

**TECHNICAL  
DESCRIPTION  
SAN/BAR MODEL 4000  
LINE CARD**

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**TECHNICAL DESCRIPTION**  
**SAN/BAR MODEL 4000 LINE CARD**

**I. GENERAL**

The San/Bar Model 4000 Line Card is a simplified KTU line circuit designed for full compatibility with all types of key systems working in conjunction with central office or PBX/PABX equipment. All functions and options conform to established operating practices.

**II. DESCRIPTION**

The item comprises a single sided (double sided for the "E" unit) 3-1/2" x 4-3/4" x 1/16" printed circuit board for the mounting of the circuit components consisting of relays, reed and telephone type, transistors, capacitors, switch, lamp, resistors, handle and "U" link sockets.

For longer life and greater reliability, the contact fingers of the p.c. board are rhodium plated. As an aid of servicing, each circuit component is identified by the silk screening on the p.c. board.

**III. FEATURES**

The basic specifications and features are as follows:

**1. Voltage D.C.**

Operates 20 thru 28 volts D.C. Voltage transients on the 24 volt power supply will not cause false ringing-in.

**2. Current Consumption**

There is no idle current consumption.

In talk or ringing, 30 milli-amps (K1 or K2 relay).

In hold, 60 milli-amps (K1 or K2 relay).

Check lamp, 40 milli-amps addition, via the momentary switch as required.

**3. Ringing Sensitivity**

Guaranteed operation with 65 volts ringing signal.

**4. Parallel Dialing**

A remote two wire telephone instrument dialing (on the central office side) will not cause false ringing-in.

**5. False Ringing**

Line induced AC voltages will not cause false ringing-in.

**6. Response Time**

Guaranteed 200 milli-seconds of ringing signal will trigger the ring-in circuitry.

**7. Line Reversal**

Unit operation is independent of line polarity.

#### 8. Ringing Time-Out

Two options are furnished either 6 or 15 seconds  $\pm 20\%$ . (See schematic and option chart).

#### 9. Busy Light

A light emitting diode is provided to indicate a busy line condition.

#### 10. Divided Ringing Option

The unit includes a two-party ringing option by the use of "U" links and sockets furnished. The unit is factory set for bridged ringing. (See schematic and option chart).

#### 11. Hold Function

Hold function switching time  $30 \pm 10$  milli-seconds.

### IV. APPLICATION

The 4000 Line Card can be used on any existing KTU system as a replacement unit or for additional lines/extensions as required. In areas where AC line induction is a problem, the 4000 Line Card has application.

If an existing 24 volts KTU power supply is creating operating problems with loading transients, the 4000 Line Card has application.

On PBX use by key operation, the 4000 Line Card has instantaneous ring-in response.

On PBX and/or Centrex use where transfer and hold problems with KTU operation can arise, the 4000 Line Card has application because of its fast response into hold.

Where it is desirable to have day and night line calling discrimination, the two-party option on the 4000 type line card can be used.

### V. MOUNTING

The 4000 will mount in any standard 300 series mounting shelf. For those installations where only two units are required, the SB302A apparatus box may be used.

### VI. CIRCUIT DESCRIPTION

The 4000 is schematically illustrated by SB drawing #4000001. As shown, the line card circuit includes three relays, K1, K2, and K3.

Relay K1 generally enables ringing and associated lamp control at a subscriber station in response to ringing signal transmitted from a central office for incoming calls. K1 also operates to prepare the telephone circuit for a hold condition. Relay K2 essentially operates in response to a subscriber being "on-line," and also serves to prepare the line card circuit to have the telephone circuit placed in a hold condition when the relay K1 is energized. Relay K3 energizes the line card circuit in response of line current attendant to a subscriber being "on-line." K3 also detects ringing.

### VII. OPERATION (Incoming Call)

See schematic drawing #4000001.

An incoming call will apply ringing voltage to T and R (bridged) and T or R to ground (divided ringing), and this is rectified in the bridge CR1-CR4 to operate K3 relay through coil R. C1 blocks DC current flow into the bridge network when the telephone circuit is completed for a conversation. Resistor R9 and C1 provided a high impedance to voice frequencies. R1 and C4 filters the rectified ringing voltage to prevent relay chattering. Contact K3A closes and applies negative potential to the base of Q1 through R5 and R8, and Q1 conducts to energize K1 with C3 and R10 acting as a time constant circuit. Contacts K1-A through K1-E operate to afford the following functions:

K1-A connects line card pins 5 and 6. (ST & LG) to start the interrupter.

