SECTION 981-010-100
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AT&TCo Standard

PRIVATE BRANCH EXCHANGE TIE TRUNK CIRCUITS

GENERAL DESCRIPTIVE INFORMATION

CONTENTS PAGE

1. GENERAL

1.01 This section describes the various PBX tie trunk arrangements that are in general use. It is based on overall circuit operation and conditions. The detailed description of specific equipment units is covered in the associated SD drawings and CD sheets. Similarly, the detailed description of signaling methods and transmission considerations is covered in other BSPs as listed in Part 7.

2. DEFINITIONS

2.01 The terms PBX, Centrex—CU, and Centrex—CO may be considered synonymous for the purposes of information presented herein.

2.02 ***A PBX tie trunk*** is a direct circuit between two PBXs and has no switching at any intermediate point. The physical connection between the two PBXs may be as simple as a pair of wires (sometimes called a tie line) or may involve 4-wire terminating sets, repeaters, carrier systems, and one or more central offices.

2.03 A ***tandem tie trunk network*** consists of a number of PBXs interconnected by tie trunks. This network enables a PBX station or attendant to reach any other PBX station or attendant within the network by progressively dialing through intermediate PBXs of the network. See 2.04.

2.04 ***Universal service*** is defined as the interconnection between a tandem tie trunk network and the regular message network DDD at one point only on any one call.

2.05 ***Joint hold*** is a part of some terminals and is defined as holding the originating end busy as long as the terminating end is held.

3. TIE TRUNK CIRCUIT CHARACTERISTICS

3.01 There are several characteristics of a tie trunk circuit that must be considered in its use:

- Method of selection
- Selection at both ends or only one end
- Signaling to and from distant PBX
- Terminating only or terminating and through service
- Transmission and impedance factors
- PBX with which trunk is used
- Connecting circuit at the distant PBX and in some cases, intermediate equipment in the central office.

TRUNK SELECTION

3.02 A tie trunk can be manually selected by the attendant, dial selected by a station, or dial selected by the attendant. A single trunk circuit may be selected in more than one way.

3.03 Connection is made to a manually selected tie trunk by the attendant plugging into the tie trunk jack on the switchboard or operating a key on a console. For a manual PBX, manual selection is the only type available.

3.04 For manual auxiliary switchboards or PBXs with consoles, both manual and dial selection can be used. The dial selection may be by attendant or station. With dial selection, the trunk is connected to the switching equipment of the PBX and is reached by dialing a tie trunk access code.

ONE-WAY AND 2-WAY TRUNKS

3.05 The selection of a tie trunk may be from only one end, or it may be from both ends. Also, on trunks that may be selected at both ends, the type of trunk operation may be different in each direction.

3.06 A one-way trunk is a trunk that is selected at only one of the two connecting PBXs. If the local PBX selects the trunk, it is called ***outgoing***. If the distant PBX selects the trunk, it is ***incoming***. Where the type of operation differs in each direction, the operation in each direction is given, for example, outgoing automatic-incoming dial repeating.

3.07 A 2-way trunk may be selected at either end, and operation is normally the same in both directions.

TRUNK SIGNALING

3.08 Several types of signaling are used to convey information from one PBX to the other. Signaling is used for supervision (on-hook, off-hook, and flash), for information or addressing (dialing), and for ringing. The signal may be a dc voltage, a single ac frequency, or a pair of ac frequencies. Among the dc methods of signaling are loop (battery and ground, high-low, reverse battery) or E & M (simplex SX, duplex DX, composite CX).

3.09 The dc signaling method is normally used in the trunk circuit and may be converted to or from single frequency (SF) in a connecting circuit, if required.

TERMINATING AND THROUGH SERVICE

3.10 Terminating service is the connection between a tie trunk and a station or attendant of the PBX. Through service is the connection between a tie trunk and another tie trunk or to a central office trunk.

3.11 A tie trunk that provides terminating and through service requires compensation in

the circuit to maintain tolerable losses and minimize echos for both uses. The circuit may use an attenuating pad controlled by the trunk circuit. The pad is removed from the circuit on through calls and is connected on terminating calls. The pad circuit may be included in the trunk circuit equipment even though the trunk is used for terminating service only. Other tie trunk circuits used for terminating and through service have switched gain. The effective circuit gain is switched to provide compensation for the increased loss on through calls.

RANGE FACTORS

3.12 The transmission range for conversation and signaling dictates the circuit configurations (options) required in the tie trunk circuit at the PBX and the type of facility to which the tie trunk connects. If the trunk uses a completely metallic circuit, the dc resistance of the circuit will normally limit the ringing range first. If other means (repeaters, carrier, etc) are used, their requirements must be utilized to determine the usable range.

TIE TRUNK FOR PBX

3.13 The different types of PBXs have different tie trunk circuits designed for their special requirements. In some cases, a tie trunk circuit is usable with several PBXs. In other instances, a tie trunk circuit can be used with only one PBX. Occasionally, an auxiliary (adapter) circuit is needed between the trunk circuit and the PBX.

TIE TRUNK TO TIE TRUNK

3.14 A tie trunk at one PBX must be capable of connecting with the tie trunk at a distant PBX. The trunk circuits at each end do not necessarily have to be the same type trunk. For instance, a manual tie trunk can be connected to a dial repeating tie trunk. The calls from the manual end would be connected by the attendant and dialed by the attendant or by the station. The calls from the dial end would terminate on the switchboard at the manual end. The signaling at each end must be compatible or conversion must be made.

3.15 If intermediate equipment is used, the signaling between the trunk circuit and the intermediate equipment must be compatible. For trunks that pass through one or more central offices, no switching is performed in the office, but the trunk may use wiring paths in existing cables.

4. TYPES OF TIE TRUNKS

4.01 Tie trunks can be described by their use (2-way, incoming, outgoing), their selection (manual, dial), and their method of completion on incoming calls (ringdown, automatic, dial repeating). In some word descriptions, certain terms may not be used because they are implied. There are three basic types of PBX tie trunk circuits. These are as follows:

(a) ***2-Way Dial:*** Tie trunk circuits which provide dial selection of the desired station on incoming calls at the terminating end.

(b) ***2-Way Automatic:*** Tie trunk circuits which signal the PBX attendant at the distant end directly upon seizure, without the sending of a 20-Hz ringing signal, and provide answer and disconnect cord signals to both the originating and terminating PBX attendant. Selection of the desired station at the terminating end is done by the PBX attendant.

(c) ***2-Way Ringdown:*** Tie trunk circuits which require the sending of a 20-Hz ringing signal to reach the PBX attendant at the distant end. Neither the originating nor terminating PBX attendant receives answer or disconnect cord signals from the trunk. Selection of the desired station at the terminating end is done by the PBX attendant. Dial selected ringdown trunks and some manually selected ringdown trunks on consoles are arranged to send a single 2-second spurt of 20-Hz ringing upon seizure.

4.02 Permutations and one-way only use of these three basic types is possible. One such case is a one-way dial—one-way automatic tie trunk circuits for use between a dial PBX and a manual PBX.

4.03 Additional variations of these types include those tie trunk circuits having station access by dialing, direct switchboard or console access by the PBX attendant, or the combination of both dial and manual access.

4.04 Another variation of the automatic and dial types is the form of signaling to the distant

end. The two basic types of signaling are loop signaling and E & M signaling. These types are described in more detail below.

4.05 A trunk can be further classified by the form of signaling to the distant end. The trunks described here use either ringdown, loop, or E & M signaling. Loop or E & M signaling can be converted from one type to the other at an intermediate point between the PBX terminals. Loop and ringdown signaling are normally used for short distances, called short haul, where no repeaters or carrier systems are involved. E & M signaling is normally used for long distances, called long haul, where the total resistance prevents the use of loop signaling.

4.06 ***Ringdown signaling:*** In ringdown signaling, the ringing voltage (90-105 volts 20 Hz) is applied to the selected tie trunk to alert the distant PBX. This ringing voltage is applied manually by the attendant operating a ring key or automatically when the trunk is dialed. The automatic ringing will normally be applied only one time for a period of about 2 seconds. The maximum signaling range varies with the ringing voltage and is reduced by the use of transmission improvement devices, E6 repeaters, 24V4 repeaters, and line building out (LBO) networks.

