

SERVICE
KEY TELEPHONE UNITS—LINE SERVICES
DESCRIPTION
1A2 KEY TELEPHONE SYSTEM

1. GENERAL

1.01 This issue provides schematic information for the 400-series KTUs which provide line services. Line service KTUs provide switching, control, and signaling functions which permit key telephones in a 1A2 KTS to be connected to CO or PBX lines, key telephone sets of other systems, or private lines. These units include circuits for audible or visual signals and a time-out feature for incoming calls which are not answered.

1.02 This section is reissued to:

- Add information on the 400H KTU Issue 2.

1.03 The following KTUs and their functions are covered in this section.

- ♦400B, C, D, G, and H Issue 1 (all MD) and 400H Issue 2—CO or PBX Line Circuit.♦
- 414A—Manual Signaling, Ringdown, Private Line Circuit.
- 415A—Automatic, DC Signaling, Private Line Circuit.
- 416A—Station Line Circuit.
- 418A—Short Range, DC Signaling, Private Line Circuit.
- 419A—Automatic Signaling, Ringdown, Private Line Circuit.
- 461A—Manual Signaling, Ringdown, Private Line Circuit.

A. Mechanical

1.04 All circuit components on these KTUs are mounted in a plug-in printed wiring board, one end of which is equipped with contacts. A 4-inch board may have 18, 20, or 40 contacts; an 8-inch board will have 80 contacts (requiring two vertical 40-pin connectors). The circuit boards plug into mating connectors in key service units, panels, or apparatus mountings. Wiring from the connectors will be dedicated or nondedicated leads. Dedicated leads are those that normally appear on the same contacts of all KTUs, such as supply voltages and grounds, and are normally factory-wired. Nondedicated leads are those whose designation and function vary and are made available for installer connections. Figures 1 and 2 show typical 4- and 8-inch KTUs.

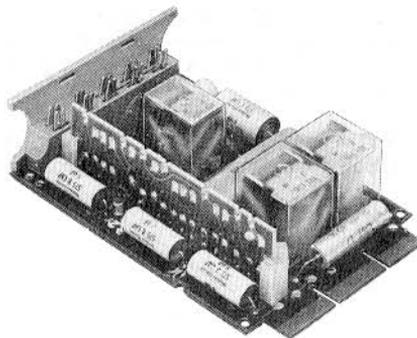


Fig. 1—Typical 4-Inch KTU

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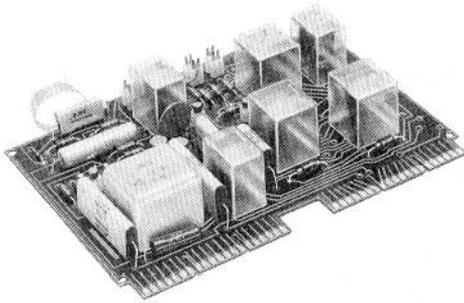


Fig. 2—Typical 8-Inch KTU

B. Electrical

1.05 Functional schematics cover the basic circuitry of each KTU, contacts used, and its relationship to telephone sets, other KTUs, power supplies, and apparatus. Dashed lines are used to simplify the schematics and to indicate intermediate circuitry. If full schematics are required, refer to the SDs listed in paragraph 1.08.

1.06 Voltages required for operation of the KTU, or provided to associated apparatus by the KTU, are shown with their connector pins. Other voltages may appear on the contacts of the mating connector, but not on the KTU, depending on the mounting arrangement.

1.07 KTUs may require the following power supply voltages and their associated grounds:

- -24V (B battery) for control
- -24V (A battery) for talk
- ±10V for visual signals
- ±105V for audible signals.



Before installing KTUs, check that the power supply polarities are correct; KTU damage may occur with the wrong polarities.

1.08 This issue of the section is based on the following drawings:

SD-69513-01, Issue 15—400D KTU (MD)

SD-69651-01, Issue 3—400G KTU (MD)

SD-69942-01, Issue 1—400H ♦Issue 1♦ KTU

♦SD-69942-01, Issue 4B—400H Issue 2 KTU♦

SD-69559-01, Issue 9—414A, 415A, 416A, 418A, 419-type, 461A KTUs.

If this section is to be used with equipment or apparatus reflecting later issues of the drawings, reference should be made to the CDs and SDs to determine the extent of the changes and the manner in which the section may be affected.

2. IDENTIFICATION

A. 400B, C, D, G, and H KTUs (CO or PBX Line Circuit)

2.01 The latest version of the line circuit KTU is the 400H ♦Issue 2♦. The 400B, C, D, G, ♦and H Issue 1 KTUs are rated MD♦. The earlier KTUs may be used for replacements or new installations when the features provided by later models are not required. There are a large number of earlier KTUs in service in the field (particularly 400Ds), and they should not be replaced if they are operating satisfactorily.

2.02 The 400-type KTUs (Fig. 3 through 9) are 4-inch 18-contact units used to provide a key telephone set with CO or PBX line services. In conjunction with the set, it provides the following features.

- Pickup and hold of a CO or PBX line.
- Flashing line lamp on incoming call.
- Audible line signal and/or common audible signal on incoming call.
- Steady lamp indicating busy condition.
- Steady or winking lamp indicating hold condition.
- Talking circuit connection to CO or PBX line maintained during periods of power failure.
- Individual line time-out on unanswered incoming calls with different timing interval options.

- Delayed hold release.
- Maximum loop resistance of 50 ohms or approximately 1000 feet of 24-gauge IW cable between KTU and telephone set.

2.03 If false release of the hold circuit is encountered, verify type of serving facility (CO, Centrex, or PBX) and apply appropriate option. Variables may be encountered in any given application which will result in unexpected false releases. In these cases, the option applied must be determined locally. See Tables A, B, and C.



In the 400D KTU (MD), option ZD is replaced by option ZJ. However, it is not necessary to update circuits previously modified with option ZD.

Note: Options ZC, ZD, and ZJ are installer provided options that delay the release of the local hold circuit when the telephone line is opened for short intervals. These line opens usually occur when the switching machine reswitches the line after the transmission path has been established. The delay interval prevents false release of hold during this action. It is not recommended that these options be applied on a widespread basis, but only if false release from hold is actually encountered.

2.04 The number of bridged ringers that may be used with each 400B, C, D, G, H ♦ Issue 1 (all MD), or H Issue 2 KTU♦ is listed in Table D.

2.05 The 400B KTU (MD) can be utilized in conjunction with 701 PBXs and the central offices listed in Table E, provided the operating characteristics in paragraph 2.06 are acceptable.

2.06 The 400B KTU (MD) has some restrictions which result from the unit's sensitivity to certain line conditions which are common to all types of telephone lines. The 400B KTU (MD) is susceptible to the following characteristics.

- (a) **Longitudinal Voltages:** KTU may ring up falsely in response to longitudinally induced 60-Hz voltage greater than 12 volts RMS. KTU may also fail to hold when induced voltages exceed 65 volts RMS in the answer state.

(b) **Polarity of Central Office Battery:**

Hold circuit will not respond when the line is associated with negative grounded battery plants such as No. 101 Electronic Switching System.

(c) **Hold Circuit:** Hold circuit cannot be released from central offices during permanent signal release routine. Release time of the hold circuit exceeds the release signal interval.

(d) **Flash and Recall:** Circuit connects a shunt across the line for 100 to 250 milliseconds when the switchhook is depressed during the station flash operation. This abbreviates or completely suppresses the flash indication.

(e) **Time-out:** Short time-out interval cannot be altered by installer.

(f) **Transmission:** A 15 dB transmission loss can be expected in arrangements that require line transmissions while the holding bridge is connected to the line.

2.07 The 400C KTU (MD) has the same characteristics as the 400B (MD) except those covered in paragraph 2.06(a).

Note: 400-type KTUs may serve a maximum of 20 multipled lamps.

2.08 The 400D KTUs (MD) stenciled SD-69513-01, Issue 10, have been modified by removal of the C4 capacitor. With this change, the circuit will not release a held line on battery reversal.

2.09 Improvements to overcome silicone contamination of the relay contacts have been included on Issue 12 and subsequent issues of the 400D KTU (MD). Repaired units containing these changes can be identified by a star or C stamped on the label after the issue number or by the new label.

2.10 The 400D KTUs (MD) stenciled SD-69513-01, Issue 13, and KTUs repaired after July 1, 1971, will have a new label which will include space for the line number and the words "Outward" and "Trouble." If the KTU is removed from service because of trouble, it shall be marked "Trouble" in the space provided before being turned in for repair. If the KTU is removed from service for reasons other than trouble, it shall be marked "Outward." The new KTUs will have a separate

TABLE A
APPLICATION OF OPTIONS ZC AND ZJ—400D KTU (MD)

PBX		TYPE OF CENTRAL OFFICE						ESS
		STEP-BY-STEP		PANEL	NO. 1 X-BAR	NO. 5 X-BAR		
		WITHOUT PERM. SIGNAL TRUNKS	WITH PERM. SIGNAL TRUNKS			UNMOD. PERM. SIGNAL TRUNKS	MODIFIED PERM. SIGNAL TRUNKS	
None		*	*	*	*	ZJ	ZJ	ZC
701	Outgoing	*	*	*	*	ZJ	ZJ	ZC
	Incoming	*	*	*	*	ZJ	ZJ	ZC
756/757/758		*	*	*	*	ZJ	ZJ	ZC
770		ZC	ZC	ZC	ZC	ZC	ZC	ZC
800/801		ZJ	ZJ	ZJ	ZJ	ZJ	ZJ	ZC
805		ZJ	ZJ	ZJ	ZJ	ZJ	ZJ	ZC
812		ZC	ZC	ZC	ZC	ZC	ZC	ZC
CSS 201		*	*	*	*	*	*	*

* None required.

label with the date of manufacture placed on the back of the handle (ie, 3-71 will identify a KTU manufactured in March 1971). The repaired KTUs will have the date of repair stamped on the printed wiring board. An orange repair date stamp indicates those units tested defective when returned from the field, and a white stamp indicates those tested O.K.

2.11 Wiring changes were made to the 400D KTU (MD) manufactured after November 1974 to cover specific trouble indications. The modified KTUs are marked Issue 15 and are recommended where the following conditions are encountered:

- Power supply voltage variations
- Non A-lead stations behind KTU
- High resistance ground.

2.12 In some instances, noise or crosstalk may be encountered due to an unbalanced condition of the transmission circuit of 400D and G KTUs while on hold. The condition can be corrected by

placing a KS-19524, L9 capacitor (60 μ F), or equivalent, across leads R (CO) and R (STA). The capacitor should be connected to the leads where they appear on the connecting blocks associated with the mounting arrangement involved. A multiple point may be required using either 183A2 adapters on the terminals or using spare terminals or another 66-type connecting block. It is not recommended that the capacitor be added to the pins of the connector where the KTU is plugged in. (The use of a capacitor is never required in a 400H KTU because its transmission circuit is perfectly balanced.)

