

550 S MAPLE  
DAN CONKLIN

STATION SYSTEM  
4-WIRE PRIVATE LINE  
TERMINATING AND STATION CIRCUIT

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SECTION I - GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

1.01 This circuit allows talking and signaling on 4-wire private line circuits. It is suitable for use with 20-Hz ac or 48-volt dc simplex signaling or with loudspeaker or SSI selective signaling. It connects the 4-wire line to the station sets on a low-impedance bus basis to minimize transmission level reduction when additional stations are bridged at branch terminals. The circuit also permits exclusion of selected station sets at each branch terminal on a local basis.

2. GENERAL DESCRIPTION OF OPERATION

2.01 The 4-wire private line terminating circuit connects to 150-ohm, or 600-ohm 4-wire transmission facilities. By the use of 227 type amplifiers and stepdown transformers at the customer's premise, it provides low-impedance connection to the receivers and transmitter networks of 4-wire station sets. Proper adjustment of the amplifiers may be checked at the central office by operating a loop back relay with 48-volts over the simplex circuit. Optional terminal strip wiring by the installer arranges the circuit for signaling with or without SSI for use with or without data service.

2.02 The pickup relay circuit arrangement facilitates connecting any station set or console at each branch terminal to any one of a number of 4-wire private lines. In conjunction with the local exclusion circuit, the pickup relays also provide for lockout of selected groups of stations from the conversation. In voice signaling applications the pickup relays also provide automatic speaker cutoff.

2.03 The exclusion circuit provides means for disabling the pickup relays of selected groups of stations at a branch terminal by operating a station set key to exclude them from a conversation. Stations at a branch terminal may optionally be connected as (a) master excluder station, (b) excluder and excluded station, (c) excluded station, (d) nonexcluded station.

2.04 The master excluder station excludes all stations at its branch terminal except stations wired as nonexcluded stations. Exclusion may be initiated either by operating the exclusion plunger key in the station set or automatically as the station goes off-hook when H option is provided in the pick-up circuit. When exclusion is initiated at the master excluder station all local excluded stations are locked out whether they were on-or off-hook. Therefore, when automatic exclusion (H option) is furnished, local conferencing involving the master excluder station is possible only with stations wired as nonexcluded (R) option.

2.05 The stations wired with excluder and excluded option may exclude other stations which are connected either as ex-

cluder and excluded or as excluded stations. These stations can initiate exclusion only if they themselves are not already locked out. They may be excluded either by the master excluder station or by any other excluder and excluded station. The excluded stations may not exclude other stations but may be locked out by any type of excluding station. The nonexcluded stations are not excluded by any station but may be wired to lock out others as master excluder (M option) or excluder station (Q option).

2.06 The station circuit provides talking battery and ground to station sets and converts loop dialing to 1 and 2 lead dialing in conjunction with the dialing circuit for SS1 selective signaling application. The station circuit also provides means for controlling the transmit pair from the station set for push-to-talk operation.

2.07 Incoming signaling to the 20-Hz ac or 48-volt dc signaling circuit or to the selective signaling receive circuit initiates single spurt or locked in steady or interrupted ringer or buzzer signaling at station set locations. Selected groups of stations with individual SS1 selective signaling codes may be signaled with a single group code by use of the group code relay circuit. Locked in signaling, when not answered, is released by a time-out circuit.

## SECTION II - DETAILED DESCRIPTION

### 1. 4-WIRE PRIVATE LINE TERMINATING CIRCUIT

1.01 Figure FS1 terminates the transmit and receive pairs of a 4-wire private line and provides a low-impedance bus connection to a multiple of station sets. Wiring options arrange the circuit for 150-ohm or 600-ohm service and for signaling with voice (loudspeaker), 20-Hz ac simplex, 48-volt dc simplex or SS1 Selective Signaling System.

