SIGNALING CONSIDERATIONS

SWITCHED SPECIAL SERVICE CIRCUITS

CONTENTS PAGE

1. GENERAL

1.01 This section provides general information on signaling and signaling considerations for switched special services circuits. Switched special service circuits have access to the message telecommunication service (MTS) network. General layout and test information is provided to operating company personnel responsible for the installation and maintenance of switched special service circuits.

1.02 Whenever this section is reissued the reason(s) for reissue will be given in this paragraph.

1.03 There are two broad areas of signaling, customer line signaling and interoffice trunk signaling. Customer line signaling is the communication between the customers telephone set and the switching system serving the customer. An explanation of customer line signaling is covered in Section 975-110-100. Interoffice trunk signaling is concerned with the communication of call handling information between switching systems within the MTS network. An explanation of interoffice signaling is covered in Section 975-120-100. Emphasis in this Section will be on customer line signaling for switched special service circuits.

1.04 Switched special service circuits perform the same basic functions as message telephone service, but they may provide any of the following features:

(a) Additional signaling stage (ie, ground start)

(b) Function over greater distances from the serving central office (CO) (ie, foreign exchange line)

(c) Special rate treatment (ie, Wide Area Telecommunications Service)

(d) Remote and/or alternate answer of an incoming call to a main telephone (ie, off-premise extension)

(e) Special call handling (ie, hotel-motel LD lines).

1.05 There are five main classes of signals used on customer loops between the telephone set and the serving CO switching system. These are:

(a) Address

(b) Supervisory

(c) Alerting

(d) Control

(e) Information.

1.06 ***Address*** signals convey the information concerning the called number to the switching system in the form of dial pulses or TOUCH-TONE® frequencies.

1.07 ***Supervisory*** signals are on-hook and off-hook conditions to provide circuit indications such as circuit idle, circuit busy, seizure, and disconnect.

1.08 ***Alerting*** signals are those whose primary function is to alert an operator or a customer to some need. Included in this group are such signals as ringing, rering, recall, and receiver-off-hook signals.

1.09 ***Control*** signals are used for auxiliary functions associated with equipment connections to the customer loop. Typical examples are toll diversion and ground start.

1.10 ***Information*** signals are tones or announcements that inform the customer about the progress of the call. Included in this class are dial tone, busy tone, overflow, and recorded announcements.

1.11 Table A provides a list of the various signals along with the following information:

(a) What the signal is

(b) Its use or meaning

(c) The signal direction in relation to the serving office

(d) The on-hook, and off-hook conditions associated with the signal.

2. SUBSCRIBER LINE SIGNALING TECHNIQUES

2.01 Loop start signaling is the normal type of signaling between a CO switching system and a customer telephone set (refer to Fig. 1A). When the handset is removed from its cradle or switchhook at the station end, a resistance of approximately 200 ohms is placed across the line toward the switching end as a request for service.

2.02 Loop start signaling is required when providing service to an off-premise PBX station, a foreign exchange line, or a manual PBX.

2.03 An incoming call to the station end is recognized by the receipt of the 20-Hz ringing signal only. The usual ringing signal consists of a 2-second ringing period followed by a 4-second silent period. A station line can be seized for as long as 4 seconds before a seizure can be recognized at the station. The person at the station may attempt to originate a call during this interval. This is not considered a problem since the person who is originating a call from the station end is usually the person to whom the call is being directed.

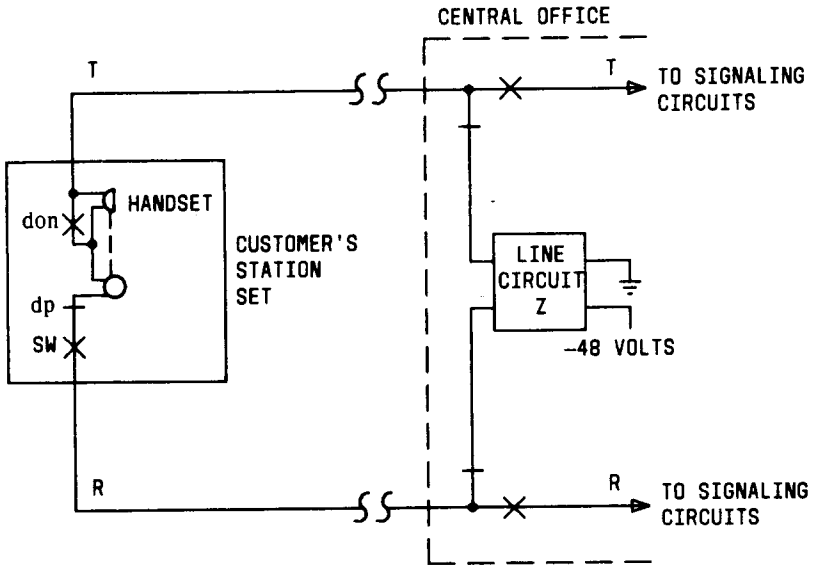
2.04 Ground-start signaling is required when providing service to a dial PBX, or to an ACD (Fig. 1B).

2.05 In many ways a dial PBX is similar to a dial CO in that any one of the dial PBX stations can dial other telephones, and also originate and receive calls over the same trunk between the serving CO and the dial PBX. Since this trunk can be seized at either end, it is apparent that special means must be taken to transmit seizure signals in each direction as quickly as possible. In the description of loop-start signaling it was noted that 4 seconds could elapse before the station end of the facility recognized a seizure by the switching end. ***Ground-start signaling eliminates the 4-second seizure delay.*** When ground-start signaling is employed, the subscriber line circuit at the CO is modified by removing the ground which is normally connected to the tip conductor of the line in the idle or on-hook state. This standard modification is shown on the subscriber line circuit SD drawing for the particular switching system involved.

2.06 When the CO switching equipment seizes the trunk for a call toward the dial PBX, it immediately places a ground on the tip conductor. The trunk circuit at the PBX recognizes the presence of ground on the tip as a seizure signal and immediately makes itself unavailable to outgoing calls from the PBX. When the 20-Hz signal is received, a signal is given to the PBX attendant to indicate an incoming call. Modern PBXs including the 800, 801, 805, 812 and DIMENSION® do not have ringing detectors. If the tip ground persists for 1 second, it is assumed to be a legitimate call. The presence of 20-Hz ringing is ignored.