2.13 Either the 400G KTU (MD) or the 400H KTU can be used for any 1A2 KTS CO or P3X line circuit application. The 400H KTU is subject to restrictions described in paragraph 2.17. In addition to circuit improvements, the 400G KTU (MD) and 400H KTU differ from earlier 400-type KTUs in that they have a line status indicator and option plugs for connecting the various options.

2.14 Line status is indicated by a light emitting diode (LED) located in the option block-handle assembly of the 400G KTU (MD) (Fig. 4) or 400H

TABLE B
HOLD RELEASE OPTIONS—400G KTU (MD)

PBX	TYPE OF CENTRAL OFFICE						
	STEP-BY-STEP		PANEL	NO. 1 X-BAR	NO. 5 X-BAR		ESS
	WITHOUT PERM. SIGNAL TRUNKS	WITH PERM. SIGNAL TRUNKS			UNMOD. PERM. SIGNAL TRUNKS	MODIFIED PERM. SIGNAL TRUNKS	
None	R	R	R	R	R	R	*
701	R	R	R	R	R	R	*
756/757/758	R	R	R	R	R	R	*
770	*	*	*	*	*	*	*
800/801	R	R	R	R	R	R	*
805	R	R	R	R	R	R	*
812	*	*	*	*	*	*	*
CSS 201	*	*	*	*	*	*	*

* Factory-provided option, 600 ms (minimum) time-out.

Note: R option is short time-out, 25 ms minimum.

KTU (Fig. 7). The LED will light in all active states of the line circuit as shown in Table F. Those 400G KTUs (MD) labeled Issue 2 ♦ or 3♦ are equipped with a 556A LED which replaces the original 538A LED.

2.15 Features or service options are connected in the 400G KTU (MD) (Fig. 5, 6, and Table B) and in the 400H KTU (Fig. 8, 9, and Table C) by means of option plugs in the option block-handle assembly. Spare option plugs are available for the 400G KTU (MD) by ordering a D-180768 Kit of Parts; each kit contains five option plugs. For the 400H KTU, ♦the KS-21290L7 option plugs are available as COM CODE 841732613.♦

2.16 The 400G KTU (MD) can be arranged for short interval ringup time-out (approximately 5 seconds) by providing option Z or, for long interval time-out (approximately 20 seconds), by removing option Z. With the 400H KTU, Issue 1 (MD), a short interval time-out is factory-provided and cannot be altered. ♦In Issue 2 or later of the 400H KTU, the time-out interval can be

lengthened by means of option plugs in the block handle assembly.♦

2.17 The 400H KTU has a pair of test pins, accessible through a window in the front of the option block-handle (Fig. 7), which allows an installer or repairperson to determine whether the KTU is on an active CO/PBX line even when no telephone set is connected. When the two pins are shorted together with a screwdriver blade, the line status LED will light and the associated interrupter motor will start if the KTU is connected to an active line. If it is not, the LED will remain dark, but the interrupter motor will still start. In COM KEY* 2152, the interrupter runs continuously as long as power is connected.

* Trademark



Observe the following restrictions on the use of the 400G KTU (MD) and 400H KTUs:

TABLE C

HOLD RELEASE OPTIONS – 400H KTU

PBX	TYPE OF CENTRAL OFFICE						
	STEP-BY-STEP		PANEL	NO. 1 X-BAR	NO. 5 X-BAR		ESS
	WITHOUT PERM. SIGNAL TRUNKS	WITH PERM. SIGNAL TRUNKS			UNMOD PERM. SIGNAL TRUNKS	MODIFIED PERM. SIGNAL TRUNKS	
None	R	R	R	R	R	R	S
701	R	R	R	R	R	R	S
756/757/758	R	R	R	R	R	R	S
770	S	S	S	S	S	S	S
800/801	R	R	R	R	R	R	S
805	R	R	R	R	R	R	S
812	S	S	S	S	S	S	S
CSS 201	S	S	S	S	S	S	S

Note: S option is factory-provided for long time-out. R option is short time-out.

- The 400H KTU must be in the off-hook state with dial tone on the line for at least 2 seconds before it can be put into the hold state. When testing a 400H KTU:

- (1) Go off-hook
- (2) Listen for dial tone
- (3) Wait at least 2 seconds after dial tone is received
- (4) Depress hold button
- (5) If a test call is dialed, wait at least 2 seconds after the called end answers before placing the line on hold.

- The 400H KTU will not go into the hold state if the noise voltage on the tip and ring leads at the time the HOLD button on the telephone set is depressed is greater than 2.5 volts. ♦ In addition, following

rotary dialing or CO switching noise, an interval of 2 seconds must pass before the 400H KTU can be placed in the hold condition.♦

- For large centralized installations, 584C panels fully loaded with 400H Issue 1 (MD) KTUs are limited to two panels per 19- or 20-type power units and five panels per 29- or 30-type power units. Fully loaded 620A panels are limited to eight panels per 90-type power units. ♦ This restriction does not apply to Issue 2 or later of the 400H KTU.♦
- The 400H KTU contains a relay having mercury-wetted contacts and must be mounted in the proper position. Current production of the 400H KTU has an arrow printed on the front label which indicates the proper installation position.
- When a 109A interconnect unit is used to provide music-on-hold with a 400H KTU, a 106D varistor must be placed

TABLE D
RINGING BRIDGE LIMITATIONS—400-TYPE KTU

KTU	MINIMUM RMS RINGING VOLTAGE (20 Hz)	MINIMUM LEAKAGE RESISTANCE (OHMS)	MAXIMUM NUMBER OF BRIDGED RINGERS			
			0	1	2	3
			MAXIMUM RINGING RANGE (OHMS)			
400B (MD)	72V	15K	4446	1788	1119	814
	80V		6062	2438	1526	1110
	84V		6871	2763	1729	1258
		10K	5140	2434	1594	1185
400C (MD)	72V	15K	4060	1722	1093	800
	80V		5537	2349	1490	1091
	84V		6225	2662	1689	1237
		10K	4799	2354	1560	1166
400D (MD)	72V	15K	2408	1334	922	705
	80V		3284	1819	1258	961
	84V		3722	2062	1426	1090
		10K	3148	1873	1333	1034
400G (MD)	72V	10K	3100	2000	1475	1150
400H	80V		4000	2550	1900	1500
Issue 1 (MD)	84V		4500	3000	2125	1625
400H Issue 2	84V		5850	3500	2500	1800

between option block terminals 5 and 6 of the 109A interconnect unit.

- The short ringing time-out interval provided in the 400H Series 1 (MD) KTU may be unsuitable for use with manual PBXs. Issue 2 of the 400H KTU can be used in these applications with option X provided.
- For proper lamp operation, the 400H KTU requires ac power with the proper connections of the ac voltage and ground leads. A dc voltage cannot be used for lamping or interrupter. Care should be taken to avoid shorting the L and LG

leads as this may result in damage to the KTU. (With earlier 400-type KTUs, shorting of the L and LG leads resulted in a blown fuse.)

- The 400H KTU is compatible only with Issue 5 and later issues of the 412A KTU (auxiliary relay circuit). Issues 1 through 4 of the 412A may be used if the 186-type protection networks are clipped out of the circuit.
- When music-on-hold is required in conjunction with 400-type line circuits, the music-on-hold KTU installed must be compatible with the mounting facilities

◆ TABLE E ◆

KTU COMPATIBILITY WITH CENTRAL OFFICES

TYPE KEY TEL SYS	TYPE KTU	ESS			NO. 5 X-BAR CENTREX			NO. 1 X-BAR	NO. 5 X-BAR	PANEL	SXS WITH PS TRUNKS
		BRIDGE RESW OPEN* 462 ms	CKT MOD	RLS ON PS OPEN* 1000 ms	BRIDGE RESW OPEN* 20 ms	CKT MOD	RLS ON PS OPEN* 144 ms	RELEASE ON PS OPEN*			
								400 ms	144 ms	530 ms	1000 ms
1A2	400A, B, and C (all MD)	Yes	—	No	Yes	—	No	No	No	No	No
	400D (MD)	No	OPT ZC	Yes	No	OPT ZJ	Yes	Yes	Yes	Yes	Yes

* Reswitch (Resw) opens specified are maximums and permanent signal (PS) release opens are specified at minimums.

TABLE F
INDICATIONS OF LINE STATUS LED

LINE STATUS	LED CONDITION	
	400G KTU (MD)	400H KTU
Idle	Off	Off
Ringing	Steady	Flashing
Off-Hook	Steady	Steady
Hold	Steady	Winking

available and the type of 400 line circuit utilized. A 451-type KTU cannot be plugged into a connector intended for a 498A, and vice versa (see Section 518-215-401). Table G provides compatibility information for providing music-on-hold.

- If the A and A1 leads are shorted for more than 15 seconds, the 400H KTU may go into a hold condition when the short is removed. This condition may also occur when auxiliary equipment is used on the line which grounds the A lead. It may be released from hold by

momentarily unplugging the KTU, momentarily shorting the tip-ring leads, or taking a phone off-hook on the associated line.

- Use of a 400H KTU behind PBXs equipped with J53050F interconnect units (trunk level access to customer-provided equipment), of models earlier than Issue 2B, may result in reports of extra dial pulses. If the interconnect unit is equipped with a 14A resistance lamp, replace with a 14B.
- A 400H KTU cannot be used in a 50A CPS, 8A KTS or 4ACD because of a circuit in compatibility.
- Under some conditions, tests made at the local test desk or by mechanized loop test (MLT) may cause the 400H KTU to ring up.

Note: Care should be taken to observe all the conditions noted in the use of the 400H KTU to reduce possible customer reports or service outages.

TABLE G
MOUNTING, LINE CIRCUIT, AND MUSIC-ON-HOLD COMPATIBILITY

KEY SYSTEM		MUSIC-ON-HOLD*		LINE CIRCUIT
1A2 Key Telephone System		Without		All
		With	451B	400G, D, or earlier (MD)
			498A and 116A1 CM	All
COM KEY 718 1434 2152	570A 580A	Without		All
	702A 703A	With	451B	400G, D, or earlier (MD)
	570B 580B	Without		All
	702B 703B	With	498A and 116A1 CM	All

*Information on the 498A KTU and 116A1 CM can be found in Section 518-215-401. The 451B KTU is covered in Sections 518-215-401 and 463-341-103.

B. 414A KTU (Manual Signaling, Ringdown, Private Line Circuit)

2.18 The 414A KTU (Fig. 10) is a 4-inch, 20-contact unit for connecting a telephone set to a private line terminated at a distant location. Another tie line circuit KTU is required at the distant location. A nonlocking key on the telephone set, or an externally mounted key in addition to the line pickup key, is required for signaling. The 414A KTU provides a talking and manual signaling circuit with the following operating features.

