

REMOTE TEST SYSTEM
CENTRA-LINE 612A
MAINTENANCE

1. GENERAL

1.01 This Section contains maintenance instructions for the CENTRA-LINE 612A Remote Testing System.

1.02 This Section includes a functional description of the system, troubleshooting procedures, periodic checks and adjustment procedures, information on replacement and repair parts, and system specifications.

1.03 It is recommended that maintenance personnel become familiar with Section 662-495-900SW, Operation and Test Procedures, before attempting to perform maintenance on this system.

2. FUNCTIONAL DESCRIPTION

2.01 A description of every card's contribution to the operation of the system is provided in the following paragraphs. Supplementing this description is a photograph of the master station and one of the remote station, and also a block diagram of each station. The photographs point out the physical location of every card, while the block diagrams show their electrical relationships.

2.02 MASTER STATION - Figure 1A is a rear view of the master station with its cover off, exposing the arrangement of the cards within. A retaining bar, which extends across the front of the cards and is designed to hold them in place, has also been removed to reveal the cards in their entirety. Figure 1B is a front view of the master station showing the functional grouping of the console's controls. Figure 2 is the corresponding block diagram of the master station, and the basis of the following description.

2.03 CONSOLE KEYBOARDS - Functionally, the console control panels are separated into four keyboard groups, each of which has a number of pushbuttons. All control operation and meter function pushbuttons are arranged in a logic OR configuration. Thus, when any of them is pressed, it connects a ground potential to one of two matrices, meter function or control ops, initiating a unique code in the scanner. To allow the use of binary coding, mechanical interlocking is employed within each keyboard group. (The details of the coding in terms of d-c logic levels are described in paragraph 3.) The DIAL TONE, LINE REVERSE, and auxiliary CONTROL (1 through 7) pushbuttons initiate independent functions. The IN-DIAL pushbutton, however, must be used in conjunction with other pushbuttons (see paragraph 2.05) in order to initiate the in-dial function.

2.04 METER FUNCTION MATRIX - The meter function matrix is associated with the meter function keyboard and with control pushbuttons 1 through 7. Operation of any pushbutton in the meter function group causes the matrix to produce, in parallel form, a binary-coded d-c input at the scanner. Logic gating circuits in the matrix develop the proper code for each input function.

2.05 CONTROL OPS MATRIX - This matrix receives its input from the control operations keyboard and from the dial-tone, line-reverse and in-dial functions. Like the meter function matrix, it provides, in parallel form, a binary-coded d-c output to the scanner whenever any of its associated keyboard pushbuttons is operated. When this occurs, the matrix's electronic interlocking circuits inhibit the keyboard associated with the meter function matrix. Operation

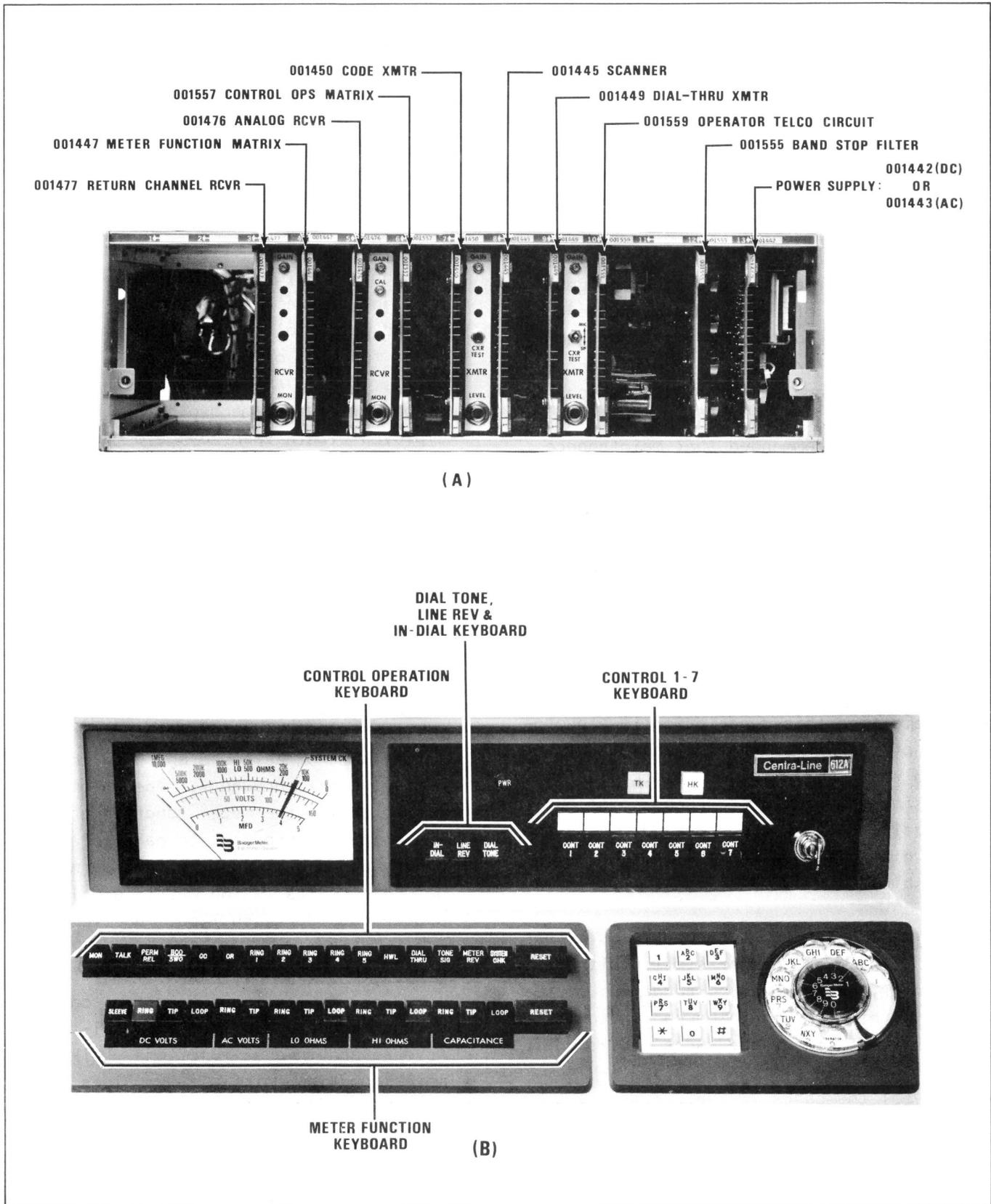


Figure 1 - Rear View of 001480 Master Station Showing Card Arrangement (A), and Front View Showing Functional Grouping of Console Keyboards (B)

