

STATION SYSTEMS  
 KEY TELEPHONE SYSTEM NO. 1A2  
 CO OR PBX LINE CIRCUIT  
 400G KTU

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SECTION I - GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

1.01 The CO or PBX Line Circuit, when installed in Key Telephone System No. 1A2, provides the means for signaling subscriber stations on a central office or PBX line; holding this line; indicating by visual signals that the line is being called, held, or is busy; originating and holding outgoing calls; and time-out of locked-in signals after incoming and held calls are abandoned.

1.02 The 400G line circuit is an improved version of the 400D circuit (SD-

69513-01, FS3). It can be used for any 1A2 key telephone system central office (CO) or private branch exchange (PBX) line circuit application.

SECTION II - DETAILED DESCRIPTION

1. 400G LINE CIRCUIT (FS1)

SIGNALING

A. Incoming Signal

1.01 In the idle circuit condition, all relays are in the unoperated state and transistors Q2 and Q3 are off. Transistor Q1 is held on by current supplied to its base through the resistor network formed by resistors R5 and RT2 (option Z) or R5, RT2, and RT1.

1.02 Ringing voltage is usually applied across the line with the tip side grounded. Ringing current then flows through the ringup bridge, which consists of the series connected primary and secondary windings of relay L, resistor R2, and capacitor C1, causing relay L to operate on each half cycle of ringing current. Relay L operating connects -24 volts through resistors R6 and R5 to the base of transistor Q1. Transistor Q1 is delayed from turning off for about 225 ms due to the action of capacitor C2. When transistor Q1 turns off, its collector voltage rises, causing transistor Q2 to turn on. Zener diode CR1 breaks down and transistor Q3 turns on, causing relay B to operate. Relay C does not operate at this time since resistor R13 limits the current through its winding to less than the operate value. Relay B operated connects ground to lead ST, lead L to lead LF, and the interrupted (option W) or steady (option T) ringing current or ground (option V) to lead RC for audible signal control. Transistor Q1 remains off and transistors Q2 and Q3 remain on until the call is answered or timed out.

B. Time-Out of Ringup Circuit - Option Z Provided

1.03 At the time transistor Q1 turns off, the voltage at the negative (-) end of capacitor CT is about -24 volts. When relay B operates, the negative end of capacitor CT is connected through relay contacts to the junction of resistors R5 and RT2. The charge on capacitor CT, which determines the time-out period, is maintained constant through the operating L contact and resistor R6. Once the circuit is operated, the charge on capacitor CT is constant regardless of the duration of the ringing burst.

1.04 When the first burst of ringing has ceased, the negative end of capacitor CT

begins to discharge toward ground through resistor RT2. Assuming a supply voltage of -26V, transistor Q1 remains off until the voltage at the negative end of capacitor CT reaches approximately -18 volts, at which time transistor Q1 turns on and its collector voltage drops. This causes transistor Q2, diode CR1, and transistor Q3 to turn off and relay B to release, and the circuit is thereby returned to the idle condition. Relay B will release within  $5 \pm 1$  seconds after ringing has been removed.

#### C. Time-Out of Ringup Circuit - Option Z Not Provided

1.05 This arrangement functions in a manner similar to that described in B., with the exception that resistor RT1 is not short-circuited, thereby raising the resistance through which capacitor CT discharges. This circuit configuration provides a time-out interval of approximately 20 seconds.

#### D. Answering an Incoming Call - Busy State

1.07 An incoming call is answered by operating the pickup key associated with the line being rung and going off-hook. The station shunt is then connected across the line through the switchhook and key contacts, and ringing is tripped at the CO. Ground is also connected through the switchhook and key contacts to lead A, causing relay A to operate. Operated relay A contacts shunt terminals 1 and 3 of relay L, preventing it from operating on line current; connect -24 volts to the winding of relay C, causing it to operate; and disconnect the negative lead of capacitor CT from the base circuit of transistor Q1, causing the transistors to switch states. Transistor Q1 turns on, causing Q2 and Q3 to turn off, and relay B releases. Relay C operated disconnects capacitor C2 from the base of transistor Q1 to prevent any delay of the turnon of transistor Q1. Relays A and C operated establish the talking path, disconnect the ringup bridge from the line to prevent transmission loss, connect lead L to  $\pm 10$  volts, and open lead RC to discontinue local audible signaling.

#### OUTGOING CALL - BUSY STATE

1.08 The procedure for making an outgoing call is the same as that for answering an incoming call except that transistors Q2 and Q3 are normally off and relay B is released.