- Flashing line lamp on an incoming call.
- Steady lamp indicating line busy.
- Time-out on unanswered incoming calls; optional time intervals.
- Choice of audible signals, common audible, steady, or interrupted.
- Audible ringback signal option so calling party can hear a tone from the distant telephone.
- Idle line termination when KTU is connected to lines having repeaters.
- A spare relay contact is available for control functions.
- Line hold feature is *not* available.
- Ringing ranges are shown in Table H.

C. 415A KTU (Automatic, DC Signaling, Private Line Circuit)

2.19 The 415A KTU (Fig. 11) is a 4-inch, 18-contact unit for connecting a telephone set to a private line terminated at a distant location. Another 415A KTU, or other tie line KTU which will respond to a dc signal, is required at the distant location. The distant telephone set is automatically signaled when the line key on the local telephone set is operated and the handset is lifted. The 415A KTU provides a talking and signaling circuit with the *same* operating features as the 414A KTU and, in addition, provides:

- Optional lamp wink as an indication of hold

TABLE H
RINGING RANGES—414A KTU

MINIMUM RMS RINGING VOLTAGE	STANDARD LOOPS 15K-OHM LEAKAGE	UNIGAUGE LOOPS 20K-OHM LEAKAGE*
		OHMS
75 84 92	2600 ohms	4000 4600 5000
110 120		5000 5400

*These ringing ranges are also valid with unigauge plant which may use an E6 repeater in each subscriber loop.

- Ringing ranges with -20 volt battery supply are shown in Table I.

TABLE I
RINGING RANGES—415A KTU

MINIMUM BATTERY VOLTAGE	STANDARD LOOPS 15K-OHM LEAKAGE	UNIGAUGE LOOPS 20K-OHM LEAKAGE*
-20 volts	2300 ohms	2200 ohms

*These ringing ranges are also valid with unigauge plant which may use an E6 repeater in each subscriber loop.

D. 416A KTU (Station Line Circuit)

2.20 The 416A KTU (Fig. 12) is a 4-inch, 20-contact unit for connecting a private line between a local telephone set and a telephone set at a distant location. A nonlocking key, in addition to the line pickup key at the local telephone set, is required to operate the audible signal at the distant station. The local station is signaled by lifting the handset and operating the line key associated with the set at the distant location. The 416A KTU provides a talking and signaling circuit with the following operating features.

- Visual lamp signal to indicate incoming call, or line busy.

- Choice of audible signals, common audible, steady, or interrupted.
- Audible ringback signal option.
- A spare relay contact is available for control.
- Line hold feature is **not** available.
- Ringing ranges with -20 volt battery supply on standard loops is 750 ohms.

E. 418A KTU (Short Range, DC Signaling, Private Line Circuit)

2.21 The 418A KTU (Fig. 13) is a 4-inch, 20-contact unit for connecting a private line between two telephone sets, usually on the same premises. A single KTU will serve two stations. The unit may be connected for one of three methods of signaling: two-way automatic, two-way manual, or automatic one-way and manual one-way. The 418A KTU provides a talking and signaling circuit and the following operating features.

- Flashing line lamp on an incoming call.
- Steady lamp indicating line busy.
- Choice of audible signals, common audible, steady or interrupted.
- Audible ringback signal option at both stations.
- Line hold feature is **not** available.
- Ringing range is 100 ohms with -20 volt battery supply.

F. 419-Type KTU (Automatic Signaling, Ringdown, Private Line Circuit)

2.22 The 419-type KTU (Fig. 14) is an 8-inch, 80-contact unit for connecting a telephone set over a private line to a distant location. Another 419-type KTU, or tie line KTU which will respond to and transmit ringing voltage, is required at the distant location. The distant telephone set is automatically signaled when the line key on the local telephone set is operated and the handset is lifted. The 419-type KTU provides a talking and signaling circuit with the following operating features.

- Pickup of a private line.
- Flashing line lamp on an incoming call.
- Steady lamp indicating line busy.
- Winking hold lamp.
- Choice of audible signals: common audible, steady, or interrupted.
- Audible ringback signal optional.
- Idle line termination when KTU is connected to lines using repeaters.
- Time-out on unanswered incoming calls; optional time-intervals.
- Hold-interrupt control to change status of 419-type KTU at a distant location from HOLD to Incoming Call (by switchhook flash).
- Ringing ranges are shown in Table J.

TABLE J
RINGING RANGES—419-TYPE KTU

MINIMUM RMS RINGING VOLTAGE	STANDARD LOOPS 15K-OHM LEAKAGE	UNIGAUGE LOOPS 20K-OHM LEAKAGE*
		OHMS
75 } 84 } volts (20 Hz) 92 }	2600 ohms	4000 4600 5000
110 } 120 } volts (30 Hz)		5000 5400

*These ringing ranges are also valid with unigauge plant which may use an E6 repeater in each subscriber loop.

2.23 The 419B KTU is directly interchangeable with the 419A KTU (MD). The 419B KTU should be used in those installations where problems are encountered with false ringups due to line capacitance on long loops.

G. 461A KTU (Manual Signaling, Ringdown Private Line Circuit)

2.24 The 461A KTU (Fig. 15) is an 18-contact version of the 414A KTU. The spare contact available on the 414A has been eliminated and B ground used for RG. Another tie line circuit KTU is required at the distant location. A nonlocking key on the telephone set, or an externally mounted key in addition to the line pickup key, is required for signaling. The 461A KTU provides a talking and manual signaling circuit with the following operating features.

- Flashing line lamp on an incoming call.
- Steady lamp indicating line busy.
- Time-out on unanswered incoming calls; optional time intervals.

- Choice of audible signals: common audible, steady, or interrupted.
- Audible ringback signal option so calling party can hear a tone from the distant telephone.
- Idle line termination when KTU is connected to lines having repeaters.
- Line hold feature is **not** available.
- Ringing ranges are shown in Table K.
- Line hold feature is **NOT** available.
- Ringing ranges are shown in Table J.

- NOTES:
 1. REQUIRES A MOUNTING FACILITY EQUIPPED WITH AN 18-, 20-, OR 40-PIN CONNECTOR.
 2. THE STATUS OF THE RELAYS FOR ALL FUNCTIONS OF THE KTU ARE AS FOLLOWS:

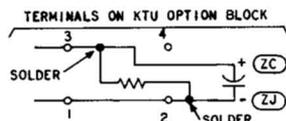
RELAY	FUNCTION		
	INCOMING RING CYCLE	ANSWERING OR INITIATING CALL	HOLD
A	R	O	R
B	O	R	O
C	R	O	O
L	O *	R	O

R= RELEASED O= OPERATE * = FOLLOWS RINGING

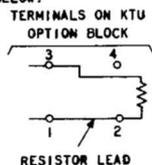
3. FOR 30 SECOND TIME-OUT CYCLE, REMOVE Z OPTION STRAP BETWEEN TERMINALS 1 AND 2.
 4. TO PROVIDE TIME-OUT CYCLES OF RING-UP CIRCUITS FROM 3.4 TO 7.5 SECONDS, REPLACE Z OPTION STRAP WITH A KS-13490, L1 OR EQUIVALENT (1/2 WATT) RESISTOR. USE ONE RESISTOR LEAD AS A STRAP BETWEEN TERMINALS 1 AND 2 AND CONNECT THE OTHER LEAD TO TERMINAL 3. USE TABLE BELOW FOR RESISTOR VALUE REQUIRED FOR DESIRED TIME-OUT INTERVAL.

TIME IN SEC FROM 10 SEC TO:	RESISTOR MEGOHM	EFFECT ON DELAYED HOLD RELEASE OPTIONS	
		ZC	ZJ
7.5	1.2	NONE	NONE
6.7	.75	NOT RECOMMENDED (NOTE 5)	
5.0	.39		
3.4	.20		

IF THE TIME-OUT CYCLE IS REDUCED IN CONJUNCTION WITH ZC OR ZJ OPTION, CONNECT THE RESISTOR AND CAPACITOR AS SHOWN BELOW:



IF TIME-OUT CYCLE IS REDUCED, CONNECT RESISTOR AS SHOWN BELOW:



5. NO. 1 ESS SPECIAL LINE APPLIQUE CIRCUIT (SD-1A297) SHOULD BE USED IN APPLICATIONS WHERE ZC OPTION CANNOT BE APPLIED.
 6. WHEN Z OPTION IS PROVIDED WITH ZC OR ZJ OPTIONS, REMOVE THE Z STRAP AND USE THE CAPACITOR LEAD AS A STRAP BETWEEN TERMINALS 1 AND 2.

OPTIONS

OPTION	FEATURES	OPTION BLOCK STRAPPING	
		400A,B,C(MD)	400D(MD)
Z	TIME-OUT (NOTES 3 AND 4)	LONG TIME DELAY (APPROXIMATELY 30 SECONDS)	
		SHORT TIME DELAY (APPROXIMATELY 10 SECONDS)	1 TO 2
Y	VISUAL HOLD CKT	LAMP WINK	8 TO 9
X		LAMP STEADY	10 TO 7
W	AUDIBLE SIGNAL	INTERRUPTED RING	7 TO 9
T		STEADY RING	9 TO 7
S		COMMON WITH DIODE MATRIX CONTROL	5 TO 6
V		COMMON WITH RELAY CONTROL	5 TO 6
ZC (NOTE 7)	RELEASE OF HOLDING BRIDGE FROM CO OR PBX BY LINE CURRENT OPENS GREATER THAN	500 MILLISECONDS WHEN ASSOCIATED WITH ESS HAVING RESWITCH CAPABILITY * (USE 5 UF CAPACITOR, 601A OR EQUIVALENT) † (USE 1.62 UF CAPACITOR, 701G OR EQUIVALENT)	3 TO 6
ZJ		50 MILLISECONDS WHEN ASSOCIATED WITH NO. 5 X-BAR CENTREX HAVING AUTOMATIC PERMANENT SIGNAL RELEASE * (USE 0.5 UF CAPACITOR, 575B OR EQUIVALENT) † (USE 0.162 UF CAPACITOR OR EQUIVALENT)	4 TO 8

* WHEN USED WITH Z OPTION

† WHEN USED WITH LONG TIME DELAY

‡ ONLY BARE WIRE STRAPS SHOULD BE USED ON KTUS MANUFACTURED PRIOR TO 1966

7. WHEN THE ZC OPTION IS USED DUE TO THE DELAYED RELEASE OF THE HOLDING BRIDGE, SOME TRANSMISSION LOSS IS ENCOUNTERED FOR APPROXIMATELY 1 SECOND WHEN A STATION REENTERS A HELD CALL.
 8. V OPTION MAY BE USED IN LOCALLY ENGINEERED ARRANGEMENTS OR RELAY COMMON AUDIBLE ARRANGEMENTS.
 9. ZD OPTION IS REPLACED BY ZJ OPTION, HOWEVER IT IS NOT NECESSARY TO UPDATE CIRCUITS PREVIOUSLY MODIFIED WITH OPTION ZD.