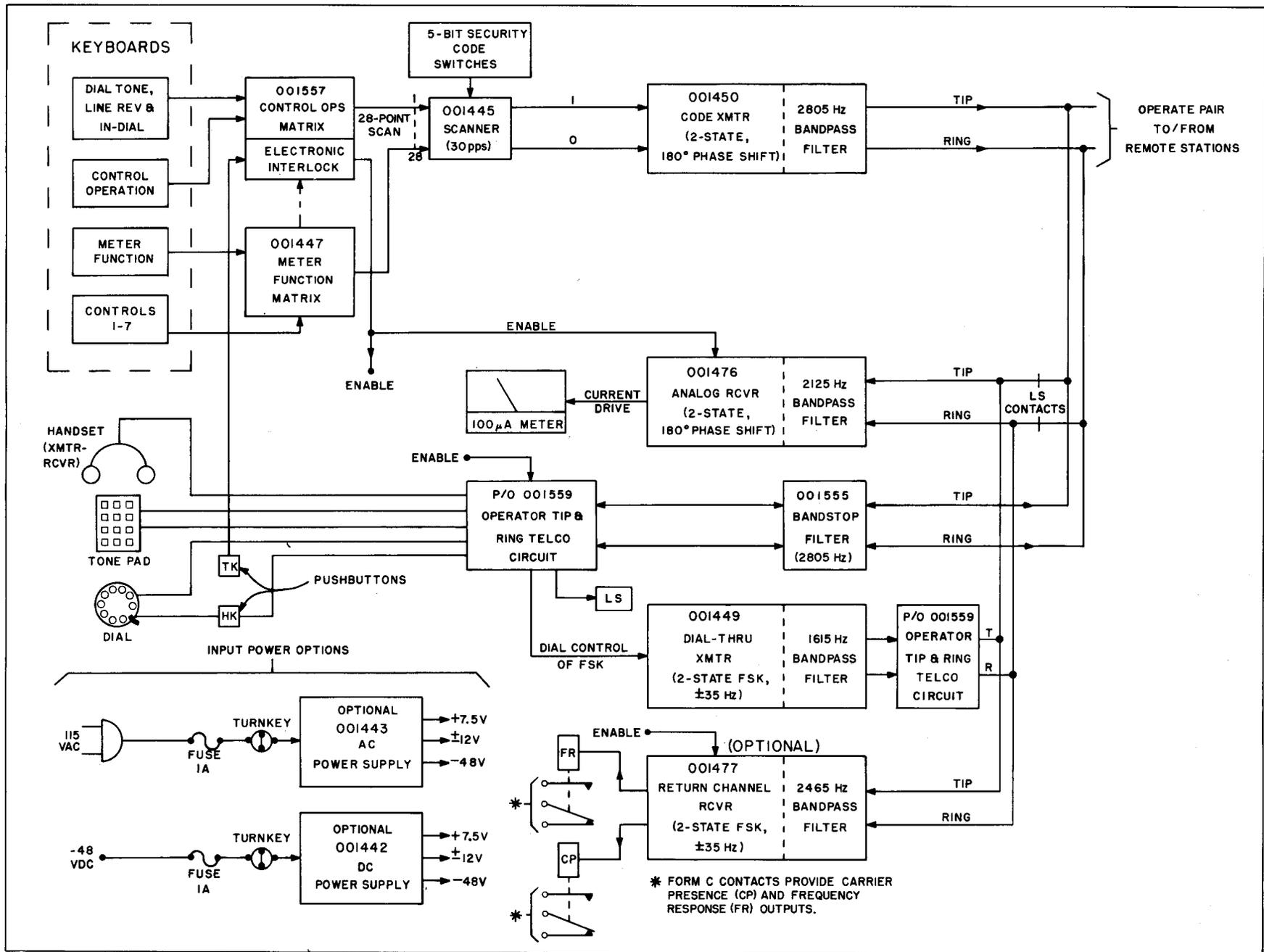


Figure 2 - Block Diagram of 001480 Master Station

of some of the control pushbuttons, however, will result in a meter function measurement, as though the corresponding meter function pushbuttons themselves were operated. These are as follows:

<u>Control Pushbutton</u>	<u>Resultant Measurement Function</u>
Coin collect (CC):	RING DC VOLTS and METER REV
Coin return (CR):	RING DC VOLTS
Permanent release (PERM REL):	SLEEVE DC VOLTS
All five ringers (RING 1 - RING 5):	LOOP AC VOLTS
Howler (HWL):	LOOP AC VOLTS (0-75V full-scale deflection)

Other electronic interlocking circuitry prevents in-dial operation until the BCO/3W0 and DIAL TONE pushbuttons are operated.

2.06 SCANNER - The scanner converts to serial output the parallel outputs of the 001447 and 001557 Matrix Cards. This serial pulse train constitutes the communications code and is applied to the code

transmitter via two logic lines, 1 and 0.

Figure 3 illustrates the structure of the communications code. It is comprised of two frames of information. The first frame is called "frame 0," the second "frame 1". Following the start pulse (0 or 1) of each frame are 12 information bits, a parity bit and an intercode. Counting the two intercodes, there is a total of 30 bits, and since the scanner operates at 30 pulses per second, it generates a complete code in one second.

The specific informational breakdown of each frame of the code is as follows:

Frame 0:

1. The five-bit binary security code established by the setting of the security switches.
2. The four-bit, binary coded output from the meter function matrix - the specific code identifies the meter function selected.
3. Three independent, uncoded bits defining the in-dial, line reverse and dial tone functions.

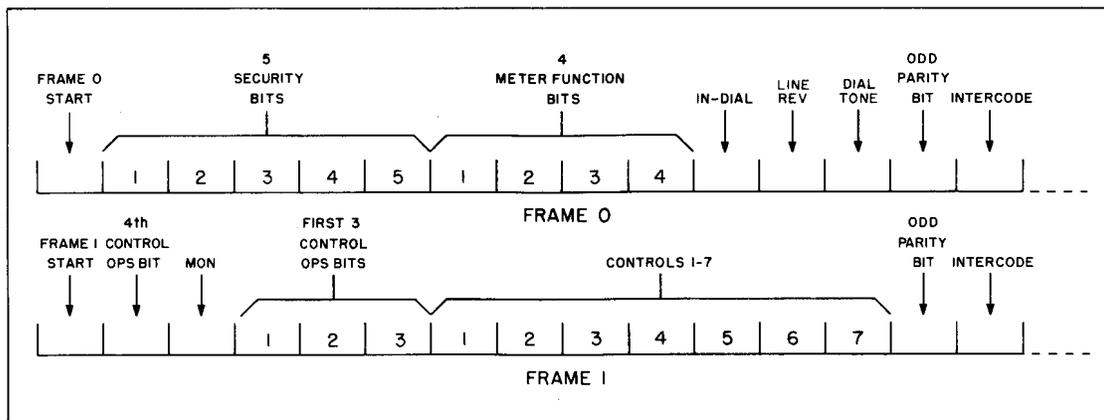


Figure 3 - Diagram of Communications Code Structure

Frame 1:

1. The fourth bit comprising the binary-coded output of the control ops matrix.
2. One independent, uncoded bit defining the monitor function.
3. The first three bits comprising the binary-coded output of the control ops matrix - the specific code identifies the control operation selected (e.g., talk, coin collect, coin return, etc.).
4. Seven independent, uncoded bits corresponding to control functions 1 through 7.