1.02 The receive pair is connected through the LINE OUT jack to terminals 4 and 1 of T3. G option is furnished for 150-ohm service or V option for 600-ohm service. The REC amplifier terminal 13 is connected to terminal 11 for either 150-ohm or 600-ohm service. The 600-ohm output terminals 4 and 8 of the REC amplifier connect either directly (Y and W options) or through the SS1 Selective Signaling System, the LBI relay and the data interface circuit to terminal 6 and 8 of step-down transformer T1.

1.03 The incoming signal level is raised by the REC amplifier to +7 dbm which is the level recommended for the single-frequency signaling unit in the SS1 Selective Signaling System. The voice-frequency amplifier in the single-frequency signaling unit is adjusted for 0 db gain, therefore, the +7 dbm signal level from the REC amplifier will appear across the primary of transformer T1. With no station sets connected to terminals T and R, the amplifier output

is terminated through transformer T1 in resistor R7 and part of the output transformer of the talk-back amplifier TB. Resistor R7 adjusts the terminating impedance so the REC amplifier appears to be terminated in a 600-ohm load. As a result of the step-down of winding ratio between terminals 6 and 8 and terminals 1 and 4, transformer T1 reduces the audio voltage to a level which will result in a -15 dbm signal into a 600-ohm instrument connected across the output leads T and R. This step-down turns ratio of transformer T1 also provides a low-output impedance of 4 ohms across output leads T and R. As a result the bridging loss due to each additional instrument is negligible.

1.04 The transmit pair is connected through the LINE IN jack to terminals 4 and 1 of transformer T4. G option is furnished for 150-ohm operation or V option for 600-ohm operation. The 600-ohm input terminals 1 and 5 of the TRS amplifier are connected either directly (options E and W) or through the SS1 selective signaling system, the LBI relay, and the data applique circuit to terminals 6 and 8 of transformer T2. The transmitter networks of the associated off-hook station sets connect through their respective switching circuits to the T1 and R1 leads and through the BUS IN jack to terminals 2 and 7 of transformer T2. The input winding of transformer T2 presents approximately 35 ohms of impedance to the signal from the relatively high-impedance station set network. This designed mismatch drops the output voltage level of the connected station set appreciably. As a result of the low impedance across the input leads T1 and R1, the bridging effect of any additional off-hook station set or station sets is negligible. The output winding of transformer T2 has an impedance of 600 ohms to match the input of the TRS amplifier. The TRS amplifier is adjusted to raise the signal to the proper level for application to the transmit pair of the 4-wire line.

1.05 A small portion of the transmitter signal on leads T1 and R1 is applied to the input terminals of the talk-back amplifier TB. The output of this amplifier is connected to the 25-ohm winding of transformer T1. Amplifier TB serves mainly as a unidirectional coupling between the transmit and receive legs of the circuit to permit conferencing between stations at the same branch location. The gain of the TB amplifier is adjusted to provide a -15 dbm signal level in a 600-ohm instrument at the BUS OUT jack when a 600-ohm signal generator is preadjusted for a 1000-cycle level of +2 dbm into a 600-ohm termination and is then connected to the BUS IN jack.

1.06 The simplex leads of transformers T3 and T4 are connected to the loopback relay circuit. The winding of relay LB is in series with transistor Q1 and diode D2. Diode D2 polarizes the circuit so the LB relay will operate when ground is on the receive simplex and -48 volts is on

the transmit simplex. Transistor Q1 is biased to saturation through resistor R6 when direct current of the proper polarity is applied. Capacitor C1 biases transistor Q1 to cut-off for pulsating currents such as result from rectified 20-Hz signals when this type of signaling is provided. Diode CR1 is a zener intended to limit the potential across a Q1. When relay LB operates, it energizes relay LBI which in turn disconnects the 4-wire circuit from the station equipment and loops the receive pair back to the transmit pair through the pad formed by resistors R1, R2, R3, and R4. This permits a tester at the central office to make transmission tests without help from the customer location.

## 2. PICKUP RELAY CIRCUIT

2.01 The pickup relay circuit FS2 is designed for growth horizontally from left to right to provide connection of a 4-wire private line to additional stations. FS2 is also arranged to grow vertically upward to connect a group of stations to additional 4-wire lines. Thus the arrangement may become a matrix with one pickup relay provided to connect each station set to each 4-wire line at the customer's premise (branch terminal).