Fig. 3—Condensed Functional Schematic of 400-Type (Except 400G and H) KTU (CO or PBX Line Circuit) (Sheet 1 of 2)

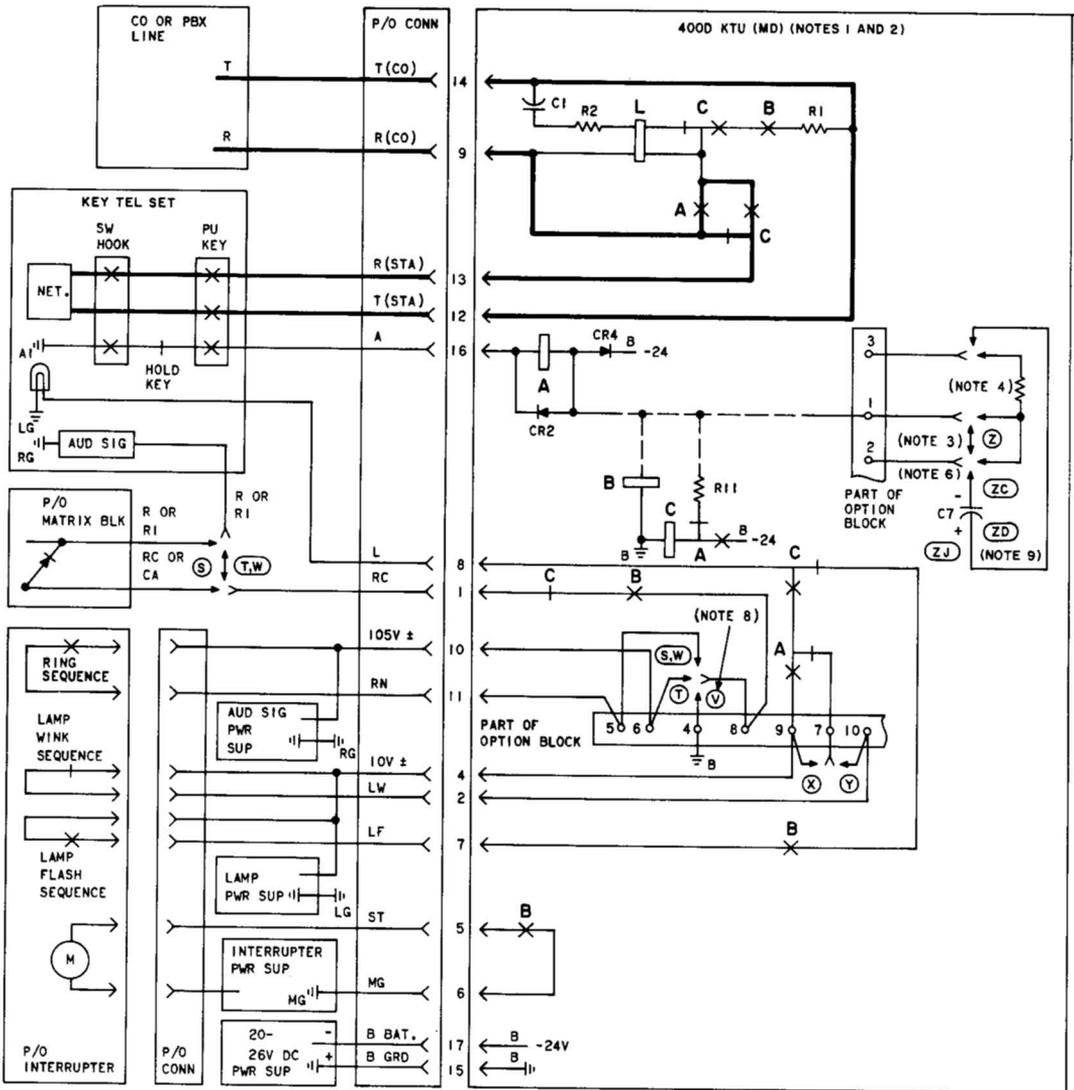


Fig. 3—Condensed Functional Schematic of 400-Type (Except 400G and H) KTU (CO or PBX Line Circuit) (Sheet 2 of 2)

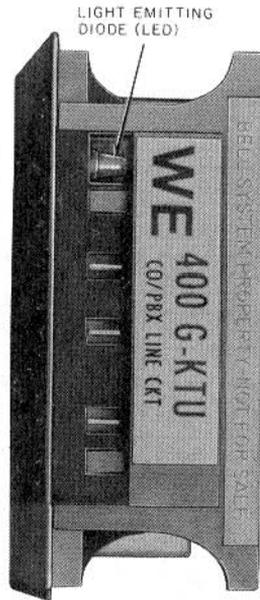


Fig. 4—Line Status Indicator in 400G KTU (MD)

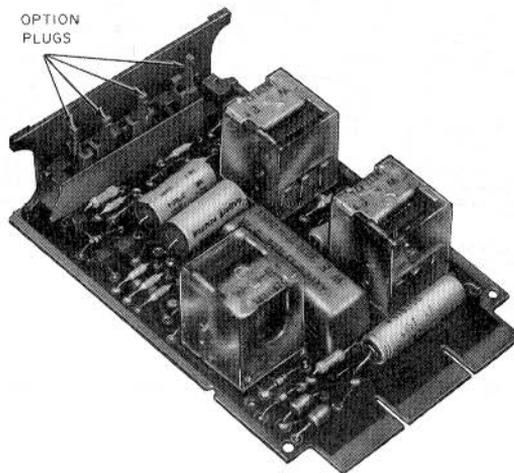


Fig. 5—400G KTU (MD)

OPTIONS

OPT	FEATURES	
M	TIMEOUT	LONG TIME DELAY (APPROXIMATELY 20 SECONDS)
Z		SHORT TIME DELAY (APPROXIMATELY 5 SECONDS)
Y	VISUAL	LAMP WINK
X	HOLD CKT	LAMP STEADY
W		INTERRUPTED RING
T		STEADY RING
S	AUDIBLE SIGNAL	COMMON WITH DIODE MATRIX CONTROL
V		COMMON WITH RELAY CONTROL
R	DELAYED HOLD RELEASE	RELEASE OF HOLDING BRIDGE FROM CO OR PBX LINE CURRENT OPENS
K		MINIMUM OF 25 MS 600 MS
N	CONNECTS TO 90A CUSTOMER PREMISES SYSTEM	

NOTES:

- REQUIRES A MOUNTING FACILITY EQUIPPED WITH AN 18-, 20-, OR 40-PIN CONNECTOR.
- THE STATUS OF THE RELAYS FOR ALL FUNCTIONS OF THE KTU ARE AS FOLLOWS:

RELAY	FUNCTION		
	INC RING CYCLE	ANS OR INIT CALL	HOLD
A	R	O	R
B	O	R	O
C	R	O	O
L	O*	R	O

- R = RELEASED
 O = OPERATE
 * = FOLLOWS RINGING
- DO NOT CONNECT RINGING VOLTAGE THROUGH TERMINAL 10 WHEN N OPTION IS PROVIDED.

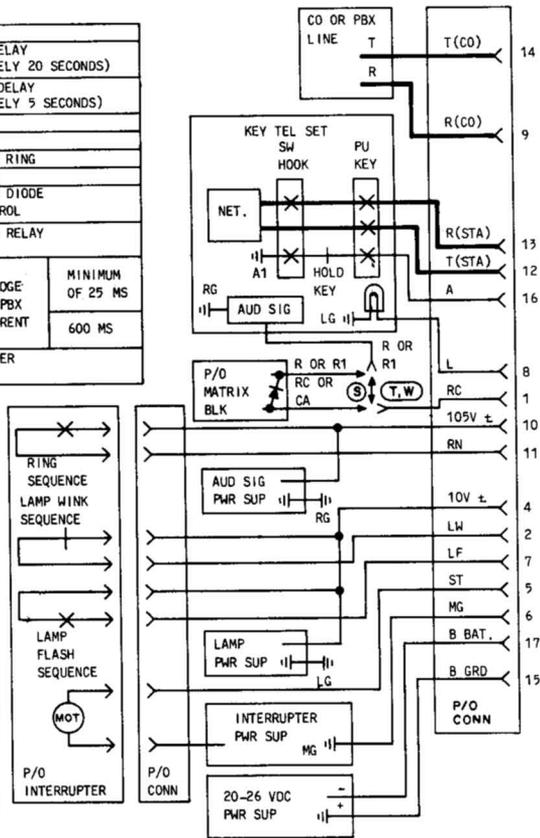


Fig. 6—Condensed Functional Schematic of 400G KTU (MD) (CO or PBX Line Circuit) (Sheet 1 of 2)

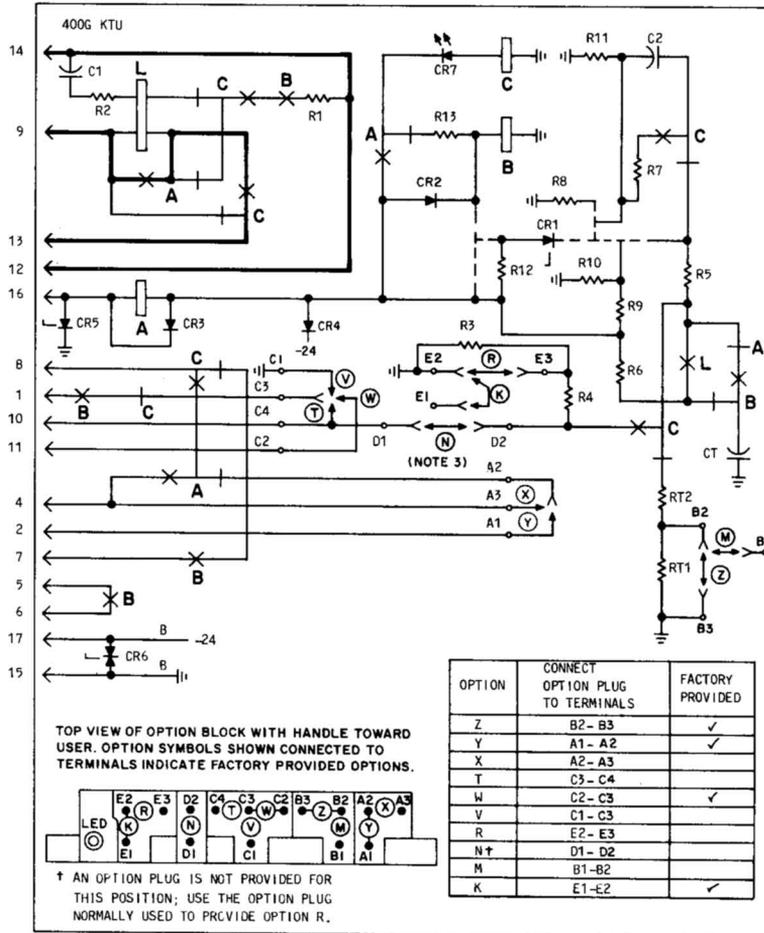


Fig. 6—Condensed Functional Schematic of 400G KTU (MD) (CO or PBX Line Circuit) (Sheet 2 of 2)

