal and stop outpulsing. Thus, to return a useful stop-dial signal when the interdigital time is 600 milliseconds, the total time requirements itemized below, measured from the end of the last pulse of a digit pulse train, must not exceed 535 milliseconds:

(a) The delay due to transit time before an off-hook is seen at the source of the stop-dial

(b) The reaction time required to generate a stop-dial

(c) The delay due to transit time before the stop-dial is seen at the originating end.

Improper adjustment of the digit pulse train detecting slow release relay in a step-by-step selector can, of course, reduce the time available for other interdigital functions.

5. LOOP SIGNALING

5.01 The basic loop signaling circuit is a series circuit such as illustrated in Fig. 4(A). It provides one signaling state when it is opened and a second when it is closed. The loop signaling apparatus is usually combined with other apparatus in a trunk circuit. A third signaling state is obtained by reversing the direction or changing the magnitude of the current in the circuit. Combinations of (1) open/close, (2) polarity reversal, and (3) high/low current are used for distinguishing signals intended for one direction of signaling (eg, dial pulse signals) from those intended for the opposite direction (eg, answering signals). The principal loop methods are described in the following paragraphs.

REVERSE BATTERY SIGNALING

5.02 Reverse battery signaling employs basic methods (1) and (2) above and takes its name from the fact that battery and ground are reversed on the tip and ring to change the signal toward the calling end from on-hook to off-hook. This is the preferred and most widely used loop signaling method. Figure 6 shows a typical application of reverse battery signaling in a common control office. In the idle or on-hook condition, all relays are unoperated and the SW contacts are open. Upon seizure of the outgoing trunk by the calling office (trunk group selection based on the office code dialed by the calling customer), the following will occur:

(a) SW2 contacts close, thereby closing loop to called office and causing the A relay to operate.

(b) Operation of the A relay signals off-hook (seizure) indication to called office.

(c) Upon completion of pulsing between offices, the called customer is alerted. When the called customer answers, the S2 relay is operated.

(d) Operation of the S2 relay operates the T relay which reverses the voltage polarity on the loop to the calling end.

(e) The voltage polarity causes the CS relay to operate, transmitting an off-hook (answer) signal to the calling end.

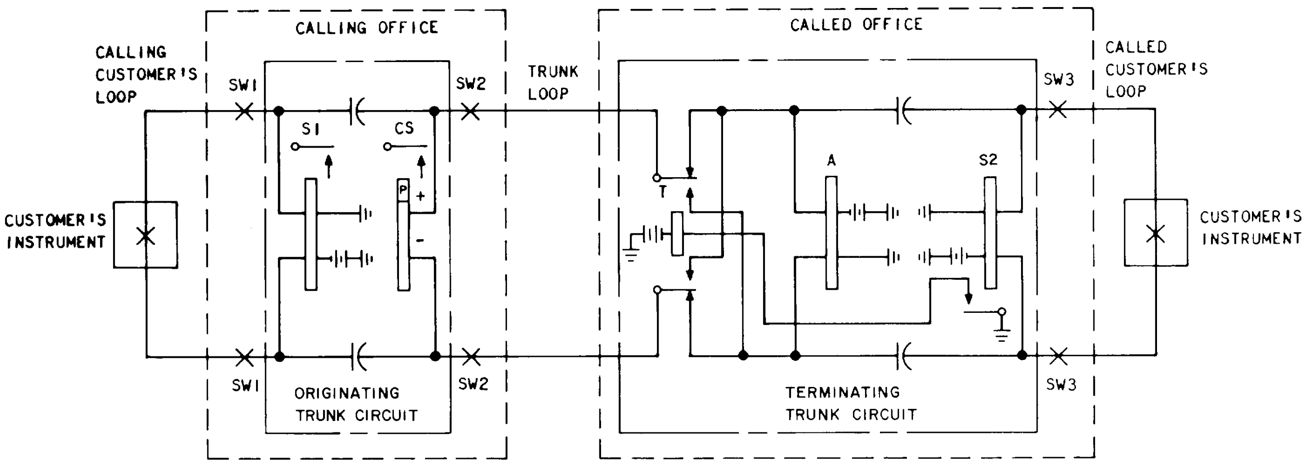


Fig. 6—Reverse Battery Signaling

5.03 When the calling party hangs up, disconnect timing per paragraph 2.13 (150 to 400 milliseconds) is started. After the timing is completed, SW1 and SW2 contacts are released in the calling office. This (1) opens the loop to the A relay in the called office and (2) releases the calling party. (The calling party is free to place another call.) The disconnect timing per paragraph 2.13 (150 to 400 milliseconds) is started in the called office as soon as the A relay releases. When the disconnect timing is completed, the following will occur:

(a) If the called party has returned to on-hook, SW3 contacts will release. The called party is free to place another call.

(b) If the called party is still off-hook, disconnect timing per Table A is started in the called office. On the completion of the timed interval, SW3 contacts will open. The called customer will be returned to dial tone. If the circuit is seized again from the calling office during the disconnect timing, the disconnect timing is terminated and the called party is returned to dial tone. The new call would be completed without interference from the previous call.

5.04 When the called party hangs up, the CS relay in the calling office releases. Then the following occurs:

(a) If the calling party has also hung up, disconnection takes place as described in the paragraph above.

(b) If the calling party is still off-hook, disconnect timing per Table B is started. On the completion of the disconnect timing, SW1 and SW2 contacts are opened. This returns the calling party to dial tone and releases the A relay in the called office. The calling party is free to place a new call at this time. After the disconnect timing per paragraph 2.13 (150 to 400 milliseconds), the SW3 contacts are released which releases the called party. The called party can place a new call at this time.

(c) If the calling office is a step-by-step office, the disconnect timing for called party on-hook and/or calling party off-hook is made in the called office. The times in Table B apply. After the disconnect interval is completed, the called party is free to place a new call.

5.05 Figure 7 illustrates repeated reverse battery signaling at a tandem office. The slow release D relay is used to hold the connection through the tandem switches.

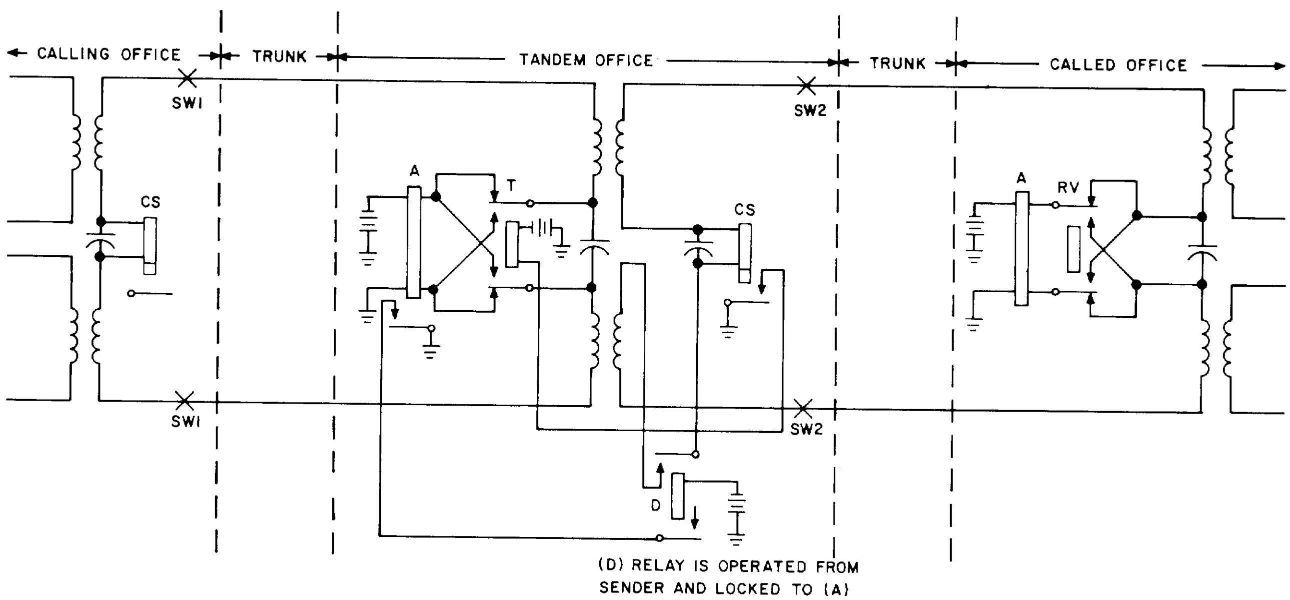


Fig. 7—Repeated Reverse Battery Signaling

BATTERY AND GROUND SIGNALING

5.06 The range of loop signaling can be increased by employing battery and ground signaling. This is accomplished by having battery and ground at both ends of the loop but with opposite polarities at each end. This doubles the voltage available for signaling. Means are provided to open and close both conductors at the originating end to furnish forward on- and off-hook signals. Reverse battery is generally used for supervisory signals from the called end (backward signals). Between digits and at the completion of pulsing, a bridge supervisory relay may be substituted for the pulsing battery and ground to detect the backward signals. This widely used arrangement is sometimes called "battery and ground pulsing—loop supervision." When maximum range is required without the use of an incoming repeater, "battery and ground pulsing, battery and ground supervision" may be employed. Caution should be observed in using battery and ground signaling since, in some cases, it may result in impulse noise which can cause adverse effects on data service. Figure 8 shows a circuit using battery and ground pulsing with loop holding.

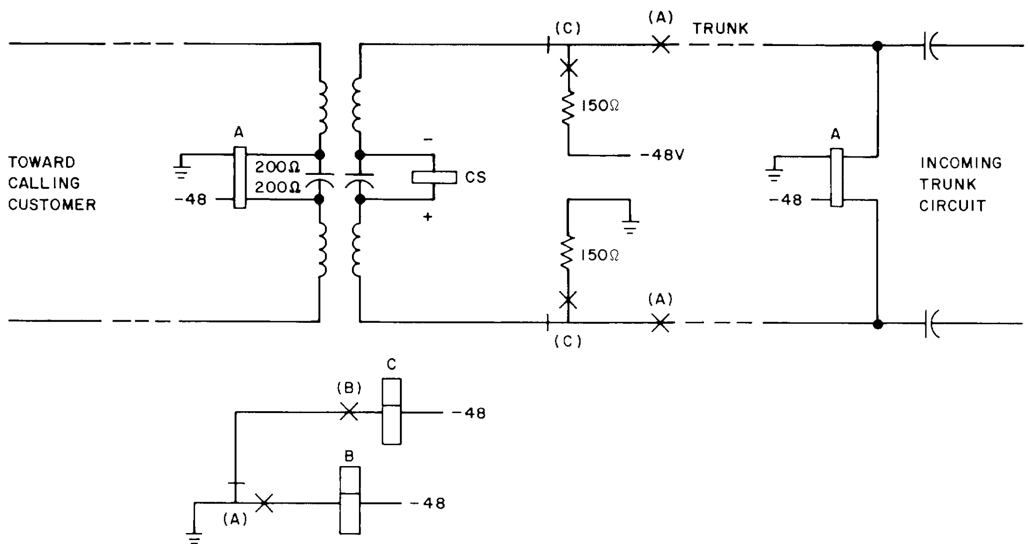


Fig. 8—Battery and Ground Pulsing with Loop Supervision

HIGH-LOW SIGNALING

5.07 In high-low signaling, a connect signal is provided by connecting battery and ground to the trunk through a marginal supervisory relay. At the called end, the on-hook (high resistance) signal is changed to low resistance for off-hook. A disconnect is indicated by an open trunk at the calling end. The basic high-low scheme, long used in straightforward local manual trunks from A to B boards, is shown in Fig. 9. The marginal cord circuit supervisory relay (C) has a noninductive winding, in addition to the operating winding, to reduce the unbalanced impedance in the voice path. This relay is adjusted to operate when the high-resistance winding of the L relay is shorted out by the S relay, even on a maximum resistance trunk. It is also adjusted not to operate and to release, if operated, on the current which results when the high-resistance winding of the L relay is not shorted, even on a minimum length trunk. Numerous auxiliary circuits and variations in relay types have been used to extend the range of conductor resistance over which signaling may be secured with adequate reliability.

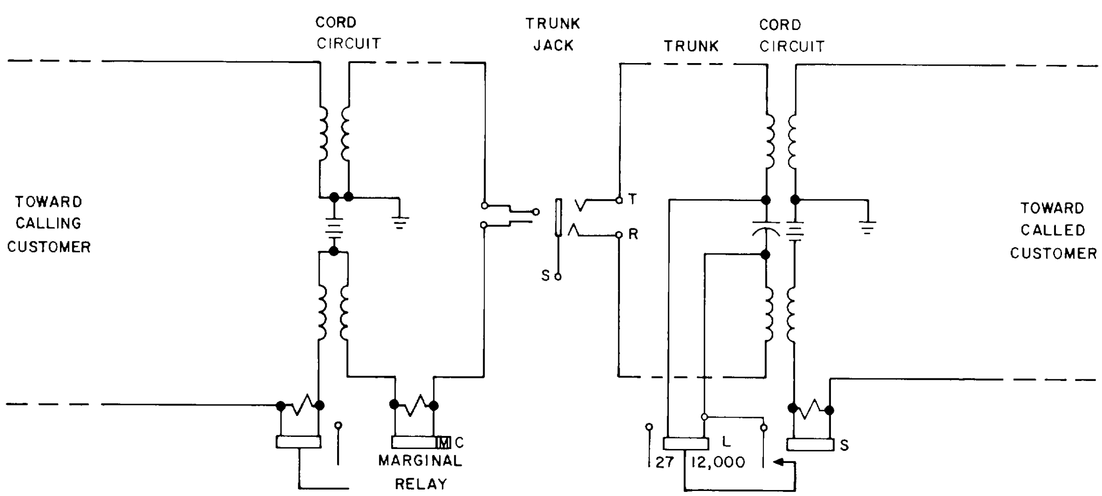


Fig. 9—High-Low Signaling

5.08 By prior usage, high-low signaling means that high and low signaling states are applied at the terminating end as a signal to the originating end. In other arrangements, the high-low signaling states may be applied at the originating end with other signaling schemes, such as reverse battery, applied at the terminating end.

A. High-Low, Reverse Battery Signaling

5.09 CAMA and TSPS trunks have the capability for being made busy from the terminating end. Figure 10 shows such a trunk originating in a step-by-step local office. These trunks are reverse battery trunks, as described in paragraph 5.02, but the outgoing trunk circuit uses a polar supervisory relay with low- and high-resistance windings (usually 200 and 30,000 ohms) to provide the on-hook, off-hook supervisory (but not the pulsing) conditions. When the trunk is idle, reversing the battery at the terminating end operates the polar supervisory relay via its 30,000-ohm winding to make the outgoing trunk busy. This feature is used for maintenance purposes. It is also used at the end of a charge call to make the outgoing trunk momentarily busy while the CAMA or TSPS office completes charging functions.

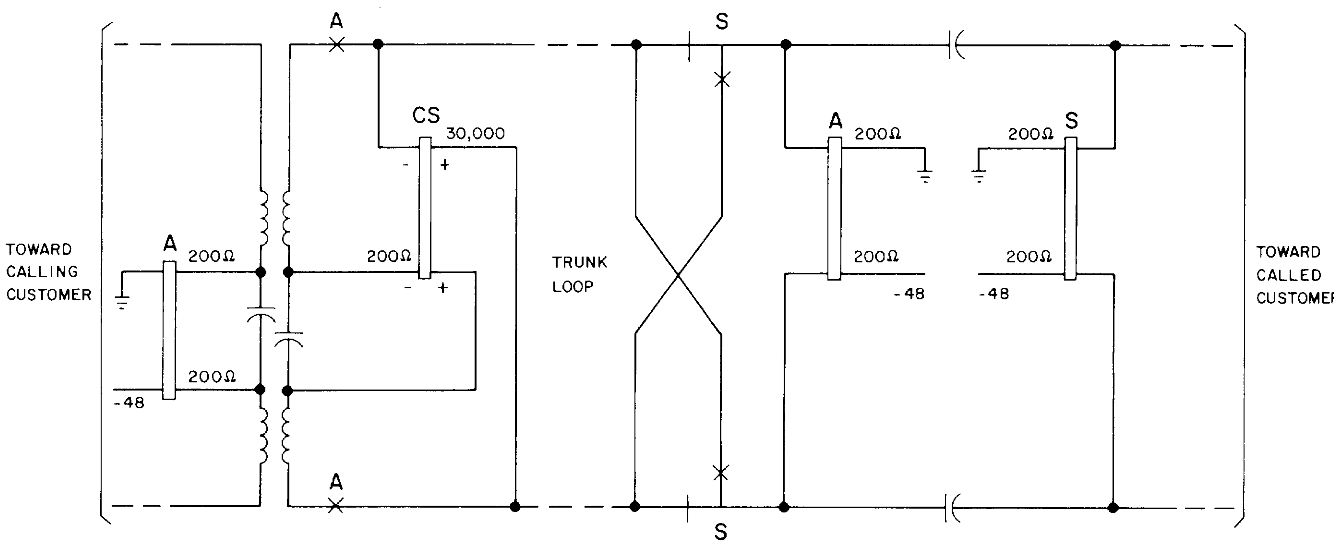


Fig. 10—High-Low, Reverse Battery Signaling

B. Reverse Battery, High-Low Signaling

5.10 This signaling arrangement is used between a local central office and an operator at a switchboard. As shown in Fig. 11, the switchboard responds to reverse battery and the local central office to high-low supervision. When the customer is connected, the A relay operates, reversing the battery; but the reverse battery is not applied to the trunk conductors until the B relay operates a fraction of a second later. At the switchboard end, the operator responds with an off-hook condition which operates the S relay, reducing the trunk resistance and operating the marginal (TK) relay. The TK relay holds the B relay operated. The trunk is now held by "joint control" and both the operator and customer must go on-hook to release the trunk. In some documents, the reverse battery, high-low scheme is simply referred to as "reverse high-low."

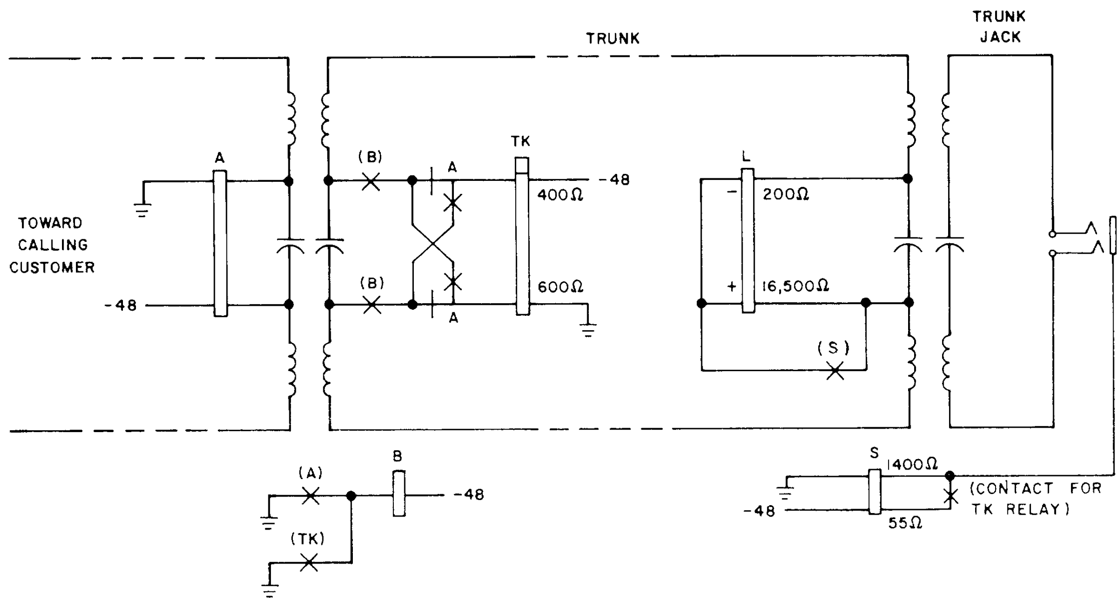


Fig. 11—Reverse Battery, High-Low Signaling

5.11 The joint control feature allows the customer to recall the operator by flashing the switchhook without fear of a premature disconnect and, on a coin trunk, it allows the operator to ring back the customer at a coin telephone after the customer has hung up. (See paragraphs 2.12 through 2.18.)

WET-DRY

5.12 A trunk is "wet" when battery and ground are connected to it. It is "dry" when battery and ground are removed. In the wet-dry signaling arrangement shown in Fig. 12, the trunk is wet during on-hook (idle) and dry during off-hook (busy). At the calling end, a connect signal is indicated by applying the CS relay to the trunk operating the L relay. Upon answer, the S relay operates applying the dry bridge to the trunk and releasing the CS relay. A disconnect is indicated by an open trunk.

5.13 By prior usage, wet-dry signaling means that the wet and dry states are applied at the terminating end as a signal to the originating end. In many switchboard arrangements presently in use, the wet-dry signaling states are applied at the originating end and additional signaling states are achieved by adding other schemes such as high-low or reverse battery.

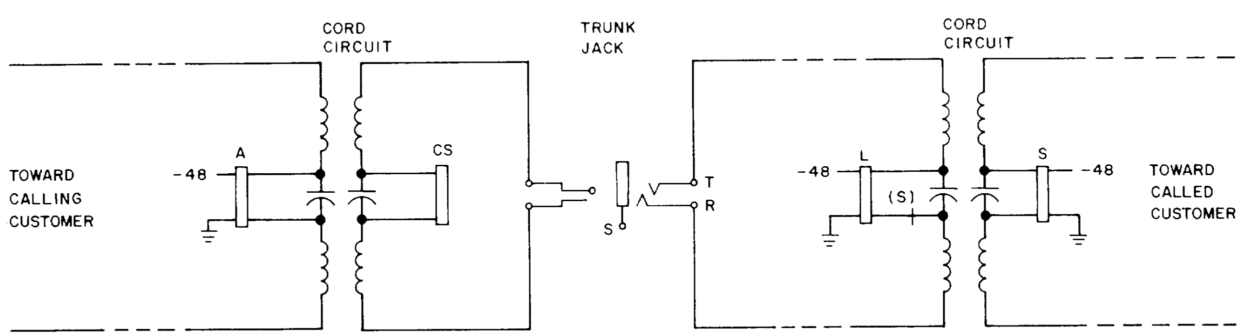


Fig. 12—Wet-Dry Signaling

IDLE CIRCUIT TERMINATIONS AND TRUNK CAPACITANCE

5.14 Idle circuit terminations do not affect signaling on E&M trunks because the T&R leads are not in the dc signaling path. Idle circuit terminations, such as the ideal transmission value of 2.16 μF in series with 900 ohms, may therefore be used. However, idle circuit terminations connected to signaling leads have a substantial effect on signaling.

5.15 In the idle condition, the termination toward the called end presented by an outgoing trunk circuit or an incoming trunk signaling or channel unit using loop signaling should not exceed 0.5 μF capacitance. This capacitance limit includes all shunt capacitances including transmission capacitors, contact network capacitors, and idle circuit termination network capacitors.

5.16 The total trunk capacitance in the on-hook state, including the idle circuit termination in the outgoing loop trunk circuit, the cable capacitance, the capacitance of any transmission repeaters, and the on-hook capacitance of an on-hook terminating channel unit, should not exceed 2 μF for trunks with a specified 2000-ohm conductor range and 4 μF for trunks with a specified 4000-ohm conductor range.

6. E&M LEAD SIGNALING

INTERFACE REQUIREMENTS

A. General

6.01 Most signaling systems, other than loop signaling, are separate from the trunk equipment and functionally are normally located between the trunk equipment and the line facility. The E&M lead signaling systems derive their name from historical designations of the signaling leads on the circuit drawings covering these systems. Traditionally, the E&M lead signaling interface consisted of two leads between the switching (trunk) equipment and the signaling equipment: the M lead which carries signals from the switching (trunk) equipment to the signaling equipment and the E lead which carries signals from signaling equipment to the switching (trunk) equipment. As a result, signals from office A to office B leave on the M lead of the trunk circuit in office A and arrive on the E lead in office B. In the same manner, signals from office B leave on the M lead and arrive on the E lead of office A. The flow of signals between two offices using E&M lead signaling is shown in Fig. 13.

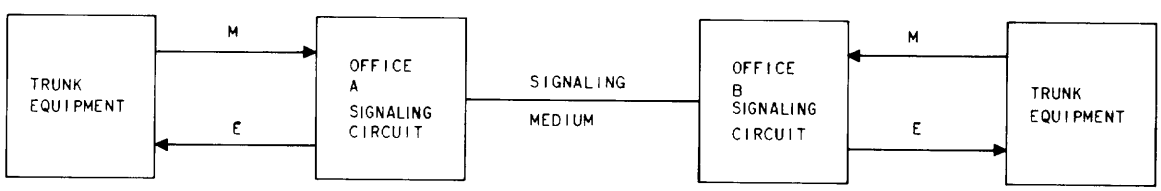


Fig. 13—E&M Lead Control Status

6.02 Historically, E&M lead signaling circuits have used only one lead for each direction of transmission with a common ground return. This means that the signaling leads have a greater noise influence than if the leads were balanced (2-wire) as are transmission circuits. While the E&M lead signaling circuits operated satisfactorily in electromechanical systems, they were not satisfactory for electronic systems. As a result, several new E&M lead interfaces have been introduced. These are described below.

B. Type I Interface

6.03 The Type I interface (Fig. 14) is the original E&M lead signaling arrangement. Signaling from the trunk circuit to the signaling facility is over the M lead using nominal -48 volts for off-hook and local ground for on-hook. Signaling in the other direction is over the E lead using local signaling facility ground for off-hook and open for on-hook. The trunk circuit sensor on the E lead should use nominal -48 volts, and essentially the full voltage should appear on the E lead during the on-hook state.

6.04 The battery supply to the M lead for the off-hook state may be applied through a current limiter to prevent blowing of fuses or circuit damage in case the M lead is accidentally grounded (not a rare event). In any case, the voltage should not drop more than 5 volts with 85 milliamperes in the M lead. In the on-hook state, the potential drop from M lead to ground at the trunk circuit should not exceed 1 volt when an external -50 volt source is connected to the M lead through 1000 ohms.

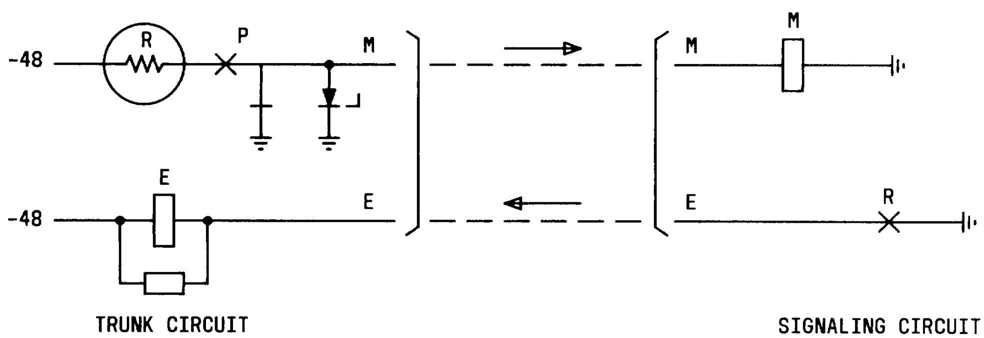


Fig. 14—Type I Interface

C. Type II Interface

6.05 The Type II interface (Fig. 15) is a 4-wire, fully looped but nonsymmetrical arrangement. Signaling from the trunk circuit to the signaling facility is by means of opens and closures across the M and SB pair of leads for on-hook and off-hook, respectively. Since the signaling facility supplies nominal -48 volts to the SB lead, the effect is to signal on the M lead with battery for off-hook and open for on-hook. Signaling in the reverse direction is by means of opens and closures across the E and SG leads for on-hook and off-hook, respectively. Since the trunk circuit grounds the SG lead, the effect is to signal on the E lead with open for on-hook and ground for off-hook. The signaling facility should supply nominal -48 volts to the SB lead through a current limiting device. Refer to paragraphs 6.34 through 6.38 for the requirements for this current limiter.

6.06 The trunk circuit sensor on the E lead should be biased with nominal -48 volts, except that if considerable loss of compatibility with test equipment can be tolerated, the voltage may be as low as -21 volts. In any case, in the on-hook state, essentially the full sensor voltage should be present on the E lead.

6.07 The sensor on the M lead in the signaling facility may be biased with a voltage in the range of +10 volts to -24 volts. When a negative bias or reference is used, it is desirable that a blocking diode be used to prevent the voltage from appearing on the M lead during the on-hook state. This is required if the voltage is more negative than -24 volts.

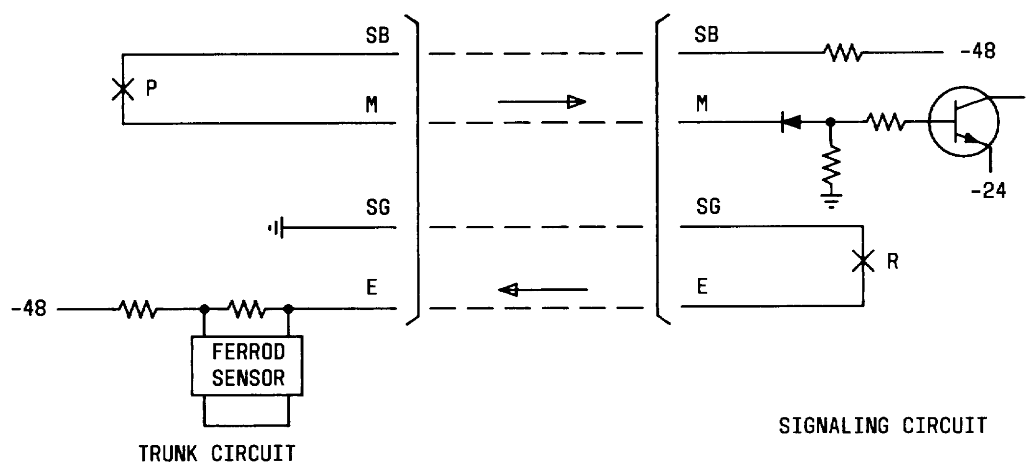


Fig. 15—Type II Interface

D. Type III Interface

6.08 The Type III interface (Fig. 16) is a compromise, partially looped, 4-wire E&M lead arrangement. It is essentially the same as the Type I interface except that the battery and ground for signaling on the M lead are supplied by the signaling facility over the SB and SG leads, respectively. The E lead in all its characteristics and requirements is identical to the Type I interface E lead except that the expected E lead current is significantly lower.

6.09 The signaling facility should supply its local ground to the SG lead and should supply nominal -48 volts to the SB lead through a current limiter. Refer to paragraph 6.39 for requirements for this limiter. The M lead sensor should meet the same requirements as in the Type II interface except that the blocking diode may be omitted.

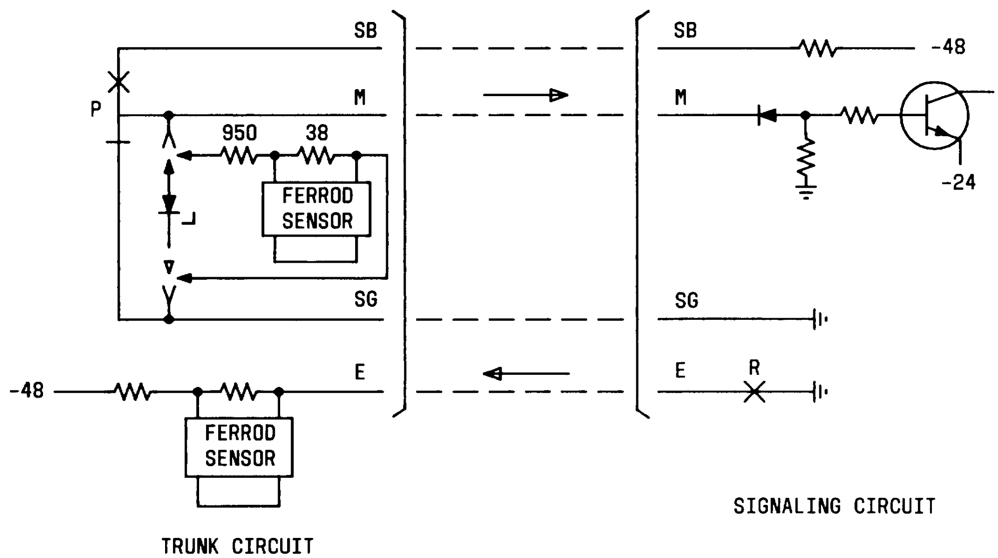


Fig. 16—Type III Interface

E. Type IV Interface

6.10 The Type IV interface (Fig. 17) is a symmetrical, 4-wire looped E&M lead arrangement. Signaling from the trunk circuit to the signaling facility is by means of opens and closures across the M and SB leads for on-hook and off-hook, respectively. Signaling in the reverse direction is identical except that it is across the E and SG leads. Since the trunk circuit grounds the SG lead and the signaling facility grounds the SB lead, the signaling over both the E&M leads is by open for on-hook and ground for off-hook.

6.11 The Type II interface in trunk circuits is identical to the Type IV interface. The requirements for both trunk circuits and signaling facilities are identical. The requirements are the same as for the trunk circuit with the Type II interface except for some modest deviations described in paragraph 6.57.

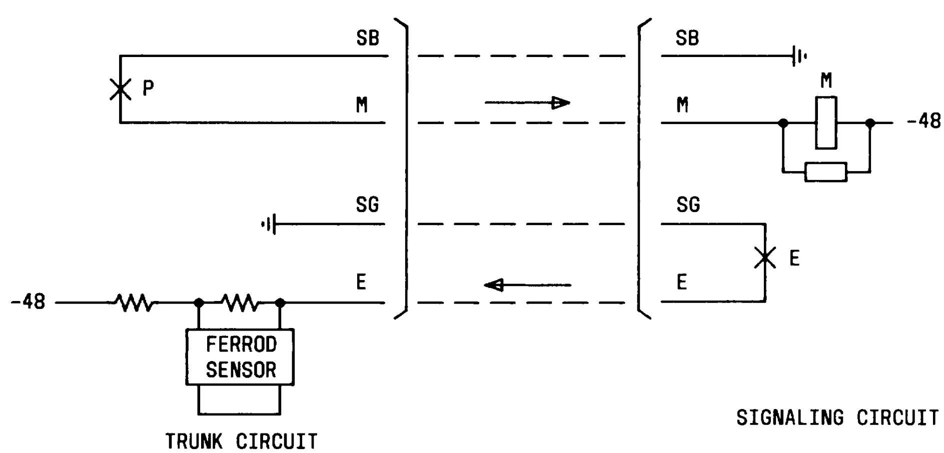


Fig. 17—Type IV Interface

F. Type V Interface

6.12 The Type V interface (Fig. 18) is a symmetrical, 2-wire E&M lead arrangement that signals in both directions by means of open for on-hook and ground for off-hook. Signaling from the trunk circuit to the signaling facility is over the M lead; signaling in the reverse direction is over the E lead. This interface is essentially the unbalanced version of the Type IV interface in which local ground is used for off-hook instead of the ground obtained over the SB or SG lead.

6.13 The Type V interface is nearly the worldwide standard outside North America. A variety of other lead designations are in use besides E&M. The known corresponding sets E, SZ1, Sa and SR, and M, SZ2, Sb and SS. "Type V interface" is a Bell System nomenclature not presently in use elsewhere.

6.14 There is a limited amount of information on any circuit requirements in use by other companies; but with the possible exception of current maximums, the requirements proposed herein for Bell System standardization should provide for complete functional compatibility with other systems. At present, the Bell System is setting an upper limit of 50 milliamperes in the E or M leads for new designs. It is hoped this will become a more widespread requirement as well as the use of "Type V" nomenclature.

6.15 The E&M lead sensors should be biased with nominal -48 volts and, in the on-hook state, essentially the full voltage should appear on the E&M leads. The sensor resistance should be high enough to limit the signaling lead currents to 50 milliamperes.

6.16 Most of the E&M lead test sets used in North America are not fully compatible with either the Type IV or V interface. The use of -48 volts on the E&M lead sensors will help in the standardizing of future test sets.

G. Signaling State Summary

6.17 Table F summarizes the signaling states with respect to the sending end. It should be noted that a bridged examination of all E leads will show essentially nominal -48 volts (or -21 volts for No. 4 ESS) on the leads during the on-hook state. For M leads, any voltage between +10 and -52.5 volts for either on- or off-hook states may be found. Table F indicates the sent signal, not what a bridged measurement might indicate.

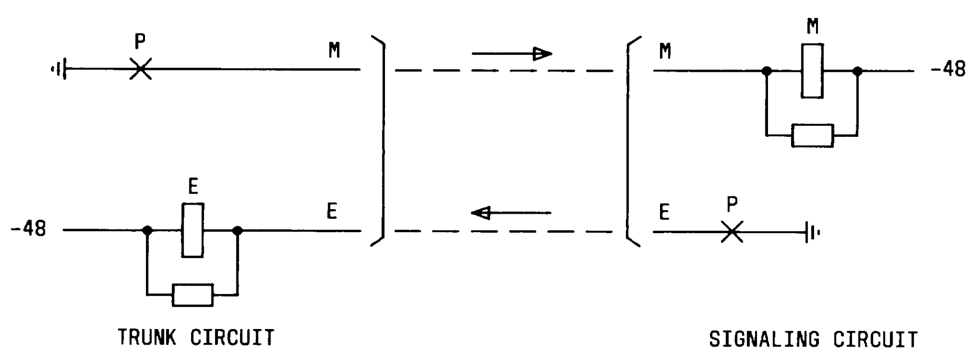


Fig. 18—Type V Interface

TABLE F

SENT SIGNAL STATES

TYPE	TRUNK TO SIGNALING CIRCUIT			SIGNALING TO TRUNK CIRCUIT		
	LEAD	ON-HOOK	OFF-HOOK	LEAD	ON-HOOK	OFF-HOOK
I	M	Ground	Battery	E	Open	Ground
II	M	Open	Battery	E	Open	Ground
III	M	Ground	Battery	E	Open	Ground
IV	M	Open	Ground	E	Open	Ground
V	M	Open	Ground	E	Open	Ground

H. Switching Means

Relay Contacts

6.18 The simplest switching means for E&M lead signaling is a relay contact. Transfer contacts are required for sending on the Type I and III M leads. To lengthen contact life and reduce current surges, a break-before-make transfer should be used and is desirable to keep the open interval during transfer to a maximum of 1 or 2 milliseconds. A transfer time in excess of 1 or 2 milliseconds may introduce distortion (increase in percent break) to dial pulsing with certain signaling facilities.

Solid-State Switches

6.19 In spite of the small size and relatively low price of modern mercury-wetted sealed contact relays, some circuit designers prefer to use solid-state switches. To maintain signaling compatibility and compatibility with the probable variety of E&M lead test equipment, the following requirements should be met:

(a) ***Type I M Lead:*** Complete requirements have not been developed specifically for this transfer switch. In the on-hook state, the potential drop from M lead to local ground should not exceed 1 volt when -50 volts through 1000 ohms is connected externally to the M lead.

(b) ***Type II M Lead:*** If the switch is polarized, reversing means should be provided. In the off-hook state, the potential drop from the M lead to SB lead should not exceed 2 volts with 50 milliamperes in the M lead. The current in the SB lead should be equal to the M lead current ±10 percent. Any difference between the two lead currents implies incomplete separation of signaling and trunk circuit power systems, a condition which is contrary to the intent of the Type II interface arrangement. Unless opto-isolators (or equivalent) are used, it appears that perfect separation cannot be achieved, hence the ±10 percent allowance given above. In the on-hook state, very little leakage is permitted. If the M lead is grounded, the M lead current should not exceed 100 μA whether the SB lead is open or connected to -50 volts. If a grounded source of ±12 volts is connected to the M lead while the SB lead is open, the M lead current should not exceed 24 μA.

The switch should operate properly when connected to a signaling facility applying nominal +12 or -42.5 to -52.5 volts on the SB lead. The switch should be reversible if it is polarized since sometimes the battery may be supplied on the M lead instead of the SB lead. Normal M lead current is well under 50 milliamperes, but it is not uncommon for the M lead to be accidentally grounded. Three types of current limiters are in use on the SB leads, leading to three fault current characteristics. Most commonly, a resistor will limit the current to a steady maximum of 175 milliamperes. Another limiter, a Positive Temperature Coefficient (PTC) thermistor, will permit a maximum current of 1.7 amperes, which drops 75 percent within about 0.5 second and stabilizes at about 30 milliamperes. The third limiter, a 13A resistance lamp or equivalent, will permit a peak of 3 to 4 amperes which will drop to 0.8 ampere within 10 milliseconds and stabilize at a maximum of about 360 milliamperes within 50 milliseconds. Additional details concerning fault currents are provided in paragraphs 6.34 through 6.38.

(c) ***Type III M Lead:*** Complete requirements have not been developed specifically for this switch. The requirements will be similar to those for the Type II M lead switch, except +12 volts will not be found on the SB lead and the leakage requirements for the on-hook state will not apply. When -50 volts through 1000 ohms is connected externally to the M lead, the potential drop between the M and SG leads should not exceed 1 volt in the on-hook state.