4.07 ***Loop signaling:*** Loop signaling involves the flow of current over the two conductors of the loop, directly operating a relay or other sensing device to indicate seizure, dial pulsing, disconnect, or other auxiliary signals. The maximum signaling range of loop type signaling is determined by the total loop resistance. For some circuits this resistance is approximately 2500 ohms. The maximum signaling range is reduced by the use of transmission improvement devices, E6 repeaters, 24V4 repeaters, and line building out (LBO) networks. Some forms of loop signaling (see tables) are not compatible with these devices. The different types of loop signaling are as follows:

- High-low signaling uses a change in current to signal origination on locally originated calls or to signal answer on calls originated at the distant PBX. This change in current is produced by changing the loop resistance. If the local PBX has high-low signaling, the distant PBX may have high-low signaling or may have reverse-battery signaling. In a typical signaling sequence, a voltage is applied to the circuit at one PBX to indicate seizure (selection) and a change in current (by change in loop resistance at the other PBX) to indicate answer.

- Reverse-battery signaling uses a reversal of the polarity of potential applied to the loop to signal answer on calls originated at the distant PBX and to signal origination on locally originated calls. A polarized relay is normally used at the distant end; the normally applied polarity of voltage will not energize the relay, but the reversed voltage polarity will. The distant PBX may or may not have the same type of signaling. In a typical signaling sequence, the local PBX seizes the circuit by completing the loop so that a voltage source at the distant PBX causes current to flow in the loop. At answer, the distant PBX reverses the polarity of the applied voltage. To release, the loop is opened by the calling PBX.

- Battery and ground signaling is signaling in which a voltage is applied at the distant PBX and the loop at the local PBX is open during the idle condition. To seize the circuit, the local PBX applies a voltage to the loop that is in series and aiding the voltage at the distant PBX. To answer, the distant PBX reverses the polarity of its applied voltage; and to hold the call, the local PBX reverses its voltage polarity. To release the connection, the loop is opened at the calling PBX. This system is similar to reverse-battery signaling but can operate over a greater range.

4.08 ***E & M signaling:*** In order to signal over trunk facilities of greater resistance than loop signaling permits; various signal transmission systems are used. These signal transmission systems have been designed to provide a common signaling interface with trunk circuits. This common interface consists of a uniform system of leads designated E & M lead signaling. Intermediate signaling links may use duplex (DX), composite (CX), single frequency (SF) signal transmission systems, or out-of-band built-in systems as in N1 and T1 carrier. Each of these systems is described in the BSPs listed in Part 7. Because DX signaling is used frequently between PBXs and because some trunk circuits have built-in DX units, a brief

discussion of DX signaling is given in the following paragraph.

4.09 The DX signaling circuit (Fig. 1) uses the same cable pair as the talking path. One wire of the pair is used for signaling and the other wire is used for earth potential correction (EPC) and to compensate for any difference in battery voltage between the two PBXs. The DX signaling circuit consists essentially of a polar relay having four windings, a resistor network, and a capacitor network. A circuit is required at each terminal of the trunk circuit. A reference voltage is applied to the junction of the P3 and P4 windings. The value of this reference voltage reflects any ground potential at the terminal and the supply voltage at the terminal. A resistor network of 1250 ohms plus the one-way trunk resistance RT between DX units balances the current between the P2 and P3 windings and the P1 winding during operation of the control relay. The resistance RT includes any 24V4 or E6 repeater and a dc path must be maintained. The capacitor network balances the line capacitance to prevent false operation or flutter of the DX relay when its control relay operates. The control relay is not part of the DX unit but connects to ground when idle and to battery supply when busy. During pulsing, the control relay follows the dial pulses. There are four conditions that the two connecting DX signaling units can have:

(1) ***Both control relays unoperated:*** A bias current will flow through windings P2 and P3 of both relays to keep them unoperated. Any difference in ground potential between the near and far ends will cause a current through winding P1 at each end. This current will tend to operate the relay at one end and keep the relay unoperated at the other end. The EPC current, caused by the reference voltage differences, flows through the P4 windings of each relay, canceling the effects of any current through the P1 windings.

(2) ***The near end control relay operated:*** The current through the near end winding P2 and P3 will tend to operate the relay, but the current through its P1 winding will more than cancel this effect. At the far end the current through the P1 winding is sufficient to overcome the effects of the current through the P2 and P3 windings and will cause the far end relay to operate for a one-way trunk resistance (RT) up to 5000 ohms.

(3) ***The far end control relay operated:*** The condition is the same as in (2) except the near end and far end are reversed.

(4) ***Both control relays operated:*** If both control relays are operated, the current through P1 will be due to the supply voltage difference between the two ends and will be cancelled by the EPC current through winding P4. The current through windings P2 and P3 is sufficient to cause the DX relay to operate. The same action occurs at both ends.

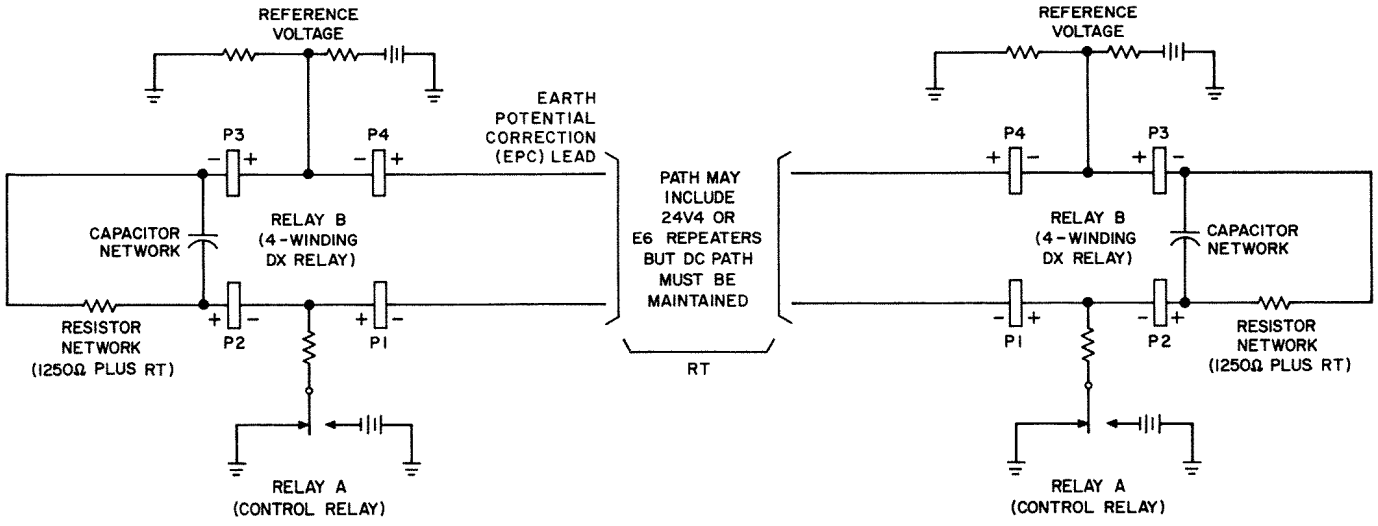

Fig. 1—DX Signaling Circuit Simplified Control Schematic

5. TRANSMISSION CONSIDERATIONS

5.01 While voice transmission has always been a consideration on PBX tie trunks, the transmission improvement program on PBX and special services circuits initiated in 1965 has placed many more stringent transmission requirements on PBX tie trunks. This has resulted in an increasing number of circuits being 4-wire from PBX to PBX, and many of those that are 2-wire use E6 repeaters to meet modern transmission requirements. The use of these transmission devices places additional requirements on PBX tie trunk circuits which include:

(a) Idle circuit terminations (ICT) which must be provided to prevent the repeater from ***singing*** due to the lack of a termination in the idle state of the trunk.

(b) Balance requirements which must be met involve meeting echo return loss and singing point objectives to prevent echo and repeater ***singing*** during the talking state of the trunk.

(c) Transmission performance suitable for data operation is frequently required. This involves the attenuation, envelope delay, and noise parameters of a facility.

(d) Pad control may be required on 4-wire tie trunks which will be switched to other tie trunks, CO trunks, and station lines. These tie trunk circuits are equipped with 2-db switchable pads to protect against echo for terminating connections. The pads should be switched out on through connections to other VNL (echo corrected) facilities and should be left in on terminating connections to station lines or other lines and trunks which do not provide adequate terminal balance.