K1-B connects lamp flash line card pin 7 to lamp line card pin 8 and line button on teletest flashes.

K1-C connects ring control voltage line card pin 1 via pin 11 to Bell/Buzzer in teletest.

K1-D no function.

K1-E prepares Q1 for switching to non-conductive state.

K1-F prepares for hold condition when K2-B closes through resistor R2 120 ohms across T and R of line card unit.

#### VIII. ABANDONED CALL

If the incoming ringing ceases due to the caller hanging up, resistor R3 and R4, depending on the option used, determine the time out charge of C3 and the holdover time before K1 releases. (R3-six seconds and R4-fifteen seconds).

#### IX. CALL ANSWERED

When the telephone receiver is off-hook and the calling line button is depressed, a ground is applied to A line card pin 16.

Relay K3 is energized and K3-A is closed.

Removal of the receiver also loops the T and R leads and the resulting CO or PBX line circuit current flow will trip the ringing signal sent out from the CO or PBX location.

The make of K3-A contact renders Q1 non-conductive to comply with the TC time constant of R3, or R4, depending on time out adjustment, R10, and C3. Relay K1 releases and lamp flashing and ringing ceases. Contact K3-A also energizes Relay K2. Relay contact K2-A through K2-F operate and afford the functions indicated below. Light emitting diode LED lights.

Transistor Q3 conducts when its base becomes positive due to the ground connection at lead A and it parallels the operation of K3-A Relay contact to furnish negative potential through R5 and R8 to maintain K1 operated in the event that the CO battery and ground becomes disconnected during switching for example plug insertion by a PBX operator.

K2-A applies an alternate ground to the K2 relay to hold it if K3 is released (K3-A) when the A lead is opened in the HOLD CONDITION.

K2-B connects R2 to tip-line to prime for HOLD CONDITION if and when K1-F closes later.

K2-C contact removes short condition from K3-L winding and R circuit energizes L winding.

K2-D breaks ringing control voltage from bell/buzzer circuit.

K2-E and K2-F determine lamp steady/wink conditions. (The contact K2-E operates to close a connection to the winking signal sources LW terminal 2 or  $\pm$  10V terminal 4, depending on the position of J6. (K1-B controls the steady state illumination of L (Contact 8) through its contact.)

The telephone circuit is now established and a telephone conversation effected. The line button lamp will be steadily illuminated until the subscriber goes off the line. Summarizing the functions of the release of K1 relay and the operation of the K2 relay follows:

**The Function of K1 relay:**

1. Open the prepared hold circuit by disconnecting the R2 resistor from the T and R leads at contact K1-F.
2. Stop the interrupter motor at contact K1-A.
3. Disconnect the ringing audible signal at contact K1-C.
4. Change the flashing lamp signal to a steady light at contact K1-B.

**The Operation of K2 relay:**

1. Prepare the hold path for resistor R2 to be connected across the T and R leads at contact K2-B.
2. Disconnects and prevents reconnection of the audible signal at contact K2-D should relay K2 reoperate in the hold condition.
3. Disconnects the lamp flashing signal at contact K2-E and prepares a circuit for the LW (wink) or the 10 AC volt steady option on the hold feature if required.
4. Connects the lamp to the 10 volt steady state at contact K2-F at the answer signal and busy condition.
5. Light emitting diode illuminates.

**X. HOLD CONDITION**

In a hold condition, the ground potential from the "A" lead is removed. This removes its positive potential from its base of the transistor Q1 which is rendered conductive; thus, the relay K1 is energized.

**Re-operation of the relay K1 will:**

1. Loop the T and R leads into the hold condition at contact K1-F via the resistor R2 which will hold the relay K3 to the Central Office or PBX line current.
2. Re-operate the interrupter motor at contact K1-A.
3. Does not reconnect the audible signal at contact K1-C because the circuit is now opened at the relay K2 contact K2-D (operated).
4. Connects the "L" lead at contact K2-E to the "X" or "Y" option to give the steady or winking lamp indication that the circuit is on hold (J6).

The "L" winding of the relay K3 is now held in series with the line via the resistor R2 (120 ohms) which simulates the telephone instrument to hold any connected circuit which may have been dialed into the Central Office or PBX.