(d) ***Type IV M Lead:*** The Type IV and II interfaces appear to be identical in trunk circuits when relay contacts are used. The difference is in the signaling facility in that it supplies battery to the SB lead for Type II operation or ground for Type IV operation. The M lead signaling formats are battery and open for Type II and ground and open for Type IV. The significance of switch leakage in the on-hook states is different. For Type II, the requirements given in (b) are for effective switch leakage to battery or ground to be at least 500 KOHM. For Type IV operation only, the leakage to ground may be as low as 100 KOHM in the on-hook state. Also, there are no expected fault currents for the Type IV M lead. Therefore, if a trunk circuit is to be used exclusively for Type IV, the switch requirements are relaxed. If the trunk circuit may be used optionally for either Type II or IV, the switch should be designed to meet the Type II requirements.

(e) ***Type V M Lead:*** The requirements for the Type V switch are the same as those for the strictly Type IV switch, with additional provisional requirements that the M lead current should be no greater than 50 milliamperes.

(f) ***Type I E Lead:*** The Type I E lead switch should supply local ground to the E lead in the off-hook state which should not exceed 2 volts potential drop across the switch when the E lead current is 250 milliamperes. The potential supplied to the switch will be between -42.5 and -52.5 volts in the on-hook state. In the off-hook state, the E lead current is commonly about 50 milliamperes; there have been no limits on the current and it may be as high as 250 milliamperes. The effective resistance of the switch in the on-hook state should be at least 100 KOHM.

(g) ***Type II E Lead:*** The Type II switch should supply a closure across the E and SG leads for off-hook. The potential drop across the switch should not exceed 2 volts with 50 milliamperes in the E lead. In the on-hook state, the effective resistance of the switch should be at least 500 KOHM. If the switch is polarized, a reversing means is required. The voltage supplied to the switch on the E lead is in the range of -21 to -52.5 volts and the SG lead is grounded. In some trunk configurations, the battery may be supplied on the SG lead and the E lead may connect to resistance ground or a voltage in the range of +10 to -24 volts.

When the SG lead connects to nominal -50 volts in the connecting circuit, it is possible for a fault ground on the E lead (not an uncommon event) to cause a surge of up to 1.7 amperes which will reduce to about 175 milliamperes within 1 second and stabilize at about 30 milliamperes after many seconds, or the fault may cause a steady current of up to 175 milliamperes. Normal E lead currents are well under 50 milliamperes. Refer to paragraphs 6.34 through 6.38 for additional details concerning current limiters.

(h) ***Type III E Lead:*** The requirements for the Type III E lead switch are the same as those for the Type I switch, except that the maximum current should not exceed 50 milliamperes. The 2-volt potential drop limit is at 50 milliamperes instead of 250 milliamperes.

(i) ***Type IV E Lead:*** Since the Type IV arrangement is symmetrical, the requirements for the E lead switch are identical to purely Type IV M lead switch requirements.

(j) ***Type V E Lead:*** Since the Type V arrangement is symmetrical, the switch requirements are the same for both E&M leads. [See (e) above.]

I. Transient Suppression

6.20 Under certain circumstances, surge or transient suppression circuitry is required. This circuitry should be provided as discussed in the following paragraphs.

Type I and III M Leads

6.21 Although it appears abnormal, tradition requires the surge suppression for Type I and III M leads be supplied by the trunk circuit. In early circuits, this was done by wiring a 1000-ohm resistor from the M lead to ground in the trunk circuit. High wattage resistors are required since they dissipate about 2.5 watts during the off-hook state. More recently, it has been recommended that a zener diode in series with a 1000-ohm 1/2-watt resistor be used as a general replacement for the higher power resistor. Tests have shown, however, that the resistor may be omitted. The present requirement is that the trunk circuit should include a 65-volt ±10 percent zener diode between the M lead and ground with the anode connected to the M lead. The diode should be able to dissipate at least 500 mW.

All E Leads

6.22 In all interface types, if the E lead sensor is inductive, the sensor should be equipped with some means of transient suppression. The requirements for it are that, when the E lead changes from off-hook to on-hook, the voltage rise should not exceed 300 volts and the rate of rise should not exceed 1 volt per microsecond. The voltage surge should not exceed 80 volts for more than 10 milliseconds. For normal relays with at least 500-ohm windings, a 185A network (470 ohms in series with 0.13 μF) will be satisfactory.

6.23 It is permissible for the signaling facility to also provide the equivalent of the 185A network across its E lead switch. Accordingly, the design of the E lead sensor should tolerate this capacitance in addition to its own capacitance and E lead capacitance.

Type II, IV, and V M Leads

6.24 If the M lead sensor (except the Type I and III interfaces) is inductive, it should be provided with a means of transient suppression. The suppressor should limit the voltage rise rate to not over 1 volt per microsecond and the peak to not over 300 volts and the voltage should not be above 80 volts for more than 10 milliseconds. For normal relays with at least 500-ohm windings, a 185A network is satisfactory (470 ohms in series with 0.13 μF).

6.25 In Type II and IV interfaces, it is ***not*** permissible to also provide a capacitor type transient suppressor across the M lead switch in the trunk circuit. If the switch requires greater protection than given by the signaling facilities, it must be by other than a capacitor network. An exception to this requirement is permitted if the trunk circuit never sends dial pulses or any other pulses with timing requirements equivalent to those of dial pulses.

J. E&M Lead Current Limits

6.26 In no case is there a lower limit set for off-hook currents in E or M leads. From a practical standpoint, the lowest usable currents are approximately 1 or 2 milliamperes. If sensor resistance is higher, the resistance-capacitance time constant will cause excessive distortion. Since there is no lower limit for currents, it is not permissible to use current sensors in any E or M lead except for the one at the end of the lead.

6.27 In the past, no upper limits were established for E or M lead currents. The maximum known M lead current to signaling facilities is approximately 85 milliamperes into E-type SF units, with the next highest being about 55 milliamperes into duplex (DX) signaling circuits. See paragraphs 6.29 through 6.39 for M lead fault currents. The highest known E lead current is into No. 5 crossbar circuits where it may reach 250 milliamperes or slightly over this amount. Most electromechanical systems use relays with currents in the 50-milliampere range. Electronic systems usually draw much lower currents.

6.28 Type V E&M leads should be equipped with sensors that limit the currents to a maximum of 50 milliamperes. It is desirable that all E&M lead currents be limited to a maximum of 50 milliamperes in new circuit designs for normal circuit operation.

K. Current Limiters

6.29 For all E leads and Type IV and V M leads, the current limits are established very simply by the supply voltage and the sensor resistance. In the case of Type I, II, and III M leads, the current limiting is done at both ends of the leads. Having to supply battery to a signaling lead is a major defect in these three interfaces. The following paragraphs discuss limiters in the battery feed to M leads or SB leads.

Type I M Lead

6.30 The trunk circuit signals off-hook by supplying nominal -48 volts to the M lead. It is not uncommon for the M lead to be accidentally grounded. In order to avoid blowing fuses or damaging the switch in such a case, it is necessary to provide some means of current limiting which will still allow normal circuit operation. In the earlier E&M lead circuits, a 13A or 19A resistance lamp was provided in the battery feed to the M lead switch. These lamps are perfectly satisfactory in most respects and are still recommended.

6.31 Several attempts to avoid the use of the resistance lamps have been made; some have been satisfactory and some have lead to incompatibilities. One design simply used one fuse per M lead. Some circuits have used PTC thermistors. Another circuit uses a 1000-ohm resistor. If thermistors or resistors are used, the resulting circuit should meet the Type I interface requirements.

6.32 Recent tests have shown that the "stiffness" of the battery supply as provided by the 13A or 19A lamp can be relaxed slightly. Under the worst known operating conditions (sending to E-type SF units), it is permissible for the current limiter to be as high as 60 ohms and for the M lead resistance to be as high as 50 ohms if the zener diode is used for transient suppression.

6.33 The new requirement for Type I M lead current limiters is that the potential drop in the trunk circuit should not exceed 5 volts at 85 milliamperes of M lead current plus any internal current.

Type II SB Lead

6.34 The signaling circuit with the Type II interface supplies battery, usually -48 volts, to the SB lead. As in the Type I interface, some means of current limiting is necessary in this battery feed. Presently three types of limiters are used in Bell System circuits: 13A resistance lamp or equivalent, 74A PTC thermistor, and fixed resistors. These devices limit the current in case the SB or M lead is accidentally grounded. A current limiter in one circuit protects the M lead switch in a different circuit, the two circuits almost always being designed by different departments or even two different companies. Some coordination of design effort and circuit requirements is clearly needed.

6.35 The known fixed resistor limiters are in the range of nominal 316 to 1000 ohms. The worst case fault current is a steady 175 milliamperes. To maintain maximum compatibility, the resistor should not exceed 1000 ohms; if the circuit may optionally provide a Type III interface, the resistor should not exceed 500 ohms. Resistors under 316 ohms may be used, but they will have to be large power types. The resistor should never be under 150 ohms.

6.36 Half of an 11B resistance lamp, the equivalent of a 13A or 19A lamp, is used in a DX circuit to limit the SB lead current. A worst case ground fault on the SB or M lead can cause a current peak of 3 to 4 amperes which drops to 800 milliamperes within 10 milliseconds and stabilizes at about 360 milliamperes within 50 milliseconds.

6.37 The third limiter is a 74A PTC thermistor used in the G-type SF signaling units. The cold resistance range is 40 to 90 ohms. Until the thermistor reaches about 50°C, it exhibits a small negative temperature coefficient. Thereafter, the coefficient becomes positive at and above the switching or Curie temperature. The detailed characteristics of this device have not been well determined nor published. The highest initial fault current will be about 1.6 amperes which may rise slightly for approximately 100 milliseconds and then decay to a few hundred milliamperes within 0.5 to 1 second. Eventually, the current will stabilize under 50 milliamperes if there is little or no series resistance to the ground fault. Series resistance limits the peak current and slows the decay after the device switches.

6.38 It is clear that existing current limiters need to be better characterized. Once this has been done, new circuits should not use limiters that create worse fault currents in M lead switching devices.

Type III SB Lead

6.39 The same current limiters are used for Type III SB leads as for Type II, except that there are three circuits known to use the resistance lamp, two DX circuits and the E&M applique. All the problems and requirements are the same as for the Type II interface, except that during normal service, the resistance of the limiter should not exceed 500 ohms if the signaling circuit or signaling interface converter circuit both furnishes the SB lead and detects the M lead signal. Where the SB lead is furnished by one circuit and the M lead detector is in another circuit, as is the case in a Type III to Type I signaling interface conversion (Fig. 19), the current limiter for the SB lead must not cause a voltage drop of more than 5 volts with 85 milliamperes flowing. Many trunk circuits with the Type III interface use 975-ohm surge suppression resistors from the M lead to the SG lead; the resultant voltage divider effect will reduce the M lead voltage to such a low value that some common test sets cannot detect the off-hook state if over 500 ohms is used in the SB lead.

L. Compatibility

6.40 When trunk and signaling circuits are designed to conform to the requirements for standard E&M lead interface types, there will be completely functional dc signaling compatibility between any trunk circuit and any signaling circuit as long as both have the same interface type. Except for any options to provide the particular interface type, no other options are required for this assured compatibility.

6.41 The requirements for the Type I interface also assure compatibility with all known E&M lead testing equipment and status indicators. The absence of ground for on-hook makes the Type II M lead incompatible with several status indicators and test sets. The low voltage for off-hook on Type III M leads when the trunk circuit uses resistance surge suppression causes incompatibility with some indicators and test equipment. The use of other than nominal -48 volts for SB leads or sensors on E leads may lead to moderate or even complete incompatibility with E&M lead test facilities. Therefore, even where the interface requirements permit using other than nominal -48 volts, there should be a very serious reason for doing it.

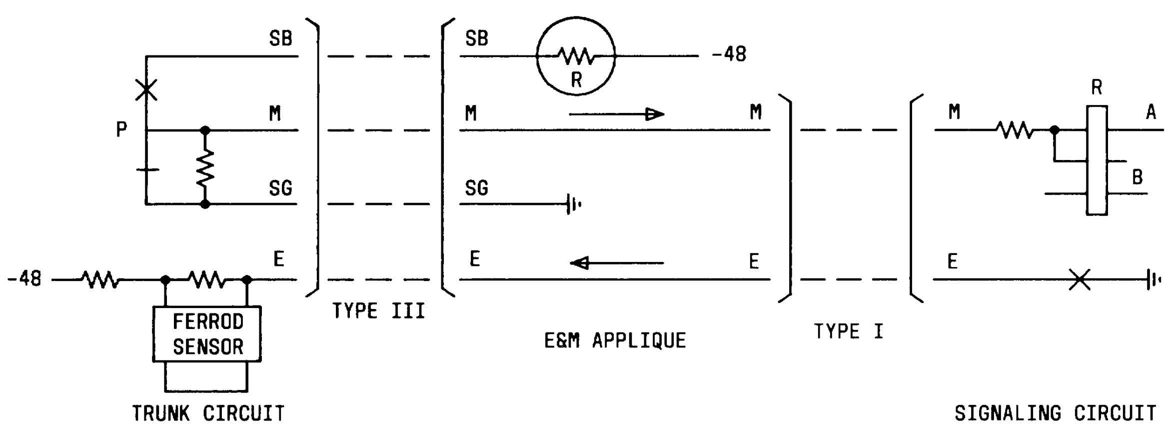


Fig. 19—Type III to Type I Conversion (Normal Range)

M. Interface Conversion

6.42 It is common to use older signaling facilities having only the Type I interface with trunk circuits having the Type II or III interface. This connection requires the use of an intermediary conversion circuit. The Bell System circuit for this is the E&M applique. This circuit has options for converting Type II or Type III to Type I; recently, an option to convert from Type II to Type V was added. Figures 19, 20, 21, and 22 show these conversions.

N. Back-to-Back Connections

6.43 Sometimes it is desirable to connect a trunk circuit of one switching system to a trunk circuit of another system in the same building. Built-up trunks sometimes make use of signaling facilities interconnected within the same building. These back-to-back connections can sometimes be made directly; otherwise, they are made through auxiliary link circuits, depending upon the interface type.

6.44 Circuits with Type I or III interfaces must use an auxiliary link for back-to-back connections as shown in Fig. 23 and 24. Circuits with Type II, IV, or V interfaces may be interconnected metallically by connecting leads SB, M, SG, and E of one to leads SG, E, SB, and M, respectively, of the other. (Omit the SB and SG leads for Type V.) If the mismatch of leads is a problem, the interconnection may be made through the E&M applique which has a lead crossover figure for this purpose only. Back-to-back connections are shown in Fig. 25, 26, and 27.

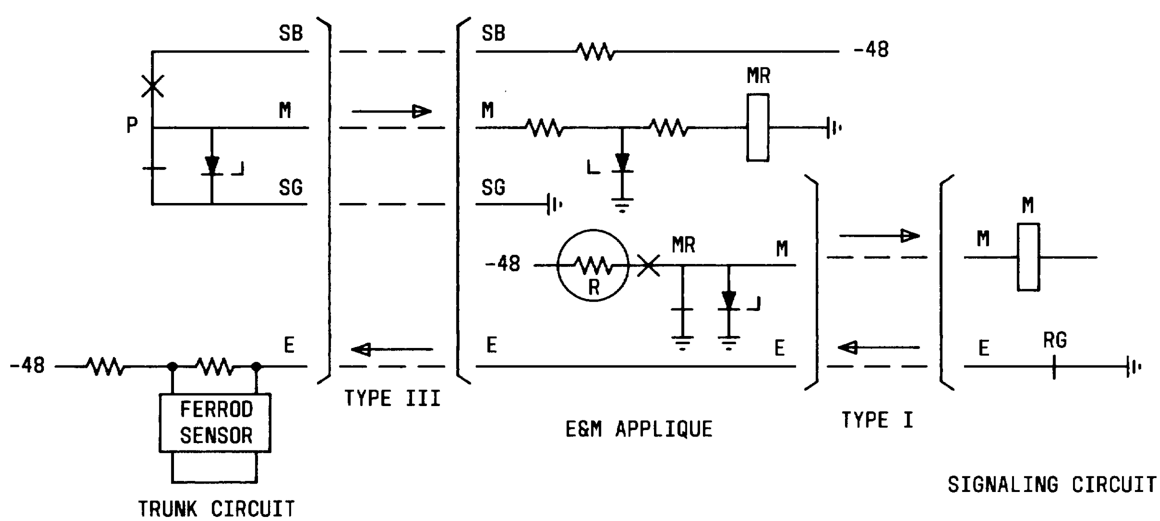


Fig. 20—Type III to Type I Conversion (Long Range)

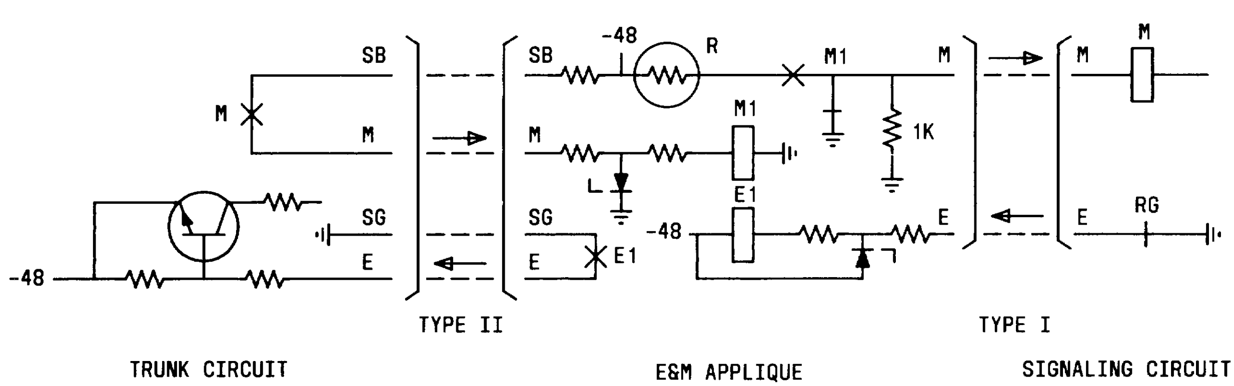


Fig. 21—Type II to Type I Conversion

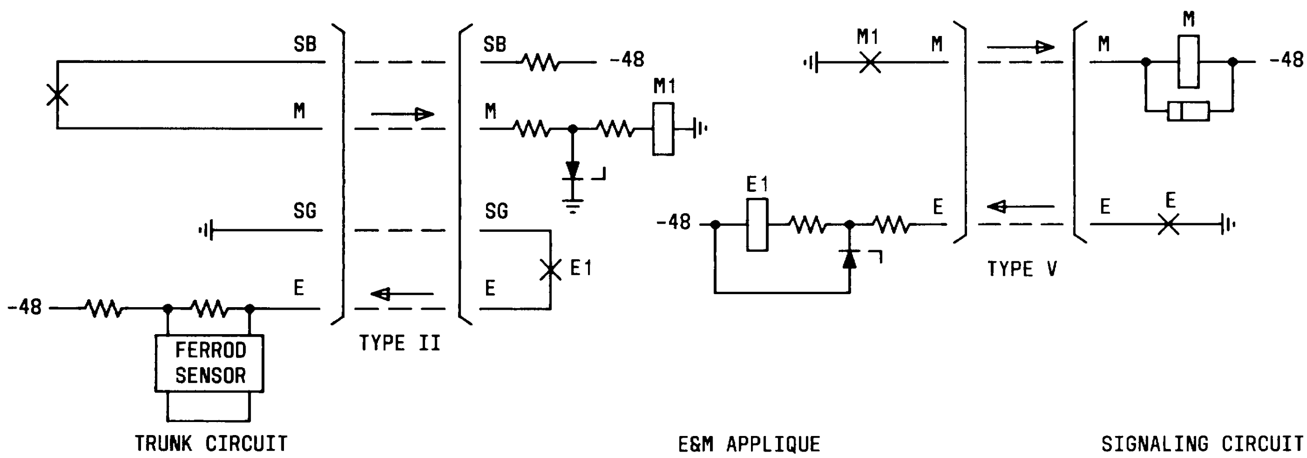


Fig. 22—Type II to Type V Conversion

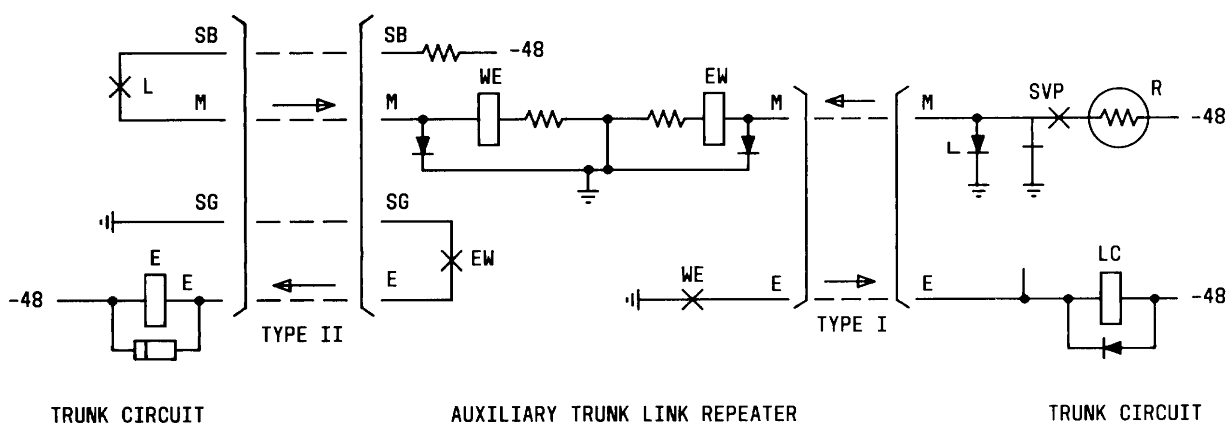


Fig. 23—Trunk Circuit to Trunk Circuit Via Auxiliary Trunk Link Repeater

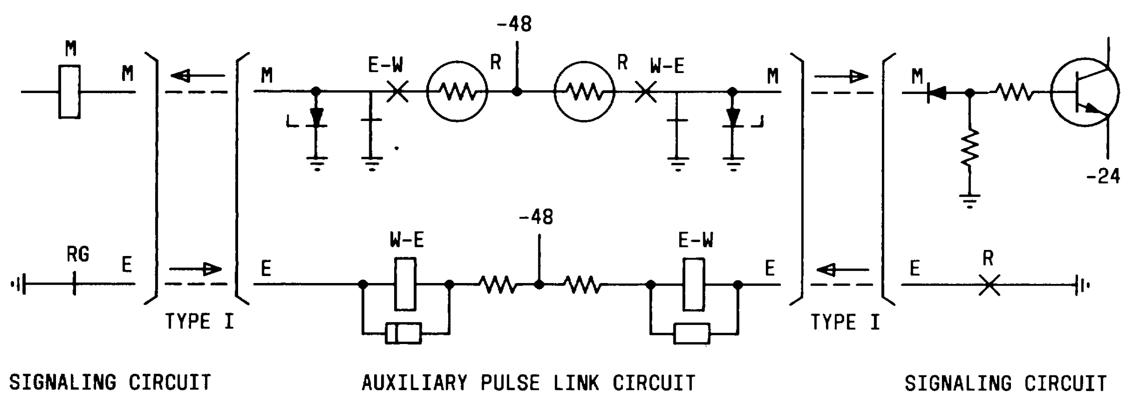


Fig. 24—Signaling Circuit to Signaling Circuit Via Auxiliary Pulse Link Circuit

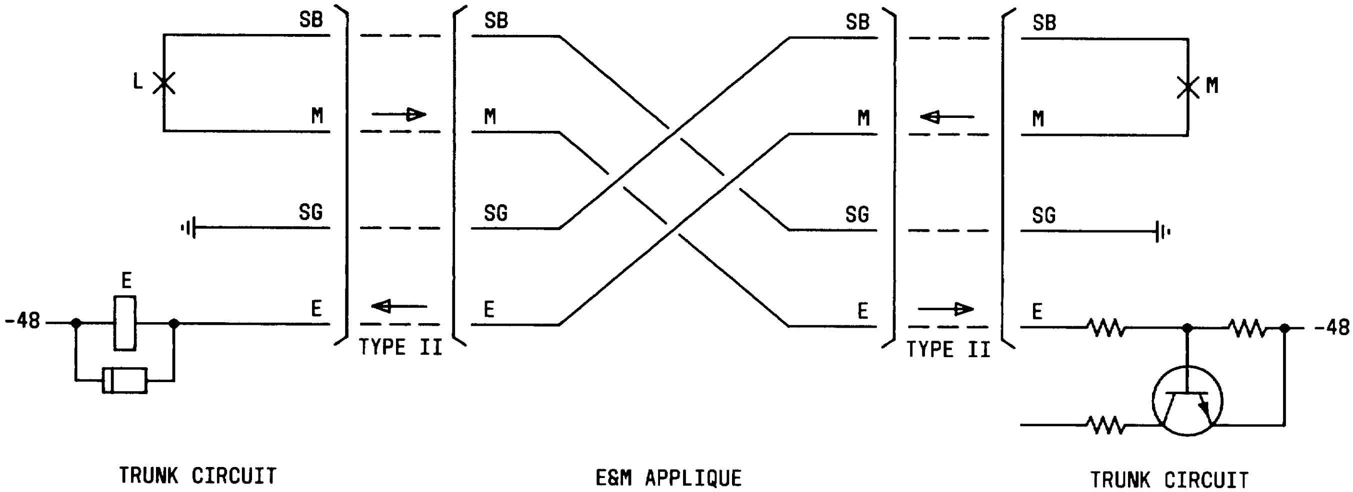


Fig. 25—Trunk Circuits Back to Back—Type II

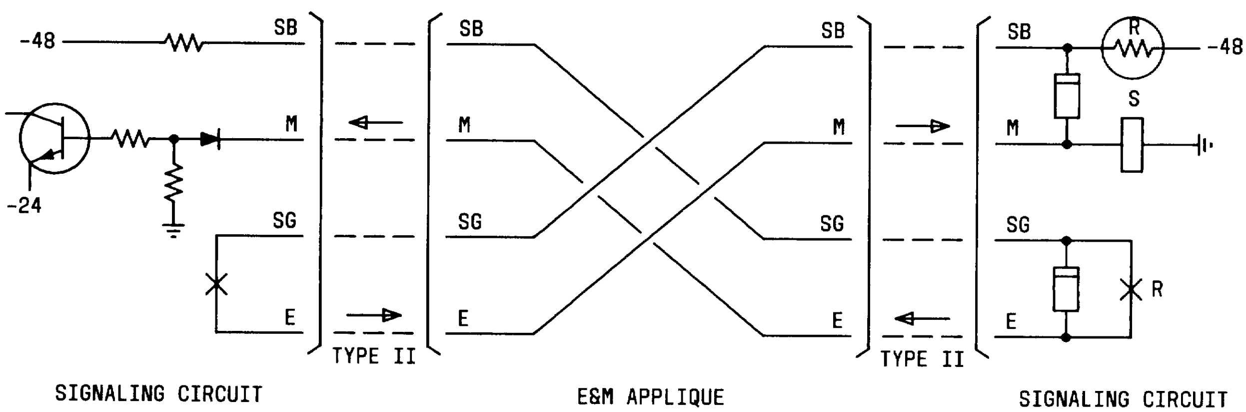
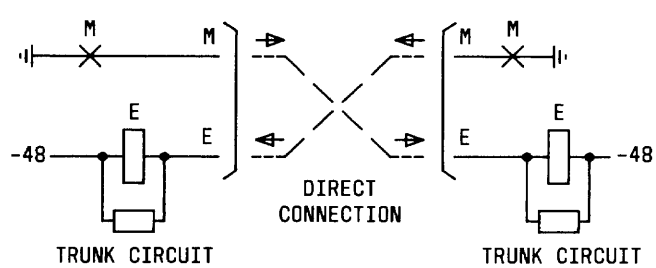


Fig. 26—Signaling Circuits Back to Back—Type II



NOTE: THE FIGURE SHOWS SIGNALING CIRCUITS BACK-TO-BACK IF ALL E&M DESIGNATIONS ARE REVERSED.

Fig. 27—Trunk Circuits Back to Back—Type V

6.45 It should be noted that, when like circuits with the Type II interface are connected back-to-back, they form a symmetrical arrangement with battery and open signaling states for both directions when signaling circuits are interconnected or ground and open states when trunk circuits are interconnected. Most E&M lead test facilities are made for the usual nonsymmetrical interfaces; therefore, some improvising is necessary to do some of the testing. If this is considered to be a serious problem, the trunk circuits may be interconnected by using an auxiliary circuit. However, no similar Bell System circuit is known for interconnecting Type II signaling circuits.

O. 60-Hz Immunity Requirements

6.46 E&M leads should remain within one building or, at most, pass between adjacent buildings. They are, therefore, not exposed to 60-Hz induction or lightning and thus have no requirements in this regard.

P. Working Range

6.47 The sensors on the E&M leads should be sensitive enough to permit each conductor, including SB and SG leads, to have at least 150 ohms. This means at least 300 ohms on a loop basis where applicable. The sensitivity should be low enough that -50 volts or ground through 20,000 ohms bridged onto either M or E leads, respectively, will not be seen as an off-hook state. Not all existing circuits meet these requirements, but new circuits should do so. The sensor on the Type III M lead should be designed to accommodate a 900-ohm surge suppression resistor from the M lead to the SG lead in the trunk circuit.

Q. Lead Designations

6.48 For Type I, II, III, and IV interfaces, the M lead is used for signaling from the trunk circuit, the E lead is used for signaling to the trunk circuit, the SB lead is used to supply battery (Types II and III) or ground (Type IV) to the trunk circuit for signaling on the M lead, and the SG lead is used to supply ground to the trunk circuit for signaling on the Type III M lead or ground to signaling circuit for signaling on the E lead (Types II and IV). When multiple sets of signaling leads are used, it is permissible to add appropriate suffixes to identify the sets.

6.49 The use of EA, EB, MA, and MB instead of E, SG, M, and SB, respectively, was started on some circuits, mostly No. 4 ESS or connecting circuits. However, just before the first cutover, it was agreed that only E, SG, M, and SB designations would be used. However, there are standard circuits that continue to use EA, EB, MA, and MB designations.

6.50 For the Type V interface, lead designations should be identical to the Type I leads in the Bell System. For interfacing with non-Bell System circuits, particularly outside North America, the E lead may also be designated SZ1, Sa, or SR and the M lead may also be designated SZ2, Sb, or SS.

R. Relative Merits

Type I Interface

6.51 In the Type I interface, battery is supplied at the trunk circuit for both the E and M leads. This causes high return current through the office grounding system. In some offices where the trunk circuits are on one floor and the signaling facilities are on another floor, special equalizing jumpers had to be added between the ground systems of the two floors to maintain the required 0.5-volt maximum potential between the two floors. This only occurs when large numbers of E&M leads are used.

6.52 The unbalanced signaling (single lead) is thought to be a potential source of interference in some electronic environments, particularly if the current exceeds 50 milliamperes. The battery feed to the M lead is probably the biggest problem with Type I as has been discussed in paragraphs 6.30 through 6.33.

Type II Interface

6.53 The Type II interface provides complete (nearly complete when some solid-state switches are used) separation between switching and signaling power systems. It is least likely (along with Type IV) to cause interference to other circuits in sensitive environments. Metallic back-to-back interconnection of like circuits is possible.

6.54 On the negative side, when a trunk circuit connects to a signaling facility having only the Type I or V interface, the interface conversion circuit will add to the installed cost of the trunk.

Type III Interface

6.55 The Type III interface is the most widely used arrangement in No. 1/1A, 2/2B, and 3 ESS offices. It provides complete separation of power systems for the M lead and allows the trunk circuit to establish and control the level of E lead current. There is no evidence that the unbalanced E lead has caused any interference problems. The conversion to Type I is much cheaper than from Type II to Type I.

6.56 The only known drawback to the Type III interface is its inability to use simple back-to-back interconnection of like circuits.

Type IV Interface

6.57 The Type IV interface has all the advantages of the Type II interface and, in addition, has no battery feed problems. It is the ideal E&M lead interface where single lead signaling is considered a hazard or where separation of power systems may be required. Its only negative feature is the lack of common E&M lead status indicators and pulsing test sets in North America.

Type V Interface

6.58 The Type V interface is a 2-wire E&M lead interface. It has no battery feed problems; although it does not provide separation of power systems, there tends to be no return ground currents between power systems. It is the worldwide standard outside North America.

S. E&M Lead Connection to Testboards

6.59 When the signaling leads of the Type I, II, III, IV, or V interface appear on jacks at testboards, only the E&M leads appear on jacks for testing. The E lead is on the tip and the M lead is on the ring of the jack.

T. List of Service Trunks

6.60 A list of service trunks using the E&M lead signaling and the various loop signaling arrangements is in Fig. 28.

U. Pulse Links and Converters

6.61 A trunk may be made up of two or more signaling sections connected in tandem using the same or different types of signaling systems. If two adjacent sections have E&M lead signaling arrangements, an auxiliary pulse link is usually provided to repeat the signals. If the signaling arrangements of the two sections are different, converters are provided. For example, if a trunk circuit employing loop signaling is connected to a trunk facility using signaling with E&M lead control, a converter is used to convert loop signaling to E&M lead signaling and vice versa.

6.62 Because of the time delay inherent in SF signaling, two signaling sections of SF signaling should not be used in applications where delay is important such as delay-dial or stop-go operation. See paragraphs 3.06 and 3.32 and the following paragraphs.

DC SIGNALING SYSTEMS

A. Composite (CX) and Duplex (DX) Signaling

6.63 CX, as well as DX, signaling arrangements were developed to provide means for dc signaling and dial pulsing beyond the range of loop signaling methods. DX and CX signaling arrangements are duplex in operation; ie, they provide simultaneous 2-way signaling paths. The circuit techniques of DX and CX are fundamentally those used in full duplex telegraph and teletypewriter operation. A sensitive polar relay at each end of the line receives signals from the distant end. Balancing networks are provided and must be adjusted for each circuit according to the impedance of the line conductors.

FUNCTION	TYPE OF EQUIPMENT	LOCATION	DIRECTION	SUPERVISION	START	ADDRESS OF CALLED PARTY	ADDRESS OF CALLING PARTY	COIN CONTROL (NOTE 1)	RINGING (NOTE 2)	OTHER SIGNALS
Recording-Completing—Special Service (Dial 0) Coin	3C-Type Switchboard or Equivalent	Remote Building	To Switchboard	E&M	None	None	None	Inband	Inband (Note 3)	None
				Loop Reverse Battery, High-Low	None	None	None	Tip and Ring	Tip and Ring	None
								Inband	Inband	None
		Same Building	To Switchboard	Sleeve Lead	None	None	None	Tip and Ring	Tip and Ring	None
Recording-Completing—Special Service (Dial 0) Noncoin	3C-Type Switchboard or Equivalent	Remote Building	To Switchboard	E&M	None	None	None	None	Inband — Wink Only and Wink and MF Tone	Emergency Ringback from Operator
				Loop Reverse Battery, High-Low	None	None	None	None	Tip and Ring	Emergency Ringback
					None	None	None	None	Inband — Wink Only	Emergency Ringback
		Same Building	To Switchboard	Sleeve Lead	None	None	None	None	Tip and Ring	Emergency Ringback
Recording-Completing—Special Service Coin and Noncoin Combined	3C-Type Switchboard or Equivalent	Remote Building	To Switchboard	Same as Recording-Completing Coin	None	None	None	Same as Recording-Completing Coin	Same as Recording-Completing Coin	Class-of-Service Tone to Operator, Emergency Ring-back
TSP—Coin (a) 0+, 1+ (b) Dial 0 (c) 00 (d) Dial 0, 00.	TSP No. 100A	Remote Building	To TSP	Loop Reverse Battery, High-Low	Wink	MF (Note 4)	MF (Note 4)	Inband or Polar Marginal	Inband or Polar Marginal	ANI Request Signal from TSP, Reverse Make-Busy
					Wink	MF (Note 4)	MF (Note 4)	Multiwink or EIS	Multiwink or EIS	
				E&M	Wink	MF (Note 4)	MF (Note 4)	Inband	Inband	ANI Request Signal from TSP, Reverse Make-Busy
					Wink	MF (Note 4)	MF (Note 4)	Multiwink or EIS	Multiwink or EIS	

Notes:

1. Coin control consists of two signals: coin collect and coin return.
2. Ringing – ringing the customer.
3. The inband signals will be preceded by a wink.
4. Special format. (See Tables N, O, P, and Q and paragraph 8.17.)
5. Also operator-attached and operator-released signals when multiwink or expanded inband signaling is used.

Fig. 28—Service Trunks

FUNCTION	TYPE OF EQUIPMENT	LOCATION	DIRECTION	SUPERVISION	START	ADDRESS OF CALLED PARTY	ADDRESS OF CALLING PARTY	COIN CONTROL	RINGING	OTHER SIGNALS
TSP—Noncoin (a) 0+ (b) Dial 0 (c) 00 (d) Dial 0, 00.	TSP No. 100A	Remote Building	To TSP	Loop Reverse Battery, High-Low	Wink	MF (Note 1)	MF (Note 1)	None	Inband— Wink Only	ANI Request Signal from TSP, Reverse Make-Busy
				E&M	Wink	MF (Note 1)	MF (Note 1)	None	Inband— Wink Only and Wink and MF Tone	ANI Request Signal from TSP, Reverse Make-Busy
TSPS—Coin (a) 1+ (b) Some or all combined (Dial 0, 00, 0+, 1+) (c) Dial 0, 00 (d) Dedicated 00.	TSPS No. 1	Remote Building	To TSPS	Loop Reverse Battery, High-Low	Wink	MF (Note 1)	MF (Note 1)	Inband or Polar Marginal	Inband or Polar Marginal	ANI Request Signal from TSPS, Reverse Make-Busy (Note 2)
					Wink	MF (Note 1)	MF (Note 1)	Multiwink or EIS	Multiwink or EIS	
				E&M	Wink	MF (Note 1)	MF (Note 1)	Inband	Inband	ANI Request Signal from TSPS, Reverse Make-Busy (Note 2)
					Wink	MF (Note 1)	MF (Note 1)	Multiwink or EIS	Multiwink or EIS	
TSPS Noncoin (a) 1+ (b) Some or all combined (Dial 0, 00, 0+, 1+) (c) 0+ (d) Dial 0, 00 (e) Dedicated 00.	TSPS No. 1	Remote Building	To TSPS	Loop Reverse Battery, High-Low	Wink	MF (Note 1)	MF (Note 1)	None	Inband— Wink Only	ANI Request Signal from TSPS, Reverse Make-Busy
				E&M	Wink	MF (Note 1)	MF (Note 1)	None	Inband— Wink Only and Wink and MF Tone	ANI Request Signal from TSPS, Reverse Make-Busy
TSPS Coin and Noncoin Combined Some or all combined (Dial 0, 00, 0+, 1+)	TSPS No. 1	Remote Building	To TSPS	Loop Reverse Battery, High-Low	Wink	MF (Note 1)	MF (Note 1)	Inband or Polar Marginal	Inband or Polar Marginal	ANI Request Signal from TSPS, Reverse Make-Busy (Note 2)
					Wink	MF (Note 1)	MF (Note 1)	Multiwink or EIS	Multiwink or EIS	
				E&M	Wink	MF (Note 1)	MF (Note 1)	Inband	Inband	ANI Request Signal from TSPS, Reverse Make-Busy (Note 2)
					Wink	MF (Note 1)	MF (Note 1)	Multiwink or EIS	Multiwink or EIS	
Toll Switch Noncoin	3C-Type Switchboard or Equivalent	Remote Building	From Switchboard	E&M	Delay-Dial	MF	None	None	Inband— Wink Only and Wink and MF Tone	None
				Loop Reverse Battery, High-Low	Delay-Dial	MF	None	None	Inband— Wink Only	None
						MF and Dial Pulse	None	None	Simplex	None
		Same Building	From Switchboard	Sleeve Lead	Delay-Dial	MF and Dial Pulse	None	None	Tip and Ring	None

Notes:

1. Special format. (See Tables N, O, P, and Q and paragraph 8.17.)
2. Also operator-attached and operator-released signals when multiwink or expanded inband signaling is used.

Fig. 28—Service Trunks (Contd)

FUNCTION	TYPE OF EQUIPMENT	LOCATION	DIRECTION	SUPERVISION	START	ADDRESS OF CALLED PARTY	ADDRESS OF CALLING PARTY	COIN CONTROL	RINGING	OTHER SIGNALS
Toll Switching Noncoin Controlled Ring	3C-Type Switchboard or Equivalent	Remote Building	From Switchboard	Same as Toll Switch Noncoin	Delay-Dial	Same as Toll Switch Noncoin	None	None	Same as Toll Switch Noncoin	Controlled Ring Signal from Operator
Toll Switching Coin	3C-Type Switchboard or Equivalent	Remote Building	From Switchboard	Same as Remote Building Toll Switch Noncoin	Delay-Dial	Same as Toll Switch Noncoin	None	Inband and Polar Marginal	Inband and Polar Marginal	None
		Same Building	From Switchboard	Sleeve Lead	Delay-Dial	MF and Dial Pulse	None	Third Wire	Tip and Ring	None
Intercept Operator (Regular)	3C-Type Switchboard or Equivalent or No. 23C Operating Room Desk	Same or Remote Building	To Equipment	E&M	None	None	None	None	None	None
				Loop	None	None	None	None	None	None
Trouble	Same as Operator	Same as Operator	Same as Operator	Same as Operator	None	None	None	None	None	None
Machine	Announcement Machine No. 11A	Same or Remote Building	To Machine	Loop	None	None	None	None	None	None
Combined (Regular, Trouble, and Machine)	No. 6A Announcement System	Same or Remote Building	To System	Loop Reverse Battery, High-Low	None	None	None	None	None	Signal to Announcement System Accompanying Seizure to Indicate Regular, Trouble, and Machine
Combined (Regular, Trouble, and Machine)	Automatic Intercept Center (AIC)	Same or Remote Building	To System	Loop Reverse Battery, High-Low	Wink	MF (Note)	None	None	None	Reverse Make-Busy
				E&M	Wink	MF (Note)	None	None	None	Reverse Make-Busy
Repair Service	Repair Service Desk No. 2, 1C	Same or Remote Building	To Repair Service Desk	Loop High-Low, Reverse Battery	None	None	None	None	None	Make-Busy Indication from Repair Desk (RSB)
Testing	Local Test Desk No. 14 or Local Test Cabinet No. 3	Same or Remote Building	To Desk, Cabinet	Sleeve Lead and Reverse Battery	None	None	None	None	None	
			From Desk	Sleeve Lead and Reverse Battery	None	MF or Dial Pulse	None	None	None	Test Signals from Test Desk (See Section 8.)