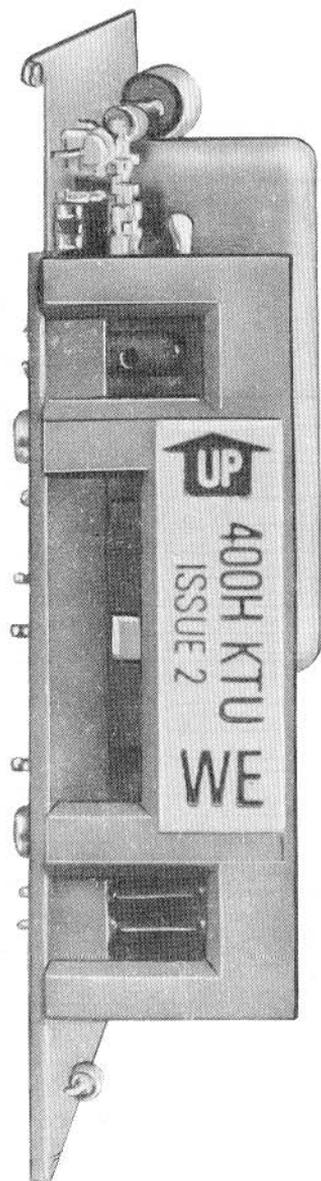


Fig. 7—Line Status Indicator and Test Pins in 400H KTU

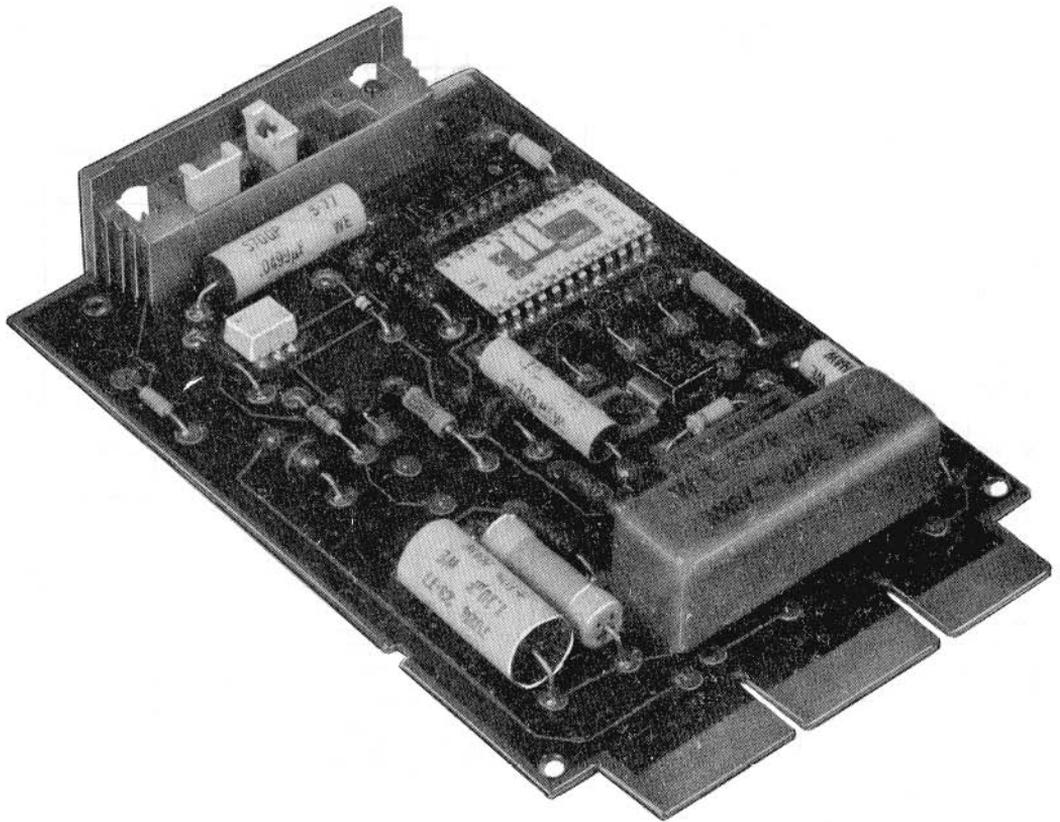


Fig. 8—400H KTU

OPTIONS

OPT	FEATURES	
T*	CO OR PBX LINE CIRCUIT	
W*	INTERRUPTED RING	
V	AUDIBLE SIGNAL	COMMON AUDIBLE WITH GROUND FOR RELAY CONTROL
S*	HOLD CIRCUIT RELEASE	LONG HOLD ABANDON TIMEOUT (FOR ESS #1, ESS #2, 812 PBX, 770 PBX, DIMENSION PBX)
R		SHORT HOLD ABANDON (FOR ALL OTHERS)
Y	TIME OUT	WITH 14 SECONDS
†		WITHOUT 6 SECONDS

*FACTORY INSTALLED

†AW OPTION PLUG IS NOT PROVIDED. USE KS21290, L7 OPTION PLUG COU CODE 841-732-613

NOTES:

1. REQUIRES A MOUNTING FACILITY EQUIPPED WITH AN 18-, 20-, OR 40-PIN CONNECTOR.
2. THE STATUS OF THE RELAYS FOR ALL FUNCTIONS OF THE KTU ARE AS FOLLOWS:
3. R109 AND Q105 PROVIDE ON ISSUE 2 OR LATER
4. T-OPTION ISSUE 1 ONLY. OPTION PLUGS J1 AND J2 HAVE BEEN REMOVED ON ISSUE 2 OR LATER
5. NOT PROVIDED ON ISSUE 2 OR LATER

RELAY	FUNCTION		
	INCOMING RING-CYCLE	ANSWERING OR INITIATING CALL	HOLD
R	0	RL	RL
H	RL	RL	0

RL - RELEASED
0 - OPERATED

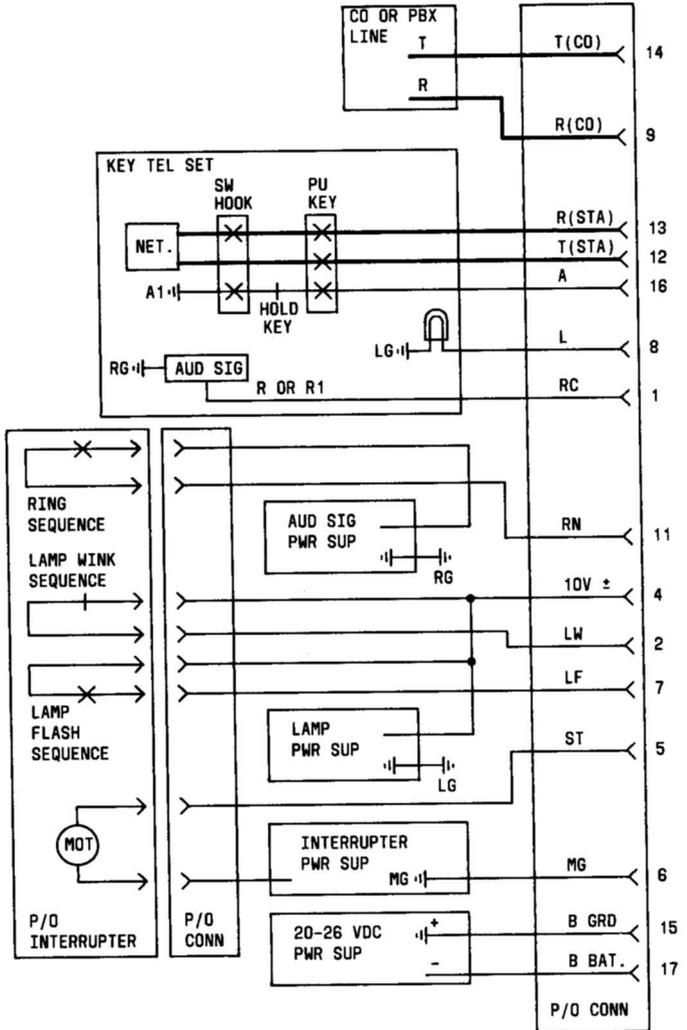


Fig. 9—Condensed Functional Schematic of 400H KTU (CO or PBX Line Circuit) (Sheet 1 of 2)