(e) The type of coupling of the tie trunk circuit is important. Circuits having bridged impedance coupling and those using type 94, 101, 202 or similar repeat coils for coupling may not have desirable transmission characteristics. Type 120, 2578, or similar repeat coils, type 4036 or similar networks, and all 4-wire terminating sets provide satisfactory transmission characteristics.

6. TANDEM TIE LINE NETWORKS

6.01 When a connection involves several PBXs, problems in supervision and pulsing are likely to occur. As a general rule, no more than three through-connecting (tandem) PBXs should be involved in one connection. The type of PBX and its position in the connection are important; therefore, coordination for all PBXs in the network is essential.

6.02 Step-by-step PBX systems use direct control switching and cause no problems when dial pulsing is used. On calls using TOUCH-TONE® addressing, each PBX must use a TOUCH-TONE register and the problems of the register-sender PBXs covered below apply. The No. 1 ESS does not accept TOUCH-TONE signaling on tie trunks at seizure because a register is not connected.

6.03 PBXs such as the 756, 757, and 800 use a register without a sender (register only) and must connect dial tone before pulsing is received. This system is satisfactory in tandem connections if the indialing equipment can recognize dial tone and delay pulsing until the register is connected.

6.04 The register-sender type operation is used with systems such as No. 101 ESS and No. 5 Centrex. These systems must connect dial tone before incoming pulses are received. If the immediately following equipment must connect a register, outpulsing can be delayed by an amount of time that will normally allow connection of the register. The No. 101 ESS can delay each digit by extending the interdigital interval if other PBXs in the connection might require delay. The first digit from a No. 5 Centrex can be delayed. Also the No. 5 centrex will accept only one stop signal, if required, between any subsequent digits.

6.05 All possible connections between PBXs must then be considered when tandem tie trunk networks are involved. An arrangement in which a No. 5 Centrex is connected through a 701B PBX to a 757A PBX would not be compatible, because the outpulsing from the No. 5 Centrex after the first digit would not be delayed to allow connection of a register in the 757A PBX. Future equipment development, however, may provide facilities to permit tandem connections in all possible arrangements.

7. REFERENCE INFORMATION

7.01 The following BSPs are listed by category as an aid to those who desire more detailed information on the general subjects covered herein.

7.02 Signaling Methods

SECTION	TITLE
179-101-101	DC Signaling
179-102-101	CX and SX Signaling
859-100-100	Signaling, Signaling Systems, and Signal Transmission Systems
975-115-100	Signals and Signaling Systems Between Offices
975-230-100	DX Signaling
975-240-100	SF Signaling
362-010-100	N1 Carrier
365-010-100	T1 Carrier

7.03 Compatibility of Signaling and Transmission Circuits

179-100-301	General
179-100-302	T1 Carrier
179-100-303	V4 Repeater
179-100-304	E-Type Signaling
179-100-305	E Repeater

7.04 Transmission

AB 22.310.00	Transmission Design Considerations and Objectives for PBX and Special Services Circuits
310-350-100	Balance Test Considerations—PBX 4-wire VNL Tie Trunks and Access Lines
332-206-100	E6 Repeaters

8. 2-WAY DIAL REPEATING TIE TRUNK CIRCUITS

8.01 The 2-way dial repeating tie trunk circuits can be seized from either end. The circuits may use E & M signaling (Table A) or loop signaling (Table B). For those circuits using loop signaling, battery and ground signaling (see 4.07) is normally used. The circuits follow and repeat outgoing dial pulses and incoming dial pulses. Some circuits may have a pulse correcting feature for incoming pulses. Access to the trunk may be either dial or manual and dial. Disconnect is always automatic when the stations go on-hook.

8.02 A variety of repeating coils, terminating circuits, repeaters, carrier systems, and signal circuits may be used with the tie trunk circuit to provide the signaling and transmission requirements between the connecting PBXs. Typical connections for the most frequently used connecting circuits with E & M lead signaling are shown in Fig. 2 through 7. The exact equipment for each instance depends upon the circuit requirements. Some of these requirements are covered in the SD for the circuit. Others must be engineered for the particular use of the circuit.

9. 2-WAY AUTOMATIC TIE TRUNK CIRCUITS

9.01 The 2-way automatic tie trunk circuits can be seized from either end. The circuits may use E & M signaling (Table C) or loop signaling (Table D). For those circuits using loop signaling, high-low signaling (see 4.07) is normally used. Access to the trunks may be either manual, dial, or both manual and dial. Disconnect is always automatic when the station goes on-hook.

9.02 There are several variations in the trunk circuit configurations because of differences in connecting equipment, signaling, and depending upon whether the circuit has 2-wire or 4-wire facilities.

10. 2-WAY RINGDOWN TIE TRUNK CIRCUITS

10.01 The 2-way ringdown tie trunk circuits can be seized from either end and require ringing voltage (20 Hz ac) power applied to the circuit to signal the distant PBX. Certain operating features are different for the various trunk circuits. Most of these variations are listed in Table E. Ringdown is normally manual except for tie trunk circuits associated with switching equipment which

has ringing power applied automatically to the circuit for about 2 seconds when the circuit is seized. These automatic ringing systems also provide automatic disconnect when the station goes on-hook. Disconnection from a manual switchboard not having automatic ringing is achieved by applying ringing to the tie trunk before the connecting plug is removed. Disconnection from stations making dial accessed calls is normally automatic.

10.02 Table E lists most of the currently standard 2-way ringdown tie trunk circuits with some of their characteristics and the equipment with which they can be used. The maximum loop resistances are given for 95-volt minimum ringing voltage and direct, repeating coil, or by-pass capacitor loops. For other conditions, information is given in the CD and SD.

11. COMBINATION AND ONE-WAY ONLY TIE TRUNK CIRCUITS

GENERAL

11.01 Certain tie trunk circuits do not have the same operating characteristics in one direction as they have in the other, or they have a combination of characteristics. Some tie trunk circuits can be seized at only one end. These types are referred to as "outgoing only" when access can be gained only at the local PBX and "incoming only" when access can be gained only at the distant PBX. A combination tie trunk circuit can be seized at either of the connecting PBXs, but the characteristics are different for operation at each end. For example, a trunk can be outgoing dial repeating and incoming automatic. Some of the various types of these tie trunk circuits are discussed below, and the characteristics of the trunk circuits are listed in Table F.

OUTGOING DIAL REPEATING, INCOMING RINGDOWN TIE TRUNK CIRCUITS

11.02 Outgoing dial repeating, incoming ringdown tie trunk circuits repeat the dial pulses on outgoing calls. Outgoing signaling is normally high-low loop (see 4.07). On incoming calls, ringing voltage is applied to the tip and ring leads at the distant PBX. The local attendant is alerted by lamps and an audible signal. Disconnect is automatic when the stations go on-hook.

OUTGOING DIAL REPEATING, INCOMING AUTOMATIC TIE TRUNK CIRCUITS

11.03 Outgoing dial repeating, incoming automatic tie trunk circuits repeat or pass the dial pulses on outgoing calls. On incoming calls the attendant is alerted by an audible signal and lamp. Signaling is different for the two directions. Outgoing signaling is normally high-low loop and incoming signaling is normally reverse battery loop.

OUTGOING ONLY DIAL REPEATING OR AUTOMATIC TIE TRUNK CIRCUITS

11.04 Outgoing only dial repeating tie trunk circuits can be seized only at the local PBX and repeat outgoing dial pulses. The automatics will connect directly to the distant attendant. Signaling is normally high-low loop. The automatic tie trunk circuit may have an audible signal and trunk lamp. An indication of idle or busy state of the trunk may be required.

INCOMING DIAL REPEATING, OUTGOING AUTOMATIC TIE TRUNK CIRCUITS

11.05 Incoming dial repeating, outgoing automatic tie trunk circuits repeat the incoming dial pulses as they are received. On outgoing calls, the distant PBX attendant is alerted by audible signal and lamp indication controlled by signaling from the local PBX. Signaling is normally reverse battery loop.

INCOMING ONLY DIAL REPEATING OR AUTOMATIC TIE TRUNK CIRCUITS

11.06 Incoming only dial repeating tie trunk circuits repeat the incoming dial pulses as received and allow direct connection to a station or trunk that is not restricted. The automatic tie trunk circuit connects directly to the attendant facility. The circuits normally use reverse battery loop signaling to indicate answer to the calling end.

OTHER TYPES OF TIE TRUNK CIRCUITS

11.07 There are numerous types of tie trunk possibilities, but the ones described are the types most frequently used. Any 2-way trunk can be used as an incoming or outgoing only type. Most dial repeating types can use automatic operation in either direction, if required.