Note: Special format. (See Tables N, O, P, and Q and paragraph 8.17.)

Fig. 28—Service Trunks (Contd)

6.64 CX signaling employs a single-line conductor with ground return for each signaling channel. A balanced polar relay is used at each end of the signaling section as shown in Fig. 29 in a symmetrical arrangement which permits full duplex operation. Higher frequency voice currents are separated from the low-frequency signaling currents by a filter arrangement called a CX or "composite" set. The crossover frequency is about 100 Hz. Two CX signaling legs can be derived from a pair of wires and four from a phantom group. These four legs can be used to signal independently with a ground return but, in most cases, one leg is used as an ac and dc earth potential compensation path. The signaling channels can be assigned independent of the voice channels with which they are physically associated because of the isolation provided by the CX sets.

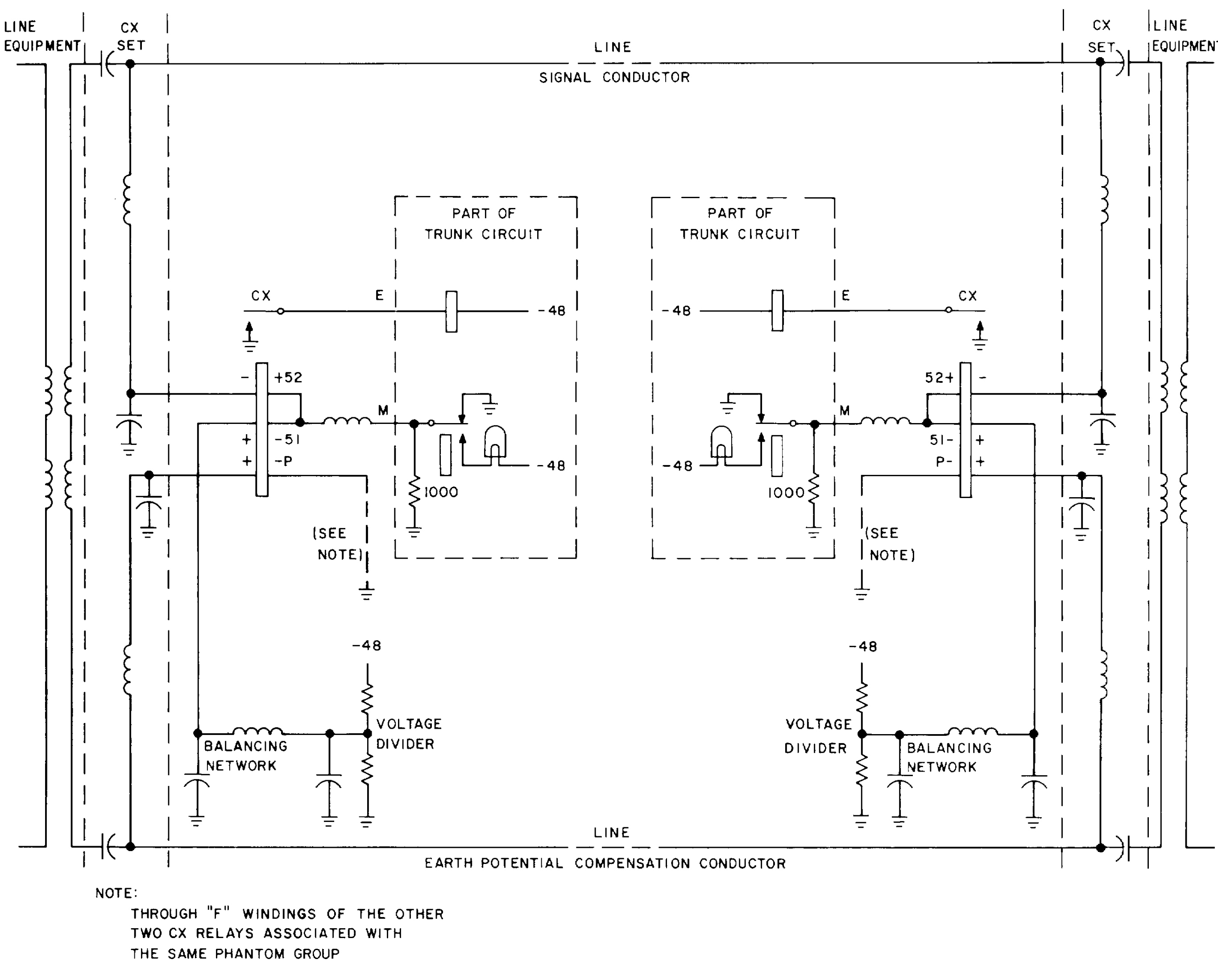


Fig. 29—Composite Signaling for One Voice Channel

6.65 Three types of CX sets are used in the Bell System and are coded as follows:

(a) ***Type C:*** Used for CX signaling on open wire and cable. This set can be used at intermediate and terminal points.

(b) ***Type D:*** Used for CX signaling on open wire and cable but only at terminal points and cannot be used for intertoll trunks. This set is similar to type C but less expensive.

(c) ***Type E:*** Used for CX signaling on cable circuits only. This set can be used at intermediate and terminal points like type C but uses less expensive components.

6.66 A number of CX signaling equipment units are available and are usually classified as either short haul or long haul with the following broad applications:

(a) ***Short Haul:*** Maximum of 4800 ohms loop resistance on cable circuits or 90 to 100 miles of open wire.

(b) ***Long Haul:*** Maximum of 12,000 ohms loop resistance. Such circuits usually include one intervening voice repeater around which the signals are bypassed.

6.67 Earth potential compensation is essential to proper performance where earth potential conditions indicate its use. On all intertoll trunks, ac and dc earth potential compensation should be used. On toll connecting trunks, its use is optional. Depending on the signaling equipment design, 1.5 to 4.5 volts difference in earth potential usually requires compensation. Under some conditions, filters may be required to overcome the effect of induced longitudinal ac voltages.

6.68 Dial pulsing on CX signaling circuits is normally at a rate of 10 PPS. Tests for dial pulse distortion, however, are made at 12 PPS and typical limits for adjusting, testing, and performance, in terms of percent break at this speed, are as follows:

	PERCENT BREAK		PULSING SPEED
	INPUT M LEAD	OUTPUT E LEAD	(PPS)
Adjust	58	59	12
Test	58	57-61	12
Expected Performance	58	55-63	12

Note: The input is at the M lead of one end of a signaling section and the output is at the E lead of the other end.

6.69 Under normal service conditions, the input to CX signaling equipment should be limited to the range of 47 to 67 percent BK or a more narrow range under unfavorable conditions. When testing at 12 PPS, the output limits of the contact that pulses the A relay of a step-by-step selector in the same office are 44 to 72 percent BK.

6.70 Dial signaling without intermediate senders or registers is not expected to be transmitted through more than four signaling links connected in tandem. This limitation applies to all types of trunk signaling. An example of this would be an N1 carrier channel, a T1 carrier channel, a DX signaling section, and a CX signaling section in tandem. The total round trip signaling delay for terrestrial facilities should not exceed 300 milliseconds for a connect plus delay-dial signal. In the case of delay-dial without integrity check, the 300 milliseconds also include time for the far-end switching system to return delay-dial.

6.71 The CX signaling circuits have been designed on the basis of total minimum insulation requirements of 160,000 ohms per mile per conductor for open-wire circuits less than 25 miles long and 200,000 ohms per mile per conductor for circuits over 25 miles in length. The requirements are based upon both the minimum insulation between conductors and a conductor to ground. These values also apply to circuits operating over combinations of cable and open wire. For cable circuits, the total minimum insulation resistance requirement for conductors is generally 60,000 ohms. At an intermediate voice repeater, such as one of the V type, either two sets of CX signaling equipment and an auxiliary pulse link may be provided or bypass equipment must be used to provide a signaling path around the repeater.

6.72 DX signaling is based upon a balanced and symmetrical circuit that is identical at both ends. It is patterned after CX signaling, but DX does not require a CX set. Figure 30 shows a trunk embodying the DX signaling features.

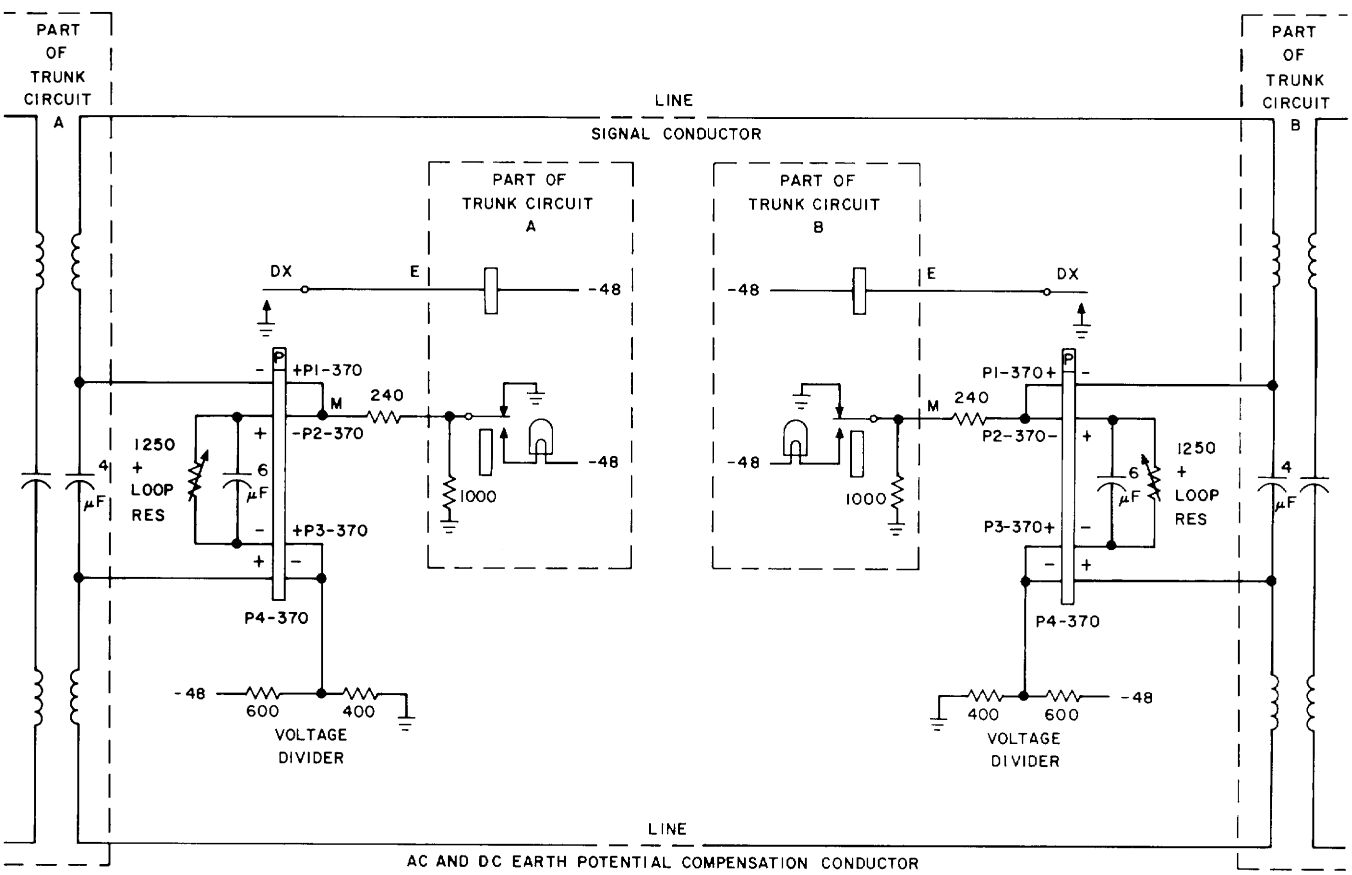


Fig. 30—DX Signaling Circuit

6.73 A DX signaling circuit uses the same conductors as the talking path and does not require a CX set or filter to separate the signaling frequencies from the voice transmission. One conductor in the DX signaling system carries the supervisory and pulsing signals. Both conductors individually carry currents resulting from differences in terminal ground potentials and battery supply voltages so that current in the second conductor can cancel the effect of this unwanted current in the first conductor. This arrangement allows for self-compensation against differences in ground potential and partial compensation for battery supply variations. It is also balanced against ac induction.

6.74 The DX signaling system may be used on both 10- and 20-PPS dial pulsing trunks. With proper balancing network adjustment, DX signaling circuits will repeat 12 PPS of 58 percent BK with a distortion not exceeding ±4 percent BK. This performance is better than most loop signaling arrangements and is equal to that of CX signaling. DX signaling is often used instead of loop signaling on longer local and tandem trunks and instead of CX or simplex (SX) on short intertoll trunks. It can be used through E-type (negative impedance) repeaters. If V-type repeaters are used, bypass equipment is required.

6.75 A single DX signaling section is limited to a maximum loop resistance of 5000 ohms. Although the signaling range of DX is less than that of CX or SX, the signal distortion is so small that two DX signaling circuits can be used in tandem for one trunk. As presently designed, Bell System DX signaling circuits are restricted to 2- or 4-wire line facilities composed of cable pairs equipped at both ends with repeating coils and having a minimum insulation resistance of 100,000 ohms.

6.76 Sometimes it is necessary to extend signaling circuit E&M leads beyond their normal limitations. For this purpose, signal lead extension circuits are used to secure adequate range. In effect, this circuit consists of a DX signaling circuit with an additional relay. This circuit, often designated DX2, converts signals from signaling circuit E lead conditions to signaling circuit M lead conditions.

6.77 Three different types of DX signaling units are used interchangeably in the Bell System: the first employs the 280-type polar relay, the second employs the mercury polar relay, and the latest employs solid-state detectors instead of the polar relay.

6.78 All types of DX signaling equipment must be balanced for proper operation. A static or dc balance is required as well as a transient balance. The dc balance is achieved by adjusting a resistor in the balancing network of the DX1 or DX2 to 1250 ohms plus the resistance of the loop.

6.79 To obtain a perfect transient balance of the R relay, it would be necessary to provide an elaborate balancing network with characteristics which exactly matched the distributed line characteristics and its capacitors. In practice, a simple balancing network consisting of the line balancing resistance shunted by an experimentally determined value of capacitance provides a satisfactory balance. This occurs because the electrical and mechanical inertia of the relay prevents response to the unbalanced portions of the transient.

6.80 In the past, optional values of 1.3, 2, 4, or 6 μF were used in the balancing network. However, all trunk arrangements can be balanced using 6 μF in the balancing network if 4 μF is used at the repeat coil midpoints of a 2-wire line or if 4 μF is used across the simplexes of a 4-wire line. This is now the recommended method of operation for DX signaling circuits.

6.81 The capacitance required in the balancing network is essentially unaffected by the value of midpoint capacitance used at the distant end of the line. Thus satisfactory operation could be obtained with a 4-μF midpoint capacitor at one end and 1 μF at the other. However, as described in the previous paragraph, 4 μF is recommended for the midpoint capacitor with 6 μF in the balancing network to assure proper transient balance.

6.82 When a change of signaling state is sent over a DX signaling facility, the time it takes that signal to arrive at the terminating circuit ranges between 2 and 25 milliseconds. This delay time is primarily dependent on the total trunk capacitance including the repeat coil midpoint capacitor, cable capacitance, and capacitance of E-type repeaters. The effect of an E-type repeater is equivalent to 0.5 μF being placed across the line. The conductor resistance is significant only insofar as it represents greater mileage and, therefore, more cable capacitance. The battery voltage and balancing network capacitor are not significant factors. The delay times are plotted in Fig. 31 for the 280 relay and mercury relay circuits, respectively. The major difference between these two circuits is the type of relay used. The mercury relay, being slightly faster than the 280 relay, provides slightly shorter delay times. The effect of cable gauge and loop resistance upon the delay times is also shown in Fig. 31.

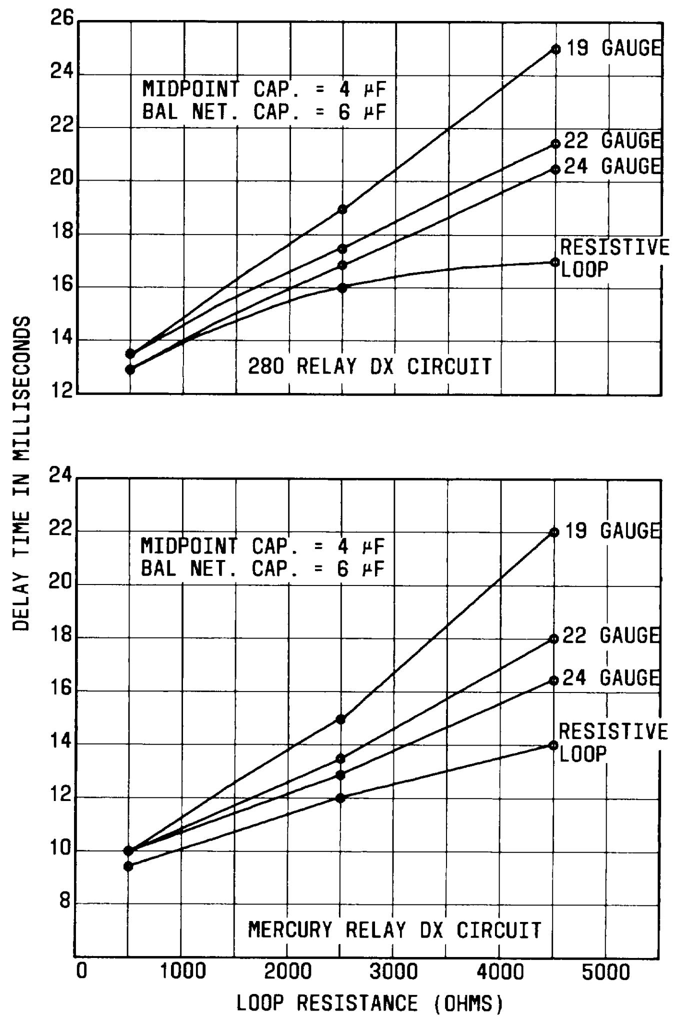


Fig. 31—Effect of Cable Gauge and Loop Resistance Upon Delay Times of DX Circuits

B. Simplex (SX) Signaling

6.83 SX signaling requires the use of two conductors for a single channel. A center tapped coil, or its equivalent, is used at both ends of the pair for this purpose. The arrangement may be a 1-way signaling scheme suitable for intraoffice use or the SX legs may be connected to full DX signaling circuits which function like the CX signaling circuits with E&M lead control. The DX signaling circuits provide 1- or 2-way full duplex operation.

6.84 Earth potential compensation requires the use of one conductor of an additional pair for each five signal channels. Thus only five SX signaling circuits are derived from six physical pairs. The signaling currents in the line side induce no voltage in the equipment since they flow in opposite directions in the two halves of the repeat coil winding and, conversely, voice currents in the equipment cause no current flow in the SX leg. SX signaling has been largely superseded for new work by the DX signaling system previously described.

7. AC SIGNALING SYSTEMS

7.01 The ac signaling systems have been designed to convey the basic trunk supervision and pulsing functions required by switching systems. They are used over network trunks where dc signaling is not feasible or economical such as long- and short-haul circuits derived from carrier systems. Two-state ac signaling can handle trunk supervision and dialing where the latter is coded by dial pulsing. Three-state ac signaling has been designed to handle foreign exchange (FX) lines. Multistate ac signaling, in the form of MF pulses, is used for addressing only and must be coordinated with 2-state signaling systems, either alternating current or direct current for supervision.

7.02 Signaling systems using both inband and out-of-band signaling frequencies are in use. Inband systems could use frequencies in the voiceband from about 500 Hz to about 2600 Hz and signaling equipment is required only at the terminals of a transmission path. Inband signals are usually of the same order of amplitude as voice currents so as not to overload voice amplifiers or cause crosstalk in adjacent channels.

7.03 Out-of-band signaling systems are those which use signals outside the band customarily used for speech transmission on telephone channels. In a sense, this includes dc methods of transmission as discussed previously in this section, but more usually it is taken to include ac systems such as the type referred to in paragraphs 7.38 through 7.42.

7.04 One of the chief problems with inband signaling is the prevention of the mutual interference between voice transmission and signaling. Voice-frequency signals are audible and, consequently, signaling should not take place during the time the channel is used for conversation. Since signal receiving equipment must remain on the channel during conversation to be ready to respond to incoming signals, it may be subject to false operation from voice sounds which resemble the tones used for signaling. Protection against voice interference can be accomplished a number of ways.

(a) Signal tones of a character not likely to occur in normal speech may be used.

(b) Timing requirements for sustained signaling tones may be used to prevent false operation due to voice frequencies occurring in the signaling band.

(c) Voice-frequency energy, other than the signaling frequency, may be detected and used to prevent the operation of the signaling receiver.

SINGLE-FREQUENCY (SF) SIGNALING

7.05 SF signaling systems are designed to pass the necessary signals for telephone trunks over voice-frequency transmission line facilities without impairing the normal use of these facilities for speech. These systems deliver and accept dc signals to and from the switching trunk equipment in the form of loop or E&M lead controls. The dc signals are transformed to ac on the line side and vice versa.

7.06 In modern SF signaling, the same voice frequency, 2600 Hz, is employed for signaling on the transmission facility in both directions. Consequently, SF signaling may be applied to any voice-grade channel of any length and makeup, provided that it is 4-wire from end to end.

7.07 Former SF signaling units, designed only for E&M signaling circuits, were able to use 1600, 2000, and 2400 Hz for signaling as well as 2600 Hz. In some instances, they were arranged to operate at one frequency (eg, 2600 Hz) in one direction and at another frequency (eg, 2400 Hz) in the other direction and could, therefore, be used on 2-wire physical facilities as well as 4-wire facilities. However, long-haul metallic facilities are being rapidly replaced by improved multiplex systems which provide 4-wire equivalent voice-grade channels, and improved dc signaling circuits make DX systems economically attractive for the remaining metallic facilities which cannot be adequately served by loop signaling circuits. The need for SF signaling on 2-wire physical facilities no longer exists; therefore, SF units for 2-wire facilities have been discontinued.

7.08 The original and some subsequent designs of SF signaling circuits employed electron tubes. Current designs, however, use solid-state devices exclusively. The on- and off-hook conditions for all Bell System types of SF signaling systems are as follows:

SIGNAL	TONE	OPERATION	LEAD	CONDITION
On-Hook	On	Sending	M	Ground
		Receiving	E	Open
Off-Hook	Off	Sending	M	Battery
		Receiving	E	Ground

7.09 Since the SF signaling system uses voice-frequency signals on the 4-wire voice path, the characteristics of SF signaling systems are quite different from those of dc signaling systems. The major differences are as follows:

(a) SF signaling systems have longer delay in signaling time as compared to the dc signaling systems.

(b) SF signaling systems have smaller pulsing speed range and percent break range than the dc signaling systems unless pulse correction is used.

(c) SF signaling systems interrupt the voice path during and after transitions between on- and off-hook.

(d) Continuous tones can cause an SF signaling system to malfunction.

E-, F-, AND G-TYPE SIGNALING

7.10 The Bell System is presently using three types of SF signaling: E-, F-, and G-type. The basic principles of all three types are the same. The differences are primarily in the packaging of the components and the design technology. All three families provide for 2- and 4-wire E&M lead trunk signaling, 2-wire loop trunk signaling, and 2- and 4-wire FX line signaling.

7.11 The E-type family is no longer manufactured but is still widely used in the Bell System. All the E-type units for trunk and FX line signaling are single-module units except for the ground-start FX line signaling units which are double-module units.

7.12 The F-type family is still being manufactured and is also widely used in the Bell System. The F-type units are basically double-module units. One module transmits and receives SF tone. This module is called a signaling converter. The other module contains the transmission equipment and the signaling equipment to convert from the dc signaling to signaling used in the other (SF) module. This module is called an auxiliary signaling unit. The single-module units are limited to 4-wire E&M lead units.

7.13 The G-type family is the latest design and uses single-module units with the signaling converter and SF tone (transmit and receive) functions in a single module.

7.14 The characteristics of the E-, F-, and G-type units are covered in Table G. The explanation that follows will be based on the E-type E&M lead units; however, the explanation also covers the F- and G-type signaling E&M lead units. The same basic principles also apply for the E-, F-, and G-type loop signaling units. Figure 32 is a simplified schematic illustrating the major features of the E-type transistorized 2600-Hz SF signaling system. A simplified diagram of the F-type SF module (FUA) is shown in Fig. 33 and the auxiliary module in Fig. 34. The G-type unit is not shown but is similar in function to the F-type unit.

A. SF Transmitter

7.15 The keyer relay (M) is operated and released by signals on the M lead and alternately removes or applies 2600 Hz to the transmit line of the facility. The M relay operates the high-level relay (HL) to remove the 12-dB pad in order to permit a high-level initial signal to secure an improved "signal-to-noise" operating environment. The HL relay is slow to release and, hence, dial pulses which operate the M relay are transmitted at an augmented level. In addition, a cutoff relay (CO) operates to block any noise which may be present from the office side of the circuit.

7.16 The E-type SF signaling units will accept and transmit dial pulses at speeds from 8 to 12 PPS with from 56 to 69 percent BK. If the range of percent break presented to the M lead is outside these limits, means must be provided to bring the range within these limits. In general, this is done with an M lead pulse corrector but, in some cases, other means can be used such as correcting problems in plant where the pulses originate. Limitations in percent break for loop-type SF signaling units are overcome by the use of units incorporating a built-in transmitting pulse corrector.

7.17 There are three types of F-type E&M lead signaling units: MF only, sender dial pulse or MF, and pulse-correcting dial pulse. To date, only a pulse-correcting, E&M lead G-type unit is available. All E-, F-, and G-type loop units contain a pulse corrector. The input and output signals for all Bell System SF units, including the M-lead pulse corrector used as an auxiliary to E-type E&M lead units, are shown in Table G, Section I, Transmitter.

7.18 When using SF signaling without pulse correction in the transmitting unit or in the transmitting M lead, the percent break range is limited to sender outpulsing. In addition, because of the pulse-shaping methods in the sender, most loop dial pulsing units also require built-in pulse correction.

7.19 The pulse correction used with SF units lengthens the short pulses and ensures a minimum interpulse interval. A typical pulse corrector lengthens any pulse over 17 milliseconds to an output of at least 46 milliseconds. In addition, the pulse corrector guarantees an interpulse output interval of at least 23 milliseconds between pulses. The distortion from M lead to tone in F-type units is +1 millisecond and on E-type units is a few milliseconds.

TABLE G

CHARACTERISTICS OF SF SIGNALING UNITS

	E&M LEAD					LOOP					
	E-TYPE	F-TYPE			G-TYPE	E-TYPE		F-TYPE		G-TYPE	
	SENDER	MF ONLY	SENDER	PULSE CORRECTION	PULSE CORRECTION	ORIGINATING	TERMINATING	ORIGINATING	TERMINATING	ORIGINATING	TERMINATING
I. TRANSMITTER											
A. Minimum detected input:											
(1) On-hook – Break		55	21	19				18		20	20
(2) Off-hook – Make.		60	21	2						14	14
B. Minimum output:											
(1) On-hook – Break		55 ±4	21 ±2	49.5 ±3.5				51 ±4		51 ±3	51 ±3
(2) Off-hook – Make.		60 ±4	21 ±2	26 ±4						26 ±2	26 ±2
C. Maximum input lengthened by pulse corrector:											
(1) On-hook – Break				50				52		51	51
(2) Off-hook – Make.										26	26
D. Distortion for inputs not lengthened by pulse corrector:											
(1) On-hook – Break		±4	±2	±3				±2		±2	±2
(2) Off-hook – Make.		±4	±2							±2	±2
E. Signal delay:											
(1) Off-hook to on-hook			13-21	17-21				13-18	19-35	19 Typical	19 Typical
(2) On-hook to off-hook.			13-21	17-21				14-19	19-35	19 Typical	19 Typical
F. Pulsing range accepted as input – Expressed as percent break:											
(1) 7.5 PPS			16-84	19-90				13.5-86			
(2) 10 PPS			21-79	20-90				18-81			
(3) 12.5 PPS.			26-74	25-90				22.5-77			
G. Transmit cut:											
(1) When both ends are on-hook	Yes	Yes	Yes	Yes				Yes	Yes		
(2) When near end is on-hook	No	No	No	No				Yes	No		
(3) Cut delay			5-13	5-15					5-15		
(4) Effective pre-cut											
(5) Near-end cut:											
(a) Both ends are on-hook:											
1. Near end goes off-hook.	80-175	105-155	80-160	106-180				94-176	110-195		
2. Far end goes off-hook, near end is off-hook.	350-750	46-55	560-860	515-780				Yes	530-760		
(b) Far end is on-hook:											
1. Near end goes on-hook.	Yes	Yes	Yes	Yes				Yes			
2. Far end goes off-hook, near end is on-hook.	No	No	No	No				No			
(c) Far end is off-hook.											
1. Near end goes off-hook.	80-175	105-155	80-160	106-180					110-195		
2. Far end goes on-hook.	Yes	Yes	Yes	Yes				Yes			
(d) Both ends are off-hook:											
1. Near end goes on-hook.	350-750	330-475	500-790	500-725					500-725		
2. Far end goes on-hook.											
II. Transmit Tone:											
(1) Normal tone level dBm0	20 ±1	20 ±0.5	20 ±0.5	20 ±0.5							
(2) High tone:											
(a) Level dBm0	8 ±1	8 ±0.5	8 ±0.5	8 ±0.5							
(b) Duration.											

Note: All values are in milliseconds unless otherwise indicated.

TABLE G (Contd)

CHARACTERISTICS OF SF SIGNALING UNITS

	E&M LEAD					LOOP					
	E-TYPE	F-TYPE			G-TYPE	E-TYPE		F-TYPE		G-TYPE	
	SENDER	MF ONLY	SENDER	PULSE CORRECTION	PULSE CORRECTION	ORIGINATING	TERMINATING	ORIGINATING	TERMINATING	ORIGINATING	TERMINATING
II. RECEIVER											
A. Minimum detected input:											
(1) On-hook — Break		55	38	38					35	43	36
(2) Off-hook — Make:											
(a) Narrowband										18	11
(b) Broadband.		55								23	59
B. Minimum output:											
(1) On-hook — Break		55 ±4	51 ±3.5	50 ±3					49 ±3	68.5 ±1.5	56.5 ±1.5
(2) Off-hook — Make:											
(a) Narrowband											
(b) Broadband.											
C. Maximum input lengthened by pulse corrector:											
(1) On-hook — Break			60	60					60		56.5
(2) Off-hook — Make:											
(a) Narrowband											
(b) Broadband.											
D. Distortion for inputs not lengthened by pulse corrector:											
(1) On-hook — Break		±4	±2	±2				±2		±2	
(2) Off-hook — Make:											
(a) Narrowband											
(b) Broadband.											
E. Signal delay:											
(1) Off-hook to on-hook		47-53	48-52	33-37				45-52	33-37	43 Typical	90 Typical
(2) On-hook to off-hook:											
(a) Narrowband											
(b) Broadband.			48-54	47-55				42-48	47-55		55 Typical
F. Pulsing range accepted as input — Expressed as percent break:											
(1) 7.5 PPS			28-90	28-90					26-90		
(2) 10 PPS			38-85	38-85					35-85		
(3) 12.5 PPS.			47-80	47-80					42-80		
G. Detector:											
(1) Bandwidth			75 Hz								
(2) Initial tolerance			±5 Hz								
(3) Aging effect			±8 Hz								
(4) Center frequency			±0.3%								
(5) Signal-guard ratio			10 dB								
(6) Sensitivity:											
(a) Minimum			25 ±1 dBm								
(b) Maximum.			+8 ±1 dBm								
H. Filter/cut operation:											
(1) Transmission path cut:											
(a) Cut time											
(b) Cut duration.											
(2) Filter insertion:											
(a) Insertion time			13 ±7								
(b) Duration.			225 ±50								
I. "G" function activation.	150-250		225 ±50								

Note: All values are in milliseconds unless otherwise indicated.

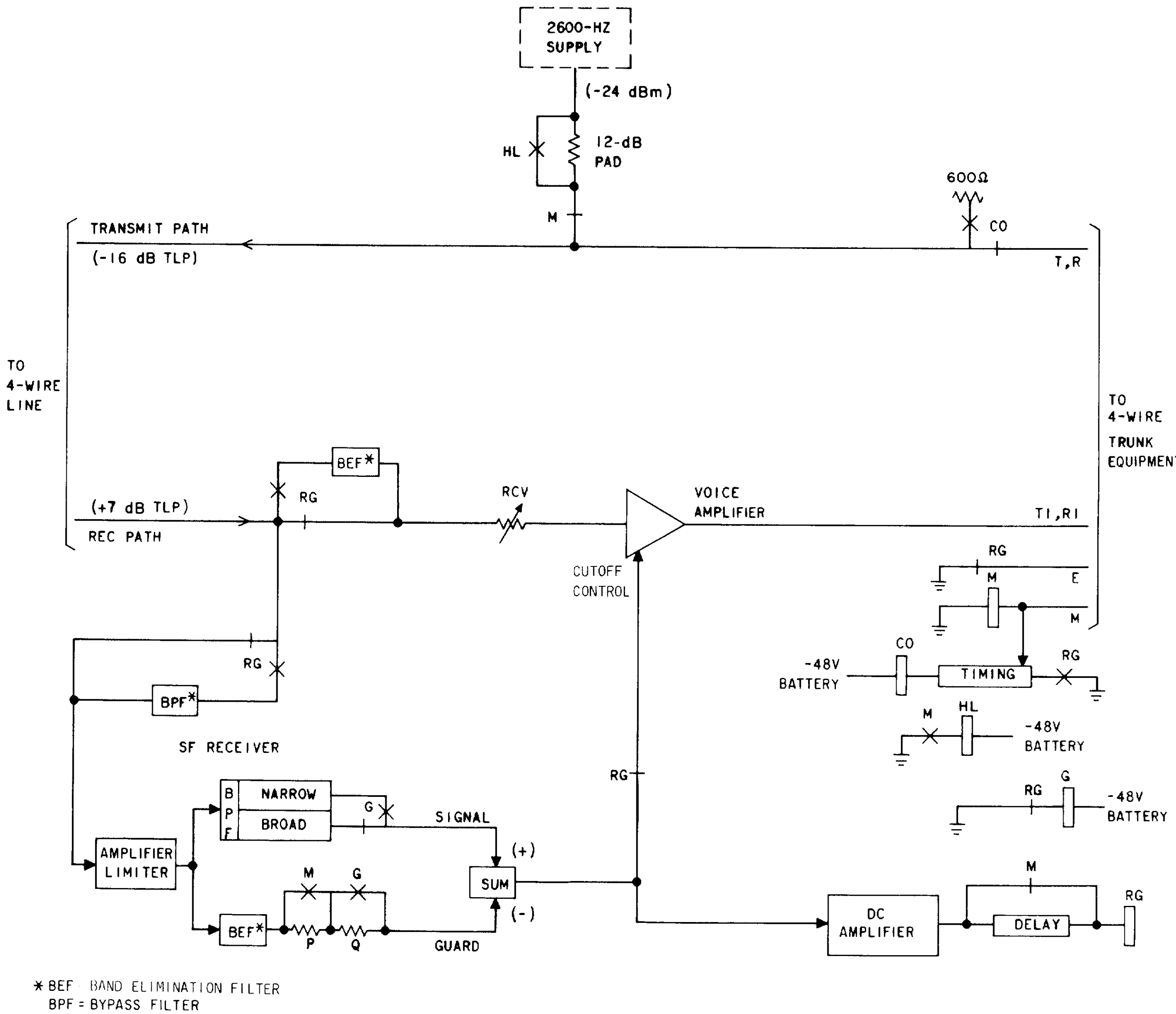


Fig. 32—Simplified Diagram of the E&M 4-Wire E-Type 2600-Hz SF Signaling System Connection to a 4-Wire Transmission Channel

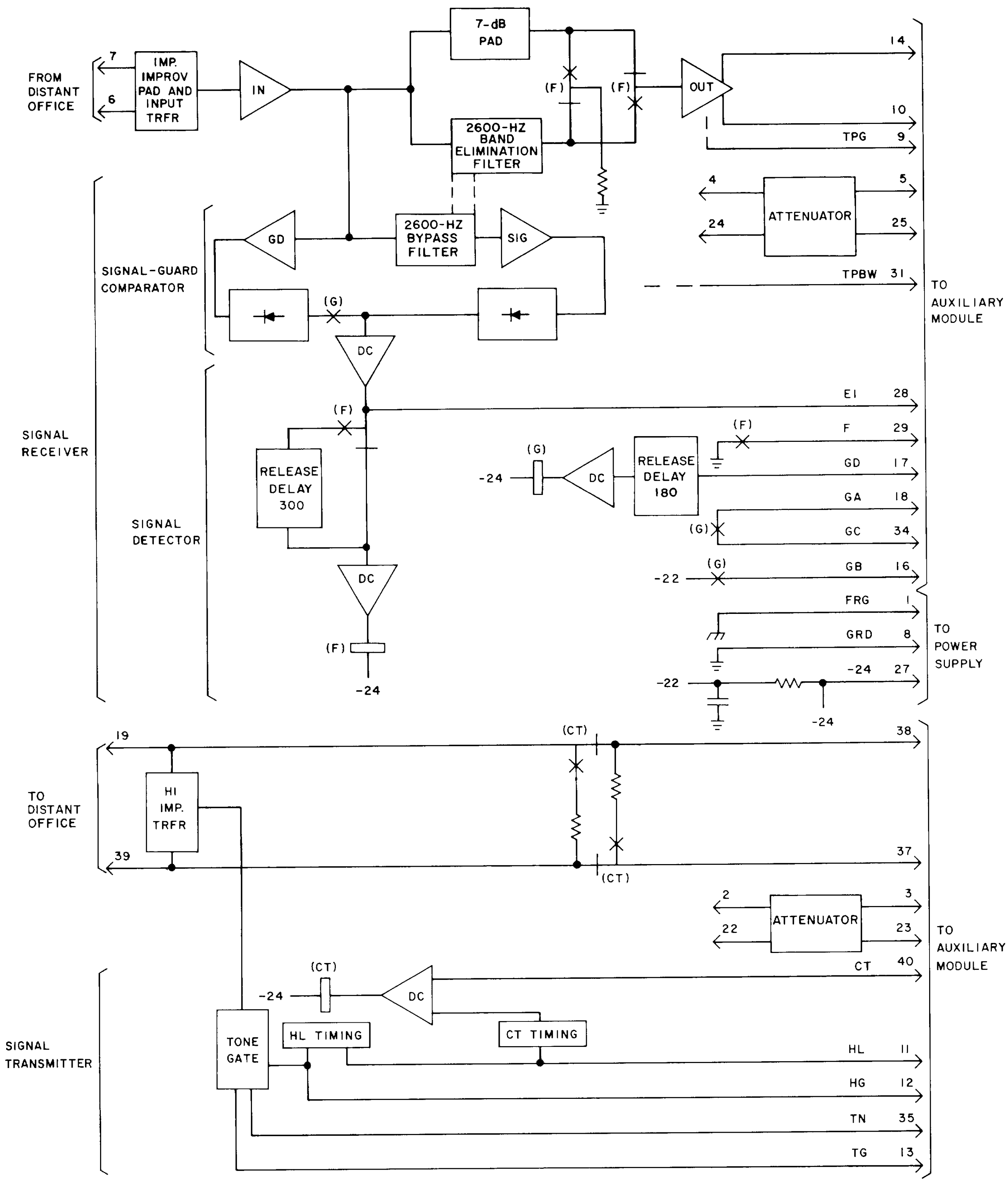


Fig. 33—FUA Signaling Converter

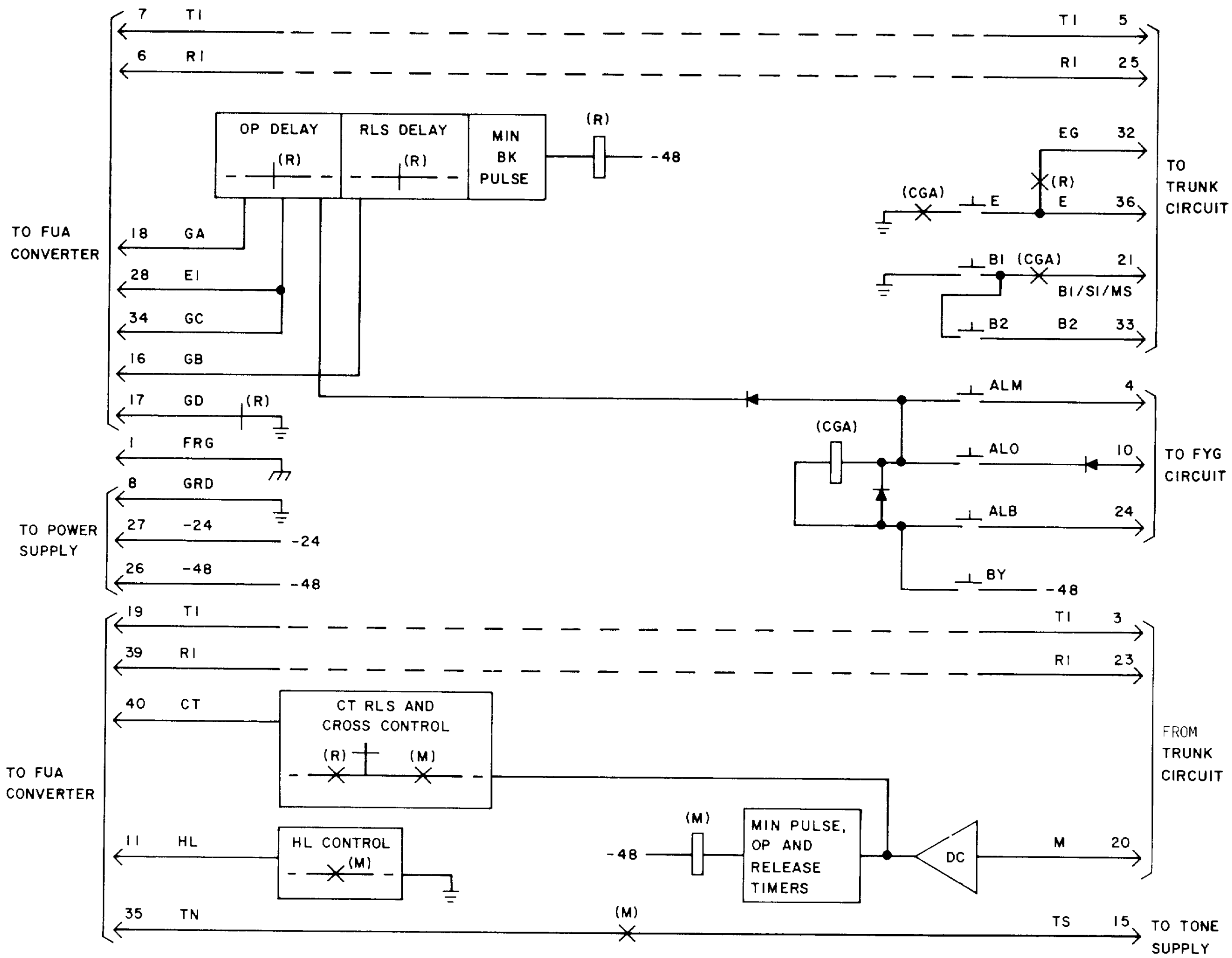


Fig. 34—FBB Signaling Auxiliary Module

B. SF Receiver

7.20 The receiving portions of the SF unit include a voice amplifier, appropriate band elimination networks, and a signal detection circuit. The voice amplifier's primary function is to block any noise or speech present in the office equipment from interfering with the operation of the signal detector and also to make up for the insertion loss of the SF signaling unit in the receive speech path. The signal detector circuit includes an amplifier-limiter, a signal-guard network, appropriate rectifiers, a dc amplifier, and a pulse-correcting circuit, the output of which operates a relay to repeat signals to the E lead of the trunk relay equipment. The characteristics of the signaling receiver portion of the E-, F-, and G-type SF signaling units are shown in Table G, Section II, Receiver. Typical transmission characteristics of an F-type E&M lead signaling unit, a G-type loop originating signaling unit, and a G-type loop terminating signaling unit are shown in Tables H, I, and J, respectively.