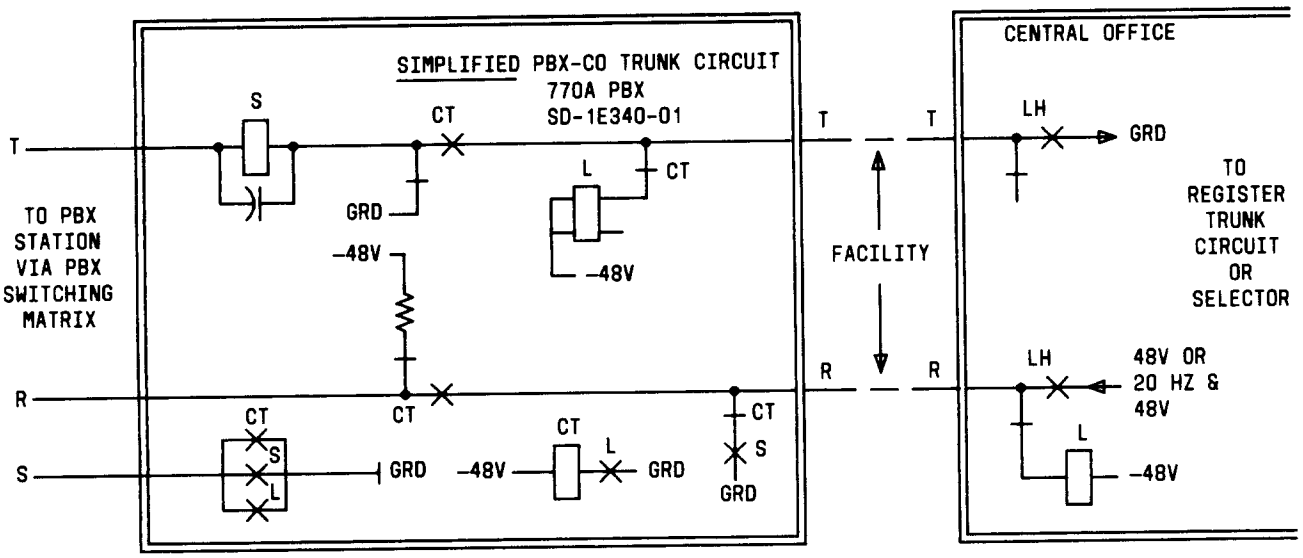
TABLE A

NAME OF SIGNAL	ON-HOOK	OFF-HOOK	DIRECTION			USE OR MEANING	INDICATION TO CUSTOMER
			CALLING END	SERVING OFFICE END	CALLED END		
A. INFORMATION							
Dial Tone			←	←		Equipment ready for dialing.	Steady Tone
Audible Ringing			←	←		Called station is being rung or awaiting operator answer.	Ringing Tone
Line Busy			←	←		Called line is busy.	60-IPM Tone
Reorder			←	←		All paths busy, all trunks busy, blockage in equipment, or incomplete registration of digits.	120-IPM Tone
Recorded Announcements			←	←		Indicates to customer reason the call cannot be completed.	
Reverting Tone	✓		←	←		Called party is on same party-line. Calling party has to hang-up while line is rung.	60-IPM Tone
Reorder Warning Tone			←	←	←	Indicates telephone conversation is being recorded.	1400-Hz tone of 0.5 second duration applied every 15 seconds.
B. SUPERVISORY							
Connect (Seizure)		✓	→	→		Requests service and holds connection.	
Recall (Customer Flashing)	✓	✓	→	→	←	Manually recalls operator to connection.	
Hold	✓	✓				By depressing hold key or switchhook connects line to a holding bridge.	
Answer		✓		←	←	Called party has answered. Charged timing begins and depends on this signal.	Audible ringing has stopped to calling customer.
Ring Trip		✓				Answer signal has been received and ringing has stopped.	Ringing has stopped to called customer.
Disconnect	✓		→	→	←	No service is desired. Message is completed. Release connection.	
C. CONTROL							
Coin Collect			←	←		To collect coins deposited in coin box.	
Coin Return			←	←		To return coins deposited in coin box.	
Toll Diversion			←	←		To indicate that a PBX station cannot make a toll call.	Recording, busy tone, or attendant.
Ground-Start			→	→	→	To seize a two-way PBX trunk without dual seizure.	
Party Identification		✓	→	→		Indicates that the Tip party is calling.	
D. ADDRESS							
Dial Pulsing	✓	✓	→	→		Indicates called number.	
TOUCH-TONE			→	→		Indicates called number.	
Digits			→	→		Indicates called number.	
E. ALERTING							
Ringing					→	Alerts called customer to an incoming call.	Bell rings or other alerting signal.
Receiver Off-Hook		✓	←	←		Alerts the customer to an off-hook receiver.	1400 + 2060 + 2450 +2600 Hz at 300 IPM.



don = DIAL OFF NORMAL CONTACTS
dp = DIAL PULSE CONTACTS
sw = SWITCHHOOK CONTACTS
z = LINE RELAY OR FERROD SENSOR

Fig. 1A—Customer Configuration Loop Start



LEGEND:
X INDICATES CONTACT CLOSED WHEN RELAY OPERATES
- INDICATES CONTACT CLOSED WHEN RELAY IS RELEASED
CT CUT THROUGH RELAY
S SUPERVISORY RELAY
LH LINE HOLD MAGNET
L LINE RELAY (CENTRAL OFFICE)
L GROUND DETECTING RELAY (PBX TRUNK)

Fig. 1B—Customer Configuration Ground Start

2.07 An outgoing call from the PBX toward the CO causes a ground to be placed on the ring conductor toward the CO. The CO equipment recognizes this as a seizure signal and prepares itself to receive dialing. When it is prepared, it places a ground on the tip conductor toward the PBX and applies dial tone. The PBX trunk circuit in turn, recognizing the tip ground as a start-dial signal, closes the line through for dialing and removes the ground which it had placed on the ring conductor earlier. After dialing, the call is completed in the usual way.

2.08 To repeat, the dial PBX recognizes ground on the tip conductor from the CO equipment as a seizure signal, the CO equipment recognizes ground on the ring conductor from the dial PBX as a seizure signal. Similarly, the dial PBX recognizes the removal of ground from the tip conductor as a disconnect signal, and the CO switching equipment recognizes the opening of the loop as a disconnect signal. The PBX does not restore the trunk to the idle state until the tip ground from the CO is removed.

2.09 When the telephone is removed from its cradle, the off-hook signal is transmitted to the CO equipment as an indication of desired service. In turn, the CO equipment transmits a dial tone signal to the customer as an indication that the CO equipment is ready to receive the called number.

2.10 Address signals are normally applied to the loop by using a rotary dial or TOUCH-TONE station set. In the off-hook condition, when the dial is pulled off normal and then released, the loop is opened and closed a number of times corresponding to the digit dialed. On a TOUCH-TONE pad, a distinct two-frequency tone is generated when the button for each digit is depressed. The total series of dc pulses or tones is considered the address or called number information.

2.11 When the telephone is returned to the cradle after the completion of the conversation an on-hook signal is transmitted to the switching system. The on-hook signal starts the release of the CO equipment used to establish the connection.

3. SIGNALING RANGE LIMITS

3.01 Switched special services circuits differ from residential or message service because engineering specifications go beyond ordinary service in respect to transmission and signaling ranges and/or customer use.

3.02 The maximum distance over which metallic loop signaling is used, may be limited by any one, or all of the following:

(a) Dial pulsing or TOUCH-TONE calling range

(b) Supervisory range

(c) Ringing range

(d) Ringing trip range

(e) Transmission considerations.