TABLE A

2-WAY DIAL REPEATING TIE TRUNK CIRCUITS WITH E AND M LEAD SIGNALING

CIRCUIT	J-SPEC	PBX OR ATTENDANT FACILITY USED WITH (Note 2)	SELECTION	MAXIMUM LOOP CIRCUIT RESISTANCE	IDLE CIRCUIT TERMINATION	PAD CONTROL	24V4 (44V4) REPEATER	E6 REPEATER	COMPATIBLE WITH CARRIER	TYPE REPEAT COIL OR BRIDGED IMPEDANCE	REMARKS
SD-65718-01	J58824BC	552,556,605, 606,607,608, 701,702,711, 740,756,757, 800, No. 5 Centrex	Manual or Dial	5000Ω for Dx (Trunk Pulsing)	YES	YES	YES	YES	YES	120	Incoming pulse correcting. Has built-in Dx signal unit. One direction can be automatic.
SD-65718-02	J58824CF	552,556,605, 606,607,608, 701,702,711, 740,756,757, 800, No. 5 Centrex	Manuel or Dial	5000Ω for Dx (Trunk Pulsing)	YES	YES	YES	YES	YES	120	Incoming pulse correcting. Has built-in Dx signal unit. One direction can be automatic.
SD-66799-01	J58824BW	552,556,605, 607,608,701, 711,740	Manual or Dial	5000Ω for Dx (Trunk Pulsing)	YES	YES	—	—	YES	—	Incoming pulse correcting. Has built-in Dx signal unit. 4-Wire only. Local station dialing through switchboard cord circuit.
SD-1A163-01	J1A033CA	No. 1 ESS Centrex	Dial	500Ω E Lead Resistance	YES	NO	YES	YES	YES	4036B NETWORK	Short haul use. 2-Wire trunk. One direction can be automatic.
SD-1A23601	J1A033CB	No. 1 ESS Centrex	Dial	200Ω E Lead Resistance	YES	YES	YES	—	YES	—	Long haul use. MF pulsing only. 4-Wire trunk. One direction can be automatic.
SD-1A237-01	J1A033CC	No. 1 ESS Centrex	Dial	500Ω E Lead Resistance	YES	YES	YES	—	YES	—	Long haul use. Dial or MF pulsing. 4-Wire trunk. One direction can be automatic.
SD-1H065-01 (A&M)	J1H005AR or AS	No. 101 ESS	Dial	—	YES	YES	YES	YES	YES	120	
SD-1H083-01	J1H005BH or BJ	No. 101 ESS	Dial	—	YES	YES	YES	YES	YES	120	One direction can be automatic.

Note 1: All circuits have both terminating and through service.

Note 2: An auxiliary trunk circuit may be required.

TABLE B

2-WAY DIAL REPEATING TIE TRUNK CIRCUITS WITH LOOP SIGNALING

CIRCUIT	J-SPEC	PBX OR ATTENDANT FACILITY USED WITH	SIGNALING METHOD	SELECTION	TERMINATING OR THROUGH SERVICE	MAXIMUM LOOP CIRCUIT RESISTANCE	REMARKS
SD-65531-01	J58824AH	608 and 701, 740,756, or 800	Bat. and Grd	Manual or Dial	Terminating	2000Ω (Non-Tandem) 1800Ω (Tandem)	None of these trunk circuits have idle circuit termination and none have pad control. None are compatible with 24V4 repeaters or carrier systems. All are conditionally usable with E6 repeaters. (See Section 175-100-305.) All have bridged impedance coupling.
SD-65535-01	J58824L	711,740,756, 757,800	Bat. and Grd	Dial	Both	2000Ω (Non-Tandem) 1800Ω (Tandem)	
SD-66042 (A&M)	J58824N	552 or 608 and 701, 740, or 756	Bat. and Grd	Manual or Dial	Both	1650Ω	
SD-66043 (A&M)	J58824P	711,740	Bat. and Grd	Dial	Both	1650Ω	
SD-66635-01	J58824AL	701	Bat. and Grd	Manual or Dial	Both	2000Ω (Non-Tandem) 1800Ω (Tandem)	
SD-1A264-01	J1A033CG	No. 1 ESS Centrex	High-low Seizure, Reverse Battery Answer	Dial	Both	5500Ω	Has idle circuit termination and can be used with 24V4 repeaters, E6 repeaters, and carrier systems. Does not have pad control. Has 4036B network coupling.

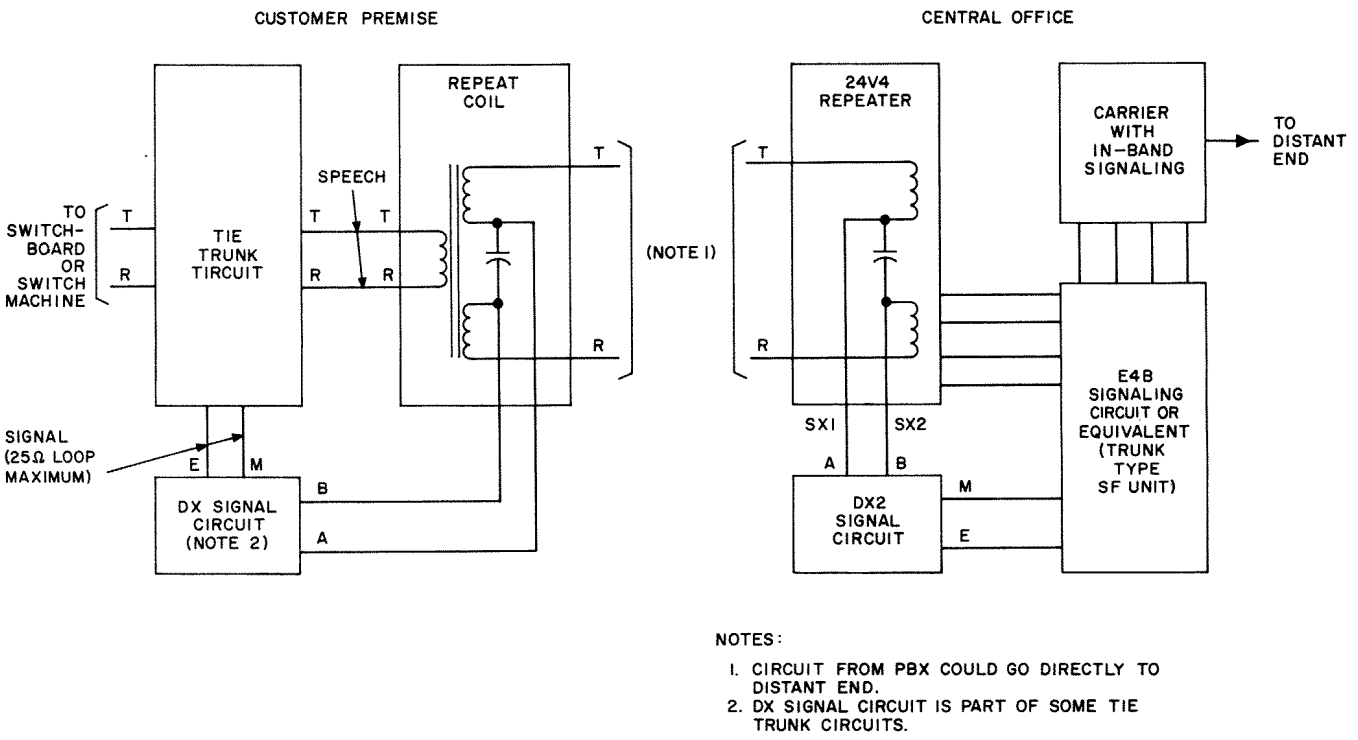

Fig. 2—Tie Trunk Circuit With E and M Lead Signaling Using DX Signal Unit and Repeat Coil for 2-Wire Circuit