By the code's odd parity is meant that if in both frames the total number of 1-bus pulses (one per bit) delivered to the 1 bus be even, the scanner adds a pulse to that bus, making the count odd. If, on the other hand, the number of pulses is already odd, the scanner applies the parity pulse to the 0 bus, keeping the 1-bus total odd.

Finally, the intercode provides separation between the two frames. In length it is equal to one bit period, but produces no modulation in the code transmitter.

2.07 CODE TRANSMITTER - The code transmitter converts the scanning pulses arriving on its 1- and 0-bus inputs into 180-degree phase shifts of its 2805 Hz tone carrier. The modulated tone is transmitted to the remote station, where it actuates a measurement or control circuit. A CXR TEST push-button and GAIN potentiometer on the front of the transmitter allow the carrier to be turned on unmodulated and adjusted to the proper level during installation and testing. The transmitter's bandpass filter serves several functions. It applies the 2805 Hz tone to the operate pair, and it also filters out undesirable sidebands and matches the impedance of the code transmitter to that of the line. Its output is connected in parallel with all the other filters.

2.08 ANALOG RECEIVER - Test measurement data transmitted by the analog transmitter at each remote station are received at the tip- and ring-input of the analog receiver. These data, representing voltage, resistance and capacitance measurements, arrive in the form of 180-degree phase shifts modulating a 2125 Hz tone. The analog receiver converts these phase shifts into a d-c microampere reading for driving the test meter on the front of the console. Two potentiometers on the front of the receiver allow respective adjustment of the gain and calibration of the analog output. Associated with the operation of the latter potentiometers is the test meter, which provides several registration marks to allow precise system calibration. The receiver's bandpass filter passes only the 2125 Hz signal, provides proper line-to-receiver impedance matching at that frequency, and rejects all other frequencies on the line.

2.09 OPERATOR TELCO CIRCUIT - This card contains the relays and relay drivers for switching in the dial-thru/in-dial, tone signaling, talk and monitor functions. It therefore provides an interface with the console's dial and tone signaling pad, the telco plug-in handset, the TK and HK circuits, the band stop filter, the dial-thru transmitter and, if used, an optional MF signaling pad. Circuits HK and TK are controlled by pushbuttons. Operation of HK (hook) loops the operate pair connected to the 001559, providing an off-hook condition to permit local telephone calls. Operation of TK (talk) enables local talk battery to be applied to the handset.

2.10 BAND STOP FILTER - The band stop filter allows passage of speech and dial pulses, but blocks the 2805 Hz tone generated in the code transmitter. This prevents the tone from interfering with speech and line-monitoring.

2.11 DIAL-THRU TRANSMITTER - Used in the dial-thru and in-dial modes of operation, the dial-thru transmitter generates a two-state FSK tone carrier modulated by make-break dial pulsing. Modulation causes the frequency to shift between two frequencies, 1580 Hz (Space) and 1650 (Mark). The transmitter's bandpass filter is tuned to the channel's center frequency, or 1615 Hz. A potentiometer and a toggle switch on the front of the transmitter permit adjusting of the transmitting level and testing of the Mark and Space frequencies.

2.12 RETURN CHANNEL RECEIVER - Optionally a part of the master station is the return channel FSK receiver. Used for return supervision applications (e.g., "wink back" indication denoting seizure of cross-bar offices), the receiver operates an output relay (FR). The state of the relay contacts determines whether a Mark (2500 Hz) or a Space (2430 Hz) signal is being received. Another relay, CP, detects the presence and absence of signal. (Both FR and CP are located within the console and are not physically part of the receiver.) The bandpass filter is set to the channel's center frequency (2465 Hz). A potentiometer on the front of the receiver sets the receiving level.

2.13 DC POWER SUPPLY - The 001442 DC Power Supply operates from a negative 48-volt source, typically an office battery. It provides regulated 7.5- and 12-volt outputs and an unregulated 48-volt output (essentially station battery) for driving the following circuits:

+7.5 V: Integrated circuit (IC) logic on Cards 001445, 001557, 001447, 001450, 001476 and 001477.

+12 V: Transistor circuits on Cards 001449, 001450, 001476 and 001477.

-48 V: Relays on Card 001559, optional relays FR and CP in console, pushbutton lamps on console, and local talk battery.

Not part of the power supply card are the fuse and the filter for the 48-volt supply. The fuse is mounted behind a protective metal strip at the rear of the console, and the filter is located inside the console, below the meter.

2.14 AC POWER SUPPLY - This power supply is similar to the one described above, but operates from 115 volts, a-c. It supplies regulated 7.5- and 12-volt outputs and two unregulated 48-volt outputs. Voltage distribution to the cards and other components is identical to that of the 001442. The power cord, fuse, transformer and the 7.5-volt rectifiers, filter and series regulator are located in the console, and not on the card.

2.15 REMOTE STATION - Figure 4 is a front view of the remote station without its upper and lower covers. Every card comprising the station is identified. Figure 5, a corresponding block diagram of the station, is the basis of the following description. (Para. 2.16 - 2.28)

2.16 CODE RECEIVER - The code receiver accepts the phase-shift modulated tone generated by the master station's code transmitter and converts the phase shifts into 100-microsecond digital pulses. These pulses appear on the 1- and 0-bus outputs, from where they are presented to the receiver logic and buffer circuits. Tuned to 2805 Hz, the receiver's bandpass filter passes only that frequency while rejecting all others. It also provides the proper impedance matching between the line and the receiver. A potentiometer on the front of the receiver provides a means of adjusting the receiver's gain.