3.03 Dial pulsing range is governed in part by the sensitivity and speed of the pulsing relay. It must maintain the percent break of the dial pulses within the limits that the associated CO or dial PBX can accept. Other factors which may reduce rotary dial pulsing range include pulse distortion, pulse mutilation, or false pulse generation. These effects can be caused by the interaction of reactive components contained in voice repeaters, terminating sets, or trunk circuits, which are in the signaling path. When TOUCH-TONE calling is used, the dialing range is limited by the transmission capability of the TOUCH-TONE oscillator at the station with respect to its output at the available line current, the transmission loss of the facility, and the sensitivity of the TOUCH-TONE receiver.

3.04 Supervisory range is the range over which a circuit can detect off-hook and on-hook signals, which are seizure and disconnect signals, respectively. Supervisory signals are not critical with respect to percent break and are normally detected by the same relay as dial pulses. The supervisory range of a specific circuit usually exceeds its dial pulsing range. Ground start circuits must detect the presence of ground on one conductor, and earth potential differences between the station and the CO may be a limiting factor.

3.05 Ringing range is determined by the RMS voltage of the ringing source, which may vary from 65 to 130 volts ac depending upon the type of ringing plant, and the current required to operate a station ringer within certain loudness limits. In the case of a PBX trunk, the ringing

range is determined by the current required to operate a ringup relay with a safety margin for circuit variations.

3.06 Modern special access circuits are arranged to trip ringing during the ringing period and/or during the silent period of the ringing cycle. Ringing trip range for the ringing period is governed by the sensitivity of the tripping relay, the 20-Hz voltage, and the voltage of the superimposed dc component. If the ringing source does not have superimposed dc, tripping can occur only during the silent period of the ringing cycle. With the latter arrangement, if the station end goes off-hook during the ringing interval, the person answering will receive 20-Hz ringing in his ear for the remaining portion of the ringing period. Tripping during the silent interval is accomplished by the relay used for dial pulsing and supervisory signals as described in paragraphs 4.02 and 4.03.

3.07 Additional considerations in determining maximum metallic loop signaling range include insulation resistance between conductors or between either conductor and ground, supply voltage variation limits, effects of any impedance compensator and/or voice repeater equipment, induced 60-Hz voltages, extension ringers, and ringing bridges in PBX switchboard cord circuits.

3.08 All of these factors are taken into account in the preparation of long line circuit range charts and similar data that specifies the maximum range over which circuits will function properly, and the maximum number of links that may be connected in tandem. Some of these sections are:

Switching System	Sections
All ESSs	851-300-170
No. 1 ESS	534-362-160
	820-010-170
No. 5 XB	534-362-156
	534-362-157
	819-021-170
No. 1 XB	534-362-151
	534-362-152
PANEL	534-362-153
	534-362-154
	534-362-155
SXS	534-362-158
	534-362-159
	814-013-170
	851-300-100
	851-300-165
	851-300-170

4. EXTENDING THE SIGNALING RANGE

4.01 When the distance between the station and the CO line circuit exceeds the normal (Fig. 2) operating range, an auxiliary circuit must be inserted between the two. The auxiliary circuit must provide the same conditions to the station as the line circuit, while providing the same conditions to the line circuit as the station. (See Fig. 3.)

4.02 For many circuits where range extension is desired, or a complete dc loop is not available (as in carrier facilities), derived dc signal paths are used. In these cases the signaling path is usually derived from the transmission path. Supervision and addressing may be converted to special signaling lead called E&M leads. The state of the M lead at the originating end determines the state of the E lead at the terminating end. And, the state of the M lead at the terminating end determines the state of the E lead at the originating end. (See Fig. 4) Therefore full two-way (duplex) signaling is provided. E&M convention is as follows:

STATE	M LEAD	E LEAD
Idle (on-hook)	Ground	Open
Seizure (off-hook)	Battery	Ground

4.03 Duplex (DX) signaling is a dc derived path used on metallic facilities. DX signaling is based on the use of a symmetrical and balanced

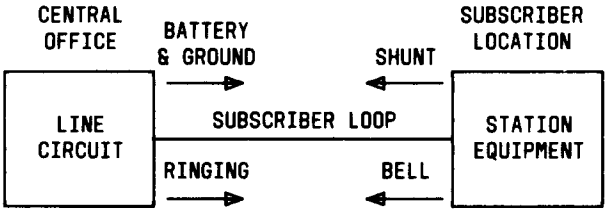


Fig. 2—Normal Operating Range

circuit that is identical at both ends of the circuit. (See Fig. 5.) Signaling and transmission are on the same path and, hence, do not occur simultaneously. One wire of the facility conductor pair is used for signaling and the other for ground potential compensation. Its chief advantage is that it can operate on circuits with loop resistances up to 5000 ohms. DX circuits are actually used to extend the E&M leads.

VOICE FREQUENCY FACILITY TERMINAL

A. General

4.04 The Voice Frequency Facility Terminal (VFFT) is a circuit-consolidating concept that combines transmission, signaling, and test access functions in one modular unit. Typical components of this unit, or bay, are channel banks, attenuators, amplifiers, equalizers, and signaling equipment.

4.05 The facility terminal concept produces a compact, flexible, and economical voice-frequency interface terminal, whose objectives are:

- To minimize the equipment and mountings required through the use of universal mountings and multi-functional plug-in units
- To minimize distributing frame terminations
- To simplify circuit design and line-up by creating a single system for transmission and signaling using similar or identical design procedures for all VFFTs
- To minimize operating costs.

4.06 There are three types of VFFTs associated with the three types of transmission media. They are the Analog Carrier Facility Terminal (ACFT), the Digital Carrier Facility Terminal (DCFT), and the Metallic Facility Terminal (MFT). During the circuit design and layout processes, the appropriate