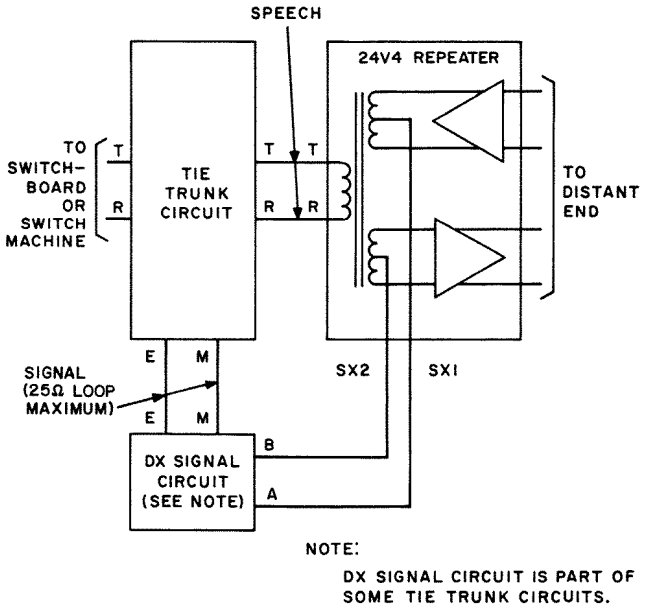

Fig. 3—Tie Trunk Circuit With E and M Lead Signaling Using DX Signal Unit and 24V4 Repeater for 4-Wire Circuit

12. SIGNALING CIRCUITS, EXTENSION CIRCUITS, AND CONVERTERS

12.01 Frequently a signaling circuit, extension circuit, or converter is needed to make a tie trunk circuit compatible with the circuit at the distant end or to enable the tie trunk circuit to connect to a carrier system. Table G lists typical circuits used with tie trunk circuits and indicates some of the operating characteristics for each circuit.

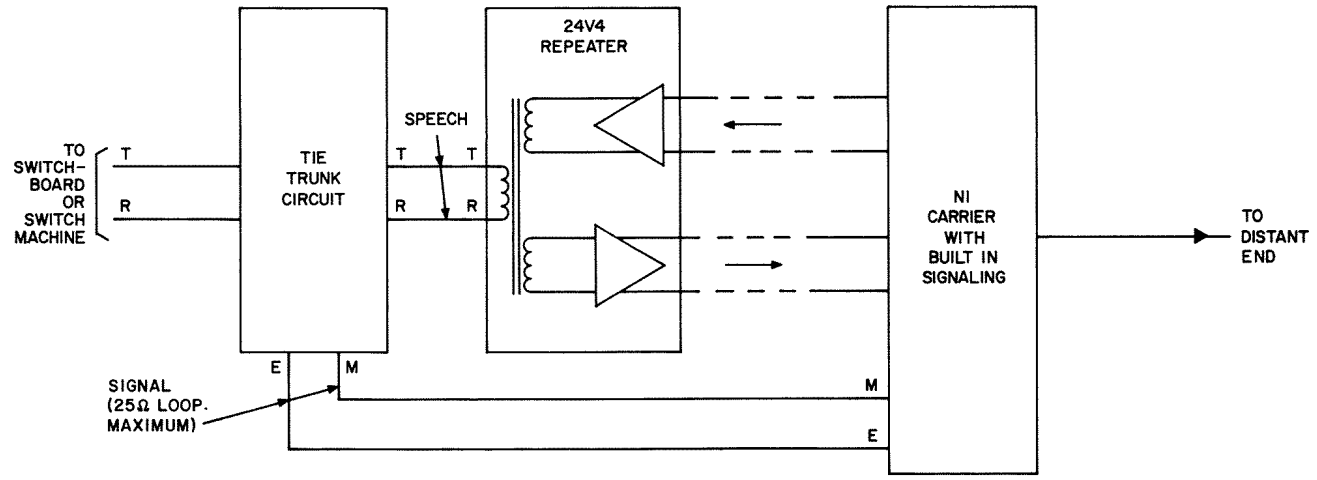

Fig. 4—Tie Trunk Circuit With E and M Lead Signaling Using 24V4 Repeater to Connect to N1 Carrier With Built In Signaling

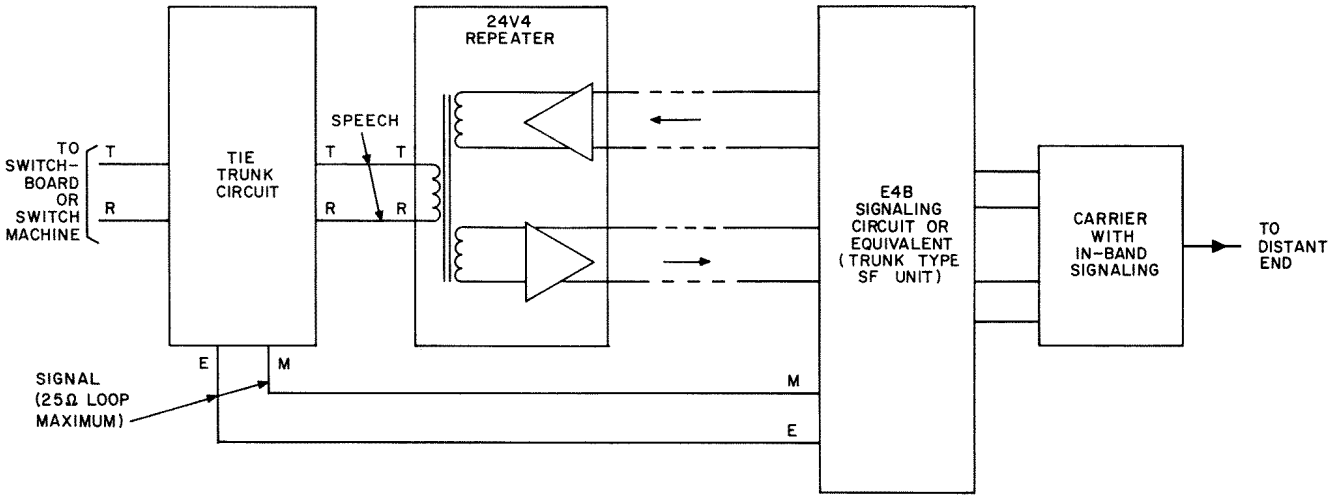

Fig. 5—Tie Trunk Circuit With E and M Lead Signaling Using 24V4 Repeater and E4B Signaling Circuit to Connect to a Carrier System With In-Band Signaling

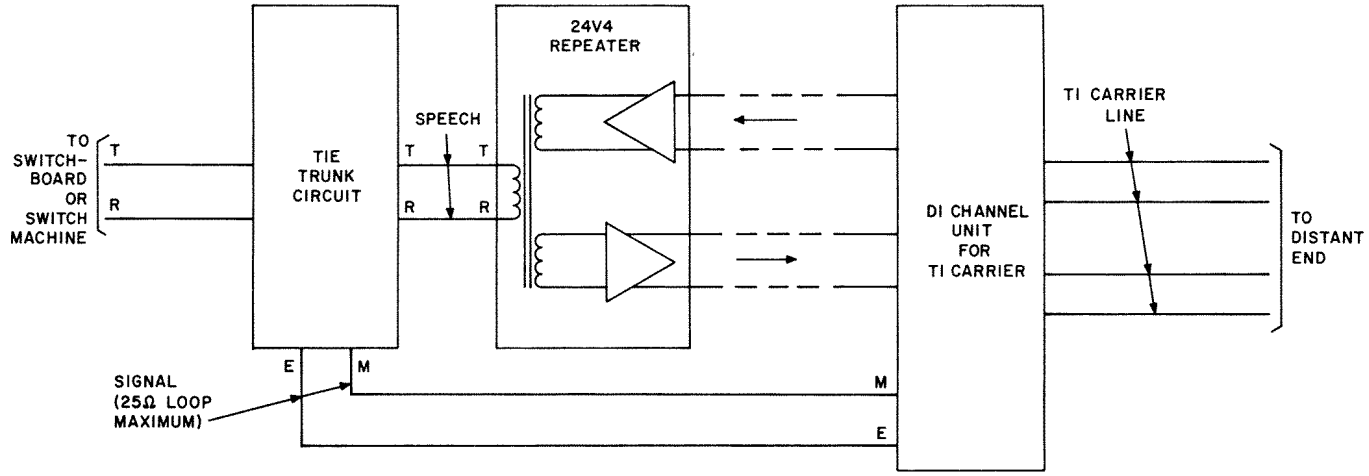

Fig. 6—Tie Trunk Circuit With E and M Lead Signaling Using DX Signal Unit and 24V4 Repeater to Connect to D1 Channel Unit For T1 Carrier