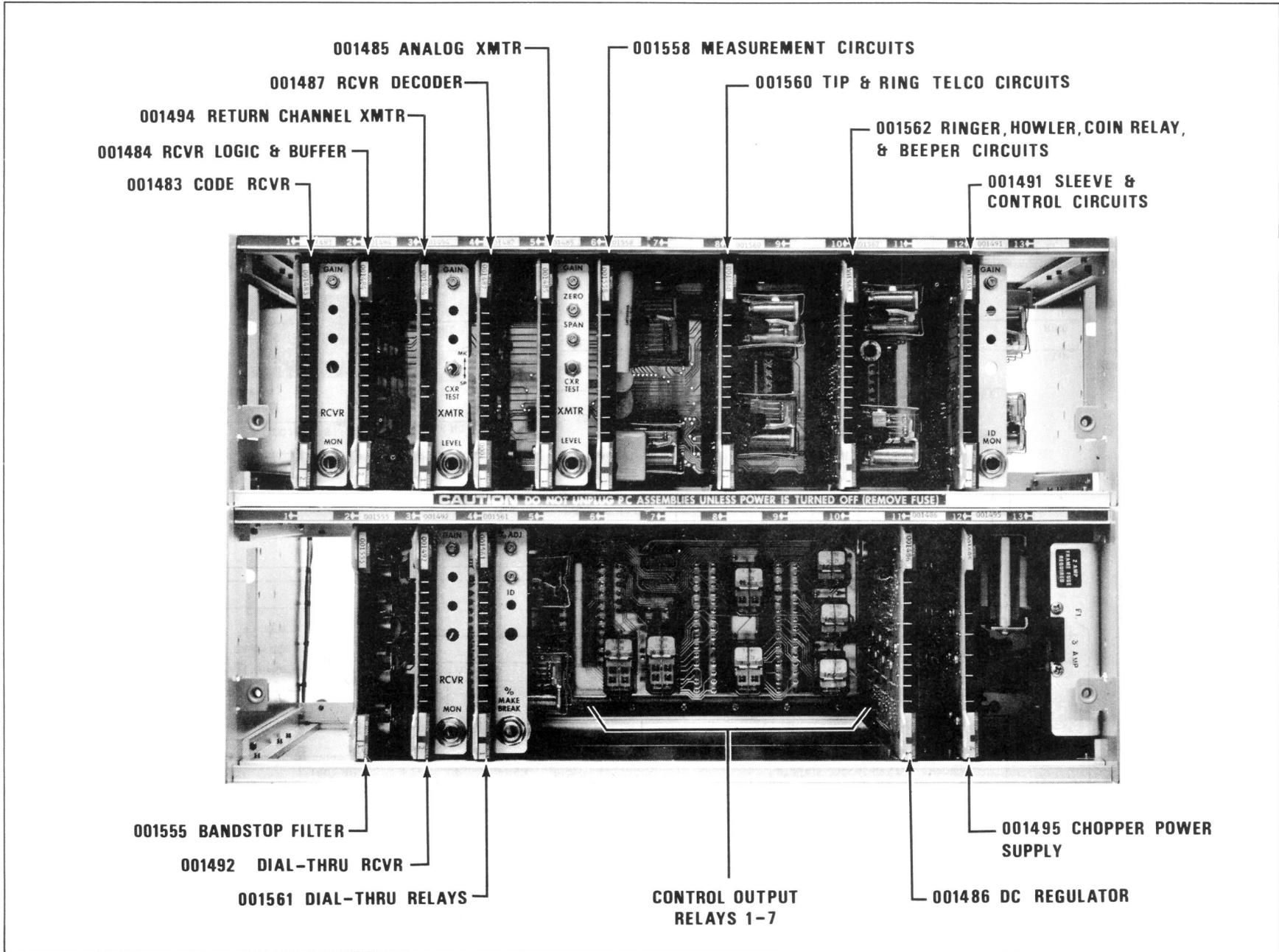


Figure 4 - Front View of 001481 Remote Station Showing Card Arrangement

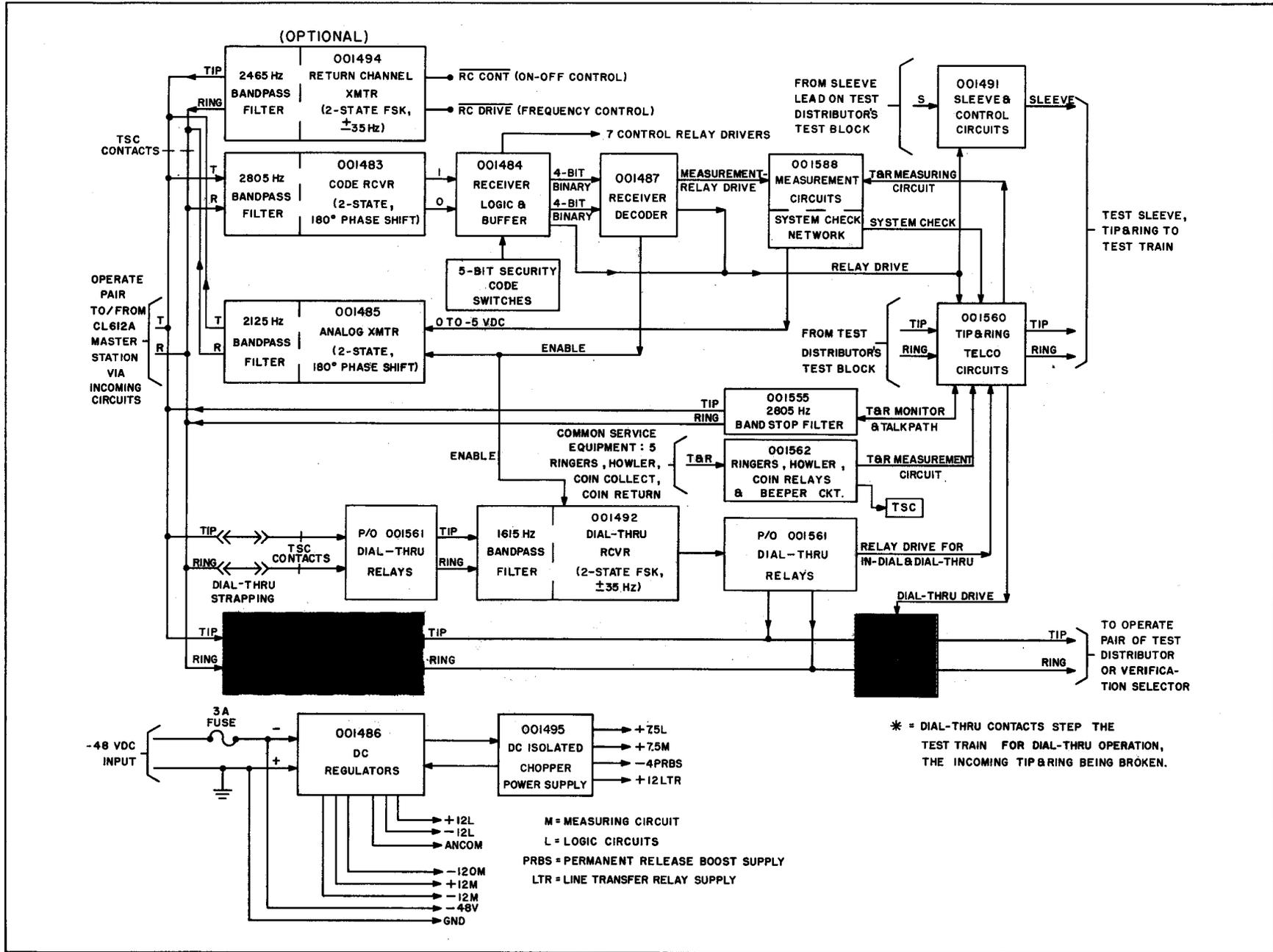


Figure 5 - Block Diagram of 001481 Remote Station

2.17 RECEIVER LOGIC AND BUFFER - Upon receiving the 1 and 0 pulses, the receiver logic and buffer stores and checks them, one frame at a time. (Remember that the pulses form two intercode-separated frames - see Fig. 3.) The logic circuits check each frame for too many or too few pulses, besides checking the start and parity pulses for integrity. Having been checked in this manner, the first frame is stored while the second is shifted in and similarly checked for overflow or underflow and odd parity. Only if the code checks are successful and if the settings of the remote station's security switches match exactly those of the master station will the two frames be presented as a parallel output. Part of the output consists of two four-bit binary codes defining the meter- or control function selected at the master station, and is applied to the receiver decoder. Other segments of the output are independent bits that drive the seven control output relays (Fig. 4) and other relays in the tip and ring telco circuits.

2.18 RECEIVER DECODER - The receiver decoder decodes the binary inputs representing the meter- and control functions. Its output circuit contains transistors for driving relays in the measurement circuits, and provides decoded signals for actuating control relays and their transistor drivers in the tip and ring telco circuits and the sleeve and control circuits. When a measurement of any kind is called for, the decoder enables the analog transmitter; when dial-thru operation is signaled, it enables the dial-thru receiver.

2.19 MEASUREMENT CIRCUITS - Those circuits that measure voltage, resistance and capacitance are located on this card, together with the relays that are instrumental in selecting the appropriate circuit. The relays are operated by transistor drivers in the receiver decoder.

A built-in system-checking network (whose actuating relay is located in the tip and ring telco circuits) permits the integrity of the system to be checked through measurement of a standard test voltage, resistance and capacitance. Measurement on a subscriber's line is done via the tip and ring telco circuits, which provide interfacing between the test train and the measuring circuits.

2.20 ANALOG TRANSMITTER - Receiving at its input 0- to negative 5-volt signals representing measured quantities, the analog transmitter converts them into 180-degree phase shifts of its 2125 Hz tone carrier. The modulated tone is conveyed to the master station via the operate pair to the incoming circuits, and from there via the trunk. Like all the other transmitters and receivers, the analog transmitter contains an integral band-pass filter for signal-coupling and impedance-matching. It also has, on its front panel, potentiometers for adjusting its gain and calibration, and a pushbutton for turning on its carrier unmodulated.

2.21 TIP AND RING TELCO CIRCUITS - Located on this card is a variety of telco control circuits-circuits involved with permanent release, dial tone, dial-thru, in-dial, etc. Most of these circuits include relays and their transistor drivers. The interrelationship between the circuits on this card and those on Cards 001558, 001562 and 001491 is a complex one, and is explored more fully in Paragraph 3. Basically, however, the circuits:

- a. Switch in either the system check source or the subscriber line for test measurements.
- b. Provide interfacing between various CL-612A circuits and the test train.
- c. Provide a through-path for talk

and monitor functions and for measurement of common service equipment potentials.

- d. Operate in conjunction with the dial-thru and in-dial circuits.