7.21 The receiver sensitivity is -29 dBm at the zero transmission level point for 4-wire line facilities. F- and G-type units are more sensitive than this. The signal-guard network provides the necessary frequency discrimination to separate signal and other-than-signal (guard) voltages. By combining the voltage outputs of the signal and guard detectors in opposing polarity, protection against false operation from speech and noise is secured. The guard feature efficiency is changed between the dialing and talking conditions to secure optimum overall operation.

7.22 An incoming signal is separated into signal and guard components by the signal and guard detectors. The width of the band of the signal component is approximately 100 Hz for E-type units, centering on 2600 Hz. The guard component is made up of all other frequencies in the voiceband. These components produce opposing voltages with a resultant net voltage in the signal detector. In the talking condition (tone off in both directions), the guard detector sensitivity is such that almost a pure 2600-Hz tone is required to operate the receiver since other-than-signal frequencies will produce a voltage opposing its operation. The guard principle is an important feature in avoiding signaling imitation by speech. It is, however, insufficient by itself to assure that a speech-simulated signal will not cause false operation of the receiver. An additional electronic time delay is, therefore, provided so that, during the dialing condition, the receiver will just operate the RG relay on a tone pulse of 35 milliseconds for E-type units. When the RG relay operates, it causes a slow relay (G) to release, greatly decreasing the sensitivity of the guard channel and making the signaling channel responsive to a wider band of frequencies. This slow release of the G relay and the resultant reduction in talk-off is known as the G function. Timing of the G function for E-, F-, and G-type SF units is shown in Table G, Section II, Receiver. E-type units can only receive dial pulsing when sending on-hook back to originating end. F- and G-type units can receive dial pulsing regardless of supervisory state.

C. Voice Path Cuts and 2600-Hz Band Elimination Filter Insertion

7.23 The E-, F-, and G-type SF signaling units interrupt the transmit voice path to improve signaling margins. Paragraphs 7.25 through 7.27 give examples when the cuts occur and the cut intervals for F-type SF signaling units. Table G, Section I, Part G, Transmit Cut, contains the cut times for typical E-, F-, and G-type SF signaling units.

7.24 A 2600-Hz band elimination filter is inserted in the receive path whenever the E-, F-, or G-type SF signaling unit receives 2600-Hz tone. The filter blocks the tone but permits audible ring, busy, and other call progress signals to be heard by the calling party without the superimposed 2600-Hz signal. In addition, the filter prevents the SF tone from entering the next signaling link. The filter insertion times are given in Table G, Section II, Part H, Filter/Cut Operation. Both the F- and G-type SF signaling units use only the filter to limit the duration of the 2600-Hz tone that can enter the next signaling link. An electronic switch is used to insert the filter over a period of time. The gradual insertion nearly eliminates any thump that would be associated with the filter insertion. The E-type units, on the other hand, must use a relay to insert the filter. The E-type units delay inserting the filter for about 100 milliseconds. To prevent excessive SF tone from entering the next link, E-type units employ an electronic cut (in the voice amplifier) in the receive path. The electronic cut limits the SF tone leak to a maximum of about 30 milliseconds. The sequence for E-type units is to operate the electronic voiceband cut, insert the filter, and restore the

TABLE H

TYPICAL TRANSMISSION CHARACTERISTICS OF F-TYPE, 4-WIRE E&M UNIT

TRANSMISSION CHARACTERISTICS – TRANSMITTING	
Insertion Loss	
Nominal at 1000 Hz	0.1 dB
Initial Tolerance	±0.05 dB
Effect of Aging and Temperature	±0.02 dB
Frequency Characteristics 200 to 4000 Hz	±0.1 dB
Return Loss (Minimum)	
250 to 3000 Hz	30 dB
Longitudinal Balance (Minimum)	
250 to 3000 Hz	65 dB
Applied Tone Levels	
High Level	−24 dBm (−16 TLP)
Low Level	−36 dBm (−16 TLP)
Tolerance	±0.5 dB
TRANSMISSION CHARACTERISTICS – RECEIVING	
Insertion Loss	
Nominal at 1000 Hz	0 dB
Initial Tolerance	±0.05 dB
Effect of Aging and Temperature	±0.1 dB
Frequency Characteristics 300 to 4000 Hz	±0.1 dB
Delay Distortion 500 to 3000 Hz	<20 μs
Insertion Loss Through Filter	
Nominal at 1000 Hz	0 dB
Initial Tolerance	±0.15 dB
Effect of Aging and Temperature	±0.1 dB
Frequency Characteristics	
300 to 2000 Hz	±0.1 dB
2600 Hz	45 dB minimum
3000 to 4000 Hz	±0.5 dB
Accuracy of Center Frequency	±0.3 percent
Return Loss (Minimum)	
Line Receive 250 to 3000 Hz	30 dB
Equipment Receive 250 to 3000 Hz	30 dB
Longitudinal Balance (Minimum)	
Line Receive 250 to 3000 Hz	65 dB
Equipment Receive 250 to 3000 Hz	60 dB

TABLE I

TYPICAL TRANSMISSION CHARACTERISTICS OF G-TYPE, 2-WIRE LOOP ORIGINATING UNIT

Line Receive Port	
Nominal Level	+7 dB TLP
Nominal Impedance	600 ohms
Return Loss (ERL)	35 dB minimum
Longitudinal Balance	
250 to 3000 Hz	
IEEE STD 455-1976	85 dB typical, 60 dB minimum
Line Transmit Port	
Nominal Level	−16 dB TLP
Maximum Output (10 dB Overload)	−6 dB TLP
Nominal Impedance	600 ohms
Return Loss (ERL)	30 dB minimum
Longitudinal Balance	
250 to 3000 Hz	
IEEE STD 455-1976	85 dB typical, 60 dB minimum
Harmonic Distortion	−50 dB minimum (second harmonic)
at −26 dBm output	−60 dB minimum (third harmonic)
SF Tone Levels	
High	−24 ±1.1 dBm
Low	−36 ±1 dBm
Off	−86 dBm maximum
Equipment Transmit Port	
Nominal Impedance	900 ohms + 2.15 μF.
Return Loss	
ERL	35 dB minimum
SRL	30 dB minimum
SRL-HI	30 dB minimum
Longitudinal Balance	
250 to 3000 Hz, 40 mA dc	
IEEE STD 455-1976	60 dB minimum
Harmonic Distortion	−50 dB minimum (second harmonic)
−3 dBm at Line Receive	−60 dB minimum (third harmonic)
	−49 dB typical THD
Port-to-Port Transmission	
Insertion Loss 600:600 ohm	
with 0 dB Attenuator Settings	
1 kHz	4.2 ±0.4 dB (Ref)
1 kHz (Transmit Cut)	Ref +69 dB minimum
200 Hz	Ref +0.75 ±0.4 dB
2600 Hz (Receive Filter In)	Ref +40 dB minimum
2600 Hz	Ref ±0.3 dB
3000 Hz	Ref ±0.3 dB
Delay Distortion (Typical)	
500 to 3000 Hz	180 μs
500	182
700	85
1000	38
1500	14
2500	2
3000	0
Transhybrid Loss at 1 kHz	
Line Receive to Line Transmit with	
0 Attenuator Settings and Equipment	
Transmit Terminated in	
900 ohms + 2.15 μF	47 dB minimum
Level Setting Attenuators	
Range	0 to 16.5 dB
Steps	0.1 dB
Accuracy (16.5 dB)	±0.1 dB

TABLE J

TYPICAL TRANSMISSION CHARACTERISTICS OF G-TYPE, 2-WIRE LOOP TERMINATING UNIT

Line Receive Port	
Nominal Level	+7 dB TLP
Nominal Impedance	600 ohms
Return Loss (ERL)	35 dB minimum
Longitudinal Balance	
250 to 3000 Hz	
IEEE STD 455-1976	85 dB typical, 60 dB minimum
Line Transmit Port	
Nominal Level	−16 dB TLP
Maximum Output (10-dB Overload)	−6 dB TLP
Nominal Impedance	600 ohms
Return Loss (ERL)	30 dB minimum
Longitudinal Balance	
250 to 3000 Hz	
IEEE STD 455-1976	85 dB typical, 60 dB minimum
Harmonic Distortion	
at −26 dBm Output	50 dB minimum (second harmonic) 60 dB minimum (third harmonic)
SF Tone Levels	
High	24 ±1.1 dBm
Low	36 ±1 dBm
Off	86 dBm maximum
Equipment Transmit Port	
Nominal Impedance	900 ohms + 2.15 μF
Return Loss	
ERL	35 dB minimum
SRL	30 dB minimum
SRL-HI	30 dB minimum
Longitudinal Balance	
250 to 3000 Hz, 40 mA dc	
IEEE STD 455-1976	60 dB minimum
Harmonic Distortion	
3 dBm at Line Receive	50 dB minimum (second harmonic) 60 dB minimum (third harmonic) 49 dB typical THD
Port-to-Port Transmission	
Insertion Loss 600:600 ohm with 0 dB Attenuator Settings	
1 kHz	4.2 ±0.4 dB (Ref)
1 kHz (Transmit Cut)	Ref + 69 dB minimum
200 Hz	Ref + 0.75 ±0.4 dB
2600 Hz (Receive Filter In)	Ref + 40 dB minimum
2600 Hz	Ref ±0.3 dB
3000 Hz	Ref ±0.3 dB
Delay Distortion (Typical)	
500 to 3000 Hz	180 μs
500	182
700	85
1000	38
1500	14
2500	2
3000	0
Transhybrid Loss at 1 kHz Line Receive to Line Transmit with 0 Attenuator Settings and Equipment Transmit Terminated in 900 ohms + 2.15 μF	47 dB minimum
Level Setting Attenuators	
Range	0 to 16.5 dB
Steps	0.1 dB
Accuracy (16.5 dB)	±0.1 dB

receive voice path. The electronic cut must be carefully controlled to minimize the thump; however, it may still be heard by persons using the facility.

7.25 Cut circuits within the signaling units used to improve signaling margins are used to cut and terminate the transmitting transmission path when both ends are on-hook for all units and also momentarily after any change in signaling state in E-type units and after most changes in F- and G-type units. The duration of this cut must be considered when tones are sent from the switching equipment after a change in signaling state.

7.26 The E-, F-, and G-type signaling units do not have identical cut time, but the following is a typical example of the transmission cut timing in an F-type sender dial pulse or MF pulse unit. The F-type unit has the transmitting path continuously cut when both ends are on-hook; when the near end goes off-hook, the transmitting path at the near end is reestablished in 80 to 160 milliseconds. At the far end, the transmitting transmission path is reestablished in 560 to 860 milliseconds. If the far end goes off-hook during this interval, the cut timing is changed to the shorter 80- to 160-millisecond interval.

7.27 If both ends are off-hook and the near end goes on-hook, the transmitting transmission path is cut and then reestablished in 560 to 860 milliseconds. Most E-type and all F-type units have the transmit path cut feature. Audible tone with flash cannot be sent through SF signaling systems. The flash will be reproduced but the tone will either be shortened or eliminated in F- or G-type signaling. In E-type signaling, tone and flash are mutually interfering. Flashing signals are no longer used. (See paragraph 2.53.)

7.28 Standard MF pulsing is not affected by these cuts because the signaling delay of the SF system plus the time required to attach a register is in excess of the cut timing.

D. Signaling Delay

7.29 The signaling delay through an SF system consists of the delay from the change of state of the dc input to application or removal of signaling tone, the transit time of the transmission facility, and the response time of the distant unit to presence or absence of tone.

7.30 The transmission delay is the 1-way delay of the transmission facilities between two network locations. This delay applies to either a forward or return signal. It depends on the transmission facility types, their lengths, and any multiplexing delays. Average delays are about 1.17 milliseconds per pair of A channel banks, 0.0062 millisecond per route mile of carrier facility (which includes cross-connections but excludes channel banks), and 0.082 millisecond per route mile of voice-frequency facility. This type delay is very short compared with other system delays. For an extreme case of 3000 carrier miles, three pairs of channel banks and 15 loop miles at each end, the total transmission delay is about 25 milliseconds. The transmission facility delays of most trunks are much less than this.

7.31 Digital transmission facilities also have associated 1-way transmission delays as follows:

(a) A pair of D channel banks have a delay of ____milliseconds.

(b) The T Carrier line has a delay of ____milliseconds (including repeaters) per mile.

(c) The No. 4 ESS has a 1-way transmission delay of ____milliseconds.

(d) The echo suppressor terminal associated with the No. 4 ESS has a 1-way transmission delay of ____milliseconds.

7.32 With F-type E&M lead units, for senderized dial pulsing (ie, without built-in pulse correction) or for MF pulsing only, the delay from on-hook to off-hook is 13 to 21 milliseconds from the time the M lead is changed from ground to battery until signaling tone is removed plus the transit time of the facility plus 48 to 54 milliseconds for recognition of tone removal and grounding the E lead (a total of 61 to 75 milliseconds plus transit time).

7.33 With F-type E&M lead units without built-in pulse correction that are suitable for senderized dial pulsing, the delay from off-hook to on-hook is 13 to 21 milliseconds from the time the M lead is changed from battery to ground until tone is transmitted plus the transit time of the facility plus 48 to 52 milliseconds for recognition of tone presence and removal of ground from the E lead (a total of 61 to 73 milliseconds plus transit time).

7.34 The delay times for E-, F-, and G-type signaling, including those in paragraphs 7.32 and 7.33, are shown in Table K.

TABLE K

SIGNAL DELAY (IN MILLISECONDS) FOR SF SIGNALING

				DISCONNECT	
	SEIZURE	START-DIAL	DELAY-DIAL OR ANSWER	ORIGINATING TO TERMINATING	TERMINATING TO ORIGINATING
I. E-Type:					
A. E&M Lead:					
(1) Sender Operation:					
Minimum	26	59	41	44	
Maximum.	78	99	96	99	
(2) Pulse Correction:					
Minimum	35	68	50	43	
Maximum.	94	114	111	114	
B. Loop-Pulse Correction:					
Minimum					
Maximum.					
II. F-Type:					
A. E&M Lead:					
(1) MF Only:					
Minimum	46				47
Maximum.	51				53
(2) Sender Operation:					
Minimum	61				48
Maximum.	75				73
(3) Sender Type Unit With Pulse Corrector:					
Minimum	70				57
Maximum.	90				87
(4) Pulse Correction:					
Minimum	59				50
Maximum.	76				58
B. Loop-Pulse Correction:					
Minimum	50				61
Maximum.	73				83
C. E&M to Loop or Loop to E&M:					
Minimum	60				47
Maximum.	90				87
III. G-Type:					
A. E&M Lead Pulse Correction:					
Minimum					
Maximum.					
B. Loop-Pulse Correction:					
Minimum					
Maximum					
Typical.	74			119	62

E. No Charge Calls

7.35 On calls for which no charges are made (where the called end does not return an off-hook signal), such as business office, repair, or service calls, the tone in the backward direction is not removed but a band elimination filter prevents the tone from reaching the calling customer. On transmission systems equipped with compandors, the presence of the backward-going tone may reduce the compandor crosstalk and noise advantage. A somewhat similar increase in noise may occur in digital carrier systems though for other reasons. An important reason for removing the frequency selectivity along with guard sensitivity is the necessity for talking to intercept operators or hearing recorded announcements under tone-on conditions. In addition, the band elimination filter, which is inserted under any on-hook condition, prevents the tone from interfering with voice transmission.

F. Continuous Tones

7.36 Continuous tones can interfere with the proper operation of SF signaling. It is obvious that pure tones near 2600 Hz will cause the far-end (receiving) unit to go on-hook. It is also true that continuous tones that are not 2600 Hz will act as guard signals and keep the signaling units off-hook even though 2600 Hz is also present. Continuous tones can also hold a unit on-hook after the 2600-Hz signaling tone is removed.

7.37 Most signaling units have the cut circuits, described in paragraphs 7.23 through 7.27, that permit use with continuous tones. However, some intertoll and many toll connecting units do not have these cut circuits. As a result, provision must be made to interrupt tone sources on a periodic basis or when supervisory state is changed. The 102 test line, for instance, would not give accurate results if the test tone and off-hook were applied at the same time because the tone would hold some SF units on-hook and keep the 2600-Hz filter in the circuit. For this reason, the tone on the 102 test line should be applied 300 milliseconds after the off-hook for proper operation.

OUT-OF-BAND SIGNALING

7.38 Certain N, O, and ON carrier channels have built-in signaling capabilities. These employ 3700 Hz as the signaling frequency which modulates the channel or twin-channel carrier frequency associated with the voice channel for which it signals. During the trunk-idle condition, the 3700-Hz tone is present in both directions of transmission and supervisory signals are transmitted by interrupting the tone in a manner similar to that already described for E-, F-, and G-type signaling systems in paragraph 7.08. Since the signaling frequency is outside the voiceband, no provision is required for protection against voice operation. In addition, compandors are not affected by the tone and signaling, if required, during the talking condition.

7.39 Speech and signaling frequencies are separated by filters. A time delay feature is provided in the signal detector circuit to minimize registration of false pulses of short duration due to noise bursts and hits on the line. Means are provided to disconnect called customers, in the event of a carrier failure, to prevent their being held out of service. In addition, after 10 seconds, the trunks using the carrier facilities are made busy to prevent lost calls.

7.40 The 3700-Hz signaling system referred to above is normally modulated from direct current to tone and demodulated from 3700 Hz to direct current at the same points where speech modems are located. In some cases, however, carrier channels are connected in tandem. If these channels have conventional channel units, the associated two signaling sections have to be connected in tandem on a dc basis. To avoid this, "through channel units" should be used at such intermediate points. These units provide demodulation and modulation of the speech channel and the 3700-Hz signaling tone together and, instead of recovering the dc signals, the 3700-Hz tone is connected through to the following carrier system on an ac basis.

7.41 The channel units of time division multiplex transmission systems using PCM (T Carrier Transmission Systems with D channel banks) have built-in signaling functions and employ out-of-band signaling. (The eighth bit of the time slots assigned to a channel and normally used for the transmission of speech is used for indicating the on-hook state during a signaling sequence in a manner analogous to the transmission of 2600-Hz tone representing the on-hook state in inband signaling. The eighth bit may be used exclusively for signaling or only every sixth frame depending on the type of channel bank.) The channel units contain the circuitry for making the necessary conversions between the digital signal on the transmission line and the form of dc signal (loop, E/M, ring, etc) required by the terminating and/or switching equipment. In respect to signaling features, D channel bank units resemble SF signaling units. However, the signal delay and signaling distortion of the D channel banks are more like CX or DX signaling than SF. The signaling delay is shown in Table L. Signaling distortion is never larger than ±5 milliseconds. The signaling range is 9 to 12 PPS at 10 to 90 percent BK.

TABLE L

END-TO-END SIGNALING DELAY TIMES FOR T CARRIER

SIGNAL		CHANNEL BANK			
		D1	D2	D3	D4
Seizure	— E&M				
	— Loop				
Start-Dial	— E&M				
	— Loop				
Answer	— E&M				
	— Loop				
Disconnect	— E&M				
	— Loop				

Notes:

1. All times are given in milliseconds
2. Transit time of the facility is not included.

7.42 One of the problems with the signaling associated with D channel banks is the accuracy with which the system transmits pulses. Many metallic loop signaling circuits have momentary splits in the pulses. These are not always seen at the far end of the circuit because the characteristics of the metallic pair smooth out these signals. However, the signaling of the D channel bank does not provide this smoothing and the split pulse can arrive at the far office where it can cause wrong numbers or other problems.

MULTIFREQUENCY (MF) PULSING

7.43 The MF pulsing system consists of transmitting and receiving equipment for transferring valid number information over telephone trunks by various combinations of two, and only two, of five frequencies in the voiceband. Each combination of two frequencies represents a pulse and each pulse represents a digit. The pulses are sent over the regular talking channels and, since they are in the voice range, are transmitted as readily as speech. MF receivers detect the pulses and transfer the digital information to control equipment which establishes connections through the switches. MF pulsing is also used to transmit calling number information in CAMA-ANI operation. In this case, the calling number is MF pulsed forward from the originating office to the CAMA office following the forwarding of the called number whether the called number is transmitted by MF or dial pulsing.

7.44 The MF system transmits only numerical information; hence, another signaling system (eg, DX, SF, or loop) must be provided for supervision. Additional signals for control functions are provided by combinations using a sixth frequency. The six frequencies are spaced 200 Hz apart. These six frequencies provide 15 possible 2-frequency combinations. Ten combinations are used for the digits 0 to 9 inclusive and one each for signals indicating the beginning (KP) and end (ST) of pulsing. The remaining three combinations are used for special signals. Figure 35 shows the digits or other usages, the associated frequencies, and the explanation for the 6-tone MF keypulsing code.

7.45 The principal advantages of MF pulsing are speed, accuracy, and range. Keysets are faster than switchboard dials and, similarly, MF senders transmit more rapidly than dial pulse senders. Consequently, MF signaling requires less holding time per call and, as a result, a relatively small number of MF senders or registers can be used as common equipment for a large number of trunks.

FREQUENCIES IN HZ	SIGNALS			
	DIGIT AND CONTROL	EXPANDED INBAND	CCITT SYSTEM 5	TSPS
700 + 900	1			
700 + 1100	2	Coin Collect		
700 + 1300	4			
700 + 1500	7			
700 + 1700		Ringback	Code 11	ST3P
900 + 1100	3			
900 + 1300	5			
900 + 1500	8	Operator Released		
900 + 1700			Code 12	STP
1100 + 1300	6			
1100 + 1500	9			
1100 + 1700	KP	Coin Return	KP1	
1300 + 1500	0	Operator Attached		
1300 + 1700			KP2	ST2P
1500 + 1700	ST	Coin Collect Operator Released		

Fig. 35—Multifrequency Codes

7.46 A typical plan of MF pulsing from a switchboard position to a crossbar office is shown in Fig. 36. In such an arrangement, MF pulses are generated by an operator using a keyset usually keying about two digits per second. In completing a call, the operator first connects the calling cord to the outgoing trunk. By depressing the front KP button, the cord connection is split and the front cord is transferred from the operator's telephone set to the keyset, the KP lamp is lighted, and the keyset circuit is prepared to send the KP signal over the trunk when the distant end signals to start pulsing. Connecting the cord to the trunk gives a connect signal to the distant end which returns off-hook supervision to delay pulsing until a sender or register is attached. When a sender has been found and the pulsing path completed to an idle receiver, the supervision changes to on-hook as a start-pulsing signal. The KP signal is then sent automatically and the positional S (sender) lamp lights.

7.47 With some switchboards, the KP signal is not sent automatically and the KP key, therefore, is not operated until the sender lamp lights. At the distant end, the KP signal prepares the MF receiver for pulses. The operator now presses a button corresponding to each digit and then the ST key to indicate the end of pulsing. Besides informing the distant sender that no more pulses are to be expected, operating the ST key disconnects the keyset from the cord, reconnects the telephone set under control of the TALK key, restores the connection between the cord pair, and extinguishes the KP and S lamps.

7.48 MF pulses are also transmitted by senders. The senders receive numbers from customers or from operators or other senders by MF pulsing, TOUCH-TONE pulsing, or dial pulsing and transmit these numbers as MF pulses. MF senders in electromechanical switching systems, in general, are required to outpulse with pulses and interdigital periods of 68 ±7 milliseconds each (a rate of approximately seven digits per second). This rate is increased to 10 PPS for intercontinental dialing using CCITT Signaling System No. 5. The No. 1/1A ESS MF senders are arranged to outpulse with pulses and interdigital periods of 60 ±0.5 milliseconds each (a rate of approximately 8.3 digits per second). The present Bell System requirements for MF pulsing are 58 to 75 milliseconds for pulses and interdigital intervals. Other MF sender pulse and interdigital intervals are as follows:

- No. 2/2B ESS, Pulses and interdigital intervals are 75 milliseconds (50-millisecond pulses and interdigital intervals are an option).
- No. 3 ESS, Pulses and interdigital intervals are 70 milliseconds (50-millisecond pulses and interdigital intervals are an option).
- No. 4 ESS.

7.49 The receiver is connected to a trunk as part of a sender or register as required. It does not respond to voice-frequency currents until it receives the KP signal. The unit then can receive and pass on the number codes and the ST signal to its associated sender or other connected equipment. Figure 37 shows the major components of an early receiver design used in electromechanical offices including an input circuit, a volume-limiting amplifier, a biasing circuit, a signal present and unlocking circuit, and the receiving channel circuits.

7.50 A check circuit in the receiver verifies that two, and only two, channel relays operate for each digit. If more or less than two channel relays are operated, a reorder signal is returned. There are also situations where the operator keys MF pulses to senders which, in turn, transmit dial pulses to step-by-step equipment. This permits operators at positions equipped for MF pulsing to establish calls through step-by-step as well as crossbar equipment.

7.51 The normal power output of MF transmitters presently used in toll switchboards, testboards, test frames, and senders is -6 or -7 dBm per frequency at the zero transmission level point. The frequencies of the supply oscillators should be within ±1.5 percent of nominal. The older equipment transmits -6 dBm0 per frequency and the newer equipment transmits -7 dBm0 per frequency. The -7 dBm0 per frequency is the new Bell System standard. However, there are no plans to change the equipment using -6 dBm0 per frequency to the new standard level.

7.52 The MF tone leakage limit when no MF signals are being sent is -58 dBm0. When MF signals are sent, the total extraneous frequency components should be at least 30 dB below the level of either of the two signal frequencies when measured over a 3-kHz band.

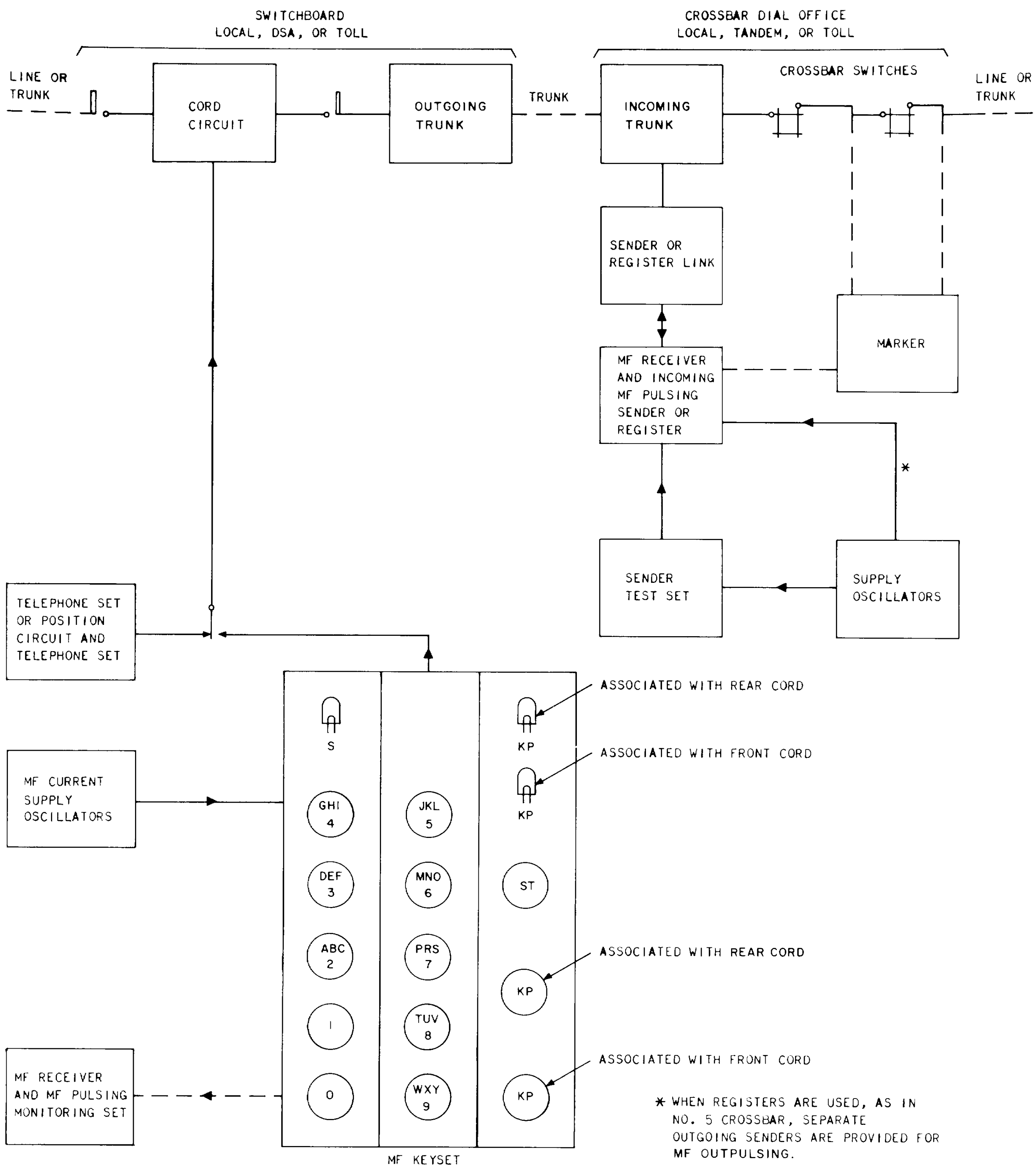


Fig. 36—MF Pulsing From a Switchboard to a Crossbar Central Office

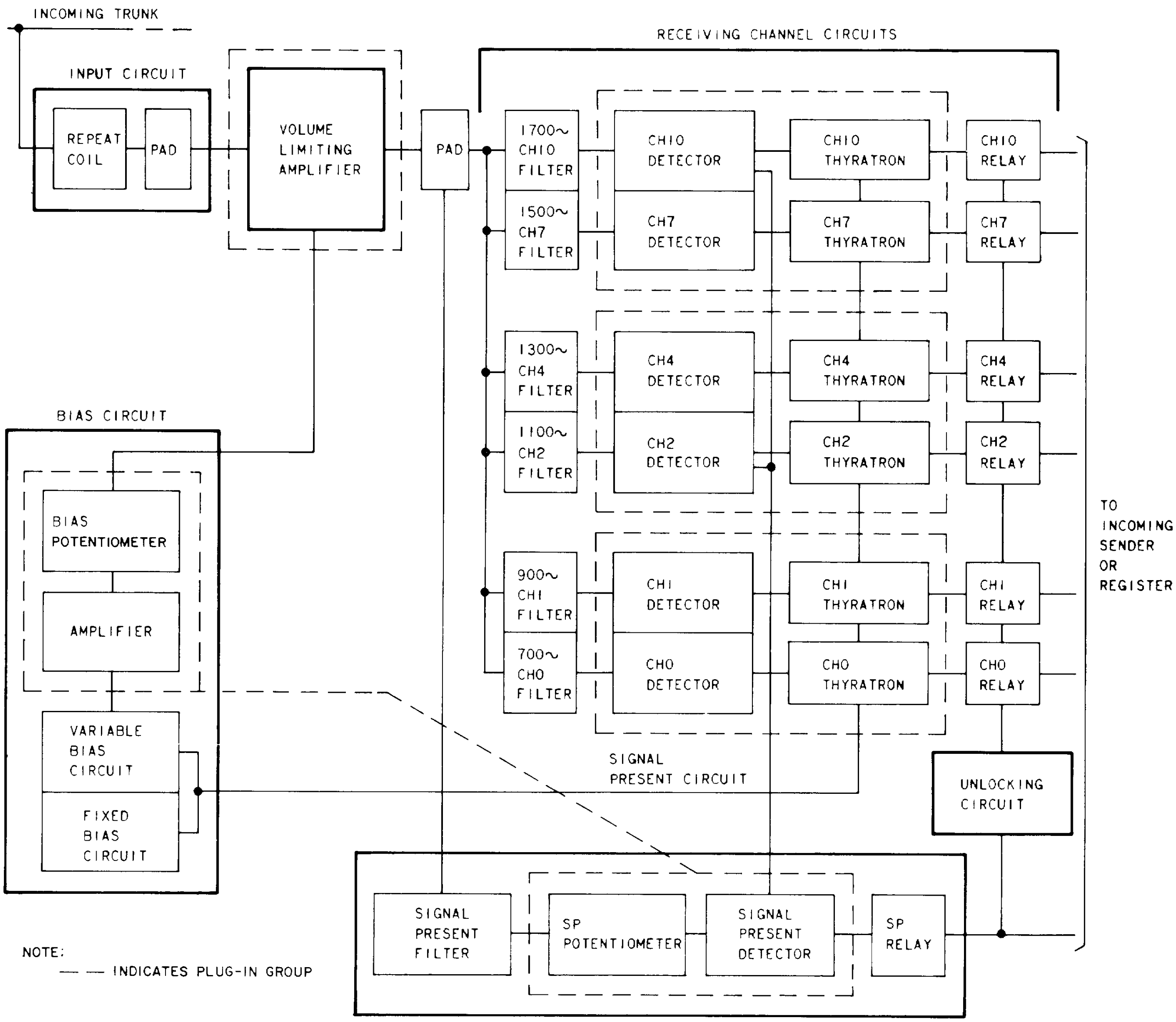


Fig. 37—MF Receiver Plan

7.53 The engineering limit for operating sensitivity of the MF receiver is -25 dBm per frequency for new receivers and -22 dBm per frequency for old receivers. These margins permit the use of MF pulsing on trunks having switch-to-switch losses of 14 dB including allowances for trunk variations, etc, when connected to switchboards, testboards, and senders. Little interference from crosstalk, noise, and echo on the line is encountered.

7.54 The receiver should be able to operate and release in the presence of message circuit noise of 63 dBrnC0 with compandored carrier systems and 50 dBrnC0 with noncompandored facilities. In addition, impulse noise at the receiver can be as high as 98 dBrnC0 with compandored carrier systems and 81 dBrnC0 with noncompandored facilities. The limits for impulse noise power represent levels which are not exceeded more than 15 times in 15 minutes.

7.55 To permit the use of MF pulsing by operators who may send a very short pulse or have a very short interdigital interval, the MF receiver will accept a minimum signal duration of 30 milliseconds and a minimum interdigital interval (no tone) of 25 milliseconds. (Both tones are transmitted simultaneously; however, either tone can be received alone for up to 4 milliseconds.) This does not imply, however, that the MF receiver would accept a series of pulses of 30 milliseconds tone and 25 milliseconds no tone.

7.56 In electromechanical offices, MF receivers are tested for slow pulsing at approximately two digits per second with 230-millisecond no-tone and 260-millisecond tone intervals. Fast pulsing is tested at ten digits per second with intervals of 35 milliseconds tone and 65 milliseconds no tone. This test is also made with the tone and no-tone intervals interchanged. Receivers are also tested for sensitivity range and for their ability to operate with maximum allowable slope in frequency transmission of 6.5 dB. Tests are also made at high input levels to check that false operation of a channel does not result from modulation products. In ESS offices, each MF receiver is tested with each MF transmitter through an environmental test circuit. The receiver is checked for sensitivity range, 6 dB of slope, false operation resulting from modulation products, timing (speed), and ability to detect operator double keying.

7.57 The KP signal duration is 90 to 120 milliseconds. The receivers are designed to accept a KP signal of 55 milliseconds minimum, but it is considered good practice for senders to outpulse KP signals near 120 milliseconds to provide margin against transmission impairments such as delay distortion and Time Assignment Speech Interpolation (TASI) clipping. The No. 1/1A ESS sends a 120 ±0.5-millisecond KP signal.

7.58 Under some conditions, the No. 4A crossbar switching machine sends a spurious initial KP signal before the normal KP signal when outpulsing on intertoll trunks. This spurious signal can be 0 to 70 milliseconds long but usually is less than 40 milliseconds long. The length of the normal KP signal is not affected by the spurious signal and remains 100 ±10 milliseconds long.

7.59 The generation of the spurious KP signal depends upon the interaction of the No. 4A crossbar office and the other office. Investigation indicates that ESSs that return a start-dial signal quickly will cause more spurious KP signals to be transmitted from the No. 4A crossbar machine than electromechanical systems that have a longer interval from seizure to the start-dial signal.

7.60 Other Bell System offices avoid call failures working with MF pulsing from a No. 4A crossbar office for one or more of the following reasons:

(a) The MF receiver used in the No. 1/1A, 2/2B, and 4 ESSs is fast enough to receive both KP signals but the software is designed to ignore multiple KP signals.

(b) In electromechanical offices with the older vacuum tube MF receiver, the receiver is too slow to receive a large majority of spurious KP signals. The MF receiver equipped with vacuum tubes was standard for all new installations in electromechanical offices until about 1973.

(c) With the new transistorized MF receiver, it is possible to receive both KP signals, but the delay inherent in electromechanical offices in returning a start-dial signal reduces the probability of producing a double KP signal to a very low value.

(d) The No. 3 ESS and AIS do not connect to intertoll trunks and, therefore, are not susceptible to the problem.

7.61 Bell System senders are so arranged that, under normal conditions, the two tones comprising an MF signal pulse are applied to the trunk simultaneously and neither tone is transmitted if either tone source should fail. MF signal receivers, however, will recognize an MF pulse as a valid signal if the two tones arrive within 4 milliseconds of each other.

7.62 Delay-dial/start-dial or wink-start signals are always required in connection with MF pulsing since MF signals are received on a common control basis by senders or registers. However, after pulsing has started, all digits are accepted without delay from the called end. For this reason, stop and go signals are not required after MF pulsing begins.

8. SPECIAL TOLL SIGNALING (CAMA, TSPS, AND IDDD)

SIGNALING TO CAMA AND TSP(S) OFFICES

8.01 Toll switching CAMA, TSP, and TSPS No. 1 offices provide the ability to record call details for customer billing. Toll switching CAMA offices handle noncoin direct-dialed calls; the TSPS is arranged to handle toll calls from noncoin and coin stations requiring operator assistance and can also operate as a CAMA office.