2.02 The PU relay operates under control of an associated station set key or console key over its A lead. When operated, PU connects the transmission and signaling leads of the associated station circuit FS3 to the transmission and signaling circuits of its 4-wire line. It also connects ground over the RL lead to FS8 or FS9 and connects -24 volts over the FW lead to operate the FW relay in the 2W-4W station set or console. When push to talk service is not required, the PU relay with S option connects ground to operate the PT relay in the station circuit. This permits a given station set to be used with or without the push to talk option depending on the needs of the 4-wire line. When loudspeaker signaling is used, the operated PU relay disconnects the associated speaker from the transmit side of the 4-wire line to silence the speaker when the station is off-hook.

## 3. STATION CIRCUIT

3.01 The station circuit FS3 provides battery and ground through the TB relay windings over the T and R leads to the transmitter network of its associated station set or console. Capacitors T and R block these battery and ground potentials from the 4-wire private line terminating circuit transformer. The windings of relay TB serve as inductors in the talking battery supply to the transmitter. During dialing with SS1 selective signaling application the TB relay converts loop dialing from the station set or console to dialing over the 1 lead to the SS1. When the dial is moved off-normal, ground on the ON lead operates relay ON.

Relay ON operates to connect ground through the 1M contact of the TB relay to the 1 lead. The operating ground for the ON relay is also connected through the 4M contact of the relay to the 2 lead. The ON relay also closes a circuit from lead P3 to P4 of FS3 to control the speaker phone when provided. The battery lead to the winding of the TB relay is also opened by the operation of relay ON. As the dial returns, relay TB follows the pulses and repeats them over the 1 lead.

3.02 Relay PT operates to ground over the PT lead from the handset switch or from the S option ground through the pickup relay circuit. The PT relay operated closes the transmit path to the pickup relay circuit and connects a ground through the pickup relay over the AG lead to control customer owned and maintained equipment such as a public address system or radio facility.

## 4. EXCLUSION CIRCUIT

4.01 When exclusion is initiated, ground is applied over the ET lead through the closed 1M contact of the operated PU relay through option M or Q to the winding of the associated EX-relay. Relay EX-E has a -24 volt battery directly connected to its 2L winding terminal. The windings of all other relays EX-A to D are connected to 24-volt battery through the 3B contact of relay EX-E nonoperated. The ground applied over the ET lead operates the associated relay EX A-E. Any relay EX A-E operated applies ground through its 2M or 11M contact to operate relay EB. Relay EB operated disconnects the operating battery from the PB leads and the SB leads of all PU relays wired with option N for excluded station or option Q for excluder and excluded station. The operated EX-relay also closes a circuit for a holding battery over its SB lead to the associated PU relay. As a result, all other excludable PU relays associated with the same 4-wire line are disabled and release if operated. Since the exclusion initiating ground must be applied through contacts of an operated PU relay, stations which have been excluded cannot override the exclusion. Stations excluded on one of a number of 4-wire private lines on the same premise remain operable on the other lines in accordance with their associated options for each line.

## 5. SS1 DIALING CIRCUIT

5.01 The SS1 dialing circuit functions in conjunction with the station circuit FS3 and pickup relay circuit FS4 to facilitate dialing into the SS1 Selective Signaling System without mutilating dialing when a second station is off-hook at the same branch terminal.

5.02 When an off-hook station set operates its pickup relay for a 4-wire line furnished with SS1, ground from the 3 lead

of FS2 is applied through the 5B or 8B contact of relay P in FS6 to the 1 lead of the SS1 selective signaling system to indicate off-hook condition.

5.03 When the off-hook station dial is moved off-normal, relay ON of FS3 operates and connects off-normal ground from the dial over the 2 lead, through the operated PU relay to operate the P relay of FS6 associated with the station and with the selected 4-wire line.