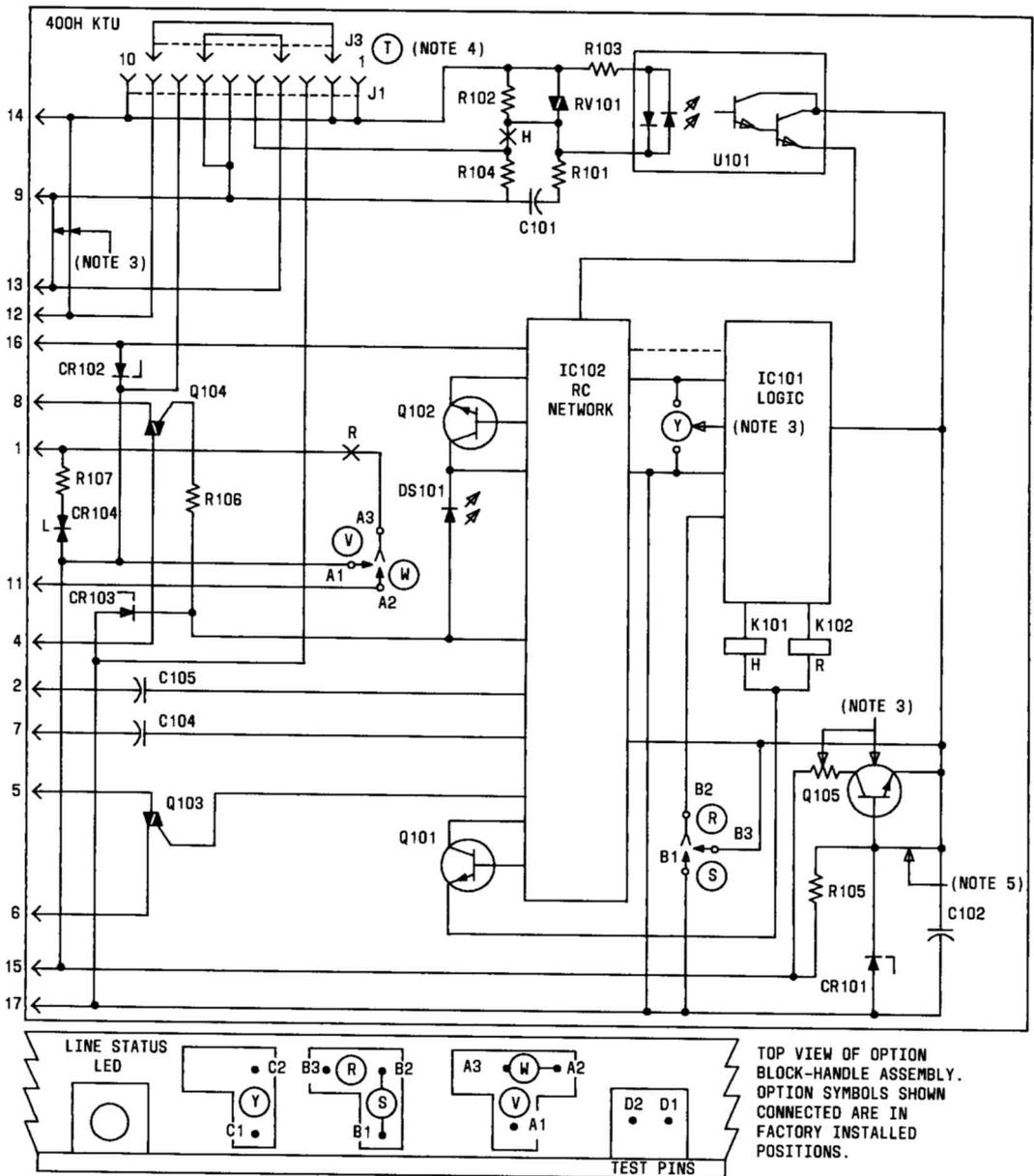


Fig. 9—Condensed Functional Schematic of 400H KTU (CO or PBX Line Circuit) (Sheet 2 of 2)

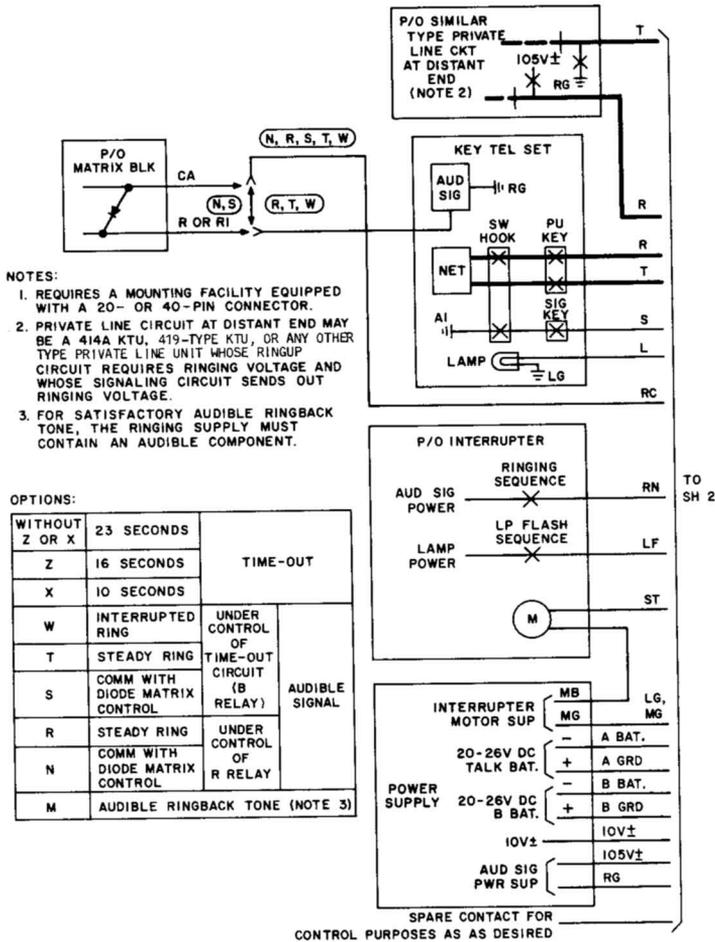


Fig. 10—Condensed Functional Schematic of 414A KTU (Manual Signaling, Ringdown, Private Line Circuit) (Sheet 1 of 2)

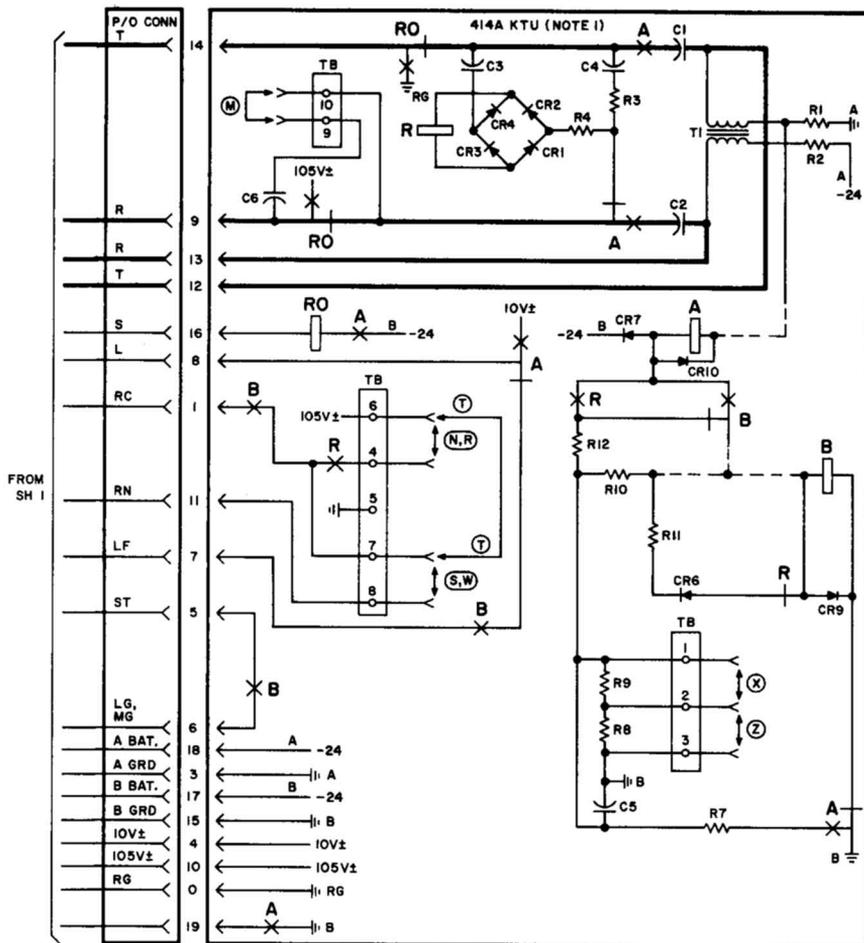


Fig. 10—Condensed Functional Schematic of 414A KTU (Manual Signaling, Ringdown, Private Line Circuit)
(Sheet 2 of 2)

NOTES:

1. REQUIRES A MOUNTING FACILITY EQUIPPED WITH AN 18-, 20-, OR 40-PIN CONNECTOR.
2. NOMINAL DC SIGNALING RANGE AT MINIMUM BATTERY VOLTAGE (-20V) IS 2200 OHMS.
3. PRIVATE LINE CIRCUIT AT DISTANT END MAY BE A 415A KTU OR ANY OTHER TYPE PRIVATE LINE UNIT WHOSE RINGUP CIRCUIT REQUIRES A DC VOLTAGE AND WHOSE SIGNALING CIRCUIT SENDS OUT A DC VOLTAGE.
4. FOR SATISFACTORY AUDIBLE RINGBACK TONE THE RINGING SUPPLY MUST CONTAIN AN AUDIBLE COMPONENT.
5. FOR IDLE LINE TERMINATION CONNECT A KS-13490, L1, 910 OHM RESISTOR IN SERIES WITH A 542F, 2 μF CAPACITOR ACROSS TERMINALS 9 AND 10. ORDER AND PLACE COMPONENTS LOCALLY.

OPTIONS:

W	INTERRUPTED RING	AUD SIG
T	STEADY RING	
S	COM WITH DIODE MATRIX CONTROL	
M	AUDIBLE RINGBACK TONE (NOTE 4)	
Y	VISUAL HOLD SIG	

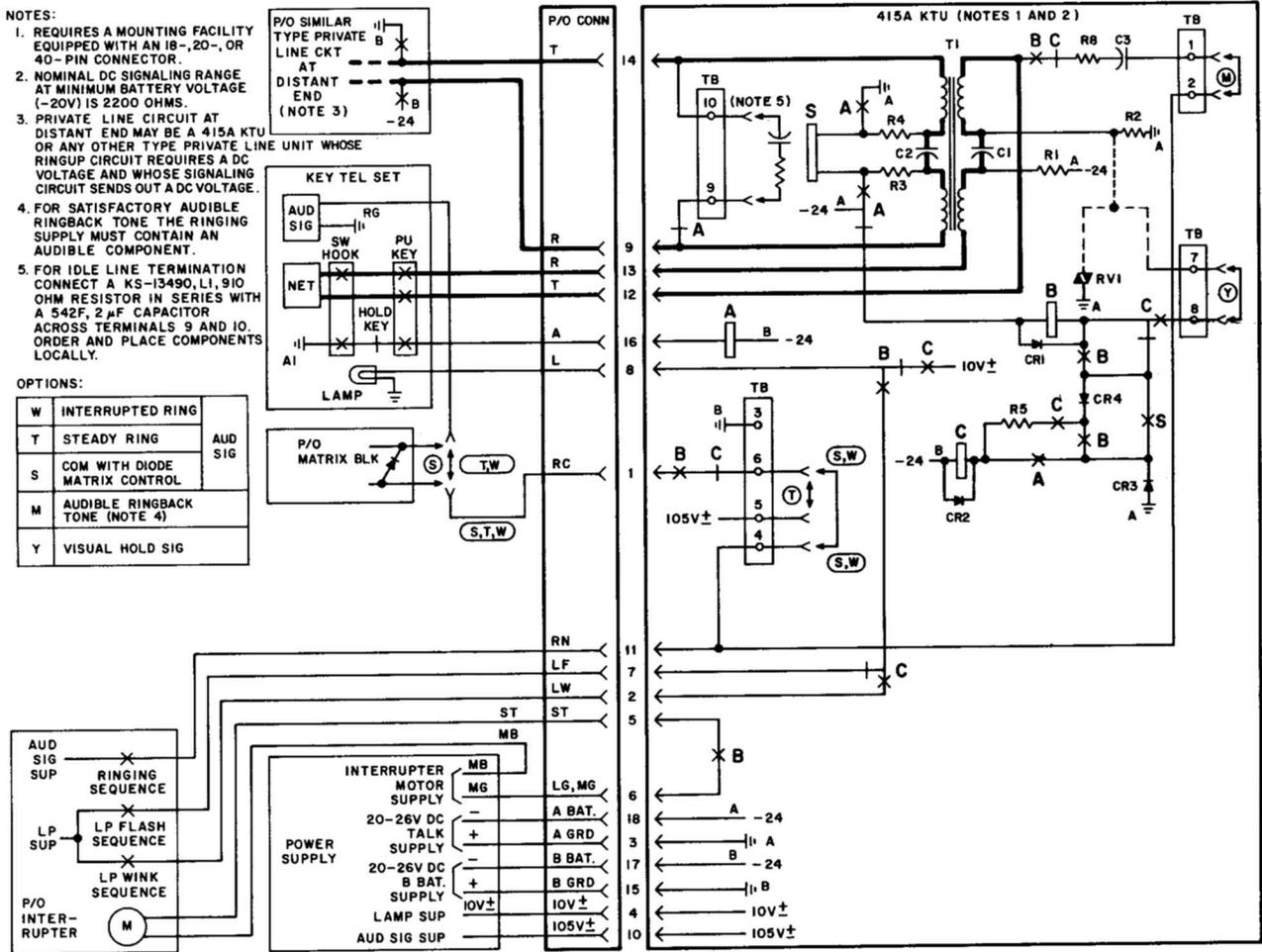


Fig. 11—Condensed Functional Schematic of 415A KTU (Automatic, DC Signaling, Private Line Circuit)