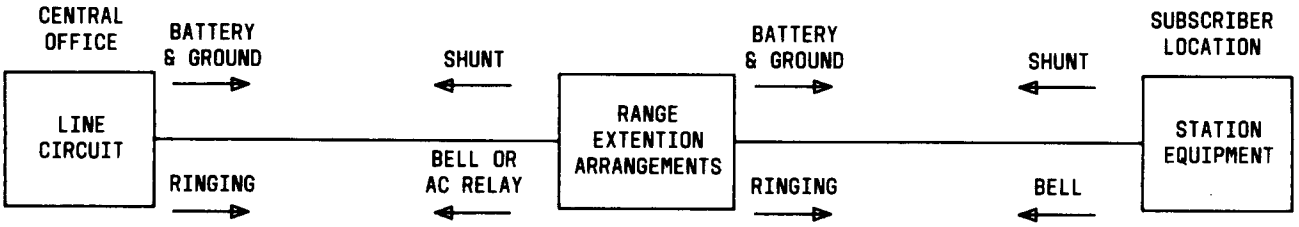


Fig. 3—Extending the Operating Range

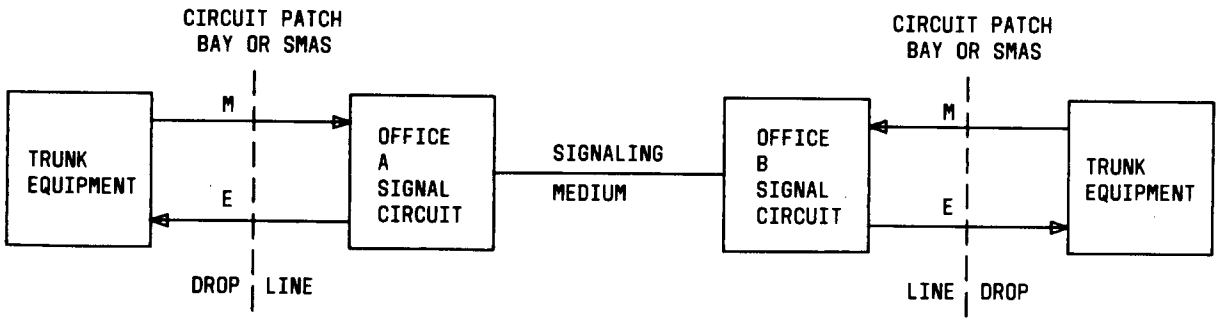


Fig. 4—E&M Signaling

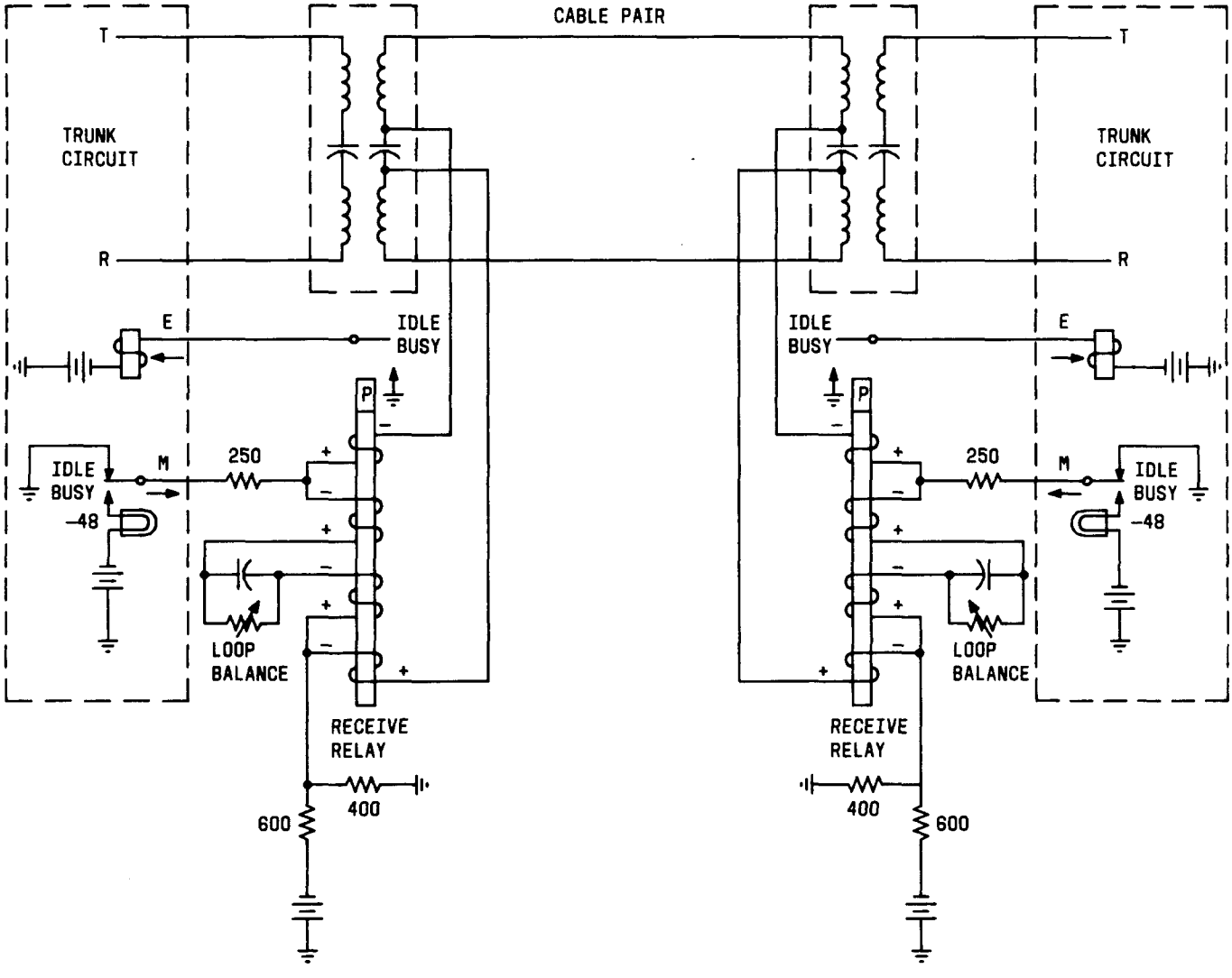


Fig. 5—DX Signaling

VFFT applicable to carrier or metallic trunk is selected. In essence, all VFFTs perform the same functions. The basic transmission functions include gain, level adjustment, amplitude equalization, balancing, and "hybrid" conversion. Basic signaling features include signal range extension, dial-pulse correction, duplex (DX) signaling, and automatic ring-down. The signaling features constitute the supervisory functions that set up a call, maintain it, and remove the set-up when the call terminates, as well as the signaling used to convey call destination information.

4.07 Most switched special service circuit applications require VF gain and dc signaling extension or conversion. The facility terminal equipment consists of plug-in modules which can be chosen to perform many combinations of signaling and transmission functions that are required to meet service objectives. Features of the MFT, DCFT, and ACFT complement each other so combinations of facilities can be utilized. (See Table B for the various types of plug-ins for different signaling and transmission configurations.)

4.08 Flexibility and maintenance are achieved by using replaceable plug-in units. The families of units and its software support simplifies standard design procedures. Integrated maintenance sectionalization capabilities for both local and remote