2.22 RINGER, HOWLER, COIN RELAY, AND BEEPER

CIRCUITS - The circuits on this card provide interfacing between the telco common service equipment and the circuits on Cards 001560 and 001558. For each function-ringer, howler, coin collect, etc.-there is a relay and transistor driver that are actuated upon receipt of an appropriate command from the master station. The beeper applies a tone to the line during MON and TALK. Tuned to 2805 Hz, the band stop filter blocks the tone received from the master station's code transmitter, thus leaving the speech and monitor path free of its interference.

2.23 SLEEVE AND CONTROL CIRCUITS - On this card are the relay circuits controlling the permanent release-, sleeve-, and access-control functions. Several of these relays are driven by circuits in the receiver decoder, some are slaved to the operation of others, most are involved with specific accessing methods such as call trap and EAS. Refer to paragraph 3 for breakdown. Located on the front panel of the card is a potentiometer. This is used for adjusting the audible level of the identification tone associated with EAS and call-trap schemes.

2.24 DIAL-THRU RECEIVER - The dial-thru receiver converts into pulses the frequency-shifted signal generated by the master station's dial-thru transmitter. The pulses, in turn, drive a loop-pulsing relay on the dial-thru relay card. The receiver is tuned to the channel's center frequency, 1615 Hz, but receives either a Mark signal (1650 Hz) or a Space signal (1580 Hz). This ± 35 Hz displacement from the center frequency is what produces the output pulses.

A potentiometer on the card's front panel allows adjustment of the receiver's gain. Notice that the receiver cannot operate unless strapping connections are made. (Refer to Paragraph 3.) These connections are made at the rear of the remote station.

2.25 DIAL-THRU RELAYS - All the relays involved in dial-thru operation are contained on this card. One of the relays, responding to the pulses developed in the dial-thru receiver, generates the loop-dialing pulses. Others interface with the test train and with the tip and ring telco circuits. The card's front panel mounts two potentiometers, one for adjusting the percent make-break of the dial pulses, the other for setting the audible level of an identification (busy) tone.

2.26 RETURN CHANNEL TRANSMITTER - Optionally used for supervision is the return channel transmitter. Like the dial-thru transmitter at the master station, it is a two-state FSK unit. The higher of its two transmitted frequencies is 2500 Hz (Mark); the lower, 2430 Hz (Space). Its bandpass filter is tuned to the channel's center frequency, 2465 Hz. A potentiometer and a toggle switch are mounted on the front of the transmitter. These allow, respectively, adjustment of the transmitting level and manual initiation of Mark and Space transmission. There are two inputs to the transmitter that must be applied via terminals at the rear of the remote station. These are called RC CONT and RC DRIVE. The first allows the transmitter's carrier to be switched on and off, and the second permits the frequency to be shifted. Typically, these inputs are derived from ground applied through dry form C relay contacts.

2.27 CHOPPER POWER SUPPLY - This is an isolated supply that operates from a standard 48-volt office battery. It converts the d-c input to an a-c

output, which is then rectified and filtered to d-c once again. Card 001486 regulates some of these d-c outputs, but several are used unregulated to drive the following circuits:

- +7.5 L: Integrated circuit (IC) logic on Cards 001483 and 001484, 001492 and 110561, and 001487.
- +7.5 M: IC logic on Card 001485. Reference is AN COM, not ground.
- 6 PRBS: Permanent release boost circuit on Card 001560.
- +12 LTR: Line-transfer relay (used with Badger 001384 Relay Transfer Panel).