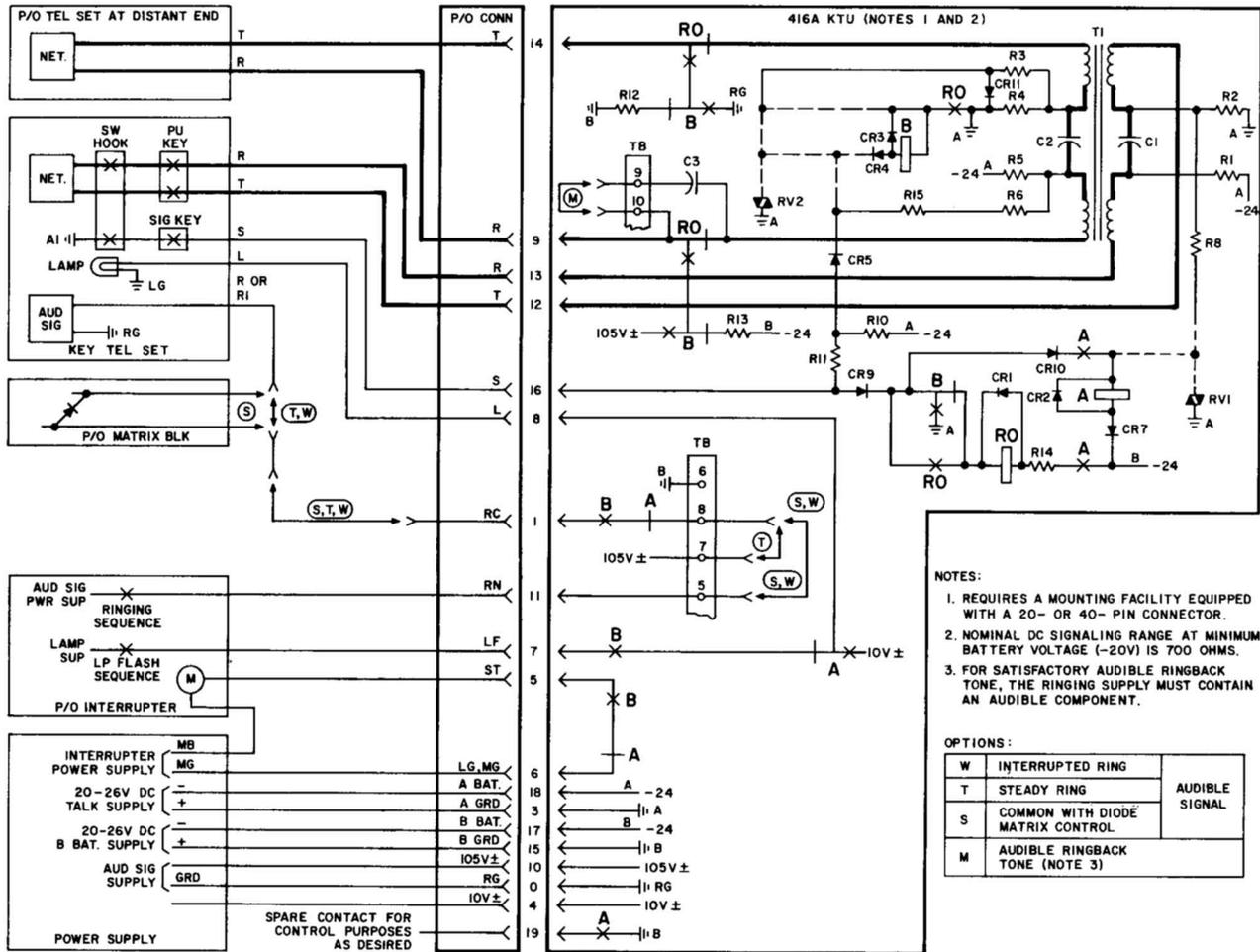


Fig. 12—Condensed Functional Schematic of 416A KTU (Station Line Circuit)

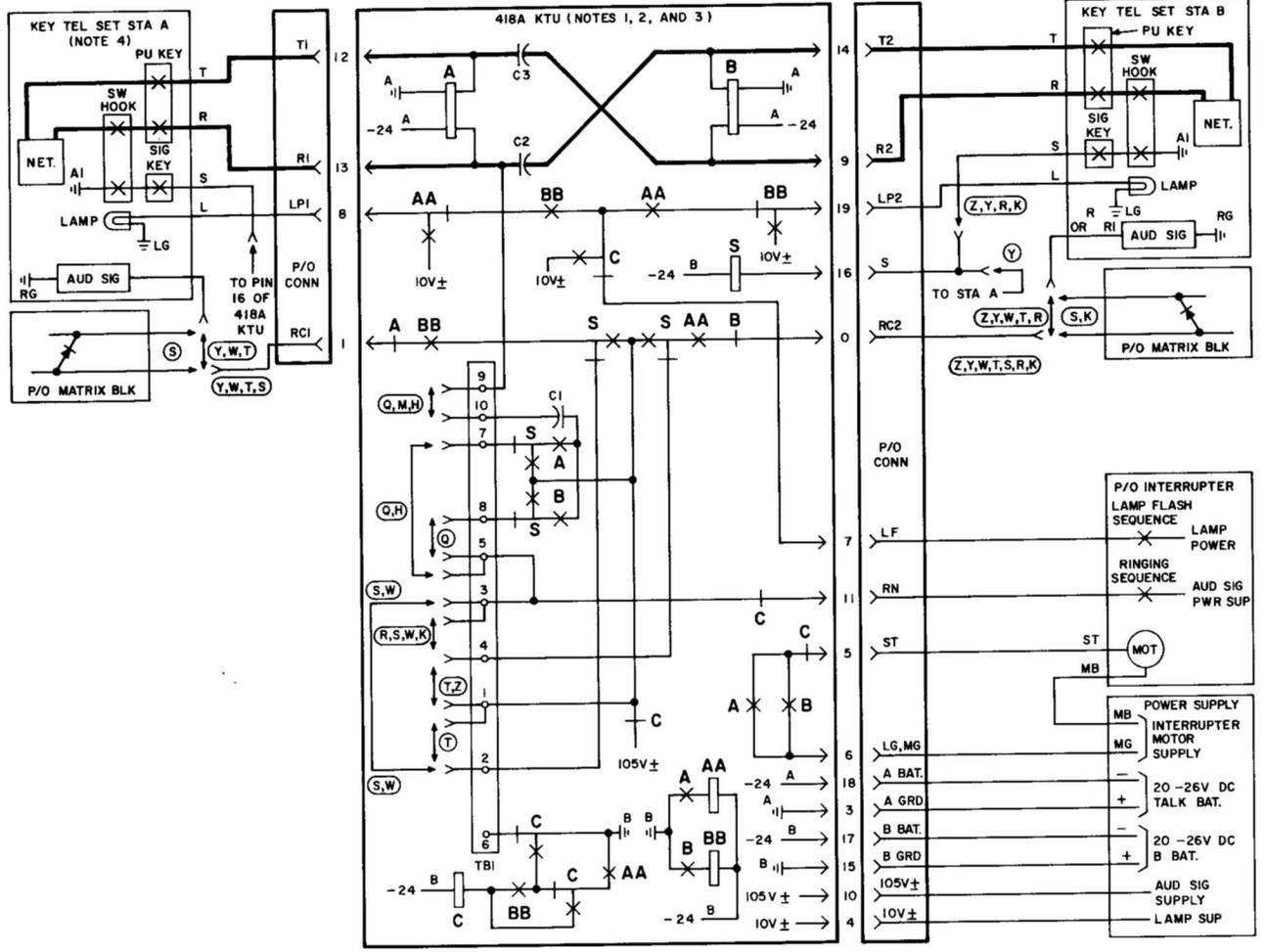


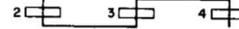
Fig. 13—Condensed Functional Schematic of 418A KTU (Short Range, DC Signaling, Private Line Circuit) (Sheet 1 of 2)

OPTIONS:

W	INTERRUPTED RING	TWO-WAY AUTOMATIC	SIGNALING
T	STEADY RING		
S	COM AUD WITH DIODE MATRIX CONTROL		
R	INTERRUPTED RING	ONE-WAY AUTOMATIC ONE-WAY MANUAL (NOTE 5)	
Z	STEADY RING		
K	COM AUD WITH DIODE MATRIX CONTROL		
Y	TWO-WAY MANUAL (NOTE 6)		
Q	TWO-WAY AUTOMATIC		AUDIBLE RINGBACK TONE (NOTE 7)
H	ONE-WAY AUTOMATIC, ONE-WAY MANUAL		
M	TWO-WAY MANUAL		

NOTES:

1. REQUIRES A MOUNTING FACILITY EQUIPPED WITH A 20- OR 40-PIN CONNECTOR.
2. FOR SATISFACTORY OPERATION OF RELAYS A AND B THE MAXIMUM DC RANGE IS 100 OHMS WITH A MINIMUM BATTERY VOLTAGE OF -20V. WHERE LAMPS ARE OPERATED FROM THE KTU WITHOUT AUXILIARY APPARATUS, THE NORMAL 50-OHM LOOP RANGE APPLIES.
3. THE CONTINUOUS METHOD OF STRAPPING MUST BE USED ON TBI FOR OPTIONS REQUIRING STRAPS BETWEEN 3 TERMINALS. FOR EXAMPLE S,W OPTION WOULD BE WIRED FROM 2, THRU 3, TO 4 AS FOLLOWS:



4. STATION "A" IS ALWAYS ASSIGNED AS THE AUTOMATIC SIGNALING STATION WHENEVER THE ONE-WAY AUTOMATIC, ONE-WAY MANUAL SIGNALING OPTION IS USED.
5. THESE OPTIONS APPLY TO THE SIGNAL KEY AND AUDIBLE SIGNAL AT STA "B" ONLY. THE AUDIBLE SIGNAL AT STA "A" IS UNDER CONTROL OF RELAY "S". THE AUDIBLE SIGNAL AT STA "A" MAY BE PART OF A COMMON AUDIBLE ARRANGEMENT PROVIDED THE DIODE MATRIX IS USED FOR CONTROL.
6. THE AUDIBLE SIGNALS AT STA "A" AND "B" MAY BE PART OF A COMM AUDIBLE ARRANGEMENT PROVIDED THE DIODE MATRIX IS USED FOR CONTROL.
7. FOR SATISFACTORY AUDIBLE RINGBACK TONE THE RINGING SUPPLY MUST CONTAIN AN AUDIBLE COMPONENT.