5.04 The P relay operated connects ground to the 2 lead of the SS1 to prepare the latter for dialing. P relay also transfers the 1 lead of the SS1 to ground over the 1 lead of FS2 and FS3 through the closed contacts of the operated TB and ON relays. As the dial returns to normal, the TB relay in FS3 repeats the dial pulses over the 1 lead to the SS1 selective signaling system. The operated P relay of FS6 prevents a second off-hook station from grounding the 1 lead over the 3 lead from the associated PU relay. When the associated SS1 Selective Signaling System is furnished with privacy or on-premise dialing, a separate dialing circuit (FS6) is furnished for each station to provide separate 1 and 2 leads to each common control or station control circuit. As the dial returns to normal the associated ON and P relays release and the steady ground is replaced on the L lead.

## 6. TIME-OUT CIRCUIT

6.01 The time-out circuit provides a timed lockup circuit for FS8 or FS9 for local audible and visual signaling. When relay RU of FS8 or relay C of FS9 operates in response to an associated signal, it locks up to -24 volt battery through FS7 over the LK lead. At the same time, a ground is applied over the HA lead to the heater element of relay TO. If the TO relay operates before an associated station set is taken off-hook, the lockup path over the LK lead is opened and the signaling circuit is released.

## 7. 20-HZ AC OR -48 VOLT DC SIGNALING CIRCUIT

7.01 When 20-Hz ringing current is applied to FS8 over the SXT and SXR leads, the current flows through normally closed contacts of relay R, the R15 resistors C3 capacitor, TH thermistor, and through the winding of relay RU in one direction, or through diode RV1 in the other direction. As a result, the rectified dc current pulses operate relay RU. Varistor RV1 limits the current through the RV1 diode and the thermistor on very short loops and during transients. Resistor R15 protects the varistor and diodes from lightning surges. The thermistor prevents relay RU from operating on transients. Power from the continuous application of ringing current

raises the temperature of the thermistor to reduce its resistance to operate the RU relay in about 0.5 second.

7.02 Relay RU locks operated on its primary winding, with B option under control of relay RL to battery over the LK lead. Relay RU also:

- (a) Connects ground to the HA lead to start timeout and to start lamp flashing circuits in the audible and visual signaling circuit.
- (b) Connects the signal lamp load to the flashing circuit.
- (c) Closes the circuit to the audible signal circuit over lead LF.

Relay RU remains locked up over the LK lead until the call is answered or until it is released by the timeout circuit.

7.03 When an incoming call is answered, ground over the RL lead from the pick-up relay operates relay RL. Relay RL operated: (a) transfers the signal lamp from flashing to steady; (b) opens the hold path of relay RU; and (c) grounds the CO lead to the timeout circuit to hold the TO relay operated. Relay RU released silences the audible signal and removes ground from the heating coil of the TO relay.

7.04 When the handset is returned on-hook, the PU relay releases and removes ground from the RL lead to release relay RL. Relay RL released: (a) disconnects ground from the CO lead to release relay TO; (b) reconnects the holding path for relay RU over the LK lead; and (c) disconnects the busy lamp from battery.

7.05 For dc signaling F option is connected, and the RU relay operates when a -48 volt potential is applied to the transmit simplex and a ground is applied to the receive simplex at the central office. This appears at the branch terminal as a -48 volt potential on the receive simplex and a ground on the transmit simplex. Diode RV2 permits the resulting polarized current to bypass the capacitor and thermistor to operate relay RU.

7.06 For signaling from the branch location to the central office the depressed S key in FS5 applies ground through FS3 and FS2 to operate the R relay of the signaling circuit associated with the selected 4-Wire line. Relay R operated disconnects the simplex leads SXT and SXR from the incoming signal detector and connects them to 20-Hz ac or to -48 volts and ground for ac or dc signaling respectively to operate a signal relay connected across the simplex leads at the central office.

8. SELECTIVE SIGNALING RECEIVE CIRCUIT

8.01 One selective signaling receive circuit per 4-wire line equipped with SS1 Selective Signaling System will provide local individual visual and audible signaling for three station sets assigned separate two digit codes.