#### HOLDING

1.09 A busy line can be placed on hold by operating the HOLD key on the telephone set. When the HOLD key is depressed, ground is disconnected from lead A, causing relay A to release. The relay A contact, shunting the relay L primary winding, opens and, since the station has not yet been disconnected from the line, relay L operates on the line current. Closure of relay L contacts 2 and 5

connects the base circuit of transistor Q1 to resistor R6 and diode CR4 to -24 volts, causing transistor Q1 to turn off and transistors Q2 and Q3 to turn on. Transistor Q3 will turn on approximately 2 ms after relay A releases, providing a hold path for relay C through resistor R13, transistor Q3, and diode CR4 to -24 volts. Relay B operates through the collector-emitter circuit of transistor Q3. Relays B and C operated:

- (a) Connect the hold bridge resistor across the CO line.
- (b) Connect lead MG to lead ST.
- (c) Connect lead L to lead LW (option Y) or to  $\pm 10$  volts (option X).

When the HOLD key is released, the station is disconnected from the line. Line current flow is maintained through the relay L winding and resistor R1 which holds the CO connection.

#### A. Release of the Holding Bridge by a Station

1.10 Any station of the key telephone system that seizes the line by operating the associated pickup key and going off-hook will cause relay A to operate. Relay A operated:

- (a) Shunts the primary of relay L, causing it to release.
- (b) Breaks the series path between the relay L primary and resistor R1.
- (c) Disconnects the negative end of capacitor CT from the base circuit of transistor Q1. Transistor Q1 will switch on after relay L releases and transistors Q2 and Q3 will turn off, causing relay B to release. Relay C remains operated under control of the relay A contacts.

The circuit is thereby restored to the busy state.

#### B. Release of the Holding Bridge From a Central Office or PBX - Open Circuit Line

1.11 In the event a held party abandons the call, the line hold condition can be released from the connecting switching equipment by interrupting line current for a minimum of 35 ms (option R provided) or 600 ms (option R not provided). This interruption causes relay L to release but transistor Q1 cannot turn on due to the -24 volt charge on capacitor CT. With relay L released, capacitor CT discharges through resistor R4 (option R) or resistors R4 and R3. When capacitor CT discharges to approximately -18 volts, transistor Q1 turns on. Transistor Q1 turning on causes transistors Q2 and Q3 to turn off; relays B and C then release. The circuit is thereby returned to the idle state.

**DISCONNECTION**

1.12 When all stations go on-hook, lead A is disconnected from ground, causing relay A to release. Release of relay A opens the holding path for relay C which, in turn, releases. In this way, the circuit is restored to the idle state.

**OPERATION WITH LOCAL POWER FAILURE**

1.13 Outgoing calls can be originated over a metallic path through the circuit when the local dc supply is inoperative. However, the ringup bridge will remain connected across the line and some transmission loss will be experienced. Incoming calls are signaled by line ringers in the usual manner, although visual and common audible signals are inoperative.

**SURGE VOLTAGE PROTECTION**

1.14 Transient voltages greater than approximately 35V on lead A will cause diode CR5 to conduct and thereby protect circuit components from being overstressed. Similarly, diode CR6 protects the circuit from component damage when transient voltages appear on leads BAT and GRD.

**LINE STATUS INDICATOR**

1.15 Light emitting diode (LED) CR7 will light in all active states of the line circuit, providing a line status indicator.

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DEPT 3221-AL-FGP

**SECTION III - REFERENCE DATA**

**1. WORKING LIMITS**

**1.01 Ringing Ranges**

Minimum RMS Ringing Voltage	Minimum Leakage Resistance	Maximum Ringing Range (ohms)			
		Maximum No. Ringers			
		0	1	2	3
72	10K	3100	2000	1475	1150
80	10K	4000	2550	1900	1500
84	10K	4500	3000	2125	1625

1.02 The maximum dc current drain at 20 volts is 58 mA and occurs during the busy state.

1.03 The station conductor loop resistance shall not exceed 50 ohms.

1.04 A maximum of 20 station lamps may be connected to lead L.

**2. FUNCTIONAL DESIGNATIONS**

2.01 None.

**3. FUNCTIONS**

3.01 None.

**4. CONNECTING CIRCUITS**

4.01 None.

**5. MANUFACTURING TESTING REQUIREMENTS**

5.01 These requirements are incorporated in X-18224.