The 48-volt input from the office battery drives the relay circuits on Cards 001491 and 001558, on 001560 through 001562, and in the cabinet; and the relay drivers on Cards 001484 and 001487. Several circuits associated with the 48-volt supply are not card-mounted: A filter and series-pass transistor are located on a meter panel behind the station's lower rear cover, to the left. The fuse is mounted behind the station's lower front cover, to the right.

2.28 DC REGULATOR - The circuits on this card regulate the 12- and 120-volt inputs received from the chopper power supply card. The regulated d-c outputs drive the following circuits:

- 120 M: Capacitance and resistance measuring circuits on Card 001558.
- ±12 M: IC logic and transistor circuits on Card 001485; resistance measuring circuit on Card 001558.
- +12 L: IC logic circuits on Cards 001483 and 001492; transistor circuits on Card 001494.
- 12 L: IC logic circuits on Cards

001483 and 001492; loop-pulsing relay on Card 001561.

All voltages followed by the letter "M" are referenced to AN COM. Those followed by the letter "L" are referenced to ground (GND).

3. TROUBLE SHOOTING PROCEDURES

3.01 The following paragraphs provide troubleshooting procedures for the CL612A System and are supplemented by the periodic checks and adjustment procedures in Paragraph 4 of this practice. With the exception of relays, no attempt is made to trace trouble to an individual component, but only to the plug-in cards. Several troubleshooting aids have been incorporated into the system to facilitate trouble isolation. Thus with a set of replacement cards (see Paragraph 5) and with a minimum of test equipment and tools, the maintenance personnel should have little difficulty in diagnosing a system problem. Card substitution then will allow rapid restoration of service.

3.02 TEST EQUIPMENT AND TOOLS REQUIRED -

Table 1 lists the test equipment and tools required for troubleshooting and servicing the system. Where possible, the table lists the recommended manufacturer's designation and application of each item.

TABLE 1
TEST EQUIPMENT AND TOOLS
REQUIRED FOR TROUBLESHOOTING

Name	Manufacturer's Designation	Application
Multi-range DC Voltmeter having sensitivity of 20,000 ohms/volt	Simpson Model 260 or equivalent*	Voltage measurement
High-impedance Headset (with series resistance of 24 k Ω)	Badger 001546 or equivalent*	Signal tracing
1/16-inch screw-driver	*	Potentiometer adjustment
Card Extenders	Badger 001261	Cards' component access

*A test kit, Badger 001546, is available from the factory. The kit contains a VOM, a 24 k Ω headset, adjustment tools, test cords and connectors.

3.03 TROUBLE ISOLATION - Basically, the CL612A System can be broken into a number of subsystems, allowing fast and direct decisions to be made regarding the location of trouble. The subsystems are identified in Figure 6, together with their reference paragraphs in this practice. Before attempting to trace a trouble to one of the subsystems, it is advisable first to determine in which part of the system the fault lies. Is the remote station malfunctioning, or the master station? If there are several remote stations in the system, access them and observe their responses (if any); a problem experienced with just one of them indicates a fault at that station. The same abnormal response from all remote stations, however, points to the master station as the source of trouble.

3.04 MASTER STATION TROUBLESHOOTING -

Where applicable, each subsystem associated with the master station is represented by a block diagram. Each section of these diagrams is analyzed, block by block, until the trouble is reduced to a card or relay. (The procedures assume prior removal of the master station's rear cover, card-retaining bar, and protective metal strip covering the terminal blocks and fuse.) Before substituting any cards or relays, however, measure all power supply voltages (Para. 3.10). If voltage measurement and subsequent component substitution fail to disclose the source of trouble, check the contacts of the pushbuttons on the appropriate console keyboard, making sure that they are operating properly.

CAUTION

Never remove or insert cards while power is applied; always remove the fuse first.

3.05 CODE CHANNEL - Figure 7 is a block diagram of the components comprising the master station's code

channel. The procedure for troubleshooting this section is as follows:

1. On the console's lower keyboard, press the SYSTEM CHK pushbutton. Then, in sequence, press the RING DC VOLTS, LOOP LO OHMS, LOOP HI OHMS, and TIP CAPACITANCE push-buttons. Repeat for several remote stations. If no meter response is obtained from any of the remote stations, continue with the following steps, keeping the SYSTEM CHK pushbutton pressed.
2. Check that the code transmitter's carrier level is adequate. If necessary, readjust the GAIN potentiometer. Should there be no transmitter carrier, substitute (if possible) Cards 001450, 001557 and 001447, one at a time, to locate the trouble. After each substitution, check for carrier level. If substitution isolates the faulty card, recheck the system for proper operation. If the fault still exists, proceed with step 3.
3. Check the setting of the security switches. If incorrectly set and resetting clears the trouble, recheck the system. Continue with step 4 if the failure still persists.
4. Connect a headset between TB2-1 (tip) and TB2-2 (ring) at the rear of the master station, then repeat step 1. Listen for a modulated carrier; i.e., a warbled, or fluctuating, 2805 Hz tone:
 - a. If an unwarbled tone is heard, proceed with step 5.
 - b. If the tone heard is warbled, proceed with step 6.
5. Connect the headset between the 001445 Scanner's C and GND test points, then between E and GND. Rhythmic patterns of clicks