8.02 When a code assigned to one of the stations is decoded by the SS1 a 100-msec ground pulse is applied over the C lead to operate the associated C relay in FS9. Relay C operates to battery through the normally closed contact 9B of the associated RL relay over the LK lead from the timing circuit in FS7 or in the visual and audible signaling circuit. It locks to ground through its 5M contact.

8.03 Relay C operated applies ground over the HA lead to start the time-out and lamp flashing circuits. If the station handset is not taken off-hook before the time-out circuit operates, battery is removed from the LK lead to release relay C. Relay C operated also: (a) connects the signaled station line lamp to flashing battery; (b) closes a circuit for audible signaling at the station; and (c) connects steady lamp battery over the BL lead to light all station lamps associated with the same 4-wire line.

8.04 When the signaled station handset is taken off-hook, the associated RL relay operates to ground from the operated PU relay. Relay RL operated: (a) opens its B9 contact to release relay C; (b) closes its M12 contact to transfer the line lamp to uninterrupted battery; (c) connects ground to the CO lead; and (d) connects lamp battery over the LB lead to the BL lead to light the associated line lamps of all station sets for busy indication.

8.05 When the handset is returned on-hook, the associated PU relay releases and removes ground from the RL lead to release relay RL. Relay RL released: (a) disconnects ground from the CO lead to release relay TO; (b) reconnects the holding path for relay C over the LK lead; and (c) disconnects the busy lamp from battery.

9. GROUP CODE CIRCUIT

9.01 The group code circuit FS10 provides means for simultaneously signaling up to five stations at each branch terminal by dialing a single two digit code.

9.02 When the group code is registered by the SS1 decoder, the 100-msec pulse on the C lead operates the group code relay GC. Relay GC operated applies ground to operate the associated C relays in FS9. Each station will then be signaled as described in Section 8.

10. LOUDSPEAKER CONTROL CIRCUIT

10.01 FS11 provides means for controlling a single loudspeaker from several station sets. When any one of the stations in the controlling group is taken off-hook, ground from A lead in FS2 is applied through the D3 diode over the C lead to operate relay LS- in FS11. Relay LS- disconnects the input of the loudspeaker from the receive point to turn off the speaker. When all station sets in the control group are on-hook, the associated LS- relay releases to reconnect the loudspeaker.

SECTION III - REFERENCE DATA1. WORKING LIMITS

1.01 Power Supply: This circuit was designed to be powered with 18 to 28 volts dc for relay operation and 14 to 28 volts dc for talking battery and amplifier power.

1.02 Loopback Relay Circuit: The loopback relay circuit is designed to operate over the simplex leads of the 1500-ohm transmit and receiving loops of 4-wire lines with a 44- to 52-volt dc potential applied at the central office.

1.03 The 20-Hz AC or 48-Volt DC Signaling Circuit: This circuit is designed to respond to  $\pm 80$  volt to  $\pm 105$  volt 20-Hz ac or 44-volt to 52-volt dc, over the simplex leads of 1500-ohm transmit and receive loops of 4-wire lines.

2. FUNCTIONAL DESIGNATIONS

None

3. FUNCTIONS

3.01 Functions are given in Section II of this CD.

4. CONNECTING CIRCUITS

(a) Toll Systems Signaling Line and Balancing Multistation Line Circuit - SD-55647-01.

(b) PBX Auxiliary Trunk Circuit - 20-Hz Simplex or Composite Signaling With or Without 600- to 1500-Hz Signaling or SS1 Selective Signaling System - SD-66679-01.

(c) Visual and Audible Signaling Circuit - SD-69249-01.

(d) Auxiliary Service Transfer Circuit -  
SD-69422-01.

(f) Station Systems Key and Telephone Cir-  
cuit (for 2- and 4-Wire Lines) -  
SD-69455-01.

(e) Station Systems Key and Telephone  
Circuit - SD-69425-01.

(g) SS1 Selective Signaling System -  
SD-98093-01.

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