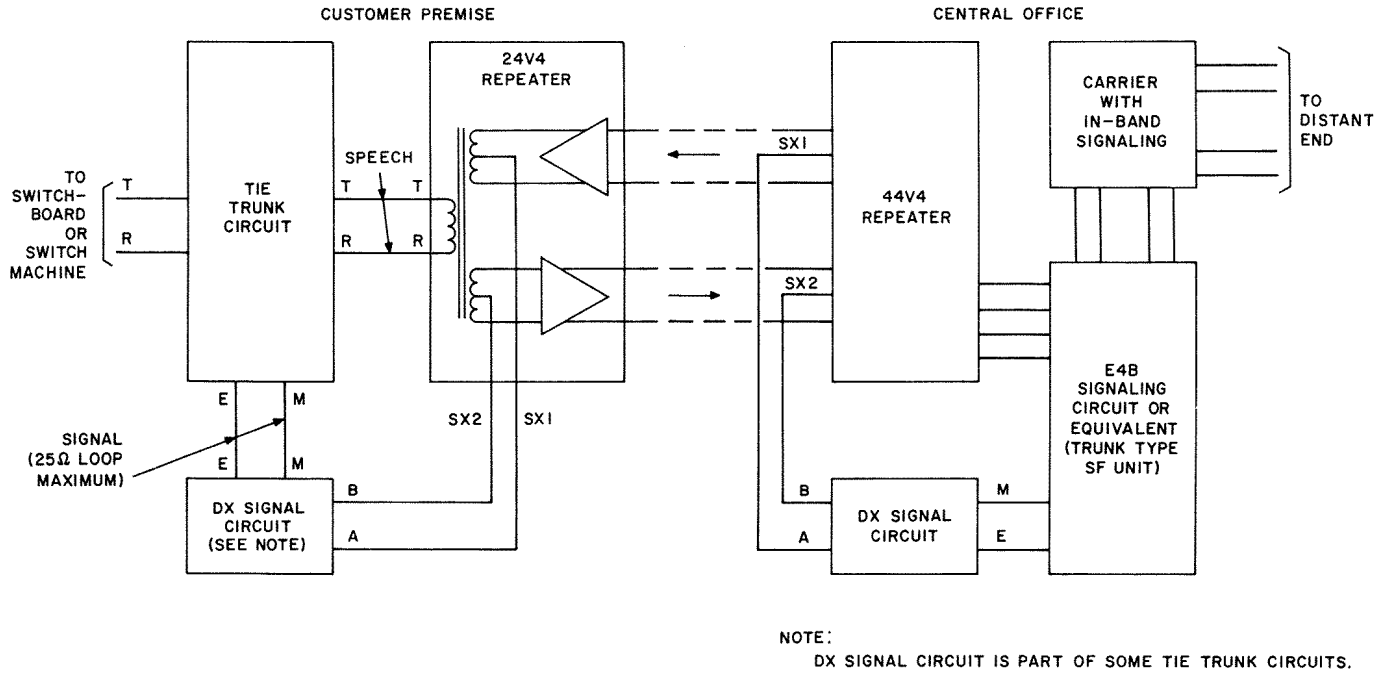

Fig. 7—Tie Trunk Circuit With E and M Lead Signaling Using DX Signal Unit and 24V4 Repeater to Connect to Carrier Equipment at the Central Office

TABLE C

2-WAY AUTOMATIC TIE TRUNK CIRCUITS WITH E AND M LEAD SIGNALING

CIRCUIT	J-SPEC	PBX OR ATTENDANT FACILITY USED WITH	SELECTION	IDLE CIRCUIT TERMINATION	PAD CONTROL	24V4 (44V4) REPEATER	E6 REPEATER	COMPATIBLE WITH CARRIER	TYPE REPEAT COIL OR BRIDGED IMPEDANCE	REMARKS
SD-67009-01	J58840G	552,555,556,605, 606,607,608	Manual	YES	YES	YES	—	YES	—	
SD-1H061-01 (A&M)	J1H005AT	101	Dial	YES	YES	YES	YES	YES	120	
SD-1H084-01	J1H005BK	101	Dial	YES	YES	YES	YES	YES	120	Can be dial repeating outgoing.
SD-1A163-01	J1A033CA	No. 1 ESS Centrex	Dial	YES	NO	YES	YES	YES	4036B NETWORK	Short haul 2-wire.
SD-1A236-01	J1A033CB	No. 1 ESS Centrex	Dial	YES	YES	YES	—	YES	—	Long haul 4-wire. (More economical than 1A-237.)
SD-1A237-01	J1A033CC	No. 1 ESS Centrex	Dial	YES	YES	YES	—	YES	—	Long haul 4-wire.

Notes:

1. All circuits have both terminating and through service.
2. All circuits except No. 1 ESS Centrex have 25-ohm maximum E and M lead resistance. Values for No. 1 ESS Centrex are shown in Table A. If the resistance limit is exceeded DX2 or similar signaling unit is required.

TABLE D

2-WAY AUTOMATIC TIE TRUNK CIRCUITS WITH LOOP SIGNALING

CIRCUIT	J-SPEC	PBX OR ATTENDANT FACILITY USED WITH	SIGNALING METHOD	SELECTION	TERMINATING OR THROUGH SERVICE	MAXIMUM LOOP CIRCUIT RESISTANCE	IDLE CIRCUIT TERMINATION	PAD CONTROL	TYPE REPEAT COIL OR BRIDGED IMPEDANCE	REMARKS
SD-65733-01	J59019E	507	High-Low	Manual	Terminating	2340Ω ***	YES	NO	202	All of these trunk circuits are compatible with 24V4 repeaters and E6 repeaters. They can be used with carrier systems if a suitable loop to E and M converter is used. See Table G. If, resistance limit of E, and M leads is exceeded DX2 or similar signaling unit is required.
SD-65823-01	J58837G	701B (Console)	High-Low (Rev Bat. on Through)	Manual or Dial	Both	4600Ω *	YES	NO	120	
SD-66065-01	J53120AA	552,556,605,608	High-Low	Manual	Terminating	1768Ω **	NO	NO	Bridged impedance	
SD-66066-01	J58824S	552,608,701,740, 756,800	High-Low	Manual or Dial	Terminating	4600Ω (Opt V, Adj. C, 44V at distant PBX)	NO	NO	Bridged impedance	
SD-66524-01	J59013J	555,557	High-Low	Manual	Terminating	2340Ω ***	NO	NO	202	
SD-66622-01	J58824AR	606,607,608,701, 740	High-Low	Manual or Dial	Terminating	4600Ω *	NO	NO	Bridged impedance	
SD-1H044-01	J1H005AA	101	High-Low	Dial	Both	4600Ω *	YES	YES	120	
SD-1A264-01	J1A033CG	No. 1 ESS Centrex	High-low, Seizure Reverse Battery Answer	Dial	Both	5500Ω	YES	NO	4036B Network	

*Maximum external circuit loop resistance with L relay having adjustment C and a minimum of 44 volts at the distant PBX.
**Maximum external circuit loop resistance for outgoing calls with 44-volt minimum voltage.
***Maximum external circuit loop resistance for outgoing calls with 18-volt minimum and 25-volt maximum voltage.

TABLE E

2-WAY RINGDOWN TIE TRUNK CIRCUITS

CIRCUIT	J-SPEC	PBX OR ATTENDANT FACILITY USED WITH	ATTENDANT SELECTION	TERMINATING OR THROUGH SERVICE	LOOP RESISTANCE*		IDLE CIRCUIT TERMINATION	PAD CONTROL	TYPE REPEAT COIL OR BRIDGED IMPEDANCE	REMARKS
					MAXIMUM RESISTANCE	CIRCUIT OPTION				
SD-65680-01	J59019D	507		Both	4000Ω 8000Ω	None S	YES	NO	202	All of these trunk circuits are compatible with 24V4 repeaters and E6 repeaters. They normally can be used with carrier systems if a suitable ringdown to E and M converter is used. See Table G. If resistance limit of E and M leads is exceeded DX2 or similar signal unit is required.
SD-65681-01	J53120E	607,608	Manual	Both	4000Ω	None	YES	YES	94	
SD-65702-01	J59022H	508A		Both	4000Ω 8000Ω	None W	YES	YES	120	
SD-65756-01	J58829T	756	Manual or Dial (Station dial access)	Both	2000Ω 8300Ω	None X	YES	YES	202	
SD-65825-01	J58837F	701 (Console)	Manual	Terminating	2000Ω 8300Ω	None X	NO	NO	202	
SD-66029-01	J53120AB	552,556,605	Manual	Both	3800Ω	None	YES	YES	101, 54, or 94	
SD-66522-01	J59013G	555,557	Manual	Both	2000Ω 4000Ω 5300Ω	None Y	YES	NO	202	
SD-66578-01	J53120P	552,556,605,608	Manual	Terminating	4000Ω	None	YES	NO	120	
SD-66649-01	J53120L	606,607,608	Manual	Terminating	4000Ω	None	NO	NO	Bridged impedance	
SD-66766-01	J58838DB	757	Manual or Dial (Station dial access)	Both	1700 8300	None K	YES	YES	202	
SD-1E026-01	J58860P	800	Manual or Dial (Station dial access)	Both	2000Ω	None	YES	YES	2578	

*Values of loop resistance and options are for direct, repeating coil, or by-pass capacitor circuits with 95-volt minimum ringing supply.