TABLE B

VOICE FREQUENCY FACILITY TERMINAL
SIGNALING ARRANGEMENTS

SIGNALING TYPE		LOCATION	METALLIC FACILITY TERMINAL SIGNALING UNIT (SU)	DIGITAL FACILITY TERMINAL				ANALOG FACILITY TERMINAL			TRANSMISSION CHARACTERISTICS OF DFTs AND AFTs		
				D4	D3	D2	D1	G	F	E			
LOOP START OR GROUND START		CENTRAL OFFICE END	LSR	2FXO	FXO	DM42	FX-OFF	GLA	FLA	E2L/LA	900Ω	2-WIRE	
			LSE	2FXO/GT				GLB	FLA/FUD				GAIN TRANSFER
			LS-GS CONV						FLB		600Ω		
			GS TO DX OR E&M CONV	4FXO	4WFXO			GPA	FPA		FACILITY MATCHING	4-WIRE	
										E1P	600Ω		
	LOOP START ONLY		LS TO DX OR E&M CONV	2FXOLS	FXOLS				FLC	E2L	900Ω	2-WIRE	
									FLD		600Ω		
		STATION END	LSR	2FXS	FXS	DM41	FX-SUB	GSA	FSA	E2S/SA	900Ω		
			LSE	2FXS/GT	2FSX/GT			GSC	FSA/FUD				GAIN TRANSFER
			LS-GS CONV						FSB		600Ω		
			DX OR E&M TO GS CONV	4FXS	4WFXS		4WFXS	GRA	FRA		FACILITY MATCHING	4-WIRE	
										E1R	600Ω		
	LOOP START ONLY		DX OR E&M TO LS CONV	2FXSLS	FXS-LS				FSC		900Ω	2-WIRE	
									FSD		600Ω		
DUPLEX		ANY OFFICE	DX1	4DX	4WDX		4WDX	GHA	FHA		FACILITY MATCHING	4-WIRE	
			DX1/DX2		2WDX		2WDX	GGA	FGA			2-WIRE	
				2DX/GT				GGB	FGA/FUD				GAIN TRANSFER
E&M		ANY OFFICE	SF/4-4 INT. REPTR	2E&M	2E&M	DM38	2WE&M	GAA	FAE	E1A	900Ω		
				2E&M6	2WE&M			GAB	FAF	E1A	600Ω		
				4E&M	E&M	DM35	E&M	GBA	FBC	E4B		4-WIRE	
TANDEM	E&M/SX	CENTRAL OFFICE END		4TDM	4WTDM		4WTDM	GPD	FPD		600Ω		
	E&M/SX	STATION END		4TDM	4WTDM		4WTDM	GRD	FRD				
	E&M	INTERMEDIATE		PLR	4WPLR		4WPLR	GBM	FBO	E4B			

access are provided through bays equipped with Switched Maintenance Access System (SMAS) connectors, manual access panels, and communication panels. The transmission and signaling equipment is designed to be compatible with older equipment and systems.

4.09 There is no routine maintenance required on the plug-in equipment of facility terminals after installation. In case of failure of a plug-in unit, it is replaced by a spare and the defective unit returned to the repair center for service. Test extenders are available so that tests may be made on a unit or on the associated circuit under in-service conditions, if required.

B. MFT

4.10 As with all VFFTs, MFT functions are provided by appropriate plug-in units that can be interconnected when inserted into the shelves of an MFT. The plug-ins used are the discrete transmission unit (TU) and signaling unit (SU). Combined function units (CFUs) are being developed.

4.11 Two basic arrangements for mounting these MFT plug-in units into bays are available: the single module or the double module system. In the double module system, adjacent TU and SU mountings are provided. By selecting the proper pairs of plug-ins, all transmission and signaling functions may be provided without DF cross-connections.

4.12 The CFU combines selected transmission and signaling functions into a single circuit module and can take the place of some commonly used double module designs. Use of the CFU will reduce mounting floor space requirements by 50 percent, reduce costs, facilitate circuit design, and reduce handling.

4.13 In some instances, the conditioning supplied by the MFT is not enough to ensure proper transmission and signaling. Repeaters, impedance compensation units, or other additional special conditioning circuits may be required at the customer's location. In these cases, a customer premises facility terminal (CPFT) is installed. The CPFT uses two basic types of plug-ins. One type, common to the MFT used in COs, meets a large portion of the conditioning needs. The other basic type of plug-in has the same physical form as key telephone plug-ins, providing impedance compensation with plug-in mounting convenience. The CO shelves for MFTs have been adapted for use with CPFTs. All relevant installation and application information about the MFT and MFT plug-ins is included in the CPFT documentation.

4.14 An MFT transmission unit provides all necessary transmission functions for its specific application without external equipment or plug-ins on the main unit. A series of repeaters cover the various combinations of terminal or intermediate application for 2- and 4-wire loaded or nonloaded cables. Each repeater provides its required function, including gain, level adjustment, equalization, 2- to 4-wire conversion, precision balancing and extraction of dc and low-frequency signaling for interface with any companion signaling unit. Other passive transmission units in the family include impedance compensators and 2- to 4-wire terminating sets that have level adjustment.

4.15 The MFT signaling modules perform a variety of signaling functions which are necessary in special service and other applications. Many MFT signaling modules are multifunctional and a single type of unit can replace a number of older signaling circuits. Switches located on the unit select the mode in which it operates.

4.16 The following basic signaling operations are performed by one or more of the MFT signaling modules:

- Range extension for loop-start and ground start
- Toll diversion
- Dial pulse correction and regeneration
- Duplex (DX)
- Code selected ringdown (CSR)
- Private line ringdown (PLAR)
- Loop and ground start to E&M conversion.

4.17 A loop signaling repeater (LSR) performs loop signaling functions on metallic loops. The LSR regenerates dc signals and 20-Hz ringing from the CO switching system towards the station and regenerates dc signals (including correction of dial pulses) from the station to the CO. The LSR

can be located at customer premises as well as at the CO.

4.18 The LSE is a battery boost range extension signaling unit. It adds a maximum of 12 Vdc in series with the tip and the ring conductor to increase the loop voltage by 24 volts. The 12 Vdc boost voltage is inserted in series with each conductor such that it boosts either loop start or ground start operation.

C. DCFT

4.19 The most modern DCFT equipment uses D3 integrated ciruit technology or the D4, with large scale integrated (LSI) circuitry. D4 was developed to provide a more cost effective digital terminal. It requires 50 percent less power and space on a per channel unit (plug-in) basis.

4.20 Message or special services are supplied by single module plug-ins. One example of the use of special service units in DCFTs is the foreign exchange (FX) application. The signaling features needed in FX are ground start, illustrated by the connections between a PBX and a switch and loop start, which is needed between a PBX and one of its off-premise stations. The FX channel units accommodate both ground start and loop start signaling. They are the 2-wire FXO J98726BE (office end) and the 4-wire FXS J98726BD (subscriber's end). Cost reduced units that handle only loop start are available. Four-wire units may be obtained to facilitate circuit design of long loop FX circuits.

4.21 In another application example, the pulse link repeaters (PLR) J98718SK(D3) or J98726BN(D4) together with a 4-wire E&M unit, permit back-to-back connections where E&M signaling or no signaling is involved.

4.22 The flow of signaling information between the DCFTs is used to originate, maintain, and terminate a call over the digital channel. In originating or terminating a call, the signaling circuits in the channel units respond to a change at the far end of the channel by repeating the associated circuit condition and signaling. The signaling information is encoded and transmitted over the carrier by the presence or absence of the PCM signaling bits for the channel. Two-state signaling represents two signaling states or conditions (off-hook, on-hook) which are accomplished by transmitting one signaling bit in each direction. All the channel units with signaling have primary signaling circuits to provide 2-state signaling. Four-state signaling which represents four signaling states or conditions is accomplsihed by transmitting two signaling bits, requiring appropriate channel units with additional signaling circuits.