Fig. 13—Condensed Functional Schematic of 418A KTU (Short Range, DC Signaling, Private Line Circuit) (Sheet 2 of 2)

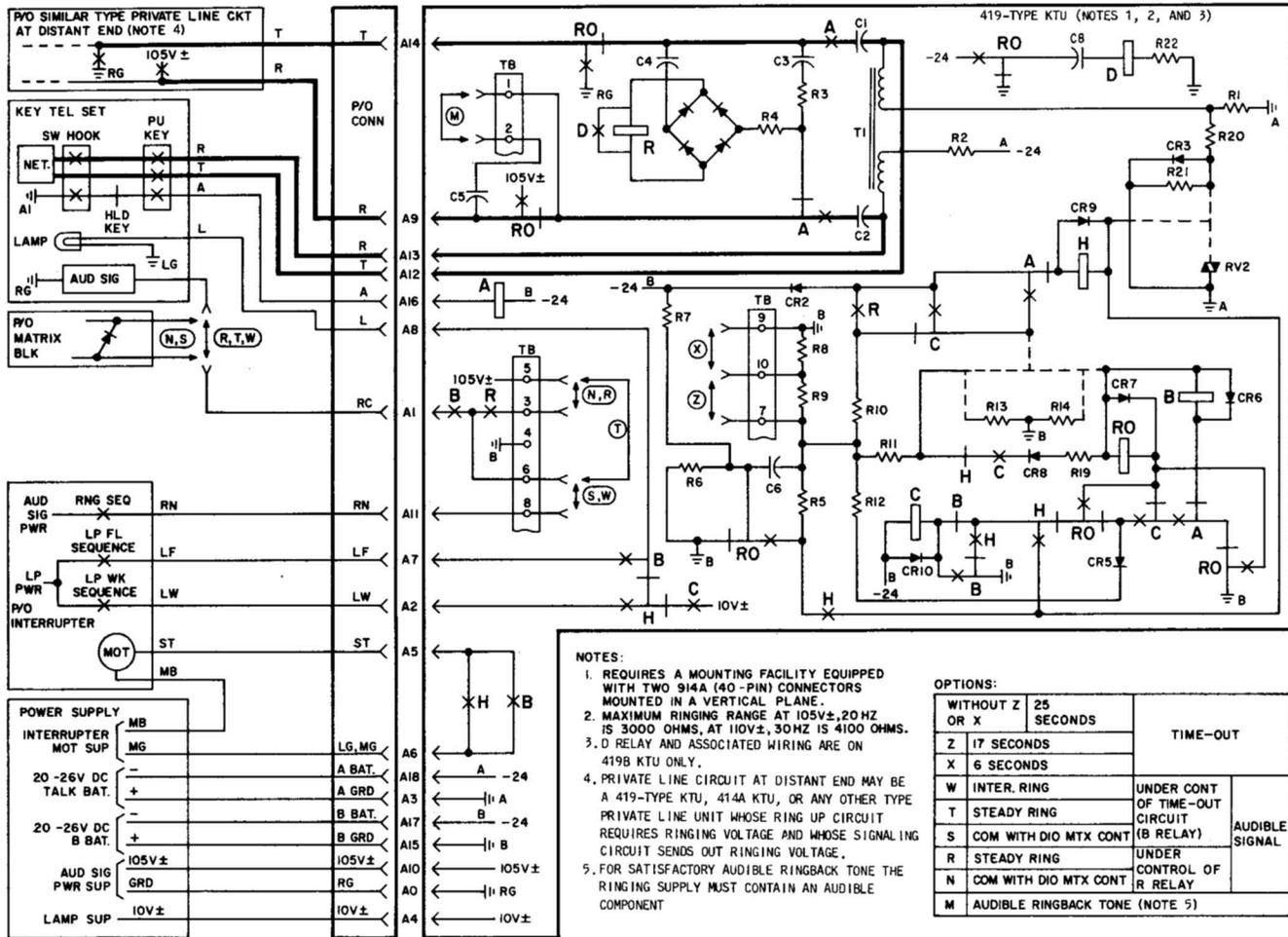


Fig. 14—Condensed Functional Schematic of 419-Type KTU (Automatic Signaling, Ringdown, Private Line Circuit)

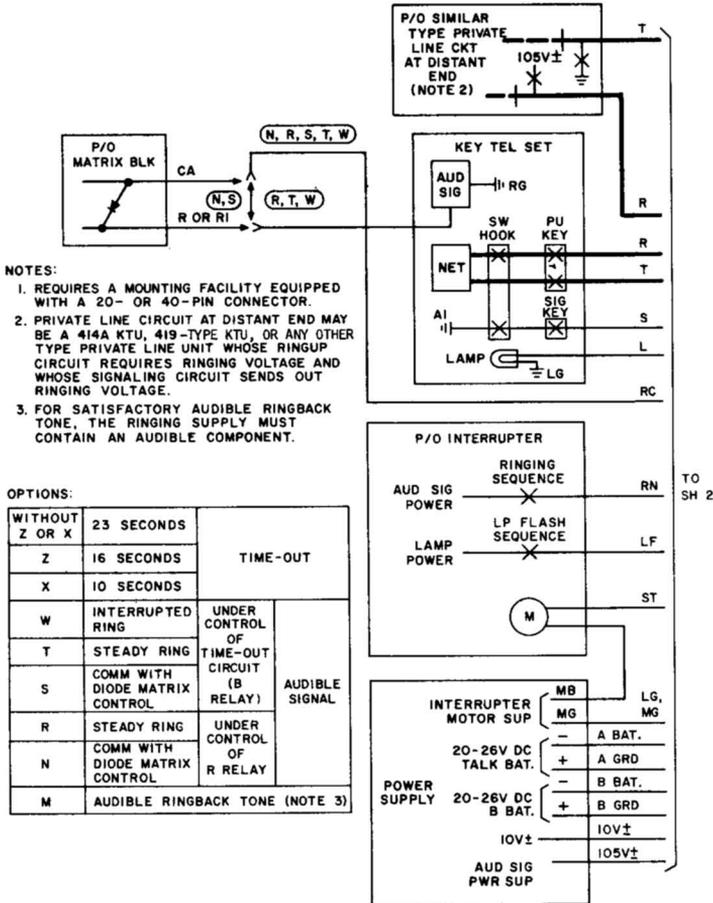


Fig. 15—Condensed Functional Schematic of 461A KTU (Manual Signaling, Ringdown, Private Line Circuit) (Sheet 1 of 2)

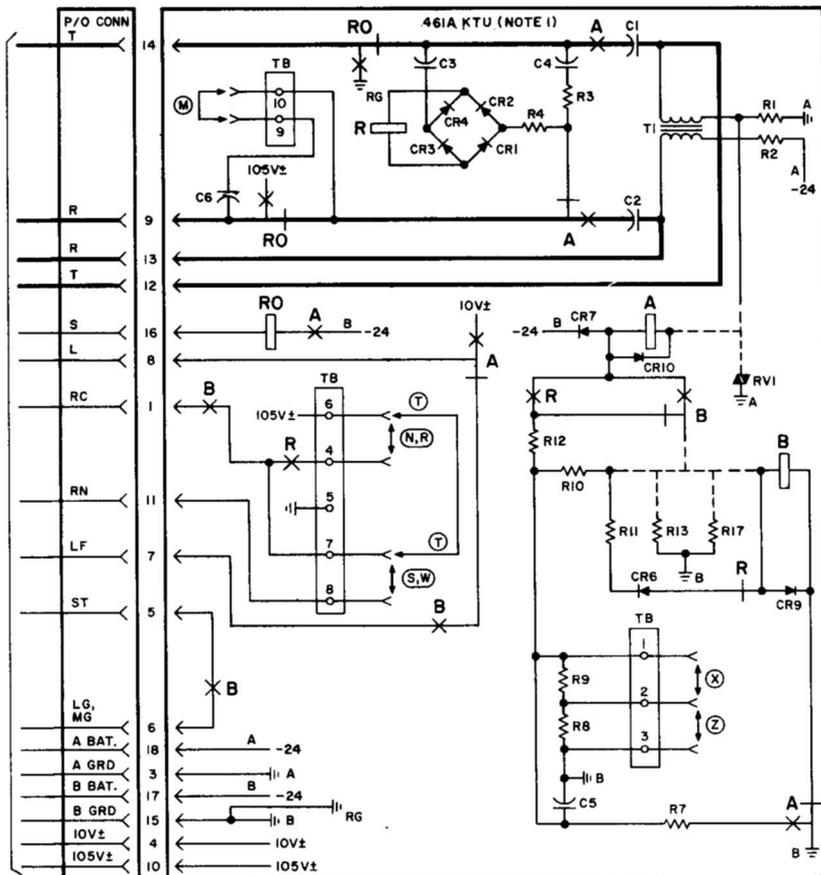


Fig. 15—Condensed Functional Schematic of 461A KTU (Manual Signaling, Ringdown, Private Line Circuit)
(Sheet 2 of 2)

**TABLE K
RINGING RANGES—461A KTU**

MINIMUM RMS RINGING VOLTAGE	STANDARD LOOPS 15K-OHM LEAKAGE	UNIGAUGE LOOPS 20K-OHM LEAKAGE*
		OHMS
75 } volts (20 Hz) 84 } 92 }	2600 ohms	4000 4600 5000
110 } volts (30 Hz) 120 }		5000 5400

*These ringing ranges are also valid with unigauge plant which may use an E6 repeater in each subscriber loop.