TABLE F

COMBINATION AND ONE-WAY TIE TRUNK CIRCUITS

TYPE OF TIE TRUNK CIRCUIT	CIRCUIT SD	J-SPEC	PBX OR ATTENDANT FACILITY USED WITH	SIGNALING	SELECTION	TERMINATING OR THROUGH SERVICE	MAXIMUM LOOP CIRCUIT RESISTANCE	IDLE CIRCUIT TERMINATION	PAD CONTROL	24V4 REPEATER	E6 REPEATER	TYPE REPEAT COIL OR BRIDGED IMPEDANCE	REMARKS
Outgoing Dial Repeating, Incoming Ringdown	SD-65699-01	J59022F	508	Outgoing— High-Low Loop Incoming— Ringing	Manual	Both	2000Ω (64V minimum ringing voltage)	NO	NO	YES	YES	120	
	SD-65701-01	J59022G	508	Outgoing— High-Low Loop Incoming— Ringing	Manual	Both	100Ω	YES	YES	—	—	120	Connects to private radio, microwave, or carrier circuit
Outgoing Dial Repeating, Incoming Automatic (See Tables A and B SD-65718-01, SD-65718-02, SD-1A163-01, SD-1A237-01, SD-1A264-01, and SD-1H084-01 can also be used.)	SD-66039-01	J59009AJ	550,551	Outgoing— High-Low Loop Incoming— Reverse Battery Loop	Manual	Both	4100Ω	NO	NO	YES	YES	Bridged Impedance	
	SD-66040-01	J53120AC	552,605,608	Outgoing— High-Low Loop Incoming— Reverse Battery Loop	Manual	Both	3100Ω (dial pulse test)	NO	NO	YES	YES	Bridged Impedance	
	SD-66523-01	J59013H	555,557	Outgoing— High-Low Loop Incoming— Reverse Battery Loop	Manual	Both	1650Ω (conductor resist) 4000Ω (external loop)	NO	NO	YES	YES	202	
Outgoing Only Dial Repeating or Outgoing Only Automatic	SD-66298-01	J53120M	606,607,608	Outgoing— High-Low Loop	Manual	—	2300Ω	NO	NO	YES	YES	Bridged Impedance	
	SD-1A165-01	J1A032BB	No. 1 ESS Centrex	Outgoing— High-Low Loop	Dial	Both	8800Ω	YES	NO	YES	YES	4036B Network	
Incoming Dial Repeating, Outgoing Automatic (See Table A and B SD-65718-01, SD-65718-02, SD-1A163-01, SD-1A237-01, SD-1A264-01, and SD-1H083-01 can also be used.)	SD-65755-01	J58824AT	756,757,800, SS400	Reverse Battery Loop	Dial	Both	2665Ω (L relay supervision)	NO	NO	YES	YES	Bridged Impedance	
	SD-1A192-01	J1A032CB	No. 1 ESS Centrex	Outgoing— Reverse Battery Loop Incoming High-Low Loop	Dial	Both	4500Ω	YES	NO	YES	YES	4036B Network	
Incoming Only Dial Repeating or Incoming Only Automatic	SD-1A166-01	J1A032AB	No. 1 ESS Centrex	Incoming— Reverse Battery Loop	Dial	Both	9200Ω	YES	NO	YES	YES	4036B Network	

Note: All these trunk circuits can be used with carrier systems if an outboard loop to E and M converter is used. See Table G. If the resistance limit of E and M leads is exceeded, DX2 or similar signaling unit is required.

TABLE G

SIGNALING CIRCUITS, EXTENSION CIRCUITS, AND CONVERTERS

TYPE CIRCUIT	DRAWING AND EQUIPMENT	INCOMING	OUTGOING
LP1 For interface between loop and SX or CX signaling circuits.	SD-95060-01 J98605AB	E and M lead to automatic. Reverse battery to seize tie trk ckt. High-low answer from tie trk ckt.	Dial, automatic, or MF to E and M lead. Tie trk seizes and pulses with High-low. Answer response to tie trk is reverse battery.
LP2 For interface between loop and SX, or CX signaling circuits.	SD-95061-01 J98605Y	E and M lead to dial or automatic. High-low seizure and pulsing to tie trk ckt. Reverse battery answer from tie trk ckt.	Automatic to E and M lead. Tie trk seizes with reverse battery. Answer response to tie trk is high-low.
LP3 For interface between loop and SX, CX, or SF signaling circuits.	SD-96398-01 J99235M	E and M lead to dial or automatic. High-low seizure and pulsing to tie trk ckt. Reverse battery answer from tie trk ckt.	—
AR0 For interface between an automatic loop circuit and a dc ringdown circuit.	SD-56131-01 J98602Y	E and M lead automatic to dc ringdown. Receives ground on E lead, changes M lead from ground to battery, applies ring signal on G or SG lead to tie trk for 2 seconds, and then returns reversal from battery to ground on M lead. Either party can rering.	—
AR1 For interface between an automatic loop circuit and a 20 Hz ringdown circuit.	SD-56199-01 J98605P or R	E and M lead automatic to 20 Hz ringdown. Receives ground on E lead, applies 20 Hz ring to tie trk ckt for 2 seconds and then returns battery on M lead. Either party can rering.	—
D0A For interface between an SX or CX signaling circuit and a dc ringdown circuit.	SD-64698-01 J98602N	E and M lead to dc ringdown. Ground on E lead causes battery on lead to dc-to-20 Hz ring circuit at tie trk ckt. Either party can rering.	Dc ring to E and M lead. Ground from tie trk ckt causes battery to ground change on M lead. Either party can rering.
D0B For interface between an SX, CX or SF signaling circuit and a dc ringdown circuit.	SD-56159-01 J98605AA	E and M lead to dc ringdown. Ground on E lead to operate dc-to-20 Hz ring circuit at tie trk ckt. Either party can rering.	Dc ring to E and M lead. Either battery or ground signal from tie trk ckt for battery to ground change on M lead. Either party can rering.

TABLE G (Cont)

SIGNALING CIRCUITS, EXTENSION CIRCUITS, AND CONVERTERS

TYPE CIRCUIT	DRAWING AND EQUIPMENT	INCOMING	OUTGOING
D1A For interface between an SX or CX signaling circuit and a 20 Hz ringdown circuit.	SD-64697-01 J98602M	E and M lead to 20 Hz ringdown. Incoming ground for 20 Hz ring to tie trk ckt. Either party can rering.	20 Hz ring to E and M lead. 20 Hz ring from tie trk ckt causes change from ground to battery on M lead. Either party can rering.
D1B For interface between an SX, CX, or SF signaling circuit and a 20 Hz ringdown circuit.	SD-56163-01 J98605M or N	E and M lead to 20 Hz ringdown. Incoming ground to battery on E lead causes 20 Hz ringing to tie trk ckt. Either party can rering.	20 Hz ring to E and M lead. 20 Hz ring from tie trk ckt causes battery to ground change on M lead. Either party can rering.
DX1 DX signaling and E and M lead extending circuit.	SD-95487-01 J98605AG	For Duplex signaling between tie trk ckts or for extending signal range where no control relay is required. Works on E and M lead basis up to 5000 ohm loop resistance.	Same as incoming.
DX2 DX signal lead extension circuit.	SD-95488-01 J98605AH	For use between a DX line and a signaling circuit. As with an E4B for converting DX signals back to E and M lead. See Fig. 2. Works on E and M lead basis up to 5000 ohm loop resistance.	Same as incoming.
PLR For interface between two E and M lead circuits.	SD-95095-01 J98605D	A pulse link repeater for connecting two E and M lead circuits together.	Same as incoming.