D. ACFT

4.23 ACFT equipment consists of plug-in units, shelves to house these plug-ins, modules that supply maintenance access, and a variety of mounting arrangements. When plug-ins are inserted into the shelves, they may be interconnected to perform the required functions of an ACFT.

4.24 The F-signaling plug-in units take two forms: the double module (DM) and the single module (SM) system. In the DM type F-signaling system, a circuit consists of two plug-ins, a universal unit (FUA or FUD), and an auxiliary unit (AUX), inserted side by side in a mounting shelf. These units provide the transmission and SF signaling needed for an interface between a carrier channel unit and a cable facility or equipment circuit. In this system, the FUA or FUD is used in every application. The FUA generates and detects the SF signaling tones to and from the 4-wire carrier channel. It also contains variable attenuators for transmission level adjustment. The FUD supplies gain in addition to the functions of the FUA. The AUX plug-in is chosen from a family of approximately 35 different units [J code J99335( )] in accordance with the transmission characteristics and type of signaling from the interfacing voice-frequency circuit. For example, in some special service private branch exchange (PBX) tie trunk applications, the J99335HA which is a 4-wire duplex unit is used in conjunction with the FUA to provide service.

4.25 The single module (SM) type F signaling system is designed to provide the E&M signaling function. E&M circuits do not require much space on a circuit board and are frequently used, so they can be combined with the FUA onto one board for 4-wire E&M trunk applications. This results in higher physical circuit density and lower circuit cost. These units are known as the FW( ) series and mount in single module bays. FW( ) units are not compatible with the FUA + AUX mounting on DM bays.

4.26 The G signaling brings with it a family of SF equipment that provides the same functions

as the F-signaling equipment in a single module plug-in system. Some advantages of the G-signaling systems are:

- ***Size Reduction.*** The functions which require two separate units in F signaling are condensed into one plug-in unit. This will double the circuit density over the F-signaling DM system.

- ***Power Reduction:*** The application of integrated circuits permit the design of functional circuits that require less power than their discrete component counterparts. Power consumption will be reduced by about 50 percent.

- ***Cost Reduction:*** The initial costs associated with buying G-signaling equipment are less than F-signaling equipment. Operational costs are reduced.

4.27 G signaling uses the modular physical design. The modular unit houses 24 circuits and is a complete operating unit with its own power converter and fuse and alarm units. The G-signaling module consists of a top cover, a back plane, and two shelves, each holding 12 signaling units and one common unit. When more than one module is mounted in a bay, only one top cover is required. Plug-ins are ordered separately.

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

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

4.30 Optional circuit conditions can be selected and provided through the use of switches.

TANDEM ARRANGEMENTS

4.31 Tandem channel units and signaling units have been designed which allow for the connection of back-to-back carrier systems. These tandem units, F, G, D1, D3, and D4, interface analog/digital or digital/digital carrier systems. Signaling conditions are converted to the presence or absence of ground pulses between the tandem units. At the terminating end, signaling pulses cause the regeneration of the original signal which may be ringing, dial pulses, tip condition from the CO line circuit or ring condition from the general start signal at the PBX.

4.32 Other arrangements are also available for back-to-back carrier channel configurations. The use of channel units with E&M signaling results in an incompatible situation with a grounded "E" lead that must be used to affect the M lead of the second carrier system. There are three methods used to solve the problem of this type of incompatibility:

(1) Back-to-back DX circuits inserted between the carrier channels.

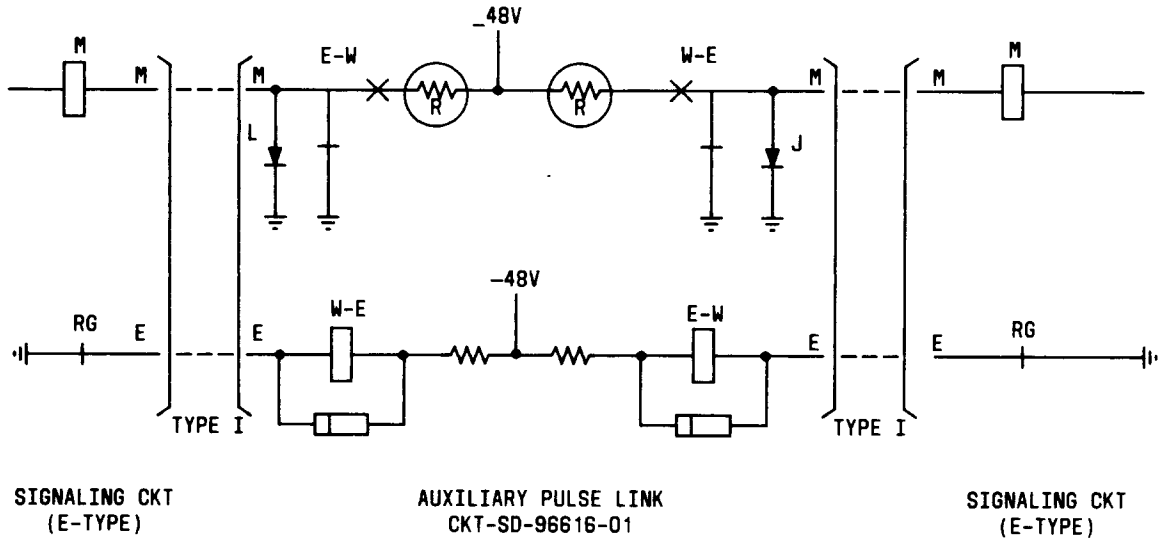
(2) Using a pulse link repeater (PLR) which is an auxiliary specifically designed for this purpose

(3) If the channel unit can be arranged for Type II E&M Interface, the leads between the channel unit can be connected directly as shown in Figure 6.

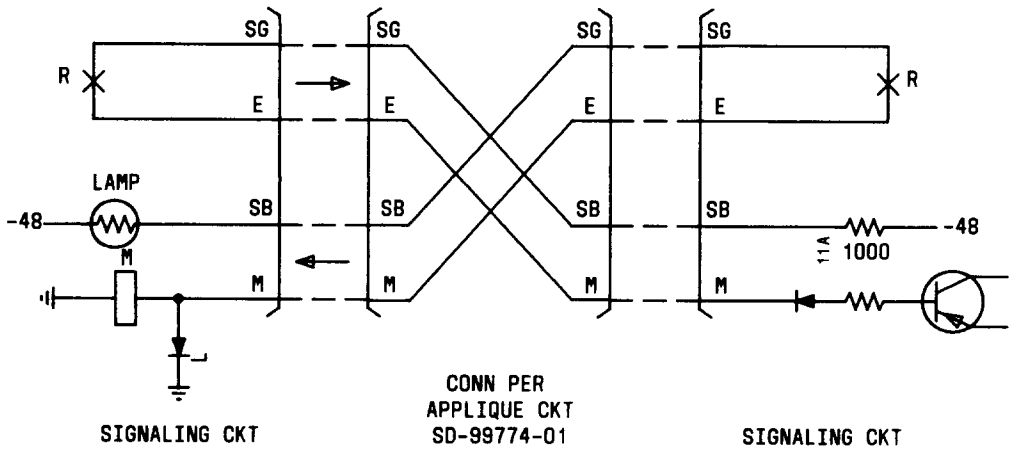
EARLIER ARRANGEMENTS

4.33 There may exist some older type of signaling arrangement on some special service circuits. These types are simplex (SX) and composite (CX).