#### XI. RETRIEVAL FROM HOLD CONDITION

This is effected by a release of the hold button which applies ground to the "A" lead to make Q1 non-conductive. Relay K1 de-energizes. In the majority of telephone exchange areas, when an outgoing call is placed into the hold condition, it will so remain until released by the re-operation of the associated line button in the keyset; however, in those telephone office areas where "Forced Release" or "Called Party Release" equipment is installed, a line disconnect condition may be given to the circuit which will release the K3 relay from the "L" winding and return the unit to the idle state.

#### XII. CALLER ABANDONS CALL ON HOLD

In the event that the calling, or distant, party hangs up or otherwise abandons a call when the telephone circuit is in a hold condition, the flow of line current ceases. The relay K3 is accordingly de-energized and the consequent opening of the contact K3-A causes de-energization of the relays K2 and K1.

#### XIII. OUTGOING CALLS

A subscriber can place an outgoing call by depressing the appropriate line button and removing his telephone receiver to an off-hook condition. Line current will flow through the loop formed by the interconnected tip and ring conductors and through the coil L of the relay K3 which is energized. Consequent closure of the contact K3-A energizes relay K2 which is evidenced by the steady illumination of the line button lamp on the key telephone unit. No ringing occurs at the telephone unit.

#### XIV. OPERATIONAL COMMENTS

1. The C2 capacitor, 65 mf 10 volt NP, is a speech by-pass capacitor for the transmission purposes.
2. The C4, 15 mf 100 volt, capacitor prevents false operation of the K3 relay, by parallel dialing.
3. The "L" winding of the relay K3 is normally short circuited to prevent false operation.
4. The zener diode CR7 protects Q1 against voltage transients in excess of 30 volts caused by the intercom dialing.

NOTE: Power switch "on" or initial line card insertion will cause a "ring-up" transient due to capacitor charge of the circuitry. This is a "one time only" transient and is not a fault condition.

#### XV. INSTALLATION

The line cards are factory set for:

1. Bridged ringing.
2. "W" ringing audible option.
3. "Y" flashing option for the hold condition.
4. The six second time-out on an abandoned call, which is the "P" option.

To change the ringing from bridged to divided ringing, move the "U" links to the alternative position for either Tip to Ground, or Ring to Ground as required in the sockets on the printed circuit board. To change all other options, it is also necessary to transfer the "U" links as required.

All sockets are clearly marked and the "U" link must be bridging the option indicated for the circuit function.