ADDENDUM 981-010-100PT
Issue A, August, 1970
Pacific Tel.

PRIVATE BRANCH EXCHANGE TIE TRUNK CIRCUITS
GENERAL DESCRIPTIVE INFORMATION

1. GENERAL

1.001 This addendum supplements Section 981-010-100.

1.002 It is issued to add information for trunk modification on 2-way automatic tie trunk circuits with loop signaling.

9. 2-WAY AUTOMATIC TIE TRUNK CIRCUITS

The following changes apply to part 9 of this section.

(a) Table D — revised.

(b) Figures 8, 9, 10, 11, and 12 — added.

TABLE D

2-WAY AUTOMATIC TIE TRUNK CIRCUITS WITH LOOP SIGNALING

CIRCUIT	J-SPEC	PBX OR ATTENDANT FACILITY USED WITH	SIGNALING METHOD	SELECTION	TERMINATING OR THROUGH SERVICE	MAXIMUM LOOP CIRCUIT RESISTANCE	IDLE CIRCUIT TERMI-NATION	PAD CONTROL	TYPE REPEAT COIL OR BRIDGED IMPEDANCE	REMARKS
SD-65733-01	J59019E	507	High-Low See Note and refer to Fig. 8	Manual	Terminating	2340Ω***	YES	NO	202	All of these trunk circuits are compatible with 24V4 repeaters and E6 repeaters. They can be used with carrier systems if a suitable loop to E and M converter is used. See Table G. If resistance limit of E and M leads is exceeded, DX2 or similar signaling unit is required. Note: Trunk unit must be modified per specified figure.
SD-65823-01	J58837G	701B (Console)	High-Low (Rev Bat. on Through)	Manual or Dial	Both	4600Ω*	YES	NO	120	
SD-66065-01	J53120AA	552, 556, 605, 608	High-Low See Note and refer to Fig. 9	Manual	Terminating	1768Ω**	NO	NO	Bridged Impedance	
SD-66066-01	J58824S	552, 608, 701, 740, 756, 800	High-Low See Note and refer to Fig. 10	Manual or Dial	Terminating	4600Ω (Opt V, Adj. C, 44V at distant PBX)	NO	NO	Bridged Impedance	
SD-66524-01	J59013J	555, 557	High-Low See Note and refer to Fig. 11	Manual	Terminating	2340Ω***	NO	NO	202	
SD-66622-01	J58824AR	606, 607, 608, 701, 740	High-Low See Note and refer to Fig. 12	Manual or Dial	Terminating	4600Ω*	NO	NO	Bridged Impedance	
SD-1H044-01	J1H005AA	101	High-Low	Dial	Both	4600Ω*	YES	YES	120	
SD-1A264-01	J1A033CG	No. 1 ESS Centrex	High-Low, Seizure Reverse Battery Answer	Dial	Both	5500Ω	YES	NO	4036B Network	

* Maximum external circuit loop resistance with L relay having adjustment C and a minimum of 44 volts at the distant PBX.
** Maximum external circuit loop resistance for outgoing calls with 44-volt minimum voltage.
*** Maximum external circuit loop resistance for outgoing calls with 18-volt minimum and 25-volt maximum voltage.

FIG. 8

MODIFICATION FOR 507
P.B.X.
T-65733-11 PARTIALLY SHOWN
J-59019E

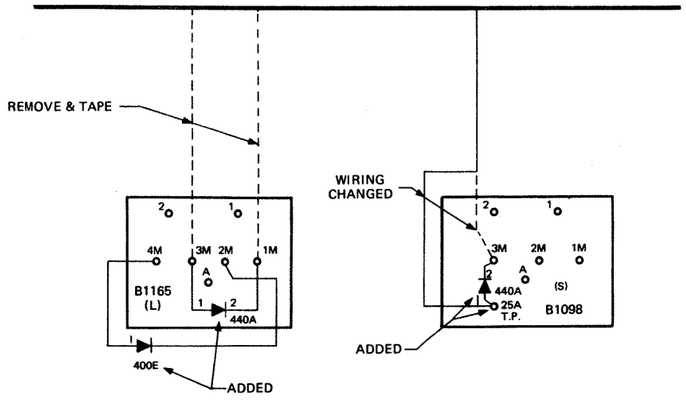

FIG. 9

MODIFICATION FOR 552, 556, 605, 608
P.B.X.
T-66065-33 PARTIALLY SHOWN
J-53120AA

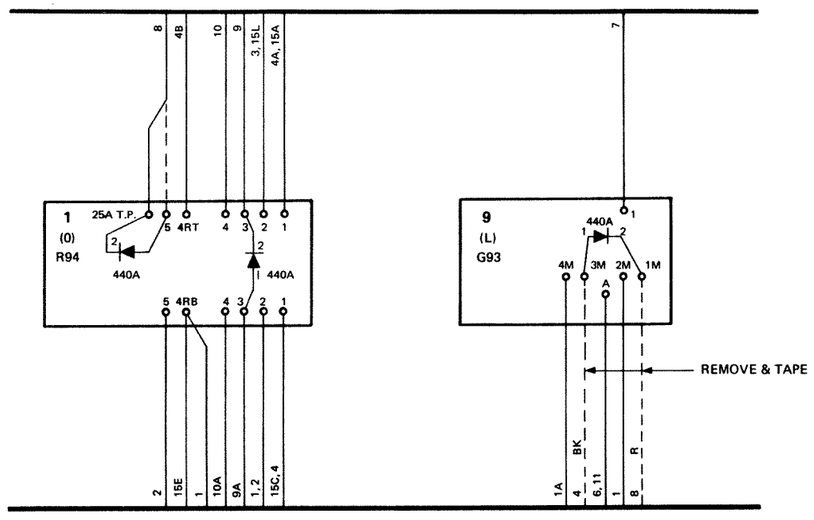

FIG. 10

MODIFICATION FOR 552, 556, 605, 608
P.B.X.
T-66066-16 PARTIALLY SHOWN
J-58824S-I

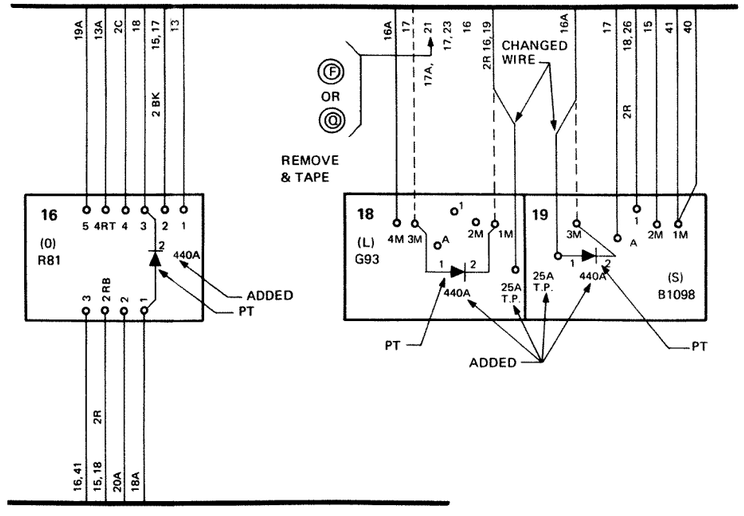

FIG. 11

MODIFICATION FOR 555, 557
P.B.X.
T-66524-11 PARTIALLY SHOWN
J-59013J-I

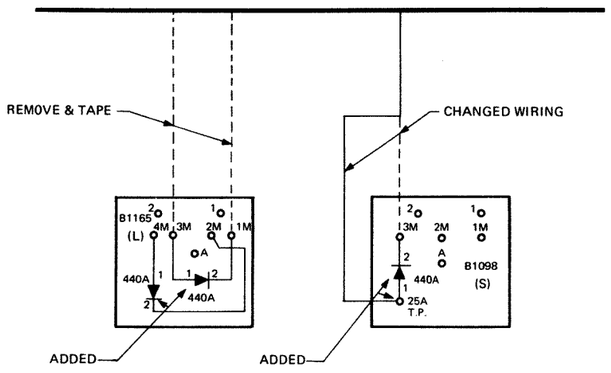

FIG. 12

MODIFICATION FOR 552, 556, 607
P.B.X.
T-66622-12 PARTIALLY SHOWN
J-58824AR-I