4.34 ***Simplex Signaling*** The method of connecting a simplex signaling circuit is shown in Figure 7. By feeding the signaling



(A) AUXILIARY PULSE LINK REPEATER



(B) TYPE II INTERFACE

Fig. 6—Back-to-Back E&M Signaling

currents through the center taps of the line transformer, the flux due to the signaling current canceled and the signals are not transmitted beyond the transformers.

By paralleling the two conductors, the circuit resistance is halved, thus extending the range compared to loop signaling.

4.35 ***Composite Signaling.*** This method consists essentially of combining a voice transmission path with dc signaling path by means of a high-pass, loss-pass filter arrangement as shown in Figure 8. The signals are transmitted between central offices over one wire of the transmission circuit with ground return. Where necessary, the second conductor of the transmission path can be used to compensate for differences in

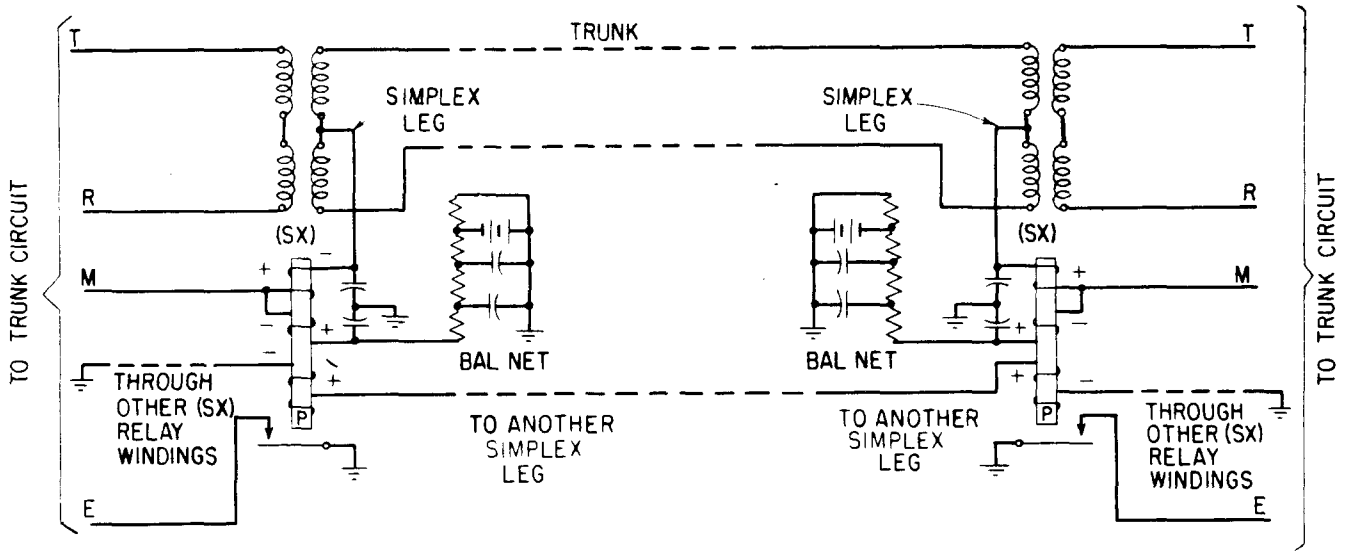


Fig. 7—SX Signaling

earth potential between the two offices. The crossover frequency of the filter arrangement is approximately 100 Hz. Thus, interference from signaling currents is blocked from the voice frequency spectrum.

4.36 Both SX and CX signaling have been superseded by DX signaling.

5. TESTING CONSIDERATIONS

5.01 The number of different arrangements available for providing special access service makes it very important that certain precautionary steps be taken. Some of the more important are:

(a) Check the SD Drawings and CD Sheets to ascertain that the proper options and figures are used.

(b) Visually check the equipment to ensure that the correct equipment and options are actually connected.

(c) The tester should familiarize himself with the various operating conditions of the circuit to be tested. A few brief notes pertaining to the operation of a specific circuit will quite often prove helpful in testing and servicing the circuit. These notes should be attached to the circuit layout card or sketch.

5.02 Circuit order tests should be made in accordance with the sections covering the type of facility assigned to the service. (See Sections 331-100-500 and -501 and other sections as applicable for 1004-Hz transmission tests and noise measurements.)

5.03 Local practices should be followed in removing circuits from service. It is important, however, that both ends of the circuit be made busy in those cases where it can be seized by switching equipment at either end.

5.04 Certain precautions should be observed when monitoring circuits. The circuit can be monitored at standard monitoring jack appearances of carrier channels and repeaters without affecting circuit operation or balance conditions. Monitoring across the 2-wire loops requires use of a high-impedance monitoring arrangement that does not place a direct current path across the loop.

5.05 In testing the signaling and supervisory functions of the special access circuit, the tester should place a call from a local telephone to the subscriber by dialing the number assigned to the circuit, or by having the operator make the connection. The subscriber should then be requested to place a call over the circuit to a telephone at the tester's location. During both calls, all signaling and supervisory functions such as dialing, ringing, tripping, etc, should be checked. Overall signaling