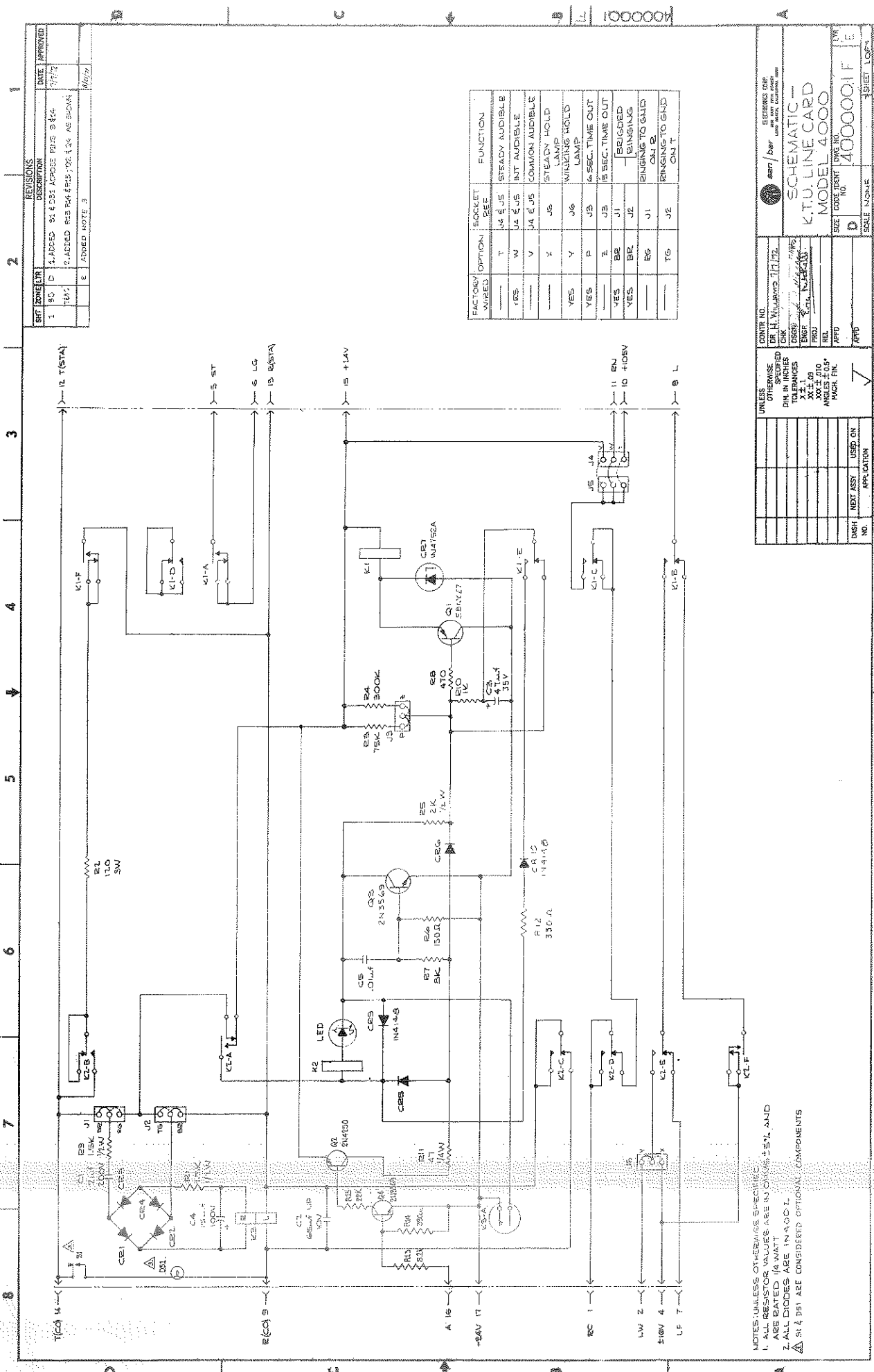
#### **XVI. MAINTENANCE**

This unit requires no field maintenance.

#### **XVII. LIGHTNING**

As a matter of interest to Special Service Groups and to Installers of KTU systems in areas of high thunderstorm activity, the following information is offered:

Continued and extensive tests of line card failures due to lightning damage indicates that the best protection is to have a separate earth ground (water pipe) for the KTU power supply and not to use an adjacent or easily available AC circuit ground for this purpose.



REV	ZONE/CTR	DESCRIPTION	DATE	APPROVED
1	80 D	1. ADDED 81 & 82 AS PER 3-8-64	7/77	
	74/2	2. ADDED 83, 84, 85, 86, 87, 88 AS SHOWN		
	E	ADDED NOTE B		

FACTORY WIRED	OPTION	SOCKET	FUNCTION
YES	T	J4 & J5	STEADY AUDIBLE LAMP
YES	W	J4 & J5	INT. AUDIBLE LAMP
YES	V	J4 & J5	COMMON AUDIBLE LAMP
YES	X	J6	STEADY HOLD LAMP
YES	Y	J6	WINKING HOLD LAMP
YES	P	J6	4-SEC. TIME OUT LAMP
YES	L	J6	16-SEC. TIME OUT LAMP
YES	BB	J1	BEINGING BEINGING
YES	BR	J2	BEINGING BEINGING
YES	BS	J1	BEINGING TO GND ON B
YES	TS	J2	BEINGING TO GND ON T

CONTR. NO. \_\_\_\_\_  
 DR. H. W. ...  
 CHK. ...  
 DESIGNED BY ...  
 ENG. ...  
 PROJ. ...  
 FILE ...  
 APPD. ...

UNLESS OTHERWISE SPECIFIED:  
 DIM. IN INCHES  
 TOLERANCES  
 XX.1 .03  
 XX.2 .05  
 XX.3 .10  
 ANGLES 90°  
 HATCH FIN.

SCALE NONE

SHEET 1 OF 1

NOTES: UNLESS OTHERWISE SPECIFIED:  
 1. ALL RESISTOR VALUES ARE IN OHMS, 1K = 1,000, 1M = 1,000,000, AND  
 ARE RATED IN WATT  
 2. ALL DIODES ARE IN A.C. L.  
 3. 81 & 82 ARE CONSIDERED OPTIONAL COMPONENTS