8.02 The CAMA equipment records the called number as it is pulsed from the local office. It also records the calling number as it is pulsed from the local office providing that it is equipped with ANI. If ANI equipment is not available at the local office, or if the calling customer is on a 4-party or multiparty line, or if there is an identification failure at the local office, an operator is temporarily connected to the call to record the calling number. This method of operation is called Operator Number Identification (ONI).

8.03 The primary information categories transmitted from a local office to a CAMA or TSPS are the called number and the calling number. The called number is sent on either an immediate-dial basis for dial pulse calls or on a wink-start basis for MF pulsing calls. On dial pulse calls, the CAMA or TSPS goes off-hook toward the local office after the end of dialing has been recognized by a suitable timing interval. On MF pulsing calls to electromechanical CAMA offices (No. 4 crossbar, crossbar tandem, or No. 5 crossbar), the CAMA office returns an off-hook signal to the local office when the signal present (SP) circuit in the MF receiver indicates that the start (ST) pulse is no longer being received. On MF pulsing calls to electronic CAMA (No. 1/1A or No. 4 ESS) or TSPS offices, the off-hook from the CAMA or TSPS office can be returned to the local office as soon as the ST pulse is recognized by the CAMA or TSPS. As a result, the off-hook can arrive at the class 5 office while the ST pulse is still being sent.* This off-hook indication signals the local office to start outpulsing the ANI information. There is no requirement for a delay between the receipt of the off-hook start-dial by the local central office and sending of the KP pulse of the ANI information. However, it is good practice to have a minimum delay of 50 milliseconds between these two signals to permit the transients associated with the off-hook start-dial signal to dissipate before the first MF pulse is sent. (See paragraph 3.28 for information on a similar situation with the on-hook start-dial signal used to send address information.) MF pulsing is always used to send the ANI information.

* In Bell System local offices, the senders do not recognize the return of an off-hook signal while the ST pulse is being sent because they are all blind to the supervisory state during and after the outpulsing of the ST pulse. For information concerning unexpected stops, see paragraphs 3.33 through 3.35.

8.04 The 1975 issue of ***Notes on Distance Dialing*** simply indicated that the CAMA or TSPS went off-hook toward the local office when the called number was received.

8.05 The pulsing requirements between the CAMA or TSPS office and the local and distant offices for the called and calling number are the same as the requirements for normal pulsing on the network. (See paragraphs 7.43 through 7.62 and Part 4.) However, for the ANI case, the signaling formats are somewhat different than in network pulsing. The signaling formats for the called and calling numbers are covered in paragraphs 8.15 and 8.17.

8.06 On ONI calls, the CAMA or TSPS incoming trunk goes off-hook toward the local office, in the same manner as described in paragraph 8.03, after the called number has been received. This off-hook signal indicates to the local originating office that the call is being processed satisfactorily. Once the trunk has gone off-hook for either an ANI or ONI call, it will remain off-hook for the rest of the call except for wink signals associated with coin control and rering.

8.07 The trunk may be forced off-hook toward the local office for maintenance reasons. This off-hook should make the local office trunk busy. This feature is known as reverse make-busy. There is no guarantee, however, that the local office will always receive an off-hook on every call to CAMA or TSPS. Certain calling sequences, such as permanent signal, partial dial, or vacant code, may not result in an off-hook toward the local office.

SIGNALING TO CAMA

8.08 The following Bell System switching machines may be arranged as CAMA serving offices:

- Step-by-step intertoll
- No. 5 crossbar
- No. 1/1A ESS
- Crossbar tandem
- No. 4A/4M crossbar
- No. 4 ESS
- TSPS.

8.09 CAMA offices have three different called number outpulsing formats. These differences are important because they impose different permanent signal and partial dial timing requirements on the connected switching systems. The CAMA systems do not always outpulse all the called number digits at one time. Outpulsing can start:

(a) As soon as sufficient digits are available to advance the call toward its destination,

(b) When the first digit of the calling number is received, or

(c) When all digits of the calling number are received.

However, the last digit of the called number is not outpulsed until the complete calling number is received. This action is known as digital dragging. Digital dragging causes a nonuniform cadence of pulses at the receiving office. As a result, the receiving office may interpret a pause in pulsing caused by digital dragging as a permanent signal or partial dial. The effects of digital dragging can be experienced in offices not directly connected to a CAMA office where step-by-step toll offices and overlap outpulsing in crossbar tandem or No. 4 crossbar are involved.

> ***Note:*** Overlap outpulsing is a method of outpulsing developed to minimize post dialing delay. With overlap outpulsing, the call is advanced toward its destination as soon as sufficient address information is available. Once a call is advanced, each succeeding digit is sent forward as soon as it is received. Thus, with overlap outpulsing, the timing of the pulses from the CAMA office can be maintained to the local central office serving the called line.

8.10 The CAMA outpulsing formats are as follows:

(a) Crossbar tandem immediate-start (dial pulse) begins outpulsing as soon as the call can be advanced toward its destination. All but the units digit of the called number can be outpulsed before the calling number is recorded.

(b) Crossbar tandem nonimmediate-start (MF or dial pulse) does not begin outpulsing until the first digit of the calling number is received. This same format is also used for calls from step-by-step (CAMA), No. 4A crossbar, No. 5 crossbar, No. 1/1A ESS, or TSPS (CAMA) using immediate-start or nonimmediate-start outpulsing.

(c) The No. 4 ESS does not outpulse the called number until the complete calling number is recorded for either immediate-start or nonimmediate-start outpulsing.

The CAMA ANI pulsing format is shown in Fig. 38.

TYPE OF CALL	CALLED NUMBER	CALLING NUMBER
Immediate-Dial (DP)	7 or 10 digits	KP — I — 7 digits — ST
Controlled Outpulsing (MF)	KP — 7 or 10 digits — ST	KP — I — 7 digits — ST

The information digit "I" has the following meanings:

	INFORMATION DIGITS	
	NONOBSERVED	OBSERVED
Automatic Identification (AI)	0	3
Operator Identification (OI)	1	4
Identification Failure (IF)	2	5

AI — Automatic Identification of the calling number has been done in the originating office; the 7-digit calling number (NNX XXXX) will follow.

OI — The calling number cannot be identified by the originating office because it is a multiparty line; Operator Identification of the calling number is required.

IF — An Identification Failure has occurred in the originating office; operator identification of the calling number is required.

Note: The above-mentioned procedure is the preferred method; but on OI and IF calls, the ST is optional.

Fig. 38—CAMA ANI Pulsing Format (Non-TSPS CAMA Office)

8.11 The recommended local or toll permanent signal and partial dial timing on trunks for new Bell System switching system designs are as follows:

	TIMING IN SECONDS	
	IMMEDIATE-START	NONIMMEDIATE-START
Permanent signal or partial dial timing	16 to 24	5 to 10
Overall timing	20 to 30	20 to 30

When crossbar tandem is no longer used in the network, the immediate-start recommendation could be reconsidered and possibly dropped.

8.12 The following shows the time intervals from request for ANI until the call is offered to an operator:

SYSTEM	SECONDS
Step-by-Step	5.0 to 9.0
No. 5 crossbar	4.4 to 8.4
No. 1/1A ESS	1.0 to 8.0
No. 2/2B ESS	Not available
No. 3 ESS	Not available
Crossbar tandem	7.5 to 10.0
No. 4A/4M crossbar	6.8 to 9.5
TSPS	12.0 to 18.0
No. 4 ESS	5.0

Note: With the exception of crossbar tandem, these times do not affect the permanent signal and partial dial timing in succeeding offices.

8.13 The operators who perform the ONI function can be CAMA or TSPS operators. When TSPS operators perform the ONI function for a separate CAMA office, the arrangement is known as CAMA transfer. With this arrangement, two voice-frequency circuits are required between the CAMA office and the TSPS: (1) the "talking path" over which call-defining zip tones are received from the CAMA office and over which the operator can converse with the customer, and (2) the "keypulse path" over which MF calling number signals are returned to the CAMA office as keyed by the operator. Table M indicates the exchange sequence of supervisory signals passed over these circuits between the CAMA office and the TSPS for loop and E&M signaling. The following will explain the various conditions for each sequence:

(a) ***Out-of-Service:*** The TSPS is not prepared to accept traffic from the CAMA office and will ignore seizure from the CAMA office. The CAMA office should recognize this state and not request service.

(b) ***Position Occupied:*** The TSPS is prepared to receive traffic from the CAMA office.

(c) ***Position Seizure:*** The CAMA office requests service from the TSPS.

(d) ***Position Busy:*** After a 700- to 900-millisecond delay, the TSPS reacts to the seizure of the CAMA office. This signals the CAMA office to send the call identity signals.

(e) ***Call Identity Signals:*** A 1- or 2-pulse order tone signal is sent by the CAMA office indicating whether the calling number is required as the result of an ANI failure or for a call that is normally operator identified (ONI).

(f) ***Sender Attached:*** A sender-attached signal is sent by the CAMA office to indicate that it is prepared to receive MF calling number signals.

(g) ***Position Attached:*** A position-attached signal is sent by the TSPS to indicate when an operator is actually attached to the trunk and ready to serve the customer. Position attached may occur before sender attached when a TSPS is lightly loaded. The CAMA office should be insensitive to this sequence.

(h) ***MF Calling Number Signals:*** MF tones are sent to the CAMA office identifying the calling number.

(i) ***Reorder:*** If the CAMA office cannot recognize the calling number signals as meaningful, it will send a reorder signal. The operator will recognize this signal and key the reset signal (in TSPS, KP BACK is keyed) which should prepare the CAMA office to receive the calling number again. The operator will key the calling number again. Should the number remain unacceptable to the CAMA office, the reorder signal will again be sent to the TSPS. When the operator decides that continuing the process will not salvage the call, the operator will cause the position disconnect signal to be sent to the CAMA office.

(j) ***CAMA Release:*** If the calling number is acceptable to the CAMA office, it sends the release signal to the TSPS.

(k) ***TSPS Release:*** The TSPS will respond to the CAMA release by returning to the position occupied condition.

(l) ***Position Disconnect:*** At any point in the signaling sequence, the TSPS can terminate the call by sending the position disconnect signal. The CAMA office will respond with CAMA release.

TABLE M

SUPERVISORY SIGNAL EXCHANGE SEQUENCE

SEQUENCE STATE	SYSTEM	SIGNAL	LOOP SIGNALING				E&M SIGNALING			
			TSPS		CAMA		TSPS		CAMA	
			TALK	KP	TALK	KP	TALK	KP	TALK	KP
a	TSPS	Out Of Service	On-Hook	On-Hook	X	X	On-Hook	Off-Hook	X	X
a	CAMA	Not Requesting Service	X	X	On-Hook	On-Hook	X	X	On-Hook	On-Hook
b	TSPS	Position Occupied	On-Hook	Off-Hook	On-Hook	On-Hook	On-Hook	On-Hook	On-Hook	On-Hook
c	CAMA	Position Seizure	On-Hook	Off-Hook	On-Hook	Off-Hook	On-Hook	On-Hook	Off-Hook	On-Hook
d	TSPS	Position Busy	On-Hook	On-Hook	On-Hook	Off-Hook	On-Hook	Off-Hook	Off-Hook	On-Hook
e	CAMA	Call Identity Signals	–	–	(Zip Tones*)	–	–	–	(Zip Tones*)	–
f	CAMA	Sender Attached	On-Hook	On-Hook	Off-Hook	Off-Hook	On-Hook	Off-Hook	Off-Hook	Off-Hook
g	TSPS	Position Attached	Off-Hook	On-Hook	Off-Hook	Off-Hook	Off-Hook	Off-Hook	Off-Hook	Off-Hook
h	TSPS	MF Calling Number Signals	–	(MF Signals)	–	–	–	(MF Signals)	–	–
i	CAMA	Reorder (Or)	Off-Hook	On-Hook	On-Hook	Off-Hook	Off-Hook	Off-Hook	Off-Hook	On-Hook
i	TSPS	Reset	–	(Reset Tone†)	–	–	–	(Reset Tone†)	–	–
j	CAMA	CAMA Release	Off-Hook	On-Hook	On-Hook	On-Hook	Off-Hook	Off-Hook	On-Hook	On-Hook
k	TSPS	TSPS Release	On-Hook	Off-Hook	On-Hook	On-Hook	On-Hook	On-Hook	On-Hook	On-Hook
l	TSPS	Position Disconnect	Off-Hook (100 ms.) On-Hook	–	–	–	Off-Hook (100 ms.) On-Hook	–	–	–

* Call Identity Signal (Zip Tones):

Timing –ANI Failure 0.420 To 1.380 Second Tone

–ONI (2 Tones) 0.050 To 0.175 Second Tone
0.050 To 0.175 Second Silence
0.050 To 0.175 Second Tone

Tone
Frequency – 480Hz
Level – TSPS Expects A Minimum Of
0.062 Volt RMS (–24dBm, 900Ω Bridging)

† Reset Tone: 700 And 1700 Hz.

Note: E&M Signaling
Off-Hook = Battery On M Lead
On-Hook = Ground On M Lead

TSPS TRUNKING PLANS AND OUTPULSING FORMATS

8.14 When interfacing with end offices, the TSPS can have a variety of trunking plans and outpulsing formats as discussed in the following paragraph. However, what the customer is required to dial for the types of calls is not influenced by the trunking plan or outpulsing format used by the local central office. When it is desired to reach an operator (0 call), 0 is dialed. When special toll handling is desired (eg, collect, person-to-person, credit card, etc [0+ call]), 0 followed by the called number is dialed. The 0 and 0+ calls use the same ST pulse for identification. As a result, other means have to be used to separate these two categories of calls. In dial pulsing calls, a dialing pause of over 4 seconds after dialing 0 is considered a 0 call*. In MF pulsing calls, KP followed by a start signal of STP or ST3P, depending on the trunking arrangement but with no called number, is outpulsed to identify a 0 call.

*A complete digit must be received within 4 seconds for the call to be considered 0+; thus the customer has less than 4 seconds to dial the next digit.

8.15 The TSPS can have a variety of trunking plans as follows:

(a) Combine all coin and noncoin traffic on one supercombined trunk group. The pulsing format for this arrangement with ANI is shown in Table N.

(b) Combine all coin traffic on one trunk group and all noncoin traffic on a second trunk group. The pulsing format for this arrangement with ANI is shown in Table O.

(c) Combine all 0-, 0+ coin traffic on one trunk group and all 0-, 0+ noncoin traffic on a second trunk group. The pulsing format for this arrangement with ANI is shown in Table P. The 1+ coin and 1+ noncoin traffic would be handled on two additional trunk groups as described below.

(d) Use six individual trunk groups for 0-, 0+, 1+ coin and 0-, 0+, 1+ noncoin traffic. The pulsing format for this arrangement with ANI is shown in Table Q.

8.16 In each of the previously discussed cases where more than one type of traffic is carried on a single trunk group, each type of call is identified by distinctive MF start (ST) digits or information (I) digits transmitted from the local central office with the called and/or calling number. For dial pulsing calls, the identifying ST pulse is associated with the ANI information. For MF pulsing calls, the identifying ST pulse is associated with the address information. For both MF and dial pulsing calls, the information digit is associated with the ANI information. To separate traffic, a different information digit is used with each call to indicate whether or not it has been subject to local service observing and also whether it was processed by automatic identification, operator identification, or identification failure procedures. Tables N, O, P, and Q show this information.

8.17 Because the identifying ST pulse is associated with the called number, each of the above MF pulsing formats can be used without ANI from the class 5 office. The only usable situation under which the dial pulsing format without ANI could be used is when an individual trunk group is used for each type of service. In addition, Hotel-Motel and other screened traffic ***cannot*** be handled at the TSPS office without ANI from the class 5 office with either MF or dial pulsing. The complete TSPS pulsing formats are as follows:

(a) ***Required TSPS Multifrequency Formats:***

(1) Seizure—No start-dial signal—No address digits—No ANI

(2) Seizure—No start-dial signal—No address digits—KP-I-7 digits-ST†

(3) Seizure—No start-dial signal—No address digits—KP-I-7 digits-ST

(4) KP-ST†—No ANI

(5) KP-ST—No ANI

(6) KP-STP—No ANI

(7) KP-ST3P—No ANI

(8) KP-7 or 10 digits-ST†—No ANI

TABLE N

PULSING FORMAT FOR TSPS FROM LOCAL OFFICE

SUPER COMBINED COIN AND NONCOIN TRUNK GROUP

MULTIFREQUENCY PULSING			
TYPE OF CALL	CUSTOMER DIALS	MF-PULSED CALLED NUMBER	ANI CALLING NUMBER
Noncoin			
Direct Dialed	1* + 7 or 10 digits	KP — 7 or 10 digits — ST2P	KP — I — 7 digits — ST
Operator Assistance	0 (zero)	KP — ST3P	KP — I — 7 digits — ST
Special Toll	0 + 7 or 10 digits	KP — 7 or 10 digits — ST3P	KP — I — 7 digits — ST
Coin			
Direct Dialed	1* + 7 or 10 digits	KP — 7 or 10 digits — ST	KP — I — 7 digits — ST
Operator Assistance	0 (zero)	KP — STP	KP — I — 7 digits — ST
Special Toll	0 + 7 or 10 digits	KP — 7 or 10 digits — STP	KP — I — 7 digits — ST

DIAL PULSING			
TYPE OF CALL	CUSTOMER DIALS	DIAL-PULSED CALLED NUMBER	ANI CALLING NUMBER
Noncoin			
Direct Dialed	1* + 7 or 10 digits	7 or 10 digits	KP — I — 7 digits — ST2P
Operator Assistance	0 (zero)	Seizure — No digits	KP — I — 7 digits — ST3P
Special Toll	0 + 7 or 10 digits	7 or 10 digits	KP — I — 7 digits — ST3P
Coin			
Direct Dialed	1* + 7 or 10 digits	7 or 10 digits	KP — I — 7 digits — ST
Operator Assistance	0 (zero)	Seizure — No digits	KP — I — 7 digits — STP
Special Toll	0 + 7 or 10 digits	7 or 10 digits	KP — I — 7 digits — STP

Note: Information digit I has the following meaning:

	NONOBSERVED	OBSERVED
Automatic Identification (AI)	0	3
Operator Identification (OI)	1	4
Identification Failure (IF)	2	5
Hotel-Motel — without room number identification	6	6
Special Screening (eg, Charge-a-Call)	7	7
High Capacity Mobile (AMPs)	8	8
Hotel-Motel — with room number identification	91	91

* The prefix 1 may be used as an optional access digit.

TABLE O

PULSING FORMAT FOR TSPS FROM LOCAL OFFICE

COMBINED COIN OR COMBINED NONCOIN TRUNK GROUP

MULTIFREQUENCY PULSING			
TYPE OF CALL	CUSTOMER DIALS	MF-PULSED CALLED NUMBER	ANI CALLING NUMBER
Direct Dialed	1* + 7 or 10 digits	KP — 7 or 10 digits — ST	KP — I — 7 digits — ST
Operator Assistance	0 (zero)	KP — STP	KP — I — 7 digits — ST
Special Toll	0 + 7 or 10 digits	KP — 7 or 10 digits — STP	KP — I — 7 digits — ST

DIAL PULSING			
TYPE OF CALL	CUSTOMER DIALS	DIAL-PULSED CALLED NUMBER	ANI CALLING NUMBER
Direct Dialed	1* + 7 or 10 digits	7 or 10 digits	KP — I — 7 digits — ST
Operator Assistance	0 (zero)	Seizure — No digits	KP — I — 7 digits — STP
Special Toll	0 + 7 or 10 digits	7 or 10 digits	KP — I — 7 digits — STP

Note: Information digit I has the following meaning:

	NONOBSERVED	OBSERVED
Automatic Identification (AI)	0	3
Operator Identification (OI)	1	4
Identification Failure (IF)	2	5
Hotel-Motel — without room number identification	6	6
Special Screening (eg, Charge-a-Call)	7	7
High Capacity Mobile (AMPs)	8	8
Hotel-Motel — with room number identification	91	91

* The prefix 1 may be used as an optional access digit.

TABLE P

PULSING FORMAT FOR TSPS FROM LOCAL OFFICE

COMBINED 0-, 0+ COIN OR COMBINED 0-, 0+ NONCOIN TRUNK GROUP

MULTIFREQUENCY PULSING			
TYPE OF CALL	CUSTOMER DIALS	MF-PULSED CALLED NUMBER	ANI CALLING NUMBER
Operator Assistance	0 (zero)	KP — ST†	KP — I — 7 digits — ST
Special Toll	0 + 7 or 10 digits	KP — 7 or 10 digits — ST†	KP — I — 7 digits — ST

DIAL PULSING			
TYPE OF CALL	CUSTOMER DIALS	DIAL-PULSED CALLED NUMBER	ANI CALLING NUMBER
Operator Assistance	0 (zero)	Seizure — No digits	KP — I — 7 digits — ST†
Special Toll	0 + 7 or 10 digits	7 or 10 digits	KP — I — 7 digits — ST†

Note: Information digit I has the following meaning:

	NONOBSERVED	OBSERVED
Automatic Identification (AI)	0	3
Operator Identification (OI)	1	4
Identification Failure (IF)	2	5
Hotel-Motel — without room number identification	6	6
Special Screening (eg, Charge-a-Call)	7	7
High Capacity Mobile (AMPs)	8	8
Hotel-Motel — with room number identification	91	91

ST† indicates that any of the usable ST signals will be accepted.

TABLE Q

PULSING FORMAT FOR TSPS FROM LOCAL OFFICE

INDIVIDUAL 0–, 0+, 1+ COIN OR INDIVIDUAL 0–, 0+, 1+ NONCOIN TRUNK GROUPS

MULTIFREQUENCY PULSING			
TYPE OF CALL	CUSTOMER DIALS	MF-PULSED CALLED NUMBER	ANI CALLING NUMBER
Direct Dialed	1* + 7 or 10 digits	KP — 7 or 10 digits — ST†	KP — I — 7 digits — ST
Operator Assistance	0 (zero)	Seizure — No digits	KP — I — 7 digits — ST or ST†
Special Toll	0 + 7 or 10 digits	KP — 7 or 10 digits — ST†	KP — I — 7 digits — ST

DIAL PULSING			
TYPE OF CALL	CUSTOMER DIALS	DIAL-PULSED CALLED NUMBER	ANI CALLING NUMBER
Direct Dialed	1* + 7 or 10 digits	7 or 10 digits	KP — I — 7 digits — ST†
Operator Assistance	0 (zero)	Seizure — No digits	KP — I — 7 digits — ST†
Special Toll	0 + 7 or 10 digits	7 or 10 digits	KP — I — 7 digits — ST†

Note: Information digit I has the following meaning:

	NONOBSERVED	OBSERVED
Automatic Identification (AI)	0	3
Operator Identification (OI)	1	4
Identification Failure (IF)	2	5
Hotel-Motel — without room number identification	6	6
Special Screening (eg, Charge-a-Call)	7	7
High Capacity Mobile (AMPs)	8	8
Hotel-Motel — with room number identification	91	91

* The prefix 1 may be used as an optional access digit.

ST† indicates that any of the usable ST signals will be accepted.

(9) KP-7 or 10 digits-ST—No ANI

(10) KP-7 or 10 digits-STP—No ANI

(11) KP-7 or 10 digits-ST2P—No ANI

(12) KP-7 or 10 digits-ST3P—No ANI

(13) KP-ST†-KP-I-7 digits-ST

(14) KP-STP-KP-I-7 digits-ST

(15) KP-ST3P-KP-I-7 digits-ST

(16) KP-7 or 10 digits-ST†-KP-I-7 digits-ST

(17) KP-7 or 10 digits-ST-KP-I-7 digits-ST

(18) KP-7 or 10 digits-STP-KP-I-7 digits-ST

(19) KP-7 or 10 digits-ST2P-KP-I-7 digits-ST

(20) KP-7 or 10 digits-ST3P-KP-I-7 digits-ST.

(b) ***Required Dial Pulsing Formats:***

(1) Seizure—No address digits—No ANI

(2) Seizure—No address digits—KP-I-7 digits-ST†

(3) Seizure—No address digits—KP-I-7 digits-STP

(4) Seizure—No address digits—KP-I-7 digits-ST3P

(5) 7 or 10 digits—No ANI

(6) 7 or 10 digits-KP-I-7 digits-ST†

(7) 7 or 10 digits-KP-I-7 digits-ST

(8) 7 or 10 digits-KP-I-7 digits-STP

(9) 7 or 10 digits-KP-I-7 digits-ST2P

(10) 7 or 10 digits-KP-I-7 digits-ST3P.

Note: ST† indicates any one of the usable ST signals (ST, STP, ST2P, ST3P).

DISCONNECT SEQUENCE ON CALLS FROM STEP-BY-STEP THROUGH CROSSBAR TANDEM CAMA OR TSPS OFFICES

A. Normal Disconnect

Calling Customer Goes On-Hook First

CAMA (1+ Noncoin)

8.18 When the calling customer disconnects, the local central office trunk circuit immediately sends on-hook to the CAMA office. After timing for a minimum of 280 milliseconds to allow the CAMA office to function, the local central office trunk circuit opens its sleeve lead for a minimum of 30 milliseconds to release the switches and the customer line. It then regrounds the sleeve to make itself busy to new calls.

8.19 When the CAMA office receives the on-hook signal from the local central office, it delays a minimum of 140 milliseconds and then sends off-hook supervision toward the called end. After an additional 90 to 290 milliseconds, the CAMA office releases the switches and, after completion of the disconnect entry, sends on-hook supervision toward the calling end. When the local central office trunk circuit receives the on-hook supervisory signal, it removes the sleeve ground, making itself available for a new call.

8.20 While the call is in progress, the CAMA trunk circuit may be conditioned, for maintenance reasons, to make the trunk busy when the call terminates. In this case, the CAMA office will not return on-hook supervision to the calling end after disconnect and the local central office will then maintain itself busy. When the CAMA office eventually reverts to on-hook, the local central office trunk circuit removes the ground from the sleeve and becomes available for a new call.

TSPS (0+ Coin, 0- Coin, and 1+ Coin)

8.21 When the calling customer disconnects, the local central office trunk circuit sends on-hook to the TSPS office immediately; but the local central office trunk circuit does not initiate its disconnect timing at this time. After a minimum of 1100 milliseconds delay to hold over possible customer flashing, the TSPS office sends an on-hook signal to the called end if not in overtime.

> ***Note:*** If in overtime, the on-hook supervision is maintained until an operator is attached to collect the overtime charges. When the overtime charges are collected, an on-hook signal is sent to the called end by the operator.

8.22 At the same time, the TSPS office sends the coin disposal signal to the local central office. If answer supervision was recorded, the coin collect signal is sent. If answer supervision was not recorded, the coin return signal is sent. The duration of the coin disposal signal varies with the type of facility. For loop signaling, the duration is 145 to 360 milliseconds; for E&M lead signaling, the duration is 1100 to 1800 milliseconds. On loop signaling trunks, the local central office trunk circuit times the duration of the coin disposal voltage to the coin telephone; on the E&M trunks, the duration of the MF tone signal from the TSPS times the duration of the coin disposal voltage to the coin telephone.

8.23 After the coin disposal signal is sent, the TSPS office sends an on-hook signal to the local central office; but the local central office trunk circuit will not release the switches until the coin disposal circuit has completed its timing.

8.24 After sending the on-hook signal to the local central office, the TSPS delays 50 to 100 milliseconds. If the calling end is still on-hook, the TSPS office returns the trunk to an idle trunk list, making it available for service.

8.25 While the call is in progress, the TSPS office may be conditioned, for maintenance reasons, to make the trunk busy when the call terminates. In this case, the TSPS office delays 800 milliseconds after sending the on-hook signal to the local central office and then, if the calling end is still on-hook, TSPS sends an off-hook signal which causes the local central office trunk circuit to ground the sleeve lead and thereby make itself busy. When the TSPS office eventually reverts to on-hook, the local central office trunk circuit removes the ground from the sleeve and becomes available for a new call.

Called Customer Goes On-Hook First

CAMA (1+ Noncoin)

8.26 When the called customer disconnects, the CAMA office trunk circuit will, after a delay of 13 seconds (minimum), send on-hook toward the called end and release the CAMA office switches, releasing the called customer.

> ***Note:*** TSPS delays 11.1 seconds (minimum) on called customer disconnects before sending an on-hook toward the called end.

8.27 After making the disconnect entry, the CAMA trunk circuit sends on-hook to the local central office trunk circuit. Upon receipt of this on-hook signal, the local central office trunk circuit, after a delay of 140 milliseconds (minimum), opens the sleeve lead for 30 milliseconds (minimum) to release the switches. It then regrounds the sleeve for 280 milliseconds (minimum) to cover the work time necessary to idle the trunk at the CAMA office. It then removes the ground to make itself available for a new call.

8.28 The release of the switches opens the customer T and R leads to the local central office trunk circuit disconnecting the customer line and releasing the A relay in the local central office trunk circuit, thereby sending an on-hook signal to the CAMA office.

8.29 Upon detection of this on-hook signal, the CAMA trunk circuit, after a delay of 140 milliseconds (minimum), returns to its idle condition and is available for a new call.

8.30 While the call is in progress, the CAMA trunk circuit may be conditioned, for maintenance reasons, to make the trunk busy. In this case, upon detection of the on-hook signal, the CAMA trunk circuit, after a delay of 140 milliseconds (minimum), returns off-hook supervision to the calling end to make the local central office trunk circuit busy.

TSPS (0+ Coin, 0- Coin, and 1+ Coin)

8.31 When the called customer disconnects, the TSPS office will, after a delay of 2 seconds (minimum), make the disconnect entry and send on-hook toward the called end, releasing the called customer.

> ***Note:*** The 2-second timing applies on coin overtime as well as time and charge calls. On coin initial period, timed released timing is 11.1 seconds.

8.32 After performing any operator functions, such as collecting additional charges, the TSPS office sends on-hook to the local central office trunk circuit. Upon receipt of this on-hook signal, the local central office trunk circuit, after a delay of 140 milliseconds* (minimum), opens the sleeve lead for 30 milliseconds (minimum) to release the switches. The trunk circuit then regrounds the sleeve to make itself busy for the 200 milliseconds (minimum) to cover the work time required to idle the trunk at the TSPS office. It then removes the ground to make itself available for a new call.

*There is an incompatibility between the minimum release time of 140 milliseconds and the maximum received coin control wink of 150 milliseconds. While there is an incompatibility in Bell System requirements, there is no incompatibility in Bell System practice which uses a relay with 190 milliseconds minimum release time and 425 milliseconds maximum release time to recognize the on-hook from the TSPS in the local office trunk circuit.

8.33 The release of the switches opens the customer T and R leads to the local central office trunk circuit disconnecting the customer line and releasing the A relay in the local central office trunk circuit, thereby sending an on-hook signal to the TSPS office.

8.34 After a delay of 240 to 345 milliseconds in the TSPS trunk circuit, the TSPS office will detect the on-hook signal and return the trunk to the idle list.

8.35 While the call is in progress, the TSPS office may be conditioned to make the trunk busy for maintenance reasons. In this case, the TSPS office, instead of returning the trunk to the idle list, will delay an additional 800 milliseconds; if the calling end is still on-hook, the TSPS office will return off-hook supervision to the calling end to make the local office trunk circuit busy.

B. Disconnect on Partial Dial Calls

Centralized Automatic Message Accounting (CAMA)

8.36 On partial dial calls, the CAMA office waits 17 to 25 seconds for the first dial pulse digit and 17 to 25 seconds between digits, recycling the timer as each digit is received. If the calling customer does not complete dialing and remains off-hook, the CAMA office functions as described in the following paragraphs.

CAMA Office With 3-Digit Register Plus Sender

8.37 The CAMA office trunk circuit sends reorder tone and waits indefinitely for the calling customer to disconnect. If the local central office trunk circuit is equipped with a disconnect timer (dial 1 for slumber), the customer will be disconnected after the time-out period and the trunk will be released forward.

CAMA Office With 10-Digit Register Plus Sender

8.38 The CAMA office register calls in a sender which directs the trunk circuit to send off-hook toward the local central office and the sender then proceeds to disconnect. When the local central office trunk circuit receives this off-hook signal, it completes line identification and outpulses the calling number. Upon disconnect of the sender, the trunk circuit again returns an on-hook signal to the local central office. The off-hook signal sent to the local central office has a duration of approximately 1 second.

8.39 Upon receipt of the on-hook signal, the local central office trunk circuit delays a minimum of 140 milliseconds and then opens the sleeve lead to disconnect the switches and the calling customer, making itself available for a new call.

Traffic Service Position System (TSPS)

8.40 On partial dial calls, the TSPS office waits 12 to 18 seconds for the first dial pulse digit and 12 to 18 seconds between digits, recycling the timer as each digit is received. If the calling customer remains off-hook, the TSPS office goes off-hook and sends reorder tone for 9.5 to 11.5 seconds. If the calling customer remains off-hook, the TSPS office sends an on-hook signal and monitors the trunk for on-hook from the calling end as described in paragraphs 8.26 through 8.30.

TSPS COIN CONTROL SIGNALS

(This information will be furnished later as a Technical Advisory.)

INTERNATIONAL DIALING—OUTPULSING FROM TSPS AND NO. 1 ESS

8.41 International dialing, which is described in Section 10, requires more digits than can be passed through the network in a single outpulsing when per-trunk signaling is used. As a result, a 2-stage outpulsing has been devised. The first stage MF outpulsing routes the call to an international gateway office. It is handled as any other network call that terminates in the North American Network. The MF signaling is on a link-by-link basis. The MF digits are received at each node (switching system used to provide the path from TSPS to an international gateway). Digits may be added or deleted for routing purposes at each node. The MF digits are again transmitted on the next transmission link in the connection. This process is repeated until the international gateway office is reached. The second stage, MF outpulsing, is done on an end-to-end basis. The MF pulses pass through the various switching offices in the connection as any other voiceband signal. The MF digits are only detected at the international gateway office.

8.42 After the international gateway receives the ST pulse from the first stage outpulsing, the international gateway delays at least 700 milliseconds to permit time for the transient conditions in the preceding switching machines to disappear. After the delay, if a register is available and attached to the circuit, a signal known as second-start-dial is sent, which is an off-hook signal of 400 milliseconds minimum duration. (A 220-millisecond off-hook must be seen at the TSPS.) At the completion of the second-start-dial signal, the TSPS or No. 1 ESS begins the MF outpulsing procedure per paragraph 3.28. The actual MF outpulsing meets the same requirements as the first stage outpulsing. (See paragraphs 7.43 through 7.62.) A 480-Hz tone is sent from the international gateway office from the time the second-start-dial signal is completed until the ST signal is received or until the MF receiver times out (10 to 20 seconds). The 480-Hz tone is to let operators know that they can start the second stage pulsing.

9. SIGNALING TO AIS

9.01 The AIS serves class 5 offices and works with either ANI or ONI identification of the called number. The signaling formats used for both ANI and ONI are shown in Table R. Numbers disconnected, in trouble, or not equipped are wired in the class 5 office to route incoming calls reaching these numbers to outgoing intercept trunks. The outgoing intercept trunks can be arranged to identify the type of intercept and to transmit the information to the AIS. The features required in the trunks and interoffice signals are shown in Fig. 39. The AIS does not generate a unique disconnect signal. The disconnect is under control of the calling party. The local central office trunk must be held busy a minimum of 450 milliseconds before reseizure to allow time for the AIS trunk to restore to the idle state.

10. CARRIER GROUP ALARM

10.01 Carrier Group Alarm (CGA) is used to minimize the effects of carrier failures on switching systems and on service. Ideally, a CGA system should: (1) busy out the failed circuits, (2) release customers from the failed circuits, (3) stop charging, (4) prevent false charging, and (5) prevent the failed circuits from seizing the central office equipment. These five objectives are effected by the CGA equipment operating on the trunk equipment. This process is referred to as ***CGA trunk conditioning***. Several vintages of CGA systems exist in the Bell System. The oldest are for use with E&M lead signaling only. The newer CGA systems handle loop reverse battery signaling as well as E&M signaling.

10.02 The operation of a CGA system can be divided into three parts: (1) detection of the carrier failure, (2) conditioning the failed trunk, and (3) reaction of the switching equipment to the processing of the failure.

TABLE R

SIGNALS TRANSMITTED TO AUTOMATIC INTERCEPT CENTER

	LOCAL OFFICE				TRUNK CONCENTRATOR
	ANI	ONI			ONI
		LOOP SIGNALING		E&M SIGNALING	
CLASS	MF	TIP	RING		MF
Regular	KP + 3 + 7d + ST	Battery	Ground	One pulse	KP + 6 + ST
Trouble	KP + 1 + 7d + ST or KP + 1 + ST	Ground	Battery	Two pulses	KP + 8 + ST
Blank or unassigned number	KP + 0 + 7d + ST or 1 KP + 0 + ST	Momentary +130V on tip and ring followed by battery on tip, ground on ring		Three pulses	KP + 7 + ST
Failure to identify line number	KP + 2 + ST				

Notes:

1. If an announcement is given to the customer before the call is completed to the AIC, the KP + 5 + ST is transmitted to the AIC.

2. Information digits and KP signals are optional.

Automatic Number Identification (ANI):

(1) Battery and ground signaling.

(2) Reverse battery answer supervision.

(3) Reverse make-busy feature to make the local central office outgoing trunk busy from the AIC.

(4) Idle condition (on-hook with battery on ring and ground on tip).

Operator Number Identification (ONI):

(1) One class (single class of intercept traffic on one trunk):

(a) With or without supervision.

(b) Supervision could be HILO, bridge, or dc signaling.

(c) No reverse make-busy feature.

(d) Idle condition same as ANI trunk.

(2) Three classes (three classes of intercept traffic on one trunk):

(a) DC signaling or dial pulse signaling. (See Table R.)

(b) No reverse make-busy feature.

(c) Idle condition same as ANI trunk.

Operator Assistance:

(1) Same as one class ONI.

Note: Local central office E&M outgoing trunks are converted to *loop* at the AIC.

Fig. 39—Interoffice Signaling for Automatic Intercept System (Incoming 2-Way Loop Trunk)

10.03 The carrier failure detection circuit is generally in the carrier terminal. With the No. 4 ESS, the software has the capability to detect carrier failure. For electromechanical systems, the trunk conditioning process is associated with the carrier or signaling equipment. Electronic systems perform at least part of the trunk conditioning process within the switching machine. The electronic systems can also use the same processing equipment as the electromechanical systems when supervisory signal trunk conditioning is used.

10.04 The CGA equipment can be collocated with or, where calling party control is used, remote from the switching system. Where there is more than one link of signaling equipment in a facility, CGA equipment can be collocated with the switching system and at one or more locations remote from the switching system. These several CGA equipments would perform the CGA trunk processing for a trunk into a switching machine. Each CGA equipment would perform the trunk processing where the associated carrier link failed.

CALL PROCESSING

10.05 The next few paragraphs will discuss CGA actions, features, and limitations in the order they would occur when a carrier system fails and then restores.

A. Between Carrier Failure and Trunk Conditioning

10.06 After a carrier failure occurs (eg, loss of synchronization in a T-Carrier system) but before CGA trunk conditioning begins, it is desirable to maintain the same supervisory states on each trunk that existed before the failure. If the carrier cannot be restored in a reasonable time, eg, 2.5 seconds, trunk processing should be initiated to remove the trunks from service. However, since there is no fixed maximum in this case, the time could be longer or shorter than the 2.5 seconds given above. The time should be long enough to maximize the possibility of restoring the carrier before trunk processing begins, but short enough so that the customers using the facility are not more annoyed by the effects caused by the delay in processing the failure than they are by the effects of the carrier failure.

10.07 This method of maintaining the previous supervisory state after failure is designed into D3 and D4 channel banks. Its advantage lies in its capability to maintain connections even though signaling may be lost due to bursts of errors with digital carrier or due to the time required to augment certain protection switches in analog or digital carrier. This method not only saves calls on short failures, it also prevents massive seizures of circuits that were idle at the time of failure. It also prevents false charging before trunk processing begins.

10.08 Another method of saving calls that could be lost to short failures is to cause all trunks to go off-hook when the carrier fails. This method has been supplanted by the method described above. However, many T-Carrier systems now in service are still using this method. Its principal disadvantage is that it causes a mass seizure between carrier failure and trunk processing and can cause false charging if the interval between carrier failure and trunk processing is more than 2 seconds.

10.09 SF signaling units have a natural tendency to remain in the same supervisory state after the failure that they were in before the failure. However, all SF units and D1 and D2 channel banks can fail off-hook, on-hook, or alternating between off-hook and on-hook.

10.10 Typical intervals between carrier failure and the beginning of trunk processing vary from 300 milliseconds to 2.5 seconds. The shorter intervals can disconnect calls that could be saved with the application of supervisory control (off-hook on all trunks or off-hook on busy trunks). The longer intervals can cause false charges unless the same supervisory state is maintained before and after failure.

B. Trunk Conditioning

10.11 There are two methods of accomplishing trunk conditioning. The first controls supervisory signals associated with the signaling systems and the second uses auxiliary signals forwarded directly to the trunk circuit or to the central control of an ESS.