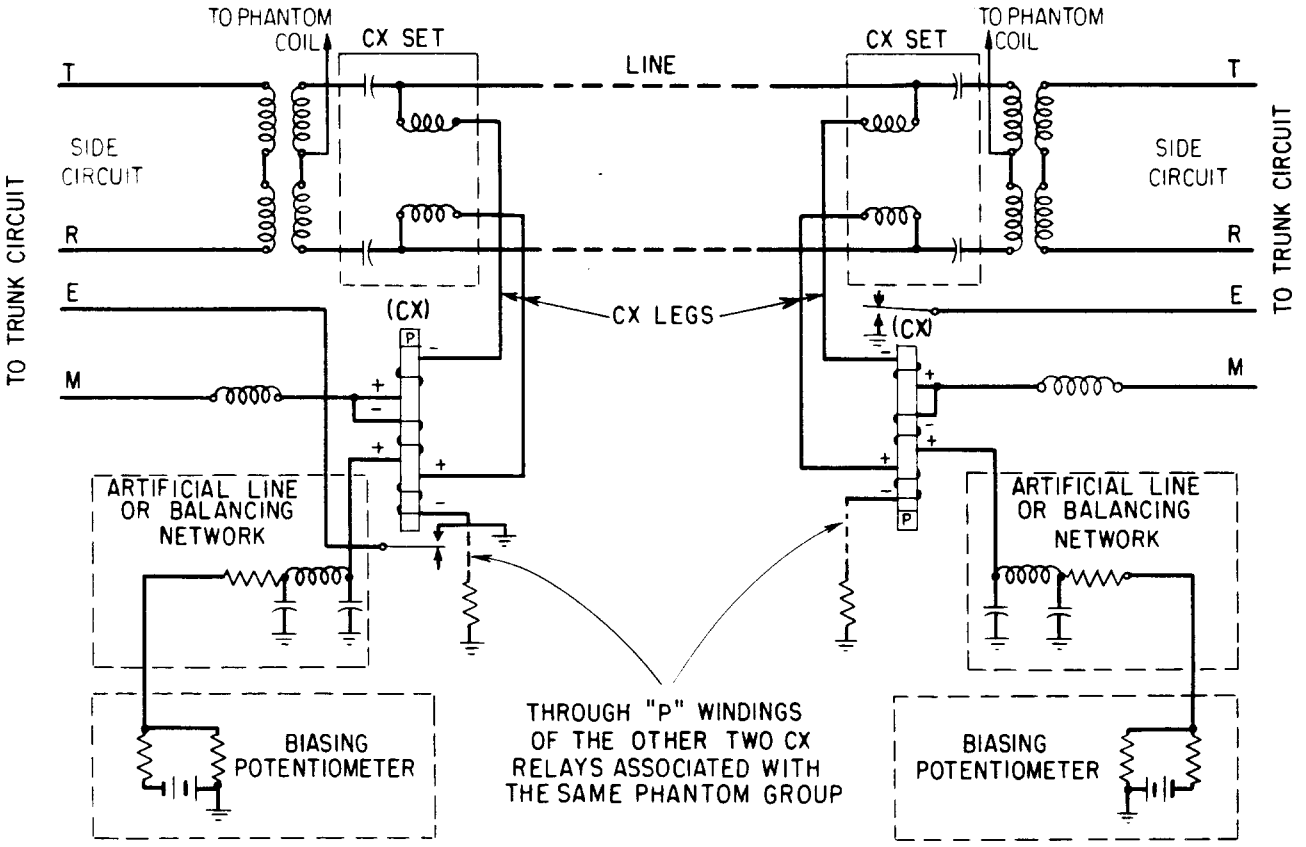


Fig. 8—CX Signaling

tests are described in Bell System Practice's Division 333.

5.06 In service, overall transmission measurements of special access circuits require several precautions to guard against erroneous results. In general, one must ensure that a seizure or off-hook condition is provided at both terminals so as to remove signal tones, open idle circuit terminations, and cut through the transmission path. The test equipment should present the proper impedance.

5.07 At the station terminal, in loop-start or ground-start applications, both the milliwatt source and the transmission measuring set must be arranged for line holding so as to provide an operate path for the supervisory relay in the special access circuit.

5.08 There are several test sets commonly used to test signaling on switched special service circuits. A brief description of various test sets is outlined in this paragraph. If more detailed information is desired, refer to the appropriate Bell System Practice's section for each test set.

5.09 Following is a list of the test sets and their functions:

(a) 1A Signaling Test Set (100-262-101)

(1) Monitors E&M lead condition

(2) Monitors dial pulses from line or drop

(3) Sends dial pulses to line or drop

(4) Sends on-hook or off-hook conditions toward line or drop

(5) Patch jack arrangement to meters for current measurements.

(b) 2B Signaling Test Set (804-911-155)

(1) Monitors E&M lead conditions

(2) Monitors dial pulses from line or drop

(3) Sends dial pulses to line or drop

(4) Key selected E lead requirements battery/ground or open/ground

(5) Vary speed and percent break of continuous or rotary dial pulses

(6) Patch jack arrangement for current and voltage measurements

(7) Can be adapted for loop pulsing tests. (Becomes 2B1 test set).

(c) 2AH Signaling Test Set (100-265-101)

(1) Measures voltage of 20-Hz and 135-Hz signaling circuits.

(d) 4A Signaling Test Set

(1) Modular construction which consists of a pulse generator, a measurement and display circuit, four optional plug-in units providing the capability for testing loop, E&M, SF, and DX signaling systems

(2) Four types of pulsing.

- Continuous pulse train
- Discrete train of one to ten pulses
- Same as above but repeated with an interdigital time of 185 msec or 680 msec
- Steady state signals corresponding to on-hook/off-hook conditions.

(3) Pulse generator switch controlled to any of the plug-in interfaces.

(4) Adjustable pulse period (PPS) and pulse width (percent break)

(5) Test functions to either line or drop

(6) E&M lamp display on line and drop lamps.

(e) 26B Signaling Test Set (Northeast Electronics)

(1) Monitors E&M lead conditions

(2) Transmits and measures adjustable pulses (PPS and percent break)

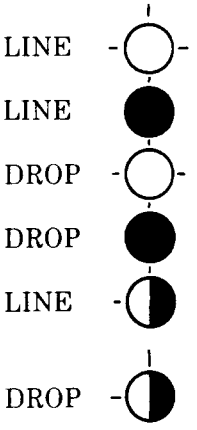
(3) Can monitor on high impedance bridged basis

(4) Internal or external power supply

(5) 26BXS SF accessory panel for testing SF signaling systems

(6) E&M lamp display on line and drop lamps.

5.10 The line and drop lamps display the following information on some of the above test sets:



5.11 The circuit is accessed by one of the following methods:

(a) A shoe or test lead inserted at the terminals of a distributing frame

(b) A patch jack specifically provided for test access

(c) Via a switched maintenance access system (SMAS)

(d) At test jacks on various types of equipment which may be part of the overall circuit.

It is possible that one circuit may contain all or any combination of access arrangements.

5.12 To make the various measurements or to monitor the circuit conditions, the test equipment is plugged into the appropriate jack access point. To make overall circuit tests, the assistance of additional personnel, trained in the

use of the various test sets, will be required at other CO locations.

SARTS

5.13 Using the Switched Access Remote Test System (SARTS) 1A, one person has the ability to test between any two access points on the circuit at one time. SARTS utilizes SMAS with a remote test system (RTS) at each access point location to perform the necessary tests.

5.14 RTS 5A has the capability to automatically provide the proper supervision, addressing sequences, and alerting to a circuit under test with the signaling formats specified by the near end operating company personnel. For a more detailed description, see Section 666-610-100.

6. REFERENCES

SECTION	TITLE
179-100-301	Signaling and Transmission Systems CompatibilityInformation—General
179-360-100	Type F Single Frequency Signaling System—General Description
179-400-100	Description Type G 2600-Hz Single Frequency Signaling
179-701-101	DC Signaling Systems—Description
179-702-101	CX and SX Signaling System—Description
332-910-100	Metallic Facility Terminal-Description
332-910-180	Metallic Facility Terminal—General Application
365-100-110	D1 Channel Units Description
365-400-104	D2 Channel Units Description
365-150-101	D3 Channel Units Description
365-170-101	D4 Channel Units Description
975-110-100	Customer Loop Signals and Signaling Systems
975-230-100	DX Signaling System—General Description Information