(1) Where trunk conditioning is accomplished through the control of supervisory signals, the associated signaling systems are forced on-hook. If the affected trunk is an incoming circuit or a 2-way trunk circuit used in the incoming mode, the on-hook will force the release of the associated switching system, thereby disconnecting established calls. The on-hook toward an outgoing trunk has no effect in systems with calling party control because the calling party can always release from the connection. Where joint hold or operator control is used, the on-hook permits the calling party to release. As will be seen in paragraphs 10.13 through 10.18, if supervisory conditioning is the only trunk conditioning used, a subsequent off-hook would trap the customer in the trunk for the duration of the carrier failure. As a result, joint hold trunks should be used with auxiliary trunk conditioning signals to busy out the trunk during carrier failure.

(2) About 10 seconds after the failure is detected by the CGA equipment, an auxiliary signal from the carrier terminal is applied to the trunk circuits of all outgoing and 2-way trunks with calling party control. This auxiliary signal forces them off-hook, thereby making them appear busy to the switching system. The 1-way incoming and joint hold circuits remain on-hook.

10.12 The disadvantage of the supervisory busy-out for 2-way trunk circuits is that, in the failed condition, a permanent signal is presented to the switching system. A large failure can tie up the office for a short period of time. In the absence of this kind of carrier failure trunk conditioning, however, repeated seizures on the trunks can occur throughout the period of the carrier failure.

10.13 Supervisory conditioning can be applied at the switching system or at a remote location for calling party control. The only requirement for remote trunk conditioning is that provisions are made to control the supervisory state of the signaling during the failure of the carrier system. Supervisory conditioning can be the sole method of trunk conditioning for calling party control. Incoming trunks and trunks using joint hold control remain on-hook during the carrier failure.

10.14 Where the trunk conditioning is accomplished using auxiliary signals, the trunk circuit is made busy by closing a contact between two auxiliary signaling leads. This auxiliary signal is applied at the time trunk processing begins and remains until the carrier is restored. Since these auxiliary leads usually have rather short resistance ranges, this method is usually limited to situations where the CGA and switching equipment are collocated. The auxiliary signals for the No. 1/1A ESS and No. 4 ESS are for a carrier group rather than a single circuit. Except for the step-by-step system and No. 4 ESS, the auxiliary signal makes the trunk circuit busy for any future usage but does not disconnect the call presently using the trunk.

10.15 Local step-by-step is a special case because the circuit is made busy by grounding the sleeve lead. This will, of course, lock the step-by-step switches to the ground on the sleeve and lock any customer trapped on that trunk out of service for the duration of the carrier failure. To prevent this, the existing call must be winked off the circuit. The sleeve lead from the step-by-step outgoing repeater to the selector is wired through the CGA equipment. In a carrier failure, the customer is winked off the circuit by removing the ground from the sleeve lead for 40 milliseconds to release the step-by-step switching train. The CGA trunk conditioning equipment applies a ground to busy out the trunk as soon as the winkoff is completed. The ground remains on the trunk sleeve lead for the duration of the failure.

10.16 The winkoff signal can occur any time after the carrier failure is recognized. Most existing CGA circuits wink off the customer after about 10 seconds of forced on-hook. As long as the customer is not locked to the failed trunk for an excessive time, the winkoff timing is not critical.

10.17 Joint hold or operator control circuits require the use of an auxiliary signal to busy out the trunk during the carrier failure. The signal is required because the supervision must remain on-hook during the failure to prevent locking a customer to the trunk circuit. When the carrier failure ends, all signaling circuits are returned to on-hook and all supervisory signals restored to normal.

10.18 The following paragraphs discuss the ways that CGA, with supervisory conditioning techniques, can be applied to various types of signaling:

(a) CGA on trunks equipped with E&M lead signaling with supervisory conditioning as the busy-out method is the most frequently used CGA arrangement on intertoll and toll connecting trunks. It has the advantage that the carrier terminal and the switching system do not have to be collocated. All E&M lead incoming and 2-way trunk circuits having calling party control will operate in this mode. Many Bell System E&M lead outgoing trunk circuits will also function in this mode. Development is now under way to increase the number of outgoing trunk circuits that will accept this make-busy mode of operation. Where outgoing trunk circuits with this make-busy mode are not available, 2-way trunk circuits can be used.

The disadvantage of this mode of make-busy is that the 2-way trunks are seized on carrier failure. This can cause a shortage of common equipment in common control offices until the permanent signal arrangements clear the condition.

This make-busy method should not be used with joint hold or operator control trunks.

(b) CGA with E&M lead supervisory signaling and auxiliary signaling trunk conditioning has the disadvantage of requiring collocation of signaling and switching equipment. It has the advantage of not seizing the switching equipment once the carrier failure is detected. In the interval between actual carrier failure and the detection of the failure, the failed circuits can seize switching equipment. The false seizure only lasts for about 2 seconds so the effect on an office would be very small.

This method can also be used for joint hold or operator control trunks.

Only the latest signaling equipments (F-type SF and D3 channel banks) have the ability at this time to apply the auxiliary signal. As a result, this is not a widely used CGA trunk conditioning method.

(c) CGA on loop reverse battery signaling trunks with supervisory conditioning as the busy-out mode is a method of trunk conditioning. Since only 1-way trunks are available, the false seizure of switching equipment, which can occur with supervisory conditioning on E&M lead signaling, is eliminated.

Use of this method requires a reverse make-busy feature in the outgoing trunk circuit. These trunk circuits are limited to CAMA and TSPS trunks at present. Since the TSPS trunk circuit is operator control supervision, only CAMA trunks are available for this method. Development is proceeding on an applique that would provide the reverse make-busy feature for existing trunks.

(d) CGA on trunks using reverse battery signaling with both supervisory and auxiliary signaling conditioning is a standard method for many loop trunks including No. 5 crossbar and step-by-step systems. It does not require collocation of the signaling and switching equipment. However, it is the only effective method for step-by-step, joint hold, and operator control 2-wire trunk circuits.

10.19 CGA on trunks to a No. 4 ESS or No. 1/1A ESS uses central control for at least part of the processing. The carrier system furnishes a loop closure on two auxiliary signaling leads to the ESS for the duration of the carrier failure. The loop closure causes the start of trunk processing within the switching system on a carrier group of 12 or 24 trunks. The No. 4 ESS does all trunk processing. The No. 1/1A ESS requires on-hook supervision from the failed incoming or 2-way trunks to process the failure properly. In addition to the CGA trunk processing, the No. 4 ESS also has a software CGA trunk processing capability that does not require either trunk conditioning from the carrier equipment or auxiliary signaling leads.

10.20 At the present time, ground on the E lead is the most often used signal on facilities that might interconnect between an Independent Telephone Company and the Bell System. All of the carrier, signaling, and switching components of this system are now available. Except for joint hold trunk circuits, this method of CGA trunk conditioning is the most universally used trunk conditioning arrangement.

10.21 Formerly, CGA was limited to short-haul carrier systems. The broadband (L) systems did not have CGA capability. A carrier failure signal is available at the broadband carrier channel bank on a per-group (12 circuits) basis. In addition, trunk conditioning will be available for broadband carrier. The trunk conditioning will use the supervisory method of conditioning by inserting a 2600-Hz SF signaling tone for an on-hook and no tone for an off-hook. However, these methods are not widely in use.

C. Carrier Restoral

10.22 As soon as the carrier failure is over, processing to restore the affected trunks begins. The exact procedure is individual to each carrier system. However, the net result, where the carrier system has direct or indirect control over the trunk processing, is to return the trunks to the idle state in a matter of seconds. Where the carrier system does not control the CGA process (eg, No. 4 ESS), manual intervention may be required to restore the trunks to service.

10.23 Carrier failure involving a TSPS can occur on either the local or the toll side of the TSPS. The failed trunks are processed by the carrier and signaling systems when the failure is between the local central office and the TSPS. When the carrier failure is between the TSPS and the toll office, the TSPS takes indirect maintenance action to place the trunks out of service after two call attempt failures.

CARRIER FAILURE BETWEEN LOCAL CENTRAL OFFICE AND TSPS

10.24 Upon carrier failure between the local central office and the TSPS, the carrier system goes through a series of actions to process the failure at both the local central office and at the TSPS.

10.25 The local central office uses a trunk circuit with operator control of disconnect (perhaps better called TSPS control of disconnect) as described in paragraph 2.17. This means that the customer is free to release until the TSPS sends an off-hook back to the local central office at the time the TSPS requests the calling number (ANI request). Once the off-hook has been sent to the local central office, the customer is locked to the trunk until the local central office sees an on-hook. Operator control of disconnect dictates that the CGA force on-hook toward the local central office for the duration of a carrier failure to prevent locking the customer to the TSPS trunk for the duration of the failure. Essentially, all CGA arrangements can provide an on-hook toward the local central office during carrier failure. To make the trunk busy during the carrier failure, the make-busy leads from the trunk circuit (or local central office in the case of ESS) must be connected to the CGA equipment which requires the collocation of switching and carrier equipment. During carrier failure, the CGA equipment should force an on-hook toward the TSPS. Essentially, all CGA arrangements can provide an on-hook toward the TSPS during carrier failure.

10.26 As a result of the CGA processing caused by a carrier failure, the following actions take place:

(1) Calls in progress are disconnected.

(2) Charges for all calls in progress are ended.

(3) The failed trunks are made busy at the local central office if the carrier is collocated and compatible with make-busy lead operation.

(4) Customers are released (winked off) or can release themselves (by hanging up) from the failed connections.

10.27 The only customers directly affected by the failure are those using the facilities at the time of failure. Of course, any customers attempting to use the group during the failure may be indirectly affected by the reduction of trunk group size or by being connected to failed trunks.

CARRIER FAILURE BETWEEN TSPS AND TOLL OFFICE

10.28 A carrier failure between the TSPS and the toll office is handled differently. There is no direct connection between the CGA circuits in the carrier system and the TSPS. Indirect maintenance action by the TSPS minimizes the service reaction during a carrier failure by removing trunks from service after two call processing failures. In order to remove trunks from service, the carrier system must provide an off-hook condition toward the TSPS toll side.

10.29 When a carrier failure occurs, a series of events takes place. The net result of these events is as follows:

(1) Calls in progress are disconnected.

(2) Charges for all calls in progress are ended.

(3) Customers are released (winked off) or can release themselves (by hanging up) from the failed connections.

(4) All trunks appear idle and available for service by the TSPS (when the customers who occupied the trunks during the failure hang up or are winked off).

10.30 The off-hook toward the toll side of the TSPS is not detected until the trunk is seized (off-hook) toward the toll office. As a result, the first time an idle trunk (involved in the failure) is used, the call attempt will fail because the CGA will be off-hook toward the TSPS.* The TSPS records the call failure but leaves the trunk in service. On the second call failure on a given trunk, the trunk is removed from service and placed on a high and wet list at the TSPS. Each trunk must fail twice with no successful sender attached signal before being removed from service. The trunk is removed from service by an on-hook signal followed by an off-hook signal to the local central office from the TSPS. The on-hook signal winks off the calling customer who returns to dial tone. The TSPS detects the on-hook from the local central office, waits 800 milliseconds and, if the calling end is still on-hook, sends an off-hook signal to the local central office. The off-hook signal makes the local central office trunk circuit busy (reverse make-busy). The reverse make-busy can be used in this case because, in contrast to carrier failures between the local central office and the TSPS, the TSPS can control the supervisory state of the trunk, thereby preventing the trapping of a customer on a failed trunk. In addition, a seizure (off-hook) is maintained toward the toll office to monitor toll office supervision and thereby detect when the carrier is restored to normal.

* Either the MF outpulser will time out or, on operator-assisted calls, the operator will release forward. The TSPS MF outpulser times out if a start-dial (on-hook) signal is not received in 16 to 24 seconds when all TSPS MF outpulsers are not busy or 4 to 8 seconds when all TSPS MF outpulsers are busy. Abandoned calls that seize an MF outpulser for more than 8 seconds are also counted as call failures.

10.31 There are no limits to the number of trunks in the same group that can simultaneously be placed on the high and wet list at the TSPS. The failed trunks are scanned every 200 milliseconds for MF trunks and 100 milliseconds for dial pulse trunks while out of service. They remain out of service until on-hook supervision is detected on the toll side. Once on-hook supervision is detected, the trunks are put in the idle state and returned to service without manual intervention.

10.32 Since an operator-assisted call would be retried by the operator, a minimum of one call and a maximum of two calls per trunk are affected by the failure. Service may be affected during the time that the failed trunks are still in service. The failure does not, however, lock out of service any customer nor does it tie up the processing capacity of the TSPS for a long time.

10.33 It is important that the carrier between the TSPS and the toll office fail in the off-hook condition toward the TSPS. Failure in the on-hook condition causes the TSPS to take a different action that results in keeping failed trunks in service and/or removing trunks from service in such a way that manual restoral is necessary.

NO. 4 ESS FAILURE

10.34 Failure of the associated No. 4 ESS toll office causes the TSPS to take indirect maintenance action to minimize the reaction to the failure. There is no possibility of completing the calls to a TSPS by redirecting the traffic during a failure of the associated toll office. Therefore, the maintenance action is limited to ensuring that traffic will resume normally when the No. 4 ESS recovers. The trunks to a failed No. 4 ESS office are removed from service after two call failures per trunk. The trunks remain out of service for 2 to 4 minutes and then return to service. In a long toll office failure, a single trunk would be placed out of service many times during the outage but return to service automatically.

10.35 The details of the maintenance reaction to a No. 4 ESS failure are nearly identical to those of a carrier failure between the TSPS and the toll office. The trunks are removed from service in an identical manner to the carrier failure case (paragraphs 10.28 through 10.33). The trunk is placed out of service at the local central office and on the high and wet list at the TSPS. The difference is that the No. 4 ESS trunk is on-hook (rather than off-hook) toward the TSPS. This changes the method of returning the trunks to service.

10.36 The TSPS trunk is off-hook toward the No. 4 ESS to monitor the toll office supervision. When the No. 4 ESS recovers, the off-hook from the TSPS will be recognized as a seizure. The No. 4 ESS will respond by sending a 140-millisecond off-hook wink to the TSPS as a start-dial signal. If the TSPS recognizes the off-hook, the TSPS will restore the trunk to service. However, the No. 4 ESS applies the off-hook signal to all trunks in a very short time. The TSPS cannot recognize the off-hook signals at the rate they are sent by the No. 4 ESS. As a result, only a few trunks are returned to service by this method because the TSPS buffer is filled to overflowing. Another TSPS action returns the other trunks to service.

10.37 In the high and wet stuck on-hook condition, the trunks remain on the high and wet list for 2 to 4 minutes. At the end of the 2- to 4-minute period, the trunks are returned to service if more than three other trunks are on the high and wet list in the stuck on-hook condition. Since this will be the case during a No. 4 ESS failure, trunks will return to service and again be removed from service many times during a long failure. This action does, however, permit the return to service of all trunks without human intervention after a No. 4 ESS failure.

11. CALL PROGRESS TONES (AUDIBLE TONE SIGNALS)

11.01 Signals in this category give information regarding the progress or disposition of telephone calls to operators and customers. The audible signals must, of course, be easy to interpret and must conform to the transmission system design requirements for signal levels and have freedom from interference effects with respect to: (1) voice currents, (2) circuit noise, or (3) other signaling systems.

11.02 The Bell System is using a great variety of different tone sources of Bell System and non-Bell System manufacture. They all meet the general requirements of being easy to interpret and not causing interference. However, the frequency content and exact level are not documented for all tones. There is no specific requirement for any tone. It is not expected that additional requirements will be established for existing tones; further, it is expected that existing tone sources will remain in service until the associated switching system is retired or until failure of the tone-generating equipment dictates replacement of the source. The level of Bell System call progress tones usually but not always lies in the range of 61 to 71 dBrnC. The tone level should be measured where it is applied to the voice transmission path at the calling customer's side of the incoming line or trunk equipment with a termination of 900 ohms.

PRECISE TONE PLAN

11.03 The "precise tone plan" has always been used in the No. 1/1A, 2/2B, 3, and 4 ESSs. The plan is based on four pure tones which, in central office applications, will be held to ±1.5 dB amplitude variation and ±0.5 percent frequency variation. These tones are 350, 440, 480, and 620 Hz. The total power of harmonics and other extraneous frequencies is at least 40 dB below the signal level measured where it is applied to the voice transmission path. The tones are assigned individually or in pairs (not modulated) to represent standard audible tone signals. The levels of the precise tones are included in paragraphs 11.07 through 11.15.

PRECISE TONE SOURCES IN ELECTROMECHANICAL OFFICES

11.04 Other types of Bell System switching systems can and have had the old tone sources replaced with precise tone sources. However, these tones may be distributed by resistive and/or capacitive networks that were not designed to produce the levels specified in the precise tone plan.

11.05 When TOUCH-TONE service is added to an office that does not have a precise tone supply, at least that portion of the office equipped for TOUCH-TONE service should be served from a precise dial tone supply. It is known, however, that some offices equipped for TOUCH-TONE service do not have a precise dial tone supply. In addition, the tone distribution system may not deliver the dial tone within the level variation specified in the precise tone plan.

NONPRECISE CALL PROGRESS TONES

11.06 The nominal frequency content of the nonprecise tones is listed in paragraphs 11.07 through 11.15. More complete information on nonprecise tones is covered in paragraph 11.16 and Table S.

DIAL TONE

11.07 Precise dial tone consists of 350 plus 440 Hz at a level of -13 dBm0 per frequency. The difference in frequency of 90 Hz gives this tone its buzzing sound. Nonprecise (old) dial tone consists of 600 Hz modulated by 120 Hz when supplied by a tone alternator or by 133 Hz when supplied by an interrupter. In this case, the modulating frequency gives this tone its low-pitched sound. Other combinations were also used.

HIGH, LOW, AND CLASS-OF-SERVICE TONES

11.08 Precise high tone consists of 480 Hz at -17 dBm0. Nonprecise (old) high tone is nominally 500 Hz when supplied from a tone alternator or 400 Hz from an interrupter.

11.09 Low tone gets its name from the prominent 140-Hz beat. Precise low tone consists of 480 plus 620 Hz at a level of -24 dBm0 per frequency. Interrupted low tone is heard by the customer when line busy, reorder, and no-circuit conditions exist.

11.10 Class-of-service tones are used at switchboards to indicate the class of service of the calling customer when more than one class is served by the same trunk group. Class of service may be indicated by either a high tone, low tone, or absence of tone.

LINE BUSY TONE

11.11 Line busy is a low tone interrupted at 60 IPM with approximately equal tone-on and tone-off times. It indicates that the called customer line has been reached but that it is busy.

REORDER, PATHS BUSY (ALL TRUNKS BUSY), NO CIRCUIT TONE

11.12 This is low tone interrupted at 120 IPM which indicates that the local switching paths to the called office or equipment serving the called customer are busy or that no toll circuit is available. This signal may also indicate a condition such as a timed-out sender or unassigned code dialed.

TABLE S

TONE INFORMATION

RINGING SYSTEM	TONE OUTPUT	TONE FREQUENCY	FREQUENCY TOLERANCE	HARMONIC DISTORTION	VOLTAGE RATIO, MODULATED TO UNMODULATED	VOLTAGE RATIO TOLERANCE	NOTE
803C	Low Tone (LT)	600/120 Hz	Both +1.7% -8.3%	Unknown	1 to 4	Unknown	
	High Tone (HT)	500 Hz	+1.7% -8.3%	Unknown	—	—	
	Audible Ring (AR)	420/40 Hz	Both +1.7% -8.3%	Unknown	1 to 4	Unknown	1
804C	Low Tone (LT)	600/120 Hz	Both +1.3% -8.3%	Unknown	1 to 4	Unknown	
	High Tone (HT)	500 Hz	+1.3% -8.3%	Unknown	—	—	
	Audible Ring (AR)	500/40 Hz	Both +1.3% -8.3%	Unknown	Unknown	Unknown	1

(See Notes at end of table.)

TABLE S (Contd)

TONE INFORMATION

RINGING SYSTEM	TONE OUTPUT	TONE FREQUENCY	FREQUENCY TOLERANCE●	HARMONIC DISTORTION	VOLTAGE RATIO, MODULATED TO UNMODULATED	VOLTAGE RATIO TOLERANCE	NOTE
805B	Low Tone (LT)	Approximately 600 Hz damped 160 times per second	±4.2% for the 160-IPS damping rate; unknown for the 600 Hz	Unknown	Unknown	Unknown	2
	High Tone (HT)	480 Hz	±4.2%	Unknown	—	—	3
	Audible Ring (AR)	Unspecified; generally has components in the 400- to 600-Hz range.	Unknown	Unknown	Unknown	Unknown	1
805C	Low Tone (LT)	600/120 Hz	Both ±X%	Unknown	Unknown	Unknown	
	High Tone (HT)	540 Hz	±X%	Unknown	—	—	4
	Audible Ring (AR)	420/40 Hz	Both +10% -8.3%	Unknown	Unknown	Unknown	1

(See Notes at end of table.)

TABLE S (Contd)

TONE INFORMATION

RINGING SYSTEM	TONE OUTPUT	TONE FREQUENCY	FREQUENCY TOLERANCE	HARMONIC DISTORTION	VOLTAGE RATIO, MODULATED TO UNMODULATED	VOLTAGE RATIO TOLERANCE	NOTE
806D and J86212T (Tones generated by high-speed interrupters)	Low Tone (LT)	Approximately 600 Hz damped 160 times per second	+15% -8.3% for the 160-IPS damping rate; unknown for the 600 Hz.	Unknown	Unknown	Unknown	2
	High Tone (HT)	480 Hz	+15% -8.3%	Unknown	—	—	3
	Audible Ring (AR)	Unknown	Unknown	Unknown	Unknown	Unknown	1
806D (Tones obtained from static frequency generators)	Low Tone (LT)	600/120 Hz	Both ±X%	Unknown	Unknown	Unknown	
	High Tone (HT)	540 Hz	±X%	Unknown	—	—	4
	Audible Ring (AR)	Unknown	Unknown	Unknown	Unknown	Unknown	1

(See Notes at end of table.)

TABLE S (Contd)

TONE INFORMATION

RINGING SYSTEM	TONE OUTPUT	TONE FREQUENCY	FREQUENCY TOLERANCE	HARMONIC DISTORTION	VOLTAGE RATIO, MODULATED TO UNMODULATED	VOLTAGE RATIO TOLERANCE	NOTE
806E	Low Tone (LT)	600/120 Hz	Both +2.8% -5.6%	Unknown	Unknown	Unknown	
	High Tone (HT)	540 Hz	+2.8% -5.6%	Unknown	—	—	
	Audible Ring (AR)	Unknown	Unknown	Unknown	Unknown	Unknown	1
806F	Low Tone (LT)	600/120 Hz	Both +2.8% -5.6%	Unknown	Unknown	Unknown	
	High Tone (HT)	540 Hz	+2.8% -5.6%	Unknown	—	—	
	Audible Ring (AR)	Unknown	Unknown	Unknown	Unknown	Unknown	1

Notes:

1. AR voltage level is unknown.
2. Derived from a 160-IPS interrupter driving a reactive circuit.
3. Derived from a 480-IPS interrupter driving a reactive circuit.
4. A frequency stability of $\pm$X% indicates limits that are directly proportional to the frequency variation of the input ac voltage only and independent of load. This will be approximately $\pm$0.5% for commercial ac service, but may be wider than this when ac supply is from emergency ac backup equipment, eg, $\pm$2%;

11.13 To a limited extent, the relative tone-on and tone-off durations were varied at one time to differentiate between local and toll offices and between types of toll offices. The precise tone plan, where installed in new step-by-step, No. 5 crossbar, and all ESS offices, calls for equal tone-on and tone-off times of 0.25 second. Taking into account all classes and types of offices at the present time, both the tone-on and tone-off durations may range from 0.2 to 0.3 second provided that the sum of the two durations is 0.5 second. The named circuit conditions are indicated by the easily recognizable 120-IPM rate, but no significance is attached to the relative tone-on and tone-off durations.

11.14 Tone should be provided at class 5 offices for 60 and 120 IPM and at class 4 and higher ranking offices for 120 IPM. These same tones are received by the calling customer on direct-dialed calls. In general, customers are not instructed on the significance of each tone. They try completing their calls again regardless of the tone received. However, detailed instruction concerning tone signals is sometimes given to PBX attendants.

AUDIBLE RINGING

11.15 Precise audible ringing consists of 440 plus 480 Hz at a level of -19 dBm0 per frequency. This signal indicates that the called line has been reached and ringing has started. It is also used on calls to operators (special service, long distance, information, etc) during the "awaiting-operator-answer" interval. Nonprecise (old) audible ringing typically consists of 420 Hz modulated by 40 Hz. Other combinations were also used.

NONPRECISE CALL PROGRESS SYSTEMS

11.16 Nonprecise call progress tones have never been well characterized and documented. Available information is contained in Table S which, when combined with that information in paragraphs 11.07 through 11.09 and 11.15, constitutes the extent of current knowledge of nonprecise call progress tone characteristics. The nominal RMS voltage given is at the output terminals of the ringing system and the tolerance is unknown. Table S contains information on the tones produced by the 803C, 804C, 805B, 805C, 806D, 806E, 806F, and J86212T nonprecise systems. The 806D system was produced in two versions, the first in which the tones were generated from high-speed interrupters and the second in which the tones were obtained from static frequency generators.

11.17 From 1946 through 1973, a combined total of 8646 of the above nonprecise systems were manufactured by Western Electric with a breakdown as follows:

SYSTEM	NUMBER MANUFACTURED
803C	938
804C	2294
805B	249
805C	181
806D	1154
806E and 806F	3330
J86212T (like 806D)	500 or less (estimated)

11.18 It is estimated that most of the nonprecise ringing systems manufactured prior to 1946 were replaced by systems manufactured during the period 1946 through 1973. As of January 1, 1979, there were 8378 electromechanical offices in existence. The vast majority of these offices undoubtedly contain ringing systems included in the above list. The combined number of ringing systems in Bell System central offices furnished by outside suppliers is considered to be relatively small.

11.19 The tone voltages of the above systems manufactured during the 1946 through 1973 interval have unknown harmonic content and are generated, in general, by high impedance sources. These sources drive reactive connecting circuits which are terminated in distributed customer lines of varying lengths. Tone modulation of low tone and audible ring tone is invariably amplitude modulation of a widely variable nature.

COIN TONES

11.20 These tones are produced by gongs or tone pulse generators in a coin telephone as nickles, dimes, and quarters are deposited. The tones are introduced to the line by separate transmitters in the coin box or by tone oscillators that enable the operator to check the amount deposited. On prepay service, in addition to the tones, a dc signal can be used by the operator or TSPS to detect whether coins have been deposited.

RECORDER WARNING TONE

11.21 When recording equipment is used, a "beep" of 1400-Hz tone is connected to the line every 15 seconds for a 0.5-second interval to inform the distant party that the conversation is being recorded. The tone source is located within the recording equipment and cannot be controlled by the party applying the recorder to the line.

NETWORK TONES

11.22 Table T documents all tones currently used in the network. Tones are included if they are now in use in the network, even though they are obsolete (ie, would not be provided in newly installed equipment). Tones are ***not*** included if they need not ever be interpreted by a person, even though they might be heard by customers or operators from time to time, ie, MF signals. Each tone appears twice, first in a table of specifications (Table T) and again in a glossary of tone meanings (Table U). The tones are numbered consecutively in Table T and appear under the same number and title in Table U.

RECEIVER OFF-HOOK (ROH) TONE

11.23 ROH tone is not a signal used in the toll network and is never placed on trunks. It is placed on lines to inform the customer that the receiver has been left off-hook. In some cases, the tone is applied to FX lines using carrier facilities.

11.24 Every effort is made to prevent applying ROH tone, either automatically or manually, to lines that could be connected to an attendant headset. Several switching systems have facilities to prevent automatic application of ROH tone. Local test desk testers are instructed not to apply ROH tone to PBXs.

11.25 Developments to prevent automatic application of ROH tone to carrier facilities in electronic systems are now being considered. The No. 5 crossbar can now prevent application of ROH tone to carrier facilities in most cases. Local test desk testers are instructed not to apply ROH tone to any line equipment connected to carrier facilities.

11.26 Test of ROH tone on actual telephone connections showed the sound pressure levels varied from 109 to 110 dBa and 108 to 109 dB SPL*.

*0 dB SPL is 0.0002 dynes per square centimeter.

11.27 The ROH tone is applied to a line two times for approximately 50 seconds each time in most Bell System switching systems. However, the No. 2/2B ESS applies ROH tone once for a period of 40 seconds. Therefore, the ROH tone is well within Occupational Safety and Health Act (OSHA) limits which permit 110 dBa for 30 minutes and 115 dBa for 15 minutes.

TABLE T

BELL SYSTEM TONES (NOTE 1)

NAME	FREQUENCIES (Hz) (NOTE 2)	TEMPORAL PATTERN (NOTE 3)	LEVELS (NOTE 4)
1. Low Tone	480 + 620 600 × 120 600 × 133 600 × 140 600 × 160	Various	–24 dBm/frequency 61–71 dBrnC 61–71 dBrnC 61–71 dBrnC 61–71 dBrnC
2. High Tone	480 400 500	Various	–17 dBm 61–71 dBrnC 61–71 dBrnC
3. Dial Tone	350 + 440 See Low Tone (except 480 + 620)	Steady Steady	–13 dBm/frequency
4. Audible Ring Tone	440 + 480 420 × 40 500 × 40	2 seconds on, 4 seconds off. . .* 2 seconds on, 4 seconds off. . .* 2 seconds on, 4 seconds off. . .*	–19 dBm/frequency 61–71 dBm/frequency 61–71 dBm/frequency
5. Line Busy Tone	See Low Tone	0.5 second on, 0.5 second off. . .	
6. Reorder (local) (toll)	See Low Tone See Low Tone 480 + 620	0.3 second on, 0.2 second off. . . 0.2 second on, 0.3 second off. . . 0.25 second on, 0.25 second off. . .	
7. 6A Alerting Tone	440	2 seconds on, followed by 1/2 second on, every 10 seconds	
8. Recorder Warning Tone	1400	0.5-second burst every 15 seconds	
9. Recorder Connected Tone	440	0.5-second burst every 5 seconds	
10. Reverting Tone	See Low Tone	0.5 second on, 0.5 second off. . .	–24 dBm/frequency
11. Deposit Coin Tone	See Low Tone	Steady	
12. Receiver Off-Hook	1400 + 2060 + 2450 + 2600	0.1 second on, 0.1 second off. . .	0 dBm/frequency
13. Howler	480	Incremented in level every 1 second for 10 seconds	Up to +40 VU
14. Partial Dial Tone	See High Tone	Steady	

(See Notes at end of table.)

TABLE T (Contd)

BELL SYSTEM TONES (NOTE 1)

NAME	FREQUENCIES (Hz) (NOTE 2)	TEMPORAL PATTERN (NOTE 3)	LEVELS (NOTE 4)
15. No Such Number ("Cry Baby")	200 to 400	Frequency modulated at 1 Hz, interrupted every 6 seconds for 0.5 second	
16. Vacant Code	See Low Tone	0.5 second on, 0.5 second off, 0.5 second on, 1.5 seconds off. . .	
17. Busy Verification Tone (Centrex	440	Initial 1.5 seconds followed by 0.3 second every 7.5 to 10 seconds (6 seconds in No. 1/1A ESS)	—13 dBm
(TSPS)	440	Initial 2 seconds followed by 1/2 second every 10 seconds	—13 dBm
18. Call Waiting Tone	440	Two bursts of 0.5 second separated by 10 seconds	—13 dBm/frequency
19. Confirmation Tone	350 + 440	0.1 second on, 0.1 second off, 0.3 second on	—13 dBm/frequency
20. Indication of Camp-On	440	1 second every time attendant releases from loop	—13 dBm
21. Special Dial Tone	350 + 440	Three bursts (0.1 second on, 0.1 second off) then steady on	—13 dBm/frequency
22. Priority Audible Ring (AUTOVON)	440 + 480	1.65 seconds on, 0.35 second off. . .	—16 dBm/frequency
23. Preemption Tone (AUTOVON)	440 + 620	Steady 3 to 15 seconds	—18 dBm/frequency
24. Data Set Answer Back Tone	2025	Steady	—13 dBm
25. Automatic Credit Card Dialing — Prompt Tone	941 + 1477 followed immediately by 440 + 350	60 msec 940 msec (exponentially decayed from —10dBm per frequency at —3 TLP at time constant of 200 msec)	—10 dBm/frequency at —3 TLP

(See Notes at end of table.)

TABLE T (Contd)

BELL SYSTEM TONES (NOTE 1)

NAME	FREQUENCIES (Hz) (NOTE 2)	TEMPORAL PATTERN (NOTE 3)	LEVELS (NOTE 4)
26. Class of Service	See High Tone	0.5 to 1 second once	
	See Low Tone	0.5 to 1 second once	
	No Tone		
27. Dial-Normal Transmission Signal	See Low Tone	Steady	
28. Dial Jack Tone	See Low Tone	Steady	
29. Order Tones			
(single-order tone)	See High Tone	0.5 second, approximately	
(double-order tone)	See High Tone	Two short spurts in quick succession	
(triple-order tone)	See High Tone	Three short spurts in quick succession	
(quadruple-order tone)	See High Tone	Four short spurts in quick succession	
30. Intercepting Loopback Tone	See High Tone	Steady	
31. Number Checking Tone	See High Tone	Steady	
	135	Steady	
32. Coin Denomination Tones			
3 slot stations 5¢	1050-1100 (bell)	one tap	
3 slot stations 10¢	1050-1100 (bell)	two taps	
3 slot stations 25¢	800 (gong)	one tap	
1 slot stations 5¢	2200 + 1700	one "beep"	
1 slot stations 10¢	2200 + 1700	two "beeps"	
1 slot stations 25¢	2200 + 1700	five "beeps"	
33. Coin Collect Tone	See Low Tone	Steady	
34. Coin Return Tone	See High Tone	0.5 to 1 second once	
35. Coin Return (Test) Tone	See High Tone	0.5 to 1 second once	
36. Group Busy Tone	See Low Tone	Steady	
37. Vacant Position Tone	See Low Tone	Steady	
38. Dial Off-Normal Tone	See Low Tone	Steady	

(See Notes at end of table.)

TABLE T (Contd)

BELL SYSTEM TONES (NOTE 1)

NAME	FREQUENCIES (Hz) (NOTE 2)	TEMPORAL PATTERN (NOTE 3)	LEVELS (NOTE 4)
39. Permanent Signal	See High Tone	Steady	
40. Warning Tone	See High Tone	Steady	
41. Trouble Tone	See Low Tone	Steady	
42. Service Observing Tone	135	Steady	
43. Proceed to Send Tone (IDDD)	480	Steady	—22 dBm
44. Centralized Intercept Bureau Order Tone	1850	500 msec	—17 dBm
45. ONI Order Tone	700 + 1100	95 to 250 msec once	—25 dBm†

Notes:

1. Tones 1 through 24 are customer tones; tones 25 through 44 are operator tones.
2. Where more than one frequency is used, the plus sign (+) means "added to" and the times sign (X) means "modulated by."
3. Three dots (. . .) in the pattern description means that the stated pattern is repeated indefinitely.
4. Except where noted, levels are given at the point of application to the circuit.

* Pattern is 1 second on, 3 seconds off . . . for PBX and centrex CU.

† At operating position.

TABLE U

GLOSSARY OF BELL SYSTEM TONES

NAME	DESCRIPTION
1. Low Tone	This is a generic tone used with various interruption patterns for the specific tones listed below and described elsewhere under their own titles. Line Busy Tone Reorder Reverting Tone No Circuit Tone No Such Number Vacant Code Group Busy Tone Deposit Coin Tone Vacant Position Tone Dial Off-Normal Tone Trouble Tone Dial Jack Tone Dial Test Signal Class of Service
2. High Tone	This is a generic tone used with various interruption patterns for the specific tones listed below and described elsewhere under their own titles. Partial Dial Tone Permanent Signal Coin Return (Test) Tone Coin Return Tone Number Checking Tone Intercepting Loopback Tone Warning Tone Order Tones Station Ringer Test Class of Service
3. Dial Tone	This tone is sent to a customer or operator to indicate that the receiving end is ready to receive dial pulses or TOUCH-TONE signals. It is used in all types of dial offices when dial pulses are produced by the customer's or operator's dials. Normally dial tone means that the entire wanted number may be dialed; however, there are some cases where the calling party must await a second dial tone or where an operator, after dialing an initial group of digits, must wait for a second dial tone before the rest of the number can be dialed. Some dialing switchboards are arranged to permit listening for dial tone between certain digits.
4. Audible Ring Tone	This is a ringing indication which is interpreted by the calling party to mean that the called line has been reached and that ringing has started. It is also used on calls to operators (special service, long distance, intercepting, etc) during the "awaiting-operator-answer" interval.

TABLE U (Contd)

GLOSSARY OF BELL SYSTEM TONES

NAME	DESCRIPTION
5. Line Busy Tone	Low tone interrupted at 60 IPM, 50 percent BK, indicates that the called customer's line has been reached but that it is busy or being rung or on permanent signal. When a line busy signal is applied by an operator, it is sometimes call a *busy-back tone*.
6. Reorder	Low tone interrupted at 120 IPM, in all types of offices, indicates that the local or toll switching or transmission paths to the office or equipment serving the called customer are busy. This signal may indicate a condition such as a timed-out sender or unassigned code dialed. It is interpreted by either a customer or an operator as a reorder signal. In No. 5 crossbar, No. 1/1A ESS, No. 2/2B ESS, and No. 1 step-by-step offices using the Precise Tone Plan, the temporal pattern is 0.25 second of low tone and 0.25 second off. In other offices, the intervals are 0.3 second of low tone and 0.2 second off (local), and 0.2 second low tone and 0.3 second off (toll).
7. Alerting Tone	Indicates that an operator has connected to the line (emergency interrupt on a busy line during a verification call).
8. Recorder Warning Tone	When recording equipment is used, this tone is connected to the line to inform the distant party that the conversation is being recorded. The tone source is located within the recording equipment and cannot be controlled by the party applying the recorder to the line. This tone is required by law and is recorded along with the speech.
9. Recorder Connected Tone	This tone is used to inform the customer that his/her call is completed to a recording machine and that he/she should proceed to leave a message, dictate, etc. It is to be distinguished from the recorder warning tone, which warns the customer that his/her 2-way conversation is being recorded.
10. Reverting Tone	The same type of signal as line busy tone is used for reverting tone in all systems. In No. 5 crossbar systems, a second dial tone is sometimes also used when a calling party identification digit is required. The reverting signal informs the calling subscriber that the called party is on the same line and that he/she should hang up while the line is being rung.
11. Deposit Coin Tone	This tone, sent from a CDO to a post-pay coin telephone, informs the calling party that the called party has answered and that the coin should be deposited.
12. Receiver Off-Hook Tone	This tone is used to cause off-hook customers to replace receiver on-hook on a permanent signal call and to signal a non-PBX off-hook line when ringing key is operated by a switchboard operator.
13. Howler	This tone is used in older offices to inform a customer that his/her receiver is off-hook. It has been superseded by the receiver off-hook tone.

TABLE U (Contd)

GLOSSARY OF BELL SYSTEM TONES

NAME	DESCRIPTION
14. Partial Dial Tone	High tone is used to notify the calling party that he/she has not commenced dialing within a preallotted time, measured after receipt of dial tone (permanent signal condition), or that he/she has not dialed enough digits (partial dial condition). This is a signal to hang up and dial again.
15. No Such Number ("Cry Baby")	This signal tells the calling party to hang up, check the called number, and dial again. Calls to unassigned or discontinued numbers may also be routed to intercepting operators or preferably to a machine announcement system, such as the 6A or 7A, which verbally supplies the required message. In some offices, reorder tone is returned in this condition.
16. Vacant Code	This tone is used in crossbar systems to indicate that the dialed office code is unassigned. In step-by-step areas, this signal is called *vacant level tone*. Recorded verbal announcements may also be used for this service. For operator-originated calls, the verbal announcement is preceded by two flashes.
17. Busy Verification Tone (Centrex)	Busy verification is a centrex feature that allows the attendant to call and be connected to a busy centrex station within the attendant's customer group. The *busy verification tone* is applied to *both* parties of the connection to inform them of the intrusion by the attendant. No tone is applied if the station called for busy verification is idle.
18. Call Waiting Tone	Call Waiting is a special service that allows a busy line to answer an incoming call by flashing the switchhook. Audible ring (instead of line busy) is applied to the calling line, and the *call waiting tone* is applied to the called line. (So that only the call*ed* party hears the tone, the connection is momentarily broken, and the other party to that connection experiences a moment of silence.) Flashing the switchhook places the existing connection on hold and connects the customer to the waiting call.
19. Confirmation Tone	This tone is used to acknowledge receipt by automatic equipment of information necessary for special services. It is currently used for: (1) Speed Calling — dialed number has been recorded or (2) Call Forwarding — dialed number has been recorded and service is activated or Call Forwarding — service is deactivated.
20. Indication of Camp-On	Attendant camp-on service allows an ESS centrex attendant to hold incoming calls to busy lines. Each time the attendant releases his/her talking connection from the loop involved in the camped-on call, the *indication of camp-on tone* is heard by the called customer if the customer has subscribed to the indication of camp-on option. The customer may get this tone several times as the attendant reconnects and releases from the loop in response to timed reminders from the console.

TABLE U (Contd)

GLOSSARY OF BELL SYSTEM TONES

NAME	DESCRIPTION
21. Special Dial Tone	This tone is used with three way calling, centrex station dial transfer, and centrex conference (station or attendant) services. The user on an existing connection flashes the switchhook, receives *special dial tone,* and dials number of the third party to be added to the connection.
22. Priority Audible Ring (AUTOVON)	This tone replaces normal audible ring for priority calls within AUTOVON.
23. Preemption Tone (AUTOVON)	This tone is provided to both parties of a connection that is preempted by a priority call from AUTOVON.
24. Data Set Answer Back Tone	This tone is heard by customers when manually initiating a data call. It normally occurs shortly after the onset of audible ringing and means that the remote data set has answered. The data set at the calling end should then be put into the data mode.
25. Automatic Credit Card Dialing — Prompt Tone	This tone is used to inform the customer that his/her credit card information must be keyed in.
26. Class of Service	These signals are used at a toll board operating as an "A" board to identify the class of service of the calling customer. The indication may be high, low, or no tone.
27. Dial-Normal Transmission Signal	This is a second dial tone returned to an operator between digits indicating that he/she may dial the remainder of the number. For example, when an operator reaches a link-type CDO via a step-by-step office after dialing a routing code, he/she must pause until an idle link at the CDO returns dial tone. This method of operation is not recommended or considered standard.
28. Dial Jack Tone	Low tone is used as a start-dial signal to tell a DSA operator that the connection reached through a dial jack is ready to receive dialing.
29. Order Tones	High tones sent over interposition, local interoffice, or toll trunks indicate: (1) to the originating operator that the order should be passed and (2) to the receiving operator that an order is about to be passed. For Call Announcer (CA) and Automatic Display Call Indicator (ADCI), the tone serves function (2) only. (a) Single-order tone — This is a relatively long (approximately 0.5 second) signal which means that the originating operator should pass the office name and number. (b) Double-order tone — This signal is two short spurts in quick succession and means that the operator should pass only the desired number.

TABLE U (Contd)

GLOSSARY OF BELL SYSTEM TONES

NAME	DESCRIPTION
29. Order Tones (Contd)	(c) Triple-order tone — This signal is three short spurts in quick succession and means that the operator should pass the office name only and wait for another order tone. (d) Quadruple-order tone — This signal is four short spurts in quick succession and means that the operator should pass the city name only and wait for another challenge. It is used in manual toll tandem (also called zip tones or trunk assignments tones).
30. Intercepting Loopback Tone	High tone sent from an intercept operator to the "A" board operator in manual offices indicates that the intercept operator has completed the call and that the "A" operator should disconnect from the circuit. The completion of intercepted calls in this manner is no longer
31. Number Checking Tone	High tone is sometimes used at DSA switchboards in No. 1 crossbar and some step-by-step areas to verify the verbal identification of the calling line.
32. Coin Denomination Tones	These tones enable the operator to determine the amount deposited in coin telephones.
33. Coin Collect Tone	Low tone over a coin recording-completing trunk informs the originating toll operator that the local operator or coin control circuit has collected the charge.
34. Coin Return Tone	High tone over a coin recording-completing trunk informs the originating toll operator that the local operator or coin control circuit has returned the charge when the connection is not completed (also called coin refund tone).
35. Coin Return (Test) Tone	High tone is used to tell an operator in a dial central office that a testman has completed a call to his/her position over a coin trunk.
36. Group Busy Tone	This audible signal is indicated by low tone on the sleeve of trunk jacks at cord switchboards. Absence of the tone tells the operator that there is at least one idle trunk in a group.
37. Vacant Position Tone	Low tone is applied to all straightforward trunks terminating in a vacated position in manual offices.
38. Dial Off-Normal Tone	Low tone is returned to an operator after he/she has completed a call into a step-by-step office and after the calling party has answered to remind him/her to restore the dial key.

TABLE U (Contd)

GLOSSARY OF BELL SYSTEM TONES

NAME	DESCRIPTION
39. Permanent Signal	A customer's line, not in use, which exhibits a steady off-hook condition is routed to a permanent signal trunk. High tone, superimposed on battery, is supplied through a resistance lamp to the ring of the trunk. The tone is used to inform an operator or other employee making a verification test that the line is temporarily out of service. An intermittent ground may also be applied to the ring of the telephone systems left in the hold condition. Typical reasons for the line condition are: (a) No dialing within the allowed waiting interval. (b) A handset is off-hook. (c) Low insulation resistance or other line trouble. In some offices, if three or more digits are dialed but not a complete telephone number or code, the call is released and dial tone is returned.
40. Warning Tone	High tone warns an operator that the circuit he/she is connected to is not in condition for normal operation. Examples: (1) An operator at an ADCI position plugs into the wrong jack. (2) An operator at a sender monitor position plugs into a sender supervisory jack while the sender is under test.
41. Trouble Tone	Low tone applied by an operator or testman at a B position in a manual office to the jack sleeve of a line or trunk in the calling multiple tells other operators the line or trunk is in trouble (also called plugging-up cord tone).
42. Service Observing Tone	This tone indicates that the trunk to which it is applied is being service observed.
43. Proceed to Send Tone (IDDD)	This tone informs the operator that an overseas sender has been seized and the address information (KP-CC-CC-ST) should be transmitted.
44. Centralized Intercept Bureau Order Tone	This tone tells the centralized intercept bureau operator that a call has reached the position.
45. ONI Order Tone	This tone tells the ONI operator that a call has reached the position.

11.28 Because of the circuit used to provide ROH tone, it is not possible to give individual tone levels at a specific reference point. Therefore, Fig. 40 and the following paragraphs will describe the ROH tone generator, distribution arrangement, and measurement equipment in some detail.

11.29 There are four Hartley oscillators, one for each frequency shown in the left portion of Fig. 40 (1400, 2060, 2450, and 2600 Hz). The oscillators depend upon circuit nonlinearities to limit output amplitude. There is no per-oscillator adjustment. The maintenance practice indicates that the oscillators are operating satisfactorily if the output of each is greater than 1 volt when measured on a 400-type Hewlett-Packard ac voltmeter.

11.30 A keyer applies and removes power from the oscillators. The keyer applies power for 0.1 second and then removes power for 0.1 second on a repetitive basis to provide 5-PPS tone from each oscillator.

11.31 A 150-KOHM resistor isolates each oscillator from a common tone bus where all four tones are present at approximately equal amplitude. A 1000-ohm potentiometer is connected from the tone bus to ground to control the voltage supplied to the amplifier. This is the only adjustable element in the ROH tone generator and distribution circuit.

11.32 The mixed and keyed tones are fed from the potentiometer to the amplifier. The output of the amplifier is a balanced signal which is fed to the resistive distribution network. The output of the amplifier is the location specified as the measuring location for adjustment purposes. A volume indicator is attached at the output of the amplifier and the potentiometer is adjusted to give a +11 VU reading at this point. The volume indicator used is described in more detail in the following paragraphs.

11.33 The ROH tone then passes through two 442-ohm resistors and a 94E repeat coil after leaving the amplifier. The tone is estimated to be at a level of +6 VU at this point and at a level of +5 VU after passing through the switching machine to the customer's side of the main distributing frame. However, there are no requirements for tone level at these locations.

11.34 The following is a synopsis of the volume indicator description:

(a) The volume indicator consists of an indicating meter and a calibrated attenuator in series. It is intended primarily for the measurement of speech or music volume or the level of a nonsinusoidal signal at a given point in a circuit. Such measurements made in VU are valid only when read in a prescribed manner on a standard VU meter having closely controlled dynamic characteristics and calibrated so that the volume indicator reads 0 VU (algebraic sum of meter needle deflection and volume indicator attenuator setting) when it is bridged across a 600-ohm circuit terminated in 600 ohms in which 1 mW of 1000-Hz power is flowing.

(b) The actual dynamic characteristic of a standard volume indicator is such that when a steady sine wave is suddenly impressed, the meter will reach 99 percent of its steady-state reading in 0.3 second ±10 percent and overswing the steady-state value by at least 1 but not more than 1.5 percent. The time for the pointer to come to rest after removal of the voltage should not be far different from the response time. It should be noted that when used to measure the level of speech or music, the indication in VU is not a true measure of average power, the meter being too slow to indicate true peak power and too fast to give a true indication of average power.

(c) For steady-state sine-wave power, the readings of the instrument in VU are numerically equal to the level in dBm (for the case of a 1000-Hz test signal in a 600-ohm circuit). Therefore, the volume indicator may be used for many types of transmission measurements where the range of the meter and its accuracy are considered adequate.

(d) As used to measure the level of the ROH tone generator, the volume indicator has an impedance of 7500 ohms.

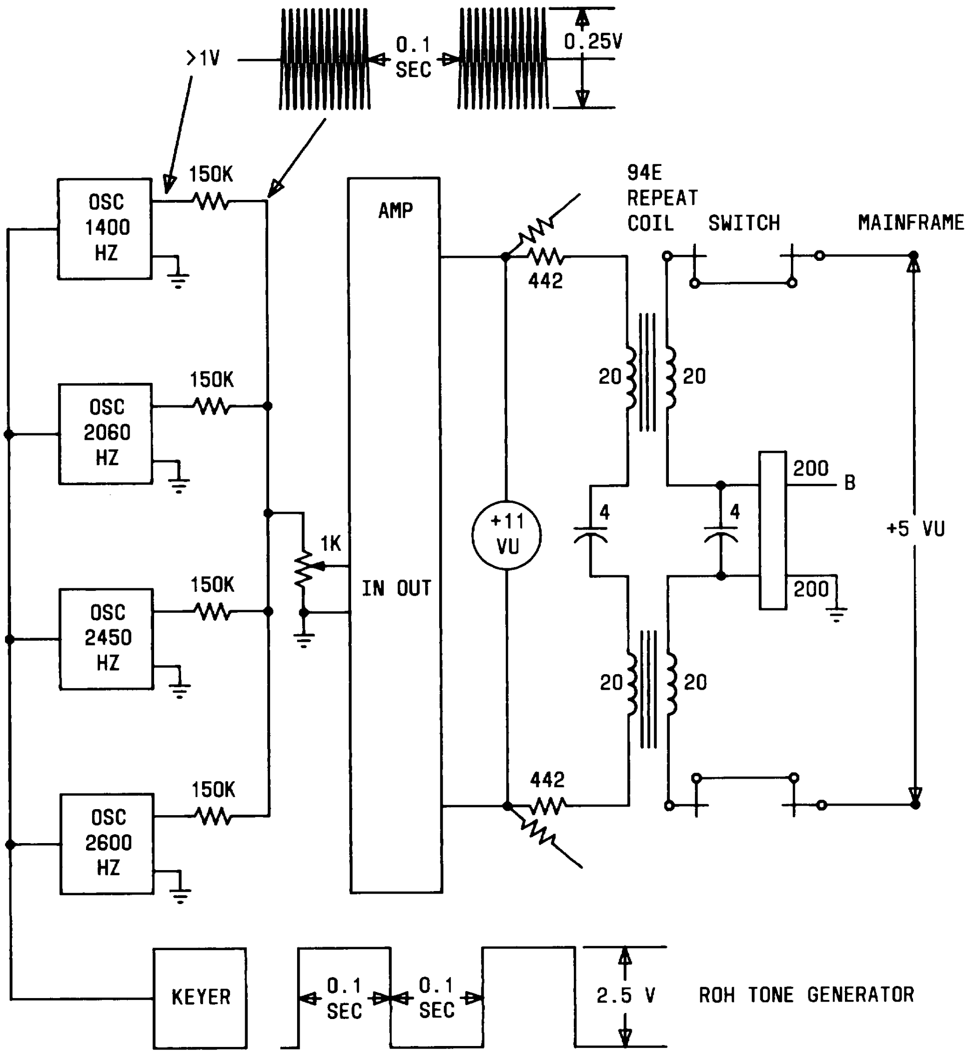


Fig. 40—ROH Tone Circuit

12. OTHER MISCELLANEOUS SIGNALS

RINGING

12.01 Ringing signals are used for alerting the called customer and are not used in interoffice signaling. Switching trains designed for controlled ringing require a ringing start signal. These trains, when used for toll dialing, must operate on an automatic ringing basis. To accomplish this, some trunk circuits and senders are arranged to generate a ringing start signal when required.

12.02 While many trunks still require a ringing start signal, the use of this signal is declining. The use of delayed ringing trunks on a standard basis was discontinued several years ago in connection with the elimination of separate toll trains in step-by-step offices. However, many locations continue to provide them in new local offices for uniform operating procedures. The TSPS does not provide a ringing start signal.

12.03 Two types of ringing start signals are employed, SX and 20 Hz. SX ringing start consists of +130 volts applied on a simplex basis to both conductors for a minimum of 0.1 second, whereas 20-Hz ringing start consists of 105 Vac ringing current applied on a loop basis for a minimum of 0.35 second. The SX ringing start signal can be applied after the first digit has been sent (as in trunk circuit design) or after all digits have been sent (as in sender design). The 20-Hz ringing start signal, however, cannot be sent until the line seizure signal has been received.

A. Ring Forward (Rering)

12.04 This is a signal used by an operator at the calling end to recall an operator at the called end on an established connection. It is originated by means of a ringing key in the cord circuit. On trunks arranged for use with E&M lead signaling systems, relays in the outgoing trunk equipment generate a single on-hook pulse for each pull of the ringing key. As applied to toll dialing circuits, ring forward is a momentary on-hook of 100 ±30 milliseconds transmitted toward the called end (50 to 140 milliseconds received) which is converted at the destination office to a recall signal on the operator's answering cord. On trunks arranged for loop signaling, an SX +130 volt ring forward signal (paragraph 12.05) is sent for 100 ±30 milliseconds.

B. Crossbar Tandem—Ring Forward Signal

12.05 The incoming intertoll trunk circuit in the crossbar tandem office will recognize a momentary on-hook signal on the E lead as a ring forward (rering) signal. To be recognized as a ring forward signal, the on-hook signal must be: (1) longer than the recognition time of the trunk circuit (about 50 milliseconds) and (2) shorter than the disconnect time of the trunk circuit (disconnect time covered in paragraph 2.13) (less than 140 milliseconds). After the recognition time has passed, the trunk circuit is primed to send this ring forward signal toward the terminating end of the circuit. When the E lead has returned to off-hook, the trunk circuit converts the incoming ring forward signal to an SX forward rering signal which is +130 volts through 2000 ohms applied for 100 milliseconds minimum to both the tip and ring leads in the terminating direction. This signal passes through the switch where one of two conditions can occur.

(1) If there is an outgoing trunk circuit in the crossbar tandem office, the ring forward signal can be converted to a form compatible to the next signaling link or blocked from progressing into the next signaling link.

(2) If there is no outgoing trunk circuit, as is the case with most loop outgoing trunks in the crossbar tandem office, the SX forward rering signal will pass through the trunk facility to the incoming trunk circuit in the terminating office. If the incoming trunk circuit does not have a supervisory relay with balanced windings, the +130 volt signal may act as a false disconnect signal. (See Fig. 41 and Section 4.)

C. Ringback

12.06 Ringback is a signal used by an operator at the called end of an established connection to recall the originating operator. The operation of the called operator's ringing key sends an on-hook pulse back to the calling end which is converted to a recall signal on the originating operator's cord lamp or TSPS console. Ringback continues as long as the called operator's ringing key is operated. Ringback is also a signal used by an operator to recall a customer or to alert the calling customer.

12.07 Operator-controlled ringing (ringback) is required on all coin lines to ring the telephone if the calling customer hangs up after the call is completed to alert the customer when an overtime deposit is necessary. It is also used to summon a customer who has requested a time and charge quote but has hung up. Ringback has also been used to identify the calling line on emergency calls, on other than 4- or 8-party lines, if the caller inadvertently hangs up before identifying the location of the emergency. This second use is not necessary and not provided for in the TSPS because the TSPS operator has the calling number, for other than 4- or 8-party lines, displayed on the position for ANI calls.

12.08 If a 4- or 8-party line customer has made an emergency call and then hung up, the calling number will not be available at the TSPS. In addition, the operator ringback request for a multiparty line is ignored in the No. 3 ESS. For emergency calls to the No. 2/2B ESS, a special emergency key is required at the TSPS in addition to the regular ringback key.

12.09 Interoffice coin trunks with the ringback feature can be arranged for unrestricted ringback or restricted ringback. With the former, ringing is applied whether the station is on- or off-hook. With the latter, ringing is applied only if the station is off-hook.

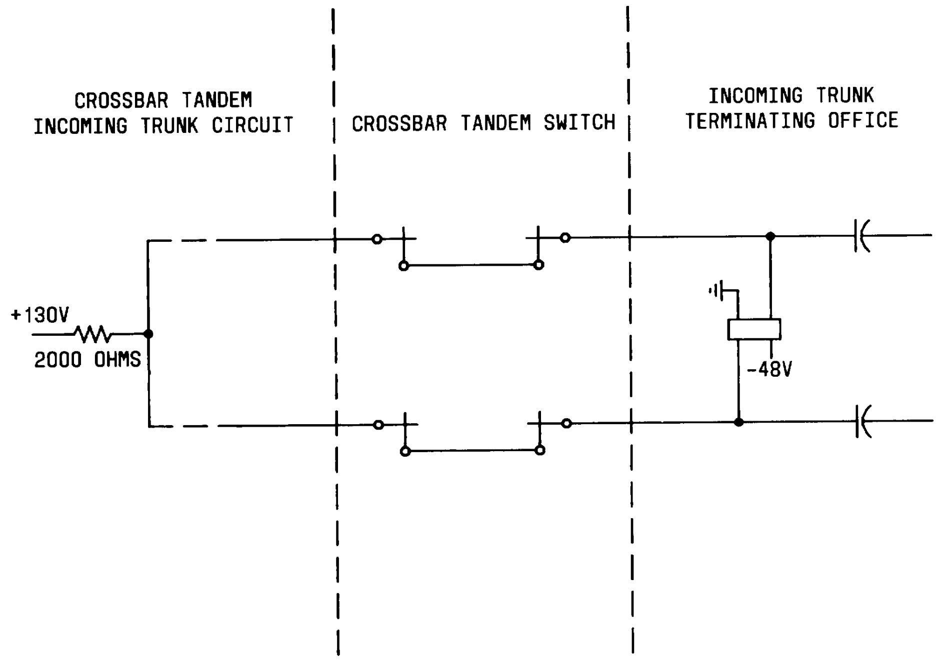


Fig. 41—Incoming Trunk Circuit Without Balanced Windings on Supervisory Relay

12.10 Unrestricted ringback is provided:

(a) For all coin lines regardless of serving office type

(b) For all single-party ESS lines

(c) For all (single-party) lines in electromechanical offices that have no party lines.

Restricted ringback is used to guard against annoying a customer if the operator should attempt to ring back against a party line and rings the wrong party.

12.11 With loop trunks to the local central office as the ringback signal, 20-Hz ringing or reverse battery can be used. Noncoin trunks can use a single wink, while coin trunks can use MF tones or multiwink, as described later, as a ringback signal.

12.12 An emergency ringback method is available for use with recording—completing trunks from some local central offices. In this case, an operator, having determined that some emergency exists on a line that has gone on-hook after being answered, can attempt to identify that line. By operating a common emergency ringback key in addition to the appropriate cord ringing key, the operator will cause that line to be rung sequentially with each possible ringing combination. If any party responds, the operator can determine a number and from this can identify all parties on the line from office or test desk records. Emergency ringback is not provided with the TSPS and is classified "manufacture discontinued" for other equipment arrangements. Therefore, there is no way in an emergency situation for TSPS to ring back a multiparty line.

D. TSPS Noncoin Wink Ringback Signal

12.13 The wink ringback signal sent from the TSPS on noncoin trunks is 75 milliseconds (+50, -5 milliseconds). The trunk circuit should be capable of recognizing an on-hook wink having a duration of 50 to 150 milliseconds.

TONES AND ANNOUNCEMENTS

12.14 Tones and announcements are used to inform customers and operators of various conditions encountered on dialed calls. They are also required for service analysis of conditions which result in failure to complete dialed calls. Analysis data are used to evaluate administrative, engineering, and maintenance efforts to improve service.

12.15 Tones are used primarily to identify busy conditions of lines and some trunks. Generally, 60-IPM tone is used to identify busy lines and 120-IPM tone is used to identify busy trunks. The appropriate customer action for either condition is to hang up and try the call again.

12.16 Announcements are used when the condition encountered requires explanation for both customers and operators. Announcements also suggest the appropriate action to be taken. The use of "no circuit" (N), "overload" (O), and "special" (X) announcements space attempts in order to relieve overloaded switching systems and trunk networks.

12.17 Local options on tones and announcements created no serious problem prior to the advent of toll dialing. However, with the system now an integrated multioffice network, a variety of tones or announcements for the same conditions are most confusing from the customer standpoint. Also, nonuniformity makes it impossible to analyze performance results with any degree of accuracy. Service evaluators (observers) identify each type of announcement by certain key words in the announcement. Therefore, uniformity of tones and announcements throughout the system is a requirement.

A. Location Codes

12.18 Identification codes are appended to recorded announcements to facilitate trouble tracing and to help locate the source of blockages encountered on the toll network. They provide a savings in both man-hours and circuit outage time since, except where CCIS is involved, call failures can be referred directly to the office where the blockage occurred.

12.19 Experience has shown that adverse customer reaction to identification codes is minimized when the code number is placed at the end of the announcement. Since announcement trunks are arranged so that a customer hears the announcement from its beginning, the code will be heard only when the customer remains on the line throughout the entire message.

12.20 Identification codes are assigned according to the following guidelines:

(a) Codes are assigned to toll switching offices.

(b) The first three digits of the code are the Numbering Plan Area (NPA) code indicating the location of the switching office.

(c) The fourth and fifth digits are assigned as follows:

- Digit 1—Assigned to switching system serving as a Regional Center
- Digit 2 or 3—Assigned to switching systems serving as Sectional Centers
- Digit 4 and higher—Assigned to Primary and Toll Center switching systems.

12.21 Switching systems with trunks utilizing CCIS should append the letter ***C*** to their identification code. For example, the code for the Atlanta 4E office, with CCIS, would be 4043C. This is done to alert network maintenance that an announcement received at a CCIS office could be the result of a blockage condition beyond the office transmitting the announcement.

12.22 Gateway office announcement codes will contain one additional suffix digit to further describe the announcement condition encountered. The authorized suffixes are as follows:

- Digit 1—International No Circuit (NC)
- Digit 2—International Reorder
- Digit 3—International Vacant Code
- Digit 4—International Unauthorized Code
- Digit 5—International Foreign Failure.

An example of an identification code of this type for Pittsburgh is 4121C1, indicating an NC condition to an international point from Pittsburgh.

12.23 Certain announcements terminated in the Mass Announcement System (MAS) will contain the identifying suffix ***M*** in addition to the area code and identification code, ie, 2141M for a Dallas MAS vacant code announcement.

12.24 Requests for new assignments or changes to United States system codes shown in Table V should be made to:

District Manager—Network Methods
Telephone: (201) 221-5788

12.25 The TransCanada Central Traffic Staff is responsible for the administration of the TransCanada code list shown in Table W.

B. Special Announcements

12.26 Recommended standard announcements in no way prohibit the use of special announcements when required for specific situations such as disasters and work stoppages.

C. Equipment Operation

12.27 Announcement trunks should be equipped for delayed cut-through so that an announcement will be heard from the start of the message. There should be an audible ring during the interval before the start of the announcement and the interval should be as short as possible. Announcements should be brief and carefully prepared. It is important also that announcement facilities be kept in working order and proper routines established to check and maintain the quality of announcements.

12.28 Announcement systems used for intercepted numbers should be arranged for operator cut-through.

D. Recommended Tones and Announcements

12.29 Figure 42 provides a list of recommended tones and announcements for the various conditions encountered. Also see Technical Advisory 28 for additional information.

12.30 Recording machines are used in the Bell System to provide announcements. A primary use of the recorded announcement machines is to provide an intercepting message to calls reaching vacant or disconnected customer numbers. One such machine provides a single channel with an announcement interval which is usually fixed for a particular installation. It may be set to one of six intervals ranging from 11 to 36 seconds. Means are provided to connect a trunk at the beginning of an announcement interval and repeat from one to nine announcements (two or three is the usual number) and then to connect to an intercept operator. Two machines are usually provided, one for service and one for standby. If the voice output of the machine in service fails, the standby machine is automatically placed in service. In multioffice cities, the machines are provided in a central location and intercept trunks may be brought into the center or to subcenters to which the announcements are transmitted.

12.31 A smaller machine is used in small dial offices where neither operator intercept nor the larger intercept machines can be economically justified. In this use, changed numbers, vacant thousands, and hundreds levels, as well as all vacant or disconnected numbers, are connected to the machine. Normally, only one machine is provided. This machine operates on a stop-start basis. When started, all subsequent calls requiring intercept in the announcement interval are cut in immediately to the machine at any stage of the announcement cycle. Provision can be made for subsequent transfers to an operator.

12.32 Direct-dialed toll calls will reach these machines when required. The announcements are so worded that the customer can understand the proper action to be taken. Also, it is desirable to inform the customer that the announcement is recorded. Connections to announcement machines should not return off-hook (answer) supervision.

12.33 Crossbar tandem and No. 4 crossbar switching systems are equipped so that appropriate recorded announcements may be returned to calls which fail to complete because:

(a) All trunks are busy due to heavy traffic or disaster.

(b) A switching system is overloaded.

(c) Vacant codes or unauthorized numbers are dialed.

(d) Operating or equipment irregularities are encountered.

12.34 Cut-through to an operator is not contemplated under these circumstances. Figure 42 contains some of the tones and announcements recommended for network dialing.

TABLE V

IDENTIFICATION CODES FOR RECORDED ANNOUNCEMENTS WITHIN THE UNITED STATES

IDENT. NO.	OFFICE
2012	Newark 4T
2014	Rochelle Park No. 1
2015	Newark-Essex No. 1
2016	Newark-Essex No. 2
2017	Newark-Jersey No. 1
2018	Newark-Jersey No. 2
2019	Paterson
20110	Hackensack
20111	New Brunswick XBT
20112	Asbury Park
20113	Freehold
20114	Morristown
20115	Bergen
20116	Flemington
20117	Clinton
20118	Newton
20119	New Brunswick 4T
20120	Newark No. 7 4T
20121	Sussex
20122	Cedar Knolls
20123	Rochelle Park No. 2
20124	Belvidere Tandem
2022	Washington 4T Sect.
2024	Washington-4E Pri.
2025	Washington-Uptown
2027	Washington-DuPont
2028	Mount Pleasant
2029	Washington-Southwest XBT
2032	New Haven 4T
2034	Hartford No. 1 and 2
2035	Hartford No. 3 4T
2036	New Haven XBT
2037	Bridgeport
2038	Stamford
2039	Waterbury
20310	Meriden XBT
20311	Danielson
20312	Danbury ESS
20313	New London XBT
20314	Norwalk
20315	Bridgeport 4A
20316	Manchester ESS
20317	Torrington ESS
20318	Meriden 1E
20319	New Britain 1E
20320	New London 1E
20321	New Haven 1E
20322	Stamford 1E
20323	Hartford 1E
20324	Norwalk 1E
20325	Bridgeport 1E
20326	Bristol 1E
20327	Middletown 1E
204	See TransCanada (Table W)
2052	Birmingham
2054	Montgomery
2055	Mobile
2056	Decatur
2057	Gadsden
2058	Huntsville
2059	Dothan 1
20510	Tuscaloosa
20511	Jasper
20512	Selma
20513	Leesburg
20514	Sheffield
20515	Foley
20516	Monroeville
20517	Atmore
20518	Dothan 2
20522	Anniston
2062	Seattle 4T Sect.
2063	Seattle 4E
2064	Seattle XBT
2065	Seattle-Mutual
2067	Tacoma
2068	Seattle 4T Pri.
2069	Everett
20610	Poulsbo 4P
2074	Portland XBT
2075	Bangor
2076	Lewiston
2077	Portland 4T
20710	North Anson
2084	Boise

TABLE V (Contd)

IDENTIFICATION CODES FOR RECORDED ANNOUNCEMENTS WITHIN THE UNITED STATES

IDENT. NO.	OFFICE	IDENT. NO.	OFFICE
2085	Twin Falls	21232	Kings No. 1 and 2
2086	Pocatello	21233	Forest Hills No. 1 and 2
2087	Idaho Falls	21235	Queens No. 1
2088	Salmon	21236	Jamaica
2089	McCall	21237	Richmond Hill No. 1
20810	Lewiston	21238	Richmond Hill No. 2
20811	Coeur D' Alene	21239	Staten Island
20812	Moscow	21242	Chelsea No. 1 and 2
		21243	Tenth Ave. No. 3
2092	Stockton No. 4T	21244	Lexington
2094	Fresno XBT	21245	Varick 4T
2095	Modesto	21246	Queens No. 2
2096	Fresno 4T	21247	West St. 6
2097	Reedly	21248	East 97th St.
2098	Stockton XBT	21249	New York No. 6
2099	Fresno ESS 1	21250	Williamsburg
		21251	New York 12
2122	New York No. 4	21252	Broadway No. 24
2123	New York No. 7	21253	Borough No. 4
2124	West St. No. 4		
2125	West St. No. 5-TSP	2132	Los Angeles No. 2
2126	Vesey No. 1	2134	Los Angeles No. 3
2127	Vesey No. 2	2135	Los Angeles 01 TSPS
2128	Vesey No. 3	2136	Gardena No. 2
2129	Borough No. 3	2137	Gardena TSPS
21210	New York No. 10 4T	21310	El Monte
21211	Tenth Ave. No. 1	21315	Sherman Oaks No. 2 4T
21212	New York No. 11 4T	21316	Sherman Oaks 02 TSPS
21213	Gotham No. 8	21331	Gardena No. 3
21214	Gotham No. 9	21340	Long Beach
21215	Interzone	21341	Santa Monica
21216	Brooklyn 4T	21373	Sherman Oaks No. 3 4T
21217	York No. 1	21374	Sherman Oaks 03 TSPS
21218	York No. 2		
21219	Amsterdam No. 1 and 2	2141	Dallas 4 ESS
21220	Broadway No. 2	2142	Dallas 4T Sect.
21221	Midtown No. 1 and 2	2144	Greenville
21222	Tenth Ave. No. 2	2145	Longview
21223	East 97th St. No. 5	2146	Athens
21224	Bronx No. 1 and TSP		
21226	Tremont No. 1 and 2	2151	Wayne
21228	Albermarle No. 1 and Brooklyn	2152	Philadelphia No. 2
21229	Albermarle No. 2-TSP	2153	Philadelphia 4 ESS
21231	Bushwick No. 1 and 2	2154	Philadelphia-East A

TABLE V (Contd)

IDENTIFICATION CODES FOR RECORDED ANNOUNCEMENTS
WITHIN THE UNITED STATES

IDENT. NO.	OFFICE	IDENT. NO.	OFFICE
2155	Philadelphia-East B	2184	Virginia
2156	Philadelphia-North A	2185	Wadena
2157	Philadelphia-North B		
2159	Tullytown	2192	South Bend 4T
21510	Reading	2194	South Bend XBT
21511	Allentown	2195	Fort Wayne
21512	Fort Washington		
21513	Easton	3012	Baltimore No. 2 4T
21514	Philadelphia No. 3 4T	3014	Baltimore TDM 3
21515	West Chester	3015	Silver Spring-Toll
21516	Lansdale	3016	Baltimore TDM 6
21517	Pottstown	3017	Baltimore TDM 7
		3018	Hyattsville
2162	Cleveland 4T Sect.	3019	Baltimore No. 9 4T
2163	Cleveland 4E Sect.	30110	Silver Spring-Local
2164	Cleveland-Clearwater No. 1	30112	Bel Air
2165	Cleveland-Garfield	30113	Salisbury
2166	Cleveland-Henderson No. 1		
2167	Cleveland-Henderson No. 2	3025	Dover
2168	Akron XBT	3027	Wilmington No. 4
2169	Canton XBT		
21610	Youngstown XBT	3031	Denver 4T Reg.
21611	Cleveland-Clearwater No. 2	3032	Denver 4T Sect.
21612	Ashtabula	3033	Denver 5 4 ESS
21613	Geneva	3034	Grand Junction
21614	Elyria	3035	Pueblo
21615	Cleveland 4T Pri.	3036	Denver No. 4 ZUNI
21616	Akron 4T	3037	Colorado Springs
21617	Warren	3038	Boulder
21618	Jefferson	3039	Ft. Collins
21619	Wooster	30310	Greeley
21620	Oberlin	30311	Sterling
21621	Youngstown 4A		
21622	Lorain	3042	Charleston
21623	Medina	3044	Clarksburg
21624	Minerva	3045	Wheeling
21625	New Philadelphia	3046	Bluefield
		3047	Elkins
2172	Springfield	3048	Fairmont
2174	Champaign 4T	3049	Lewisburg
2175	Decatur	30410	Logan
2176	Champaign XBT	30411	Weirton
		30412	Huntington
2183	Duluth	30414	Morgantown

TABLE V (Contd)

IDENTIFICATION CODES FOR RECORDED ANNOUNCEMENTS WITHIN THE UNITED STATES

IDENT. NO.	OFFICE	IDENT. NO.	OFFICE
30415	Parkersburg	3136	Detroit No. 2 4T
		3139	Flint
3052	Orlando	31310	Pontiac XBT
3054	Winter Park	31311	Plymouth 4T
3055	Miami 4T	31312	Pontiac 4T
3057	Fort Lauderdale	31313	Port Huron ESS
3058	West Palm Beach XBT	31314	Mt. Clemens ESS
3059	Ojus No. 1		
30510	West Palm Beach 4T	3141	St. Louis 4T Reg.
30511	Ojus No. 3	3142	St. Louis 4T Sect.
30512	Lake Buena Vista	3144	St. Louis TDM 1
30513	Winter Garden	3145	St. Louis TDM 2
		3146	St. Louis TSP
306	See TransCanada (Table W)	3147	Sikeston
		3148	St. Louis Kirkwood
3072	Cheyenne	3149	Jefferson City
3075	Casper	31410	Rolla
3076	Rock Springs	31411	Sullivan
3077	Sheridan	31412	Wentzville
3078	Worland	31413	Columbia
		31414	Mexico
3084	Grand Island	31415	Hannibal
3085	Sidney	31416	Poplar Bluff
		31417	Flat River
3094	Peoria 4T	31418	Cape Girardeau
3095	Peoria XBT	31419	Eldon
3096	Rock Island		
		3154	Syracuse
3122	Chicago No. 7 4 ESS	3155	Utica
3124	Chicago-Stewart No. 1 and 2	3156	Oswego
3126	Chicago-Wabash No. 1 and 2	3157	Seely T. C.
3127	Chicago-Franklin No. 1 and 2	3158	Newark
3129	Chicago-Bl. Plaine No. 1 and 2	3159	Geneva
31211	Chicago-Kedzie No. 1 and 2	31510	Watertown
31212	Oakbrook	31511	Potsdam
31213	Morton Grove	31512	Ogdensburg
31214	Northbrook No. 2 (4A)	31513	Fulton
31215	Chicago Canal/ESS Tandem		
31217	Northbrook ESS Tandem	3164	Wichita
31218	Chicago 8	3165	Hutchinson
		3166	Parsons
3132	Detroit No. 1 4T		
3134	Detroit-Cadillac-Woodward	3272	Indianapolis
3135	Detroit-University	3174	Kokomo

TABLE V (Contd)

IDENTIFICATION CODES FOR RECORDED ANNOUNCEMENTS
WITHIN THE UNITED STATES

IDENT. NO.	OFFICE	IDENT. NO.	OFFICE
3184	Lafayette	40411	Augusta
3185	Shreveport	40412	Cartersville
3186	Alexandria	40413	Rome
3187	Lake Charles	40414	Athens
3188	Monroe	40415	Cornelia
3194	Davenport	4052	Oklahoma City 4A
3195	Waterloo	4053	Oklahoma City 4E
3196	Cedar Rapids	4054	Clinton
3197	Clinton	4055	Enid
		4056	Durant
4014	Providence TDM 1	4057	Lawton
4015	Providence TDM 2	4058	Kingfisher
4016	Providence 4T		
		4062	Billings
4022	Omaha	4064	Helena
4024	Lincoln	4065	Great Falls
4025	Hastings	4066	Livingston
4026	Nebraska City	4067	Kalispell
4027	Beatrice	4068	Missoula
4028	David City	4069	Shelby
4029	Auburn	40610	Havre
40210	Fairbury	40611	Butte
40211	Geneva	40612	Glasgow
40212	Hebron	40613	Miles City
40213	Seward	40614	Glendive
40214	Superior	40615	Kallispell
40215	Tecumseh		
40216	Wahoo	4082	San Jose 4T
40217	Tora	4084	San Jose XBT
40218	Aurora	4085	Salinas
40219	Falls City	4086	Santa Clara Metro
		4087	San Jose TSPS
403	See TransCanada (Table W)		
		4121	Pittsburgh Reg. 3 4E
4041	Rockdale	4122	Pittsburgh 4T Sect. 1
4042	Atlanta 4T Sect.	4124	Pittsburgh-TDM A
4043	Atlanta 4E	4125	Pittsburgh-TDM B
4044	Atlanta XBT	4126	Greensburg
4045	Columbus	4127	Charleroi
4046	Atlanta 4T Pri.	4128	McDonald
4047	Dalton	4129	Uniontown
4048	Tocca	41210	Washington
4049	Winder	41211	Newcastle

TABLE V (Contd)

IDENTIFICATION CODES FOR RECORDED ANNOUNCEMENTS WITHIN THE UNITED STATES

IDENT. NO.	OFFICE	IDENT. NO.	OFFICE
4132	Springfield	4196	Paulding
		4197	Lima
4143	Waukesha Sect.	4198	Defiance
4144	Milwaukee No. 2	4199	Napoleon
4146	Racine	41910	Van Wert
4147	Appletown	41911	Wauseon
4148	Oshkosh	41912	Stony Ridge
4149	Watertown	41913	Mansfield
41411	Milwaukee 4T Pri.	41914	Shelby
41421	Plymouth	41915	Bucyrus
41422	Green Bay	41916	Mount Gilead
41423	Berlin	41917	Findlay
41424	Fond du Lac	41918	Sandusky
41425	Sheboygan	41919	Tiffin
		5014	Little Rock
4152	Oakland 4T	5015	Fort Smith
4153	San Francisco 43T 4 ESS	5016	Fayetteville
4154	Oakland-Franklin	5017	Jonesboro
4155	Oakland-Franklin 1	5018	Pine Bluff
4156	Oakland No. 1		
4158	San Francisco-Bush 0 and 1	5022	Louisville
4159	Oakland Eastbay 4T	5024	Paducah
41510	San Francisco-Onon	5025	Madisonville
41511	San Francisco-Onon 1	5026	Elizabethtown
41512	San Rafael	5027	Campbellsville
41513	Concord	5028	Glasgow
41514	Palo Alto	5029	Frankfort
41515	San Francisco 41T		
41516	Redwood City	5032	Portland No. 1
41517	Hayward	5033	Portland No. 2 4 ESS
41518	San Francisco 42T	5034	Eugene
41519	Oakland TSPS	5035	Pendleton
41520	San Francisco TSPS	5036	Astoria
41521	Redwood City TSPS	5037	Bend
		5038	Roseburg
		5039	Klamath Falls
416	See TransCanada (Table W)	50310	Corvallis
		50311	Salem XB
4174	Springfield	50312	Newport
4175	Joplin	50313	Albany
		50314	Baker
418	See TransCanada (Table W)	50315	Medford
		50316	Merrill
4194	Toledo	50317	White City
4195	Kenton	50318	Redmond

TABLE V (Contd)

IDENTIFICATION CODES FOR RECORDED ANNOUNCEMENTS
WITHIN THE UNITED STATES

IDENT. NO.	OFFICE	IDENT. NO.	OFFICE
50319	Burns	5122	San Antonio
50320	Hood River	5125	Harlingen
50321	Sheridan	5126	Austin 4T
50322	Myrtle Creek	5127	Harlingen 4T
50323	Beaverton	5128	Corpus Christi
50324	Hood River	5129	San Marcos
50325	Sheridan		
50326	Merrill	5132	Cincinnati 4T
50327	Burn	5134	Dayton
50328	White City	5135	Cincinnati-St. Bernard
50329	Redmond	5136	Cincinnati-West 7th
50330	Lebanon	5137	Batavia
		5138	Sydney
5042	New Orleans 4T	5139	Greenville
5043	New Orleans 4 ESS	51310	Belle Fontaine
5045	New Orleans XBT	51311	Lebanon
5046	Baton Rouge	51312	Eaton
5047	Hammond	51318	Cincinnati TSPS
5048	Covington		
5049	Houma	514	See TransCanada (Table W)
50410	Donaldsonville		
5052	Albuquerque	5152	Des Moines
5054	Roswell	5154	Mason City
5055	Alamagordo		
5056	Clovis	5162	Suffolk
5057	Demine	5163	Garden City 4E
5058	Farmington	5165	Hempstead No. 2
5059	Gallup	5166	Hempstead No. 3
50510	Hobbs	5167	Hempstead No. 4
50511	Las Cruces	5168	Deer Park No. 1
50512	Las Vegas	5169	Deer Park No. 2
50513	Raton	51610	Garden City 4T
50514	Santa Fe		
50515	Truth or Consequences	5174	Lansing XBT
		5175	Saginaw XBT
506	See TransCanada (Table W)	5176	Jackson
		5177	Lansing 4T
5074	Owatonna	5178	Saginaw 4T
5075	Windom	5179	Alma 4T
		51710	Adrian
5094	Spokane		
5095	Yakima	5182	Albany 4T
5096	Ellensburg	5184	Albany XBT
5097	Sunnyside	5185	Plattsburg

TABLE V (Contd)

IDENTIFICATION CODES FOR RECORDED ANNOUNCEMENTS WITHIN THE UNITED STATES

IDENT. NO.	OFFICE	IDENT. NO.	OFFICE
5186	Champlain	6075	Binghamton 4T
5187	Glens Falls	6076	Hornell
		6077	Ithaca
519	See TransCanada (Table B)	6078	Oneonta
		6079	Sidney
6012	Jackson	60710	Dundee
6014	Tupelo	60711	Delhi
6015	Hattiesburg		
6016	Greenwood	6082	Madison No. 2
6017	McComb	6084	Janesville
6018	Meridian	6086	La Crosse
6019	Gulfport	6087	Dodgeville
60110	Columbus	6088	Mauston
60111	Grenada	6089	Madison No. 1
60112	Laurel		
60113	Biloxi	6092	Camden 4T
60114	Natchez	6094	Camden XBT
60115	Greenville	6095	Trenton
		6096	Atlantic City
6022	Phoenix 4T	6097	Hamilton Square
6024	Mesa 4A		
6025	Tucson	6122	Minneapolis
6026	Window Rock	6123	Minneapolis 4 ESS
		6125	St. Paul 4T
6034	Manchester No. 1	6126	St. Cloud
6035	Manchester No. 2	6127	Willmar
6036	Concord		
		613	See TransCanada (Table W)
		6144	Columbus 4T
604	See TransCanada (Table W)	6145	Columbus XBT
		6146	Mt. Vernon
6054	Sioux Falls	6147	Pataskala
6055	Rapid City	6148	Sunbury
		6149	Columbus 4E
6064	Danville		
6065	Winchester	6152	Nashville
6066	Paintsville	6154	Knoxville
6067	Lexington	6155	Chattanooga
6068	Ashland	6156	Cookeville
6069	Hazard	6157	Johnson City ETS
60610	Morehead	6158	Chattanooga ESS
60611	Somerset		
		6162	Grand Rapids 4T
6070	Norwich	6164	Kalamazoo XBT
6074	Binghamton XBT	6165	Kalamazoo 4T

TABLE V (Contd)

IDENTIFICATION CODES FOR RECORDED ANNOUNCEMENTS
WITHIN THE UNITED STATES

IDENT. NO.	OFFICE	IDENT. NO.	OFFICE
6166	Grand Rapids XBT	7025	Las Vegas
6167	Traverse City	7026	Reno TSPS
6168	Muskegon 4A		
		7034	Leesburg
6172	Cambridge 18 (4 ESS)	7035	Roanoke
6173	Boston 4A (B9)	7036	Arlington-Toll TDM
6174	Newton	7037	Arlington-Local
6175	Boston-Franklin CAMA	7038	Roanoke 4A
61710	Dorchester	7039	Woodbridge
61713	Malden	70310	Arlington 4T
61715	Harrison	70311	Fredricksburg
61716	Kendall Square	70312	Winchester
61717	Boston Tandem 17	70313	Norton
61721	Brockton XBT	70314	Culpeper
61722	Brockton 4A	70315	Harrisonburg
61723	Fairhaven 4A	70316	Waynesboro
61724	Fall River	70317	Edinburg
61725	Framingham XBT No. 1	70318	Covington
61726	Framingham XBT No. 2		
61727	Framingham 4A	7042	Charlotte
61728	Lawrence XBT	7043	Charlotte 4 ESS
61729	Lawrence 4A	7044	Asheville
61730	Worcester XBT	7045	Gastonia
61731	Worcester 4A	7046	Hickory
61743	MET TDM No. 3	7047	Concord
		7048	Marshville
6182	Collinsville	7049	Sylva
6184	Olney	70410	Morganton
6185	Marion	70411	Salisbury
6186	Alton	705	See TransCanada (Table W)
6187	Centralia		
		7072	Santa Rosa No. 4
7012	Fargo 4A	7074	Santa Rosa XBT
7014	Bismarck	7075	Eureka
7015	Grand Forks		
7016	Grafton	709	See TransCanada (Table W)
7017	Fargo 1E		
7018	Jamestown	7124	Sioux City
7019	Dickinson		
70110	Williston	7132	Houston No. 1
		7133	Houston 4E
7022	Reno 4T Sect.	7134	Galveston
7024	Reno XBT Pri.	7135	Beaumont

TABLE V (Contd)

IDENTIFICATION CODES FOR RECORDED ANNOUNCEMENTS WITHIN THE UNITED STATES

IDENT. NO.	OFFICE	IDENT. NO.	OFFICE
7136	Houston No. 2	7178	Hazelton
7137	Houston No. 3	7179	York
7138	Beaumont 1E	71710	Scranton ESS
7139	Nacogdoches	71711	Harrisburg ESS
71310	Huntsville	71712	Wilkes-Barre ESS
71311	Richmond	71713	Scranton 1A ESS
		71720	Stroudsburg
7141	San Bernardino		
7142	Anaheim 28T	8012	Salt Lake City
7143	San Diego 4E	8014	Provo
7144	Anaheim XBT		
7146	Oceanside	8024	White River Junction 1A ESS
7147	Anaheim 77T	8025	Burlington
7148	Ontario 91T	8026	Rutland
7149	Anaheim 01 TSPS		
71410	Anaheim 02 TSPS	8032	Columbia
71411	San Diego 02 TSPS	8034	Greenville
		8035	Charleston
7152	Eau Claire	8036	Florence
7154	Stevens Point	8037	Rock Hill
7155	Marshfield	8038	Orangeburg
7156	Rice Lake	8039	Myrtle Beach
7157	Wausau	80310	Spartanburg
7158	Hudson	80311	Greenwood
7159	Ashland	80312	Sumter
71510	Superior	80313	Lancaster
71511	Rhinelander		
		8042	Richmond 4A
		8043	Richmond 4E
7164	Buffalo 4T	8044	Norfolk XBT
7165	Buffalo-Erie	8045	Danville
7166	Buffalo-Frontier	8046	Emporia
7167	Batavia	8047	Onancock
7168	Olean	8048	Norfolk 4T
7169	Dunkirk	8049	Lynchburg
71610	Rochester	80410	Chase City
71611	Geneseo	80411	Warsaw
71612	Jamestown	80412	Charlottesville
71613	Holcomb		
		8054	Bakersfield
7172	Harrisburg 4A	8055	San Luis Obispo
7174	Scranton 4A	8056	Newhall
7175	Williamsport		
7176	Wilkes-Barre XBT	8062	Amarillo XBT
7177	Lancaster	8064	Amarillo 1 ESS

TABLE V (Contd)

IDENTIFICATION CODES FOR RECORDED ANNOUNCEMENTS WITHIN THE UNITED STATES

IDENT. NO.	OFFICE	IDENT. NO.	OFFICE
8066	Lubbock 1 ESS	8172	Fort Worth 4A
		8173	Fort Worth 4E
807	See TransCanada (Table W)	8174	Waco
		8175	Wichita Falls
8084	Honolulu	8176	Killeen
		8177	Stephenville
8122	Bloomington	8178	Temple
8124	Evansville	8179	Cisco
		81710	Decatur
8134	Tampa No. 2		
8135	Fort Myers	819	See TransCanada (Table W)
8136	Sarasota		
8137	Winter Haven 4E	9012	Memphis
8139	St. Petersburg		
8130	Clearwater	902	See TransCanada (Table W)
81310	Avon Park		
81311	Tampa No. 3	9042	Jacksonville
81312	Naples	9043	Jacksonville 4 ESS
		9044	Leesburg
8144	Altoona	9045	Tallahassee
8145	Erie	9046	Pensacola
8146	Warren	9047	Gainesville
8147	State College	9048	Chipley
8148	Dubois	9049	Fort Walton Beach
		90410	Crestview
8151	Norway	90411	Panama City
8154	Rockford	90412	Ocala
		90413	Live Oak
8162	Kansas City 4E	90414	Daytona Beach
8166	St. Joseph	90415	Quincy
8167	Warrensburg	90416	Marianna
8168	Oak Grove	90417	Port St. Joe
8169	Harrisonville		
81610	Clinton	9064	Sault St. Marie
81611	Maryville		
81612	Lexington	9074	Anchorage
81613	Higginsville	9075	Fairbanks
81614	Milan	9076	Juneau
81615	Cameron	9077	Ketchikan
81616	Chillicothe	9078	Dead Horse
81617	Moberly	9079	Anchorage No. 2
81618	Kirksville		
81619	Sedalia	9122	Macon

TABLE V (Contd)

IDENTIFICATION CODES FOR RECORDED ANNOUNCEMENTS
WITHIN THE UNITED STATES

IDENT. NO.	OFFICE	IDENT. NO.	OFFICE
9124	Moultrie	91414	Walden
9125	Milledgeville	91415	Middletown
9127	Fitzgerald		
9128	Dawson	9152	Sweetwater
9129	Thomasville	9154	El Paso
91210	Waycross	9155	Abilene
91211	Savannah ESS	9156	Midland
91212	Hawkinsville		
91213	Millen	9161	Sacramento 4T
91214	Bainbridge	9164	Sacramento XBT
91215	Brunswick	9165	Reading
91216	Dublin	9166	Chico
91217	Valdosta	9167	Sacramento TSPS
91218	Albany	9168	Sacramento 4E
9134	Salina	9184	Tulsa
9135	Mission		
9136	Hays	9192	Greensboro
9137	Topeka	9194	Winston-Salem
		9195	Raleigh
9141	White Plains 4T Reg.	9196	Laurinburg
9144	White Plains XBT	9197	Fayetteville
9145	Mount Vernon No. 1	9198	Durham
9146	Nyack	9199	Rocky Mount
9147	Mount Kisco	91910	Wilmington
9148	Poughkeepsie	91911	Elkin
9149	Monticello-TSP	91912	Mount Airy
91410	Mount Vernon No. 2	91913	Asheboro
91411	White Plains 4T Pri.	91914	Durham EAX
91412	Reinbeck	91915	High Point
91413	Monroe	91916	Goldsboro

TABLE W

IDENTIFICATION CODES FOR RECORDED ANNOUNCEMENTS
WITHIN THE TRANSCANADA TELEPHONE SYSTEM

IDENT. NO.	OFFICE	IDENT. NO.	OFFICE
2042	Winnipeg 4ACT	41812	Montmagny
2044	Brandon SP1-4W	41813	Rimouski No. 2 SP1-4W
		41814	St. Felicien
3061	Regina No. 2 SP1-4W	41815	St. Marie de Beauce
3062	Regina No. 1 XBT	41816	Riviere du Loup
3064	Saskatoon SP1-4W	41817	Thetford Mines
3065	Moose Jaw	41818	Alma
3066	Prince Albert	41819	New Carlisle
3067	Yorkton	41820	Cap Aux Meules
4032	Calgary No. 2 SP1-4W	5062	Saint John
4034	Drumheller	50610	Moncton
4035	Edmonton No. 1	50611	Newcastle
4036	Edmonton No. 2 TOPS		
4038	Medicine Hat	5141	Montreal No. 1 4AETS
4039	Grande Prairie	5144	Montreal No. 2 XBT
40310	Calgary No. 1 XBT	5145	Montreal No. 3 SP1-4W
40311	Lethbridge SP1-4W	5146	Montreal No. 4 SP1-4W
40313	Peace River	51410	Joliette
40314	Red Deer	51411	St. Jerome
40315	Edson	51412	Valleyfield
40317	Vegreville	51413	Granby
40318	Camrose	51414	St. Jean
40320	Hay River	51415	Sorel
40321	Inuvik	51416	St. Hyacinthe SP1-4W
40322	Whitehorse		
		5194	London No. 1
4162	Toronto No. 1 4ACT	5195	Kitchener
4164	Toronto No. 2 XBT	5196	Windsor
4165	Hamilton	5197	London No. 2 SP1-4W
4166	Toronto No. 3 4AETS	51910	Brantford
4167	Toronto No. 4 SP1-4W	51911	Chatham
4168	Hamilton No. 2 SP1-4W	51912	Guelph
41610	Brampton	51913	Orangeville
41611	Fort Erie	51914	Owen Sound
41612	Markham	51915	Sarina
41614	St. Catharines SP1-4W	51916	Simcoe
41615	Newmarket	51917	Stratford
41616	Niagara Falls	51918	St. Thomas
41617	Welland	51919	Walkerton
41618	Port Hope	51920	Woodstock
41619	Oshawa SP1-4W	51921	Tillsonburg
		51922	Clinton
4182	Quebec No. 2 SP1-4W		
4184	Quebec No. 1 XBT	6042	Vancouver No. 2 4AETS
41810	Chicoutimi	6044	Abbotsford
41811	Donnacona	6046	Gibsons

TABLE W (Contd)

IDENTIFICATION CODES FOR RECORDED ANNOUNCEMENTS
WITHIN THE TRANSCANADA TELEPHONE SYSTEM

IDENT. NO.	OFFICE	IDENT. NO.	OFFICE
6048	New Westminster	7055	Sudbury
6049	Squamish	7056	North Bay
60410	Kamloops	7057	St. Ste. Marie
60413	Cranbrook	70511	Peterborough
60414	Grand Forks	70513	Chapleau
60417	Nakusp	70514	Parry Sound
60418	Nelson	70515	Orillia
60420	Trail	70516	Bracebridge
60421	Williams Lake	70517	Midland
60422	Victoria	70518	Lindsay
60423	Alert Bay	70519	New Liskeard
60424	Campbell River	70520	Timmins
60426	Duncan		
60427	Nanaimo	7092	Corner Brook SP1-4W
60428	Port Alberni	7094	St. John SP1-4W
60429	Powell River	7095	Grand Falls
60430	Prince George	7096	Bay Roberts
60432	Dawson Creek	7097	Marystown
60433	Prince Rupert	7098	Stephenville Crossing
60434	Fort Nelson		
60436	Terrace	8074	Thunder Bay SP1-4W
60437	Vancouver No. 1 FW1	80710	Geraldton
60441	Vernon	80711	Marathon
60442	Kelowna	80712	Dryden
60443	Penticton	80713	Fort Frances
6134	Ottawa No. 1 XBT	8194	Sherbrooke
6135	Ottawa No. 2 4AETS	81910	Drummondville
61310	Brockville	81911	Lac Megantic
61311	Cornwall	81912	Mount Laurier
61312	Kingston	81913	St. Agathe
61313	Smiths Falls	81914	Trois Rivieres
61314	Belleville	81915	Victoriaville
61315	Pembroke		
61316	Renfrew	9024	Halifax No. 1 4ACT
		9025	Charlottetown SP1-4W
7054	Barrie	9026	Kentville SP1-4W

CONDITION ENCOUNTERED	RECOMMENDED TREATMENT	RECOMMENDED ANNOUNCEMENT
NORMAL		
Signal to Start Dialing	Dial Tone	—
Connected to Called Line or to Operator Trunk	Audible Ringing Tone	—
Line Busy	60-IPM Tone	—
ALL TRUNKS BUSY		
Local	120 IPM Tone	—
Toll Connecting	Announcement N	We're sorry, all circuits are busy now. Will you please try your call again later. This is a recording. (Pause) (Location Code)
Intertoll		
Normal	Announcement N	We're sorry, all circuits are busy now. Will you please try your call again later. This is a recording. (Pause) (Location Code)
Disaster — RSS (Remote Switching System). Standalone Operation	Announcement X	(With flexibility due to situation) We're sorry (storm, flood, tornadoes, etc), damage in (or near) (city) has blocked your call. Emergency calls may be placed through your operator. This is a recording. (Pause) (Location Code)
SWITCHING BLOCKAGE OR COMMON CONTROL EQUIPMENT IRREGULARITY		
Local		
Switching Blockage or Equipment Irregularity	120-IPM Tone	—
No Dial Tone Situations	Announcement O	We're sorry, due to heavy calling, we cannot complete your call at this time. Will you please hang up and try your call later. If your call is urgent, please try again now. This is a recording.
Sender or Transmitter Overload	Announcement N	We're sorry, all circuits are busy now. Will you please try your call again later. This is a recording. (Pause) (Location Code)
Toll		
ESS and Common Control Systems		
Switching Path Busy	Announcement P	We're sorry, your call did not go through. Will you please hang up and try your call again. This is a recording. (Pause) (Location Code)
Sender or Transmitter Overload	Announcement N	We're sorry, all circuits are busy now. Will you please try your call again later. This is a recording (Pause) (Location Code)
Step-by-Step Systems Switching Path Busy	120-IPM Tone	—

Fig. 42—Recommended Tones and Announcements

CONDITION ENCOUNTERED	RECOMMENDED TREATMENT	RECOMMENDED ANNOUNCEMENT
NETWORK MANAGEMENT CONTROL	Announcement N	We're sorry, all circuits are busy now. Will you please try your call again later. This is a recording. (Pause) (Location Code)
	or	
WORK STOPPAGE	Announcement X	We're sorry (storm, flood, tornadoes, etc), damage in (or near) (city) has blocked your call. Emergency calls may be placed through your operator. This is a recording. (Pause) (Location Code)
MISDIALING	Work Stoppage Announcement	We're sorry, because of a work stoppage, the operator will be delayed in helping you. If your call is urgent, stay on the line and the operator will answer as soon as possible. This is a recording.
Access Code Dialed in Error	Access Code Dialed in Error Announcement	We're sorry, it is not necessary to dial a "1" (or "0") when calling this number. Will you please hang up and try your call again. This is a recording.
Access Code Not Dialed	Access Code Not Dialed Announcement	We're sorry, you must first dial a "1" (or "0") when calling this number. Will you please hang up and try your call again. This is a recording.
Vacant Code	Announcement L	We're sorry, your call cannot be completed as dialed. Please check the number and dial again or call your operator to help you. This is a recording. (Pause) (Location Code)
Unauthorized CAMA (UCA) ("1" or "0" Plus Unauthorized Code)	Announcement L	We're sorry, your call cannot be completed as dialed. Please check the number and dial again or call your operator to help you. This is a recording. (Pause) (Location Code)
Misrouted Non-CAMA (MCA) ("1" or "0" Plus Local Code)	Access Code Dialed in Error Announcement	We're sorry, it is not necessary to dial a "1" (or "0") when calling this number. Will you please hang up and try your call again. This is a recording.
Partial (Insufficient) Digits	Announcement P	We're sorry, your call did not go through. Will you please hang up and try your call again. This is a recording. (Pause) (Location Code)
NUMBERS INTERCEPTED		
Vacant or Disconnected Numbers (Includes Vacant Thousands and Hundreds)	Vacant — Disconnect Number Announcement	*Direct Operator Intercept Trunks Not Provided:* We're sorry, you have reached a number that has been disconnected or is no longer in service. If you feel you have reached this recording in error, please check the number or try your call again. *Direct Operator Intercept Trunk Provided:* We're sorry, you have reached a number that has been disconnected or is no longer in service. Please check the number and dial again, or stay on the line and an operator will answer you.

Fig. 42—Recommended Tones and Announcements (Contd)

CONDITION ENCOUNTERED	RECOMMENDED TREATMENT	RECOMMENDED ANNOUNCEMENT
Centrex Nonworking Stations	Centrex Nonworking Station Announcement	We're sorry, the number you have reached is not in service. If you are calling the (ABC Company), please dial (XXX-XXXX). If you need help, dial your operator. This is a recording.
Intra-Centrex Calls for Unassigned Numbers or Restricted Codes	Common Centrex Announcement	We're sorry, your call cannot be completed as dialed. Please check the number and dial again, or call your attendant to help you. This is a recording.
PBX Service Converted Centrex	Centrex Number Change Announcement	Telephone numbers at the (ABC Company) have been changed. For their new numbers, please dial (XXX-XXXX). This is a recording.
RECEIVER OFF-HOOK	ROH Announcement	If you'd like to make a call, please hang up and try again. If you need help, hang up and then dial your operator. This is a recording.
INITIAL COIN DEPOSIT MADE	Dial Tone First Announcement	The call you have made requires a 10-cent (initial rate) deposit. Please hang up momentarily, listen for dial tone, deposit 10 cents (initial rate), and dial your call again. This is a recording.
CUSTOM CALLING FEATURE	Custom Calling Announcement	We're sorry, your call cannot be completed as dialed. Please check your instruction manual or call the (Business Office or Repair Service) for assistance. This is a recording.
TSPS		
Queue Entrance Allowed	Float Announcement X	Due to (the emergency condition), all operators are busy now. If you will stay on the line, an operator will answer as soon as possible.
Queue Entrance Not Desired	Block Announcement X	Due to (the emergency condition), we are able to complete only emergency calls. If your call is an emergency, please dial your operator. Otherwise, please try your call later.
Queue Entrance Not Allowed by Design	Announcement P	We're sorry, your call did not go through. Please hang up and try your call again.

Fig. 42—Recommended Tones and Announcements (Contd)

TOUCH-TONE SERVICE

12.35 The Bell System TOUCH-TONE calling system provides a method for pushbutton signaling from customer stations using the voice transmission path. The code for this system provides 16 distinct signals. Each signal is composed of two voiceband frequencies, one from each of two mutually exclusive frequency groups of four frequencies each. The signal frequencies are geometrically spaced and were selected on the basis that the two frequencies of any valid signal combination are not harmonically related.

12.36 The frequency pairs assigned for TOUCH-TONE signaling are as follows:

		HIGH-GROUP FREQUENCIES (Hz)			
		1209	1336	1477	1633
LOW GROUP FREQUENCIES (HZ)	697	1	2	3	A
	770	4	5	6	B
	852	7	8	9	C
	941	*	0	#	D

Note: The * and # symbols are for new services. At present, the # is an optional end-of-dialing signal on IDDD calls to avoid timing when address lengths are variable. The new standard for custom calling services uses the format *XX(X) as customer input to the central office.

A. Requirements for a TOUCH-TONE Central Office Receiver

12.37 The requirements for the TOUCH-TONE central office receiver are as follows:

- Registration of TOUCH-TONE signals:

(a) TOUCH-TONE receiver checks that two of the tones are present and that one is from each group of four.

(b) The receiver should register the digit if the frequencies are within ±1.5 percent of their nominal values, but not register the digit if the deviation of either frequency is greater than ±3.5 percent.

(c) The receiver should register TOUCH-TONE digits as short as 40 milliseconds and should recognize interdigital intervals as short as 40 milliseconds. The shortest cycle time (tone-on plus tone-off interval) which must be accepted is 93 milliseconds. Digits less than 23 milliseconds in duration should be rejected.

(d) The receiver should register TOUCH-TONE digits with a power per frequency of -25 to 0 dBm and with the high-frequency tone power of +4 to -8 dB relative to that of the low-frequency tone as measured with a 900-ohm termination bridged across the receiver.

> ***Note:*** The overload level value of 0 dBm assumes a termination of 900 ohms. In electronic and step-by-step switching offices, the termination is 900 ohms. However, in the crossbar offices, the TOUCH-TONE receiver is bridged across a dial pulse receiver which is not a 900-ohm termination but a much higher impedance. This raises the effective voltage level of the signal at the TOUCH-TONE receiver. As a result, a receiver in a crossbar office must operate with up to 2 volts per frequency.

(e) TOUCH-TONE digits should be registered in the presence of central office precise dial tone (paragraph 11.03). The level of the dial tone is nominally -10 dBm (-13 dBm per frequency) at the point of application when a 900-ohm test termination is substituted for the customer line. However, under extreme service conditions involving critical loop lengths, the dial tone level can be as high as an equivalent of a 0-dBm total for the two frequencies as measured with a 900-ohm termination bridged across the receiver.

(f) Low-level TOUCH-TONE digits should be registered with a low error rate in the presence of Gaussian noise. Details of this test are as follows:

(1) Error rate should be less than one error in 10,000 pulses with a TOUCH-TONE pulsing rate of 10 PPS with a 50-millisecond tone-on and a 50-millisecond interdigital interval. All TOUCH-TONE digits should be incorporated in the sequence of pulses.

(2) Each TOUCH-TONE frequency should be at nominal value and at a level of -20 dBm

into a 600-ohm test termination. The method of measuring the tone levels is shown in Fig. 43.

(3) The noise source for the tests is shown in Fig. 44. The noise generator produces 0- to 3-kHz band limited Gaussian noise at a level of -35 dBm (55 dBrn or 53 dBrnC) as measured in a 600-ohm test termination.

(4) The test TOUCH-TONE receiver is connected to the digit and noise sources as shown in Fig. 45. This arrangement effectively places the TOUCH-TONE receiver across a 600-ohm test termination during the test.

(g) Low-level TOUCH-TONE digits should be registered with a low error rate in the presence of impulse noise. Details of the test are as follows:

(1) The TOUCH-TONE pulsing rate should be 10 PPS with a 50-millisecond tone-on time and a 50-millisecond interdigital interval. All TOUCH-TONE digits should be incorporated in the sequences of pulses.

(2) Each TOUCH-TONE frequency should be at nominal value and at a level of -20 dBm into a 600-ohm test termination. The method of measuring the tone levels is shown in Fig. 43.

(3) The impulse noise source for the tests should be the 201 noise tape (Note 1) shown in Fig. 46. With the noise level adjusted to 90 dBrnC (Note 2), there should be no more than 14 errors in 10,000 pulses (16.7 minutes).

Note 1: 201 noise tape available from AT&T, Director—Purchased Products, 295 North Maple Avenue, Basking Ridge, New Jersey 07920.

Note 2: Defined as 15 peaks exceeding 90 dBrnC in 15 minutes.

(4) The test TOUCH-TONE receiver is connected to the digit and noise sources as shown in Fig. 47. This arrangement effectively places the TOUCH-TONE receiver across a 600-ohm termination during the test.

(h) Double-digit registration of a single TOUCH-TONE digit should not occur often in the presence of impulse noise. Details of this test are as follows:

(1) The TOUCH-TONE pulsing rate should be 4 PPS with a 180-millisecond tone-on time and 70-millisecond interdigital interval. All TOUCH-TONE digits should be incorporated in the sequence of pulses.

(2) Each TOUCH-TONE frequency should be at nominal value and at a level of -20 dBm into a 600-ohm test termination. The method of measuring the tone levels is shown in Fig. 43.

(3) The impulse noise source for the tests is shown in Fig. 46. With the noise level adjusted to 90 dBrnC, there should be no more than 14 errors in 10,000 pulses (16.7 minutes).

(4) The test TOUCH-TONE receiver is connected to the digit and noise sources as shown in Fig. 47. This arrangement effectively places the TOUCH-TONE receiver across a 600-ohm termination during the test.

(i) TOUCH-TONE digits should be accurately registered in the presence of signal echoes which are delayed up to 20 milliseconds and reduced in level by at least 10 dB with respect to the incident signal.

(j) The average rate of digit simulation by speech, room noise, etc, prior to TOUCH-TONE signaling and during interdigital intervals, should be less than one occurrence in 3000 calls for digits 0 through 9, one occurrence in 2000 calls for digits 0 through 9 plus * and #, and one occurrence in 1500 calls for all 16 combinations.

(k) The minimum input impedance for the TOUCH-TONE receiver over the TOUCH-TONE signaling frequency range is 40,000 ohms.

(l) The minimum longitudinal balance for a TOUCH-TONE receiver is 50 dB.

• TOUCH-TONE receiver test circuit:

(a) The low-level test for electromechanical offices is -19 dBm ±1 dB per tone delivered to a 900-ohm test termination that replaces the subscriber register and TOUCH-TONE receiver.

(b) The low-level test for electronic offices is -22 dBm ±1 dB level per tone. The TOUCH-TONE is bridged across a 900-ohm resistive termination.

B. Requirements for a TOUCH-TONE Station Test Receiver

(a) The station test receiver should have an input impedance identical to, and be bridged across the loop termination at the same point as, the service receiver of the particular central office involved.

(b) The edge-band frequencies of the test receiver should be centered at ±1.5 percent of the nominal TOUCH-TONE frequency and held to a tolerance of ±0.2 percent.

(c) The effective sensitivity should be 1 ±1 dB more restrictive than the service receiver and should tolerate the same range of twist as the service receiver; ie, the test receiver should tolerate a difference in the high-frequency level with respect to the low-frequency level of +4 to -8 dB.

(d) The limiting pulsing speed and pulse duration of pulses that will be accepted by a test receiver when working in conjunction with a speed test circuit for TOUCH-TONE automatic dialers are as follows:

(1) Signals of greater than or equal to 48 milliseconds should be accepted and signals of less than 43 milliseconds in duration should be rejected.

(2) Interpulse intervals of greater than or equal to 45 milliseconds should be accepted and intervals of less than 40 milliseconds in duration should be rejected.

(3) Cycle time of greater than or equal to 97 milliseconds should be accepted and cycle times of less than 93 milliseconds should be rejected.

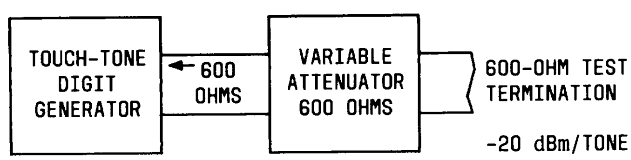


Fig. 43—TOUCH-TONE Digit Source

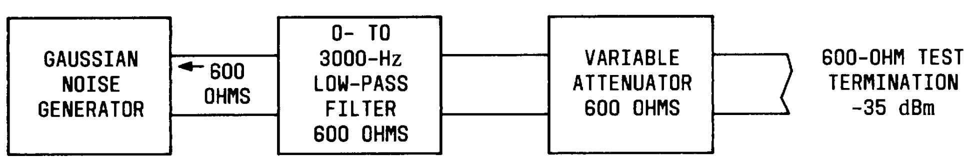


Fig. 44—Gaussian Noise Source

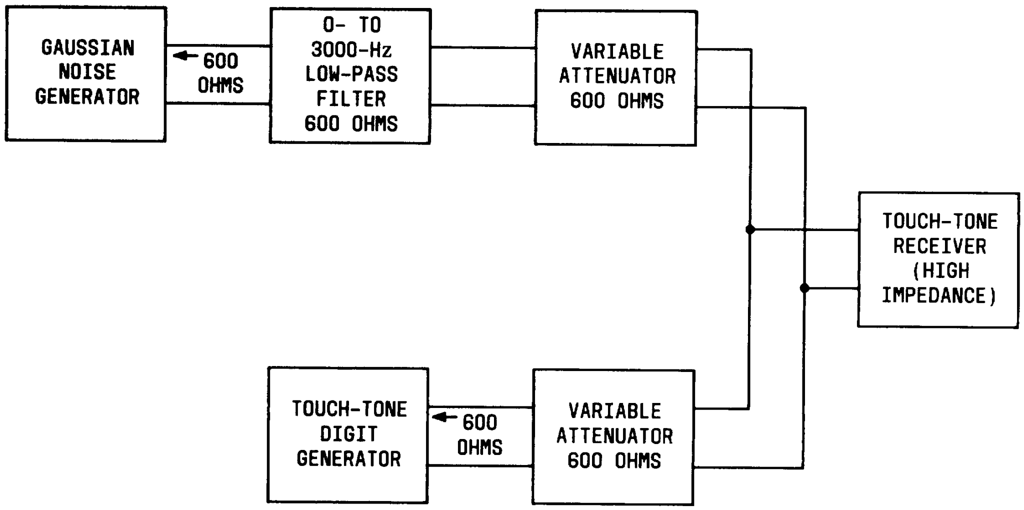


Fig. 45—Gaussian Noise Test of TOUCH-TONE Receiver

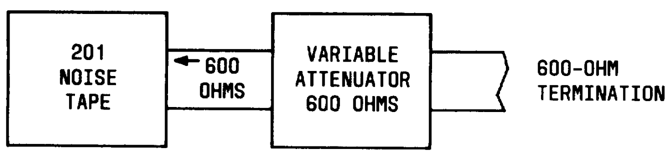


Fig. 46—Impulse Noise Source

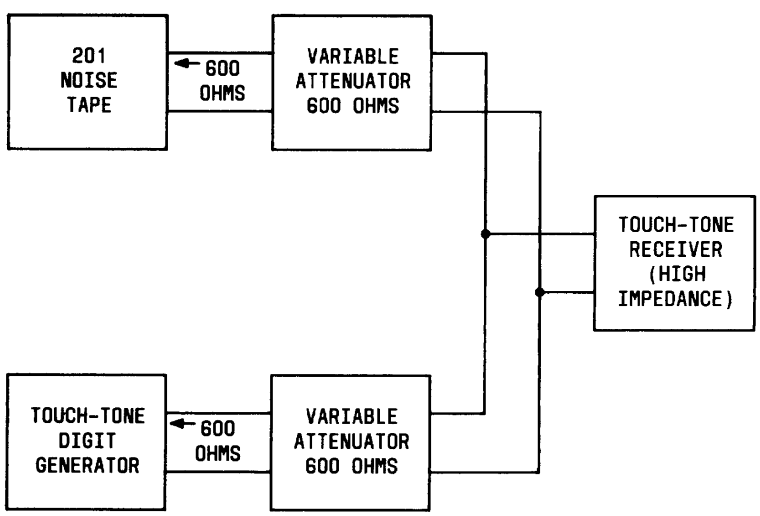


Fig. 47—Impulse Noise Test TOUCH-TONE Receiver

C. TOUCH-TONE—No. 1/1A ESS (Receiver and Transmitter)

12.38 Some TOUCH-TONE receivers, like those used in the No. 1/1A ESS, will interpret the TOUCH-TONE digit # (pound sign) as an end of dialing signal. The No. 1/1A ESS pound sign can be used to eliminate a time-out when a variable number of digits can be expected. However, other TOUCH-TONE receivers, like those used in No. 5 crossbar, will route a call to reorder if a pound sign is received while the TOUCH-TONE receiver is attached.

12.39 The No. 1/1A ESS can provide a TOUCH-TONE transmitter for outpulsing to a PBX, centrex, or other location. The transmitter always connects to a No. 1/1A ESS trunk circuit which has either line or trunk functions. A trunk circuit with line functions is used when a line is the connecting circuit at the distant end and a trunk circuit with trunk functions is used when a trunk is the connecting circuit at the distant end. The requirements for the transmitter are as follows:

(a) The tone level is -7 dBm0 ±0.5 dB per frequency.

(b) The frequency tolerance of individual frequencies is ±1.5 percent.

(c) When a TOUCH-TONE digit is being sent, the total extraneous frequency components should be at least 30 dB below the level of either of the two signal frequencies when measured over a 3KC band.

(d) The tone leakage limit when no TOUCH-TONE digit is being sent is -58 dBm0.

(e) The TOUCH-TONE transmitter is arranged to apply both tones comprising the TOUCH-TONE digit to the trunk or line simultaneously and neither tone is transmitted if either tone source should fail.

(f) The digital and interdigital interval is 50 ±0.5 milliseconds.

(g) The transmitter operates wink-start or delay-dial expected to trunks.

(h) The transmitter operates ground-start to lines.

(i) There is no option to operate dial tone start to either lines or trunks.

(j) In TOUCH-TONE signaling, there are no equivalents of the KP and ST signals used in MF pulsing.

12.40 In addition to the TOUCH-TONE transmitter, a new TOUCH-TONE receiver has been added to the No. 1/1A ESS. Like the TOUCH-TONE transmitter, the new TOUCH-TONE receiver connects only to No. 1/1A ESS trunk circuits. Unlike the TOUCH-TONE transmitter, the TOUCH-TONE receiver connects only to trunk circuits that have trunk functions. The characteristics of the new TOUCH-TONE receiver are as follows:

(a) The receiver meets the requirements given in paragraph 12.37.

(b) Both common control or manual TOUCH-TONE outpulsing is received.

(c) The receiver will provide either dial tone or a wink-start signal to the connected trunk when ready to receive information. However, a given trunk cannot send both dial tone and a wink-start signal.

12.41 The older No. 1/1A ESS TOUCH-TONE receiver connects only to lines. It only provides dial tone start (no arrangement for wink-start or delay-dial operation).

D. End-to-End TOUCH-TONE Signaling

12.42 There are several barriers to end-to-end TOUCH-TONE signaling. First, some switching systems reverse the polarity on the line during the call. This can disable the TOUCH-TONE pad. Second, to permit proper coin totalizer operation and to prevent fraud in many single slot coin telephone situations, the normal negative battery supply from the local central office is replaced with a positive battery supply. This disables the TOUCH-TONE pad. Third, echo suppressors can attenuate the TOUCH-TONE signals enough to cause signaling failures if dial tone start is used.

12.43 To enable TOUCH-TONE signaling in a telephone attached to a switching system that changes line polarity during a call, a polarity guard can be applied to the telephone. This provides proper polarity to the telephone regardless of the line polarity.

12.44 Enabling TOUCH-TONE signaling in single slot coin telephones has many ramifications which are discussed in more detail in a Technical Advisory to be issued. Briefly, complete TOUCH-TONE signaling enablement in Bell System switching systems, while preserving proper coin totalizer operation and fraud prevention, requires either (1) a polarity guard in the coin station and Automatic Coin Telephone System features in the TSPS or (2) dial-tone-first features in the class 5 switching systems and auto bill calling features in the TSPS. Dial-tone-first is covered in Section 4. Auto bill calling is covered in Technical Advisory No. 62.

12.45 When TOUCH-TONE signaling is transmitted over facilities using echo suppressors and dial tone is sent from the incoming switching system, there is some risk that the first TOUCH-TONE signal will be attenuated over the entire TOUCH-TONE digit or over the first portion of the digit as follows:

> The attenuation varies from zero loss to complete blockage of tone depending on the relative TOUCH-TONE and dial tone levels at the echo suppressor location. Under adverse conditions, typical loss for a split 4A echo suppressor is 6 dB. The echo suppressor terminal used in the No. 4 ESS introduced 11 dB of loss in a field situation (using split operation).
>
> In many of these unfavorable circumstances, the attenuation will occur over only the first portion of the pulse. The attenuated portion of the pulse can be as long as 64 milliseconds.

12.46 There is no guarantee that end-to-end TOUCH-TONE signaling with dial tone present will always work over facilities using echo suppressors. The present echo suppressors will remain in service for many years.

12.47 One solution is to use TOUCH-TONE to dial pulse converters when pulsing over facilities using echo suppressors and dial tone must be used as a start signal. In situations where the dial tone can be reduced in level or eliminated (by using a zip tone or an announcement), link-by-link or end-to-end TOUCH-TONE signaling can be successfully sent over facilities containing echo suppressors.

13. SENDER AND REGISTER TIMING AND EFFECT ON SIGNALING

13.01 The senders and registers used in toll dialing are equipped with timing functions to prevent their being held too long. The intervals allowed for the registration of digits and for a distant sender, register, or link to be attached have an effect on signaling. If any of the intervals allowed for digit registration are exceeded, the distant sender or register will route the call to reorder and release.

13.02 The requirements for digit pulsing which result from digit registration timing are given for the various switching systems in Fig. 48. Delays exceeding these intervals do not always result in reorder routing since these limits are necessarily based on minimum timing in the senders and registers. In the No. 5 crossbar system in Fig. 48, some of the intervals are automatically reduced during periods of heavy traffic in order to conserve common control equipment.

13.03 The requirements for the speed of attachment of a sender, register, or link, following receipt of a connect signal from the calling office, are shown in Fig. 3. It will be observed that, during periods of heavy traffic, some of the intervals are automatically reduced. This measure is designed to minimize the effect that delays in one office may have on other offices. Without reduced intervals, mutual delays between offices during periods of heavy traffic can pyramid, seriously impairing service.

	4A AND 4M			4A AND 4M CAMA		CROSSBAR TANDEM (INCL CAMA)		NO. 5 CROSSBAR (INCL CAMA)		STEP-BY-STEP CAMA		NO. 1 ESS		OBJECTIVE FOR NEW SYSTEMS	
	DP SENDER	DP REG	MF	DP	MF	DP ‡	MF	DP	MF	DP	MF	DP	MF	DP	MF
First digit must be received in less than ______ seconds from seizure.	10	16	10	16		15		19 4.4¶		15		16 10¶		16-24	5-10
Each digit must be received within ______ seconds after previous digit.														16-24	5-10
Both second and third digits must be received in less than ______ seconds from registration of first digit.	10		10	—		—		—		—		—			
Second and third digits must each be received in less than ______ seconds from registration of previous digit.		16		16		15		19 4.4¶		15		16 5¶			
Fourth digit must be received in less than ______ seconds from registration of third digit.	3*	3		16		15				15		16 5¶			
When total number of digits expected is indicated to register by classmarks or translation of one or two initial digits, each digit after third digit must be received in less than ______ seconds from registration of previous digit.		—		—		—		19 4.4¶		—		—			
When total number of digits expected is not indicated to register, each digit after third digit must be received in less than ______ seconds from registration of previous digit.		3		—		—		2.8** (tube timer) 3.2** (trans. timer)		—		—			
Each digit after fourth digit must be received in less than ______ seconds from registration of previous digit.	3*	3		16†		15†, §		—		15†		16 5¶			
All digits must be received in less than ______ seconds from seizure.					10		20	19	19		19		16 10¶		20-30††
All remaining digits must be received in less than ______ seconds from registration of third digit.	10		10	—		—		—		—					

*Units not incorporating recent changes have comparable but not identical timing.

†In the future, the interval following the seventh digit will be subject to 3-second time-out if interchangeable code assignments make this necessary.

‡ Includes both 3- and 10-digit register operation.

§ Assumes discontinuation of timing for stations digit.

¶ Under overload conditions.

**Centrex (1XX and 0XX) only.

††Optional.

Fig. 48—Digit Timing Requirements (Minimums)