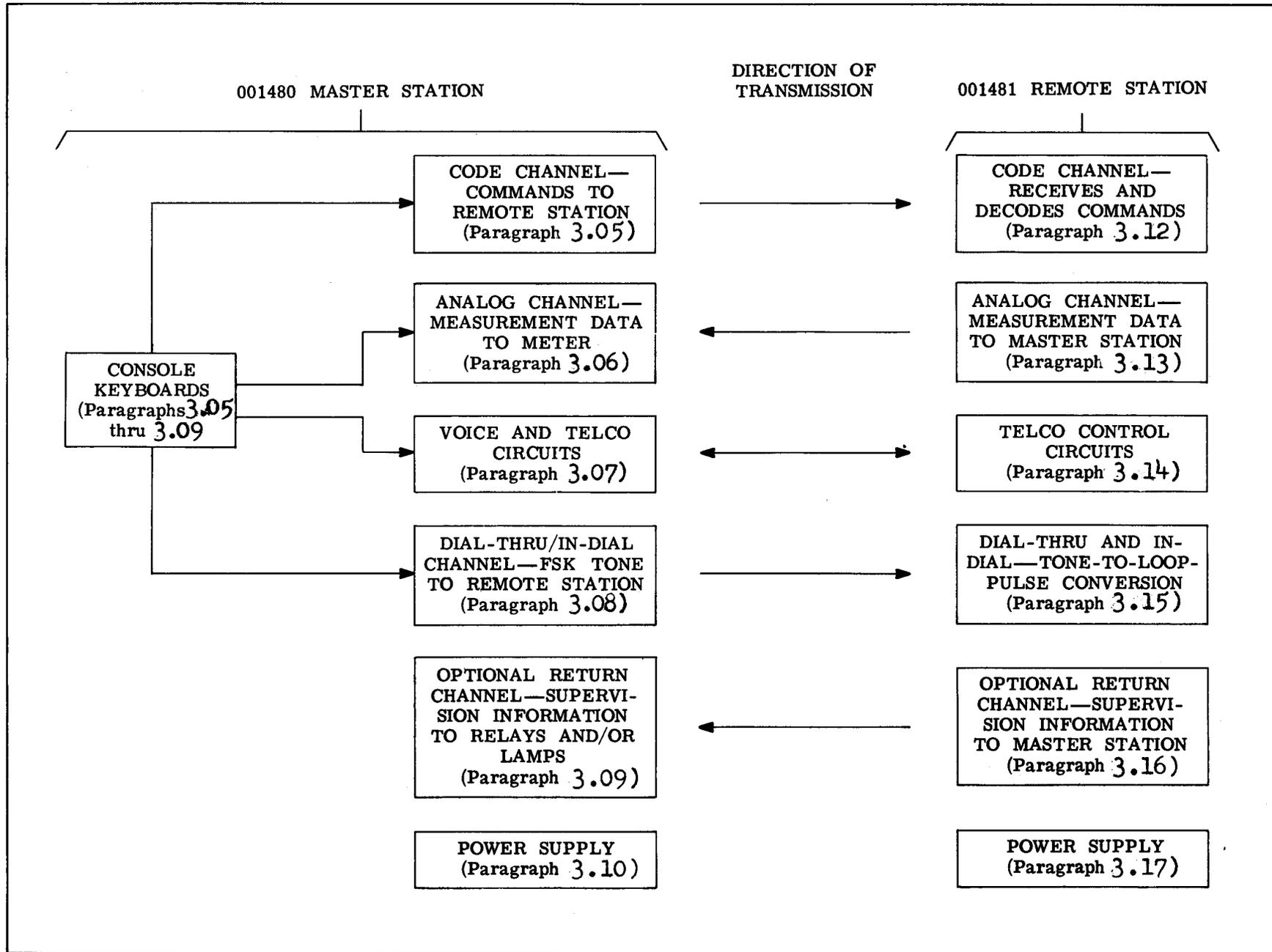


Figure 6 - Diagnostic Block Diagram of CL612A's Subsystems, with Textual References

indicate satisfactory scanner operation, and thus code transmitter failure; replace Card 001450. Absence of clicks points to a faulty scanner; replace Card 001445.

6. Using a 20,000 ohm/volt d-c voltmeter, check the scanner inputs for proper coding, as described in Table 2. Make the measurements at the indicated d-c test points on the two matrix cards (001557 and 001447), referencing each measurement to GND. (See the typical voltmeter connection in Fig. 7.) A reading of +0.2 to +0.8 VDC represents a logic 0; +3.5 to +5 VDC, a logic 1. Make certain that on the console the correct pushbutton is pressed. Improper readings indicate replacement of Card 001557 or Card 001447.

3.06 ANALOG CHANNEL - The procedure for troubleshooting the analog channel components is as follows, and is referenced to Figure 8:

1. Connect a headset between TB2-1 (tip) and TB2-2 (ring) at the rear of the master station.
2. On the console's lower keyboard, initiate a SYSTEM CHK measurement. (Refer to step 1 of paragraph 3.05.) Listen in the headset for the initial 2805 Hz carrier signal from the code transmitter, followed, after one or two seconds, by another carrier signal of 2125 Hz. The second signal is the analog measurement returned from the remote station for driving the console meter.
 - a. If signals are heard, but no meter deflection occurs, check or substitute relay K3 on the motherboard. (Figure 9) Also,

check for adequate carrier at the analog receiver, readjusting, if necessary, the receiver's GAIN potentiometer. If the level is satisfactory, proceed with step 3.

- b. If neither signal is heard, check that the code channel is working properly. (Refer to paragraph 3.05.)
 - c. If only the code transmitter's signal is heard, the return signal being absent, refer to the remote station troubleshooting procedures beginning with paragraph 3.11.
3. Connect the headset between test points G and GND on the analog receiver and listen for low-frequency clicks. If no clicks are heard, but the analog carrier is present and of sufficient level, the receiver is not enabled.
 4. Since electronic interlocking circuits on the two keyboard matrix cards (001557 and 001447) generate the enabling signal, it will be necessary to substitute each of these cards with a spare in order to determine the source of the problem.
 5. If, after card substitution, meter deflection still is not obtained, plug in a spare receiver card (001476). Continued absence of deflection then indicates a possibly defective meter.

3.07 VOICE AND TELCO CIRCUITS - Card 001559 is the focal point of control for the console's rotary dial and tone pad, the telco handset and optional MF tone signaling pad. (See Fig. 10) Various relays on the card provide circuit-switching in response to related pushbutton operations at the console. The relays and circuits can be checked as follows:

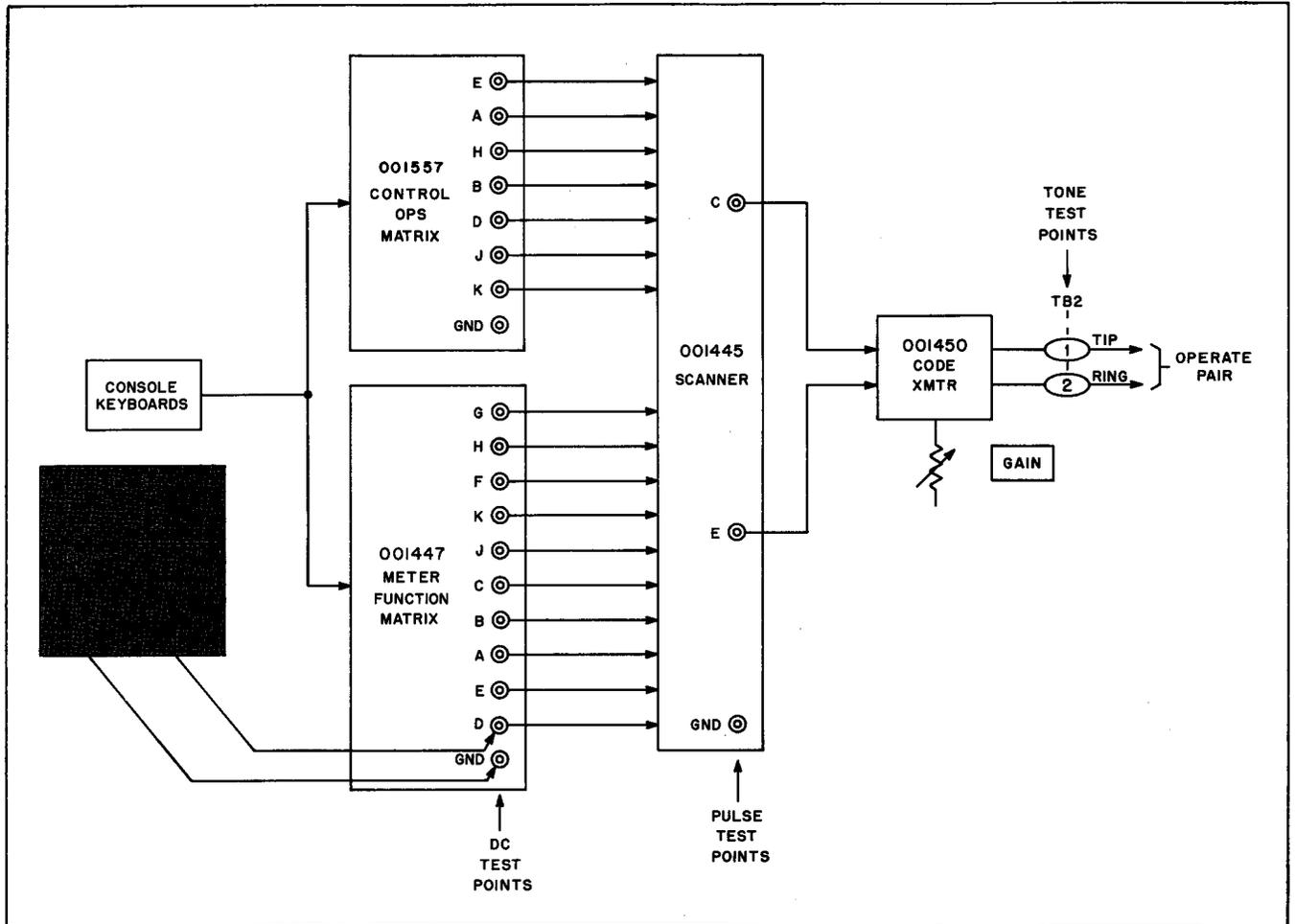


Figure 7 - Block Diagram of Components Comprising Master Station's Code Channel

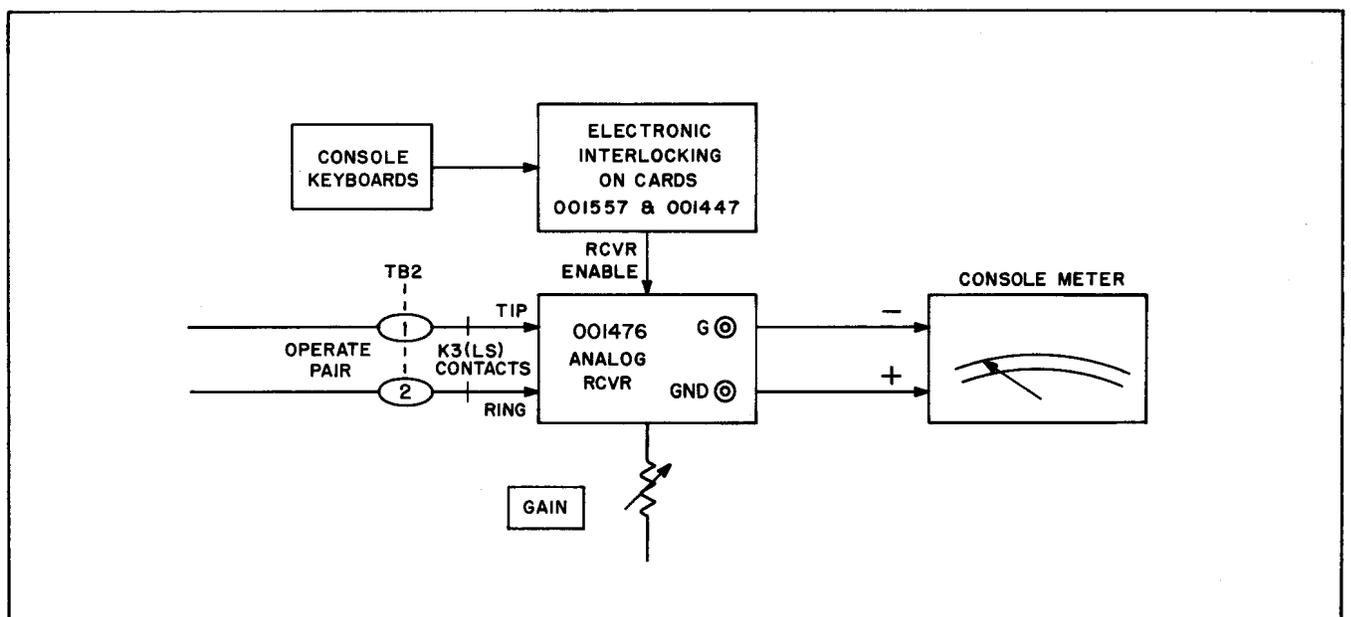


Figure 8 - Block Diagram of Components Comprising Master Station's Analog Channel

TABLE 2
 PUSHBUTTON OPERATION VS CORRESPONDING CODING STRUCTURE

Pushbutton Operated		Code Generated at 001557 Test Points						Code Generated at 001447 Test Points						Pushbutton Operated		Code Generated at 001557 Test Points						Code Generated at 001447 Test Points														
		E	A	H	D	B	K	J	G	H	F	K	J			C	B	A	E	D	E	A	H	D	B	K	J	G	H	F	K	J	C	B	A	E
DC VOLTS	SLEEVE	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	RING 1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0		
	RING	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	RING 2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0		
	TIP	0	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	RING 3	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0		
	LOOP	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	RING 4	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0		
AC VOLTS	RING	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	RING 5	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0			
	TIP	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	HWL	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0			
LO OHMS	RING	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	DIAL THRU	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0			
	TIP	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	TONE SIG	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0			
	LOOP	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	METER REV	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0			
HI OHMS	RING	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	SYSTEM CHK	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0			
	TIP	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	IN-DIAL (with BCO/3WO and DIAL TONE)	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0			
	LOOP	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	DIAL TONE	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0			
CAPACITANCE	RING	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	CONT 1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0			
	TIP	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	CONT 2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0			
	LOOP	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	CONT 3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0			
MON		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	CONT 4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0		
TALK		0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	CONT 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
PERM REL		0	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	CONT 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
BCO/3WO		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
CC		0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0																			
CR		0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0																			

NOTE: Control 7 is not assigned a test point. To check it, place Card 001447 in a 001261 Card Extender, plug the extender into the card's position in the card cage, press pushbutton CONT 7, and then check for a logic 1 (+3.5 to +5 VDC) at pin A13 on the extender. The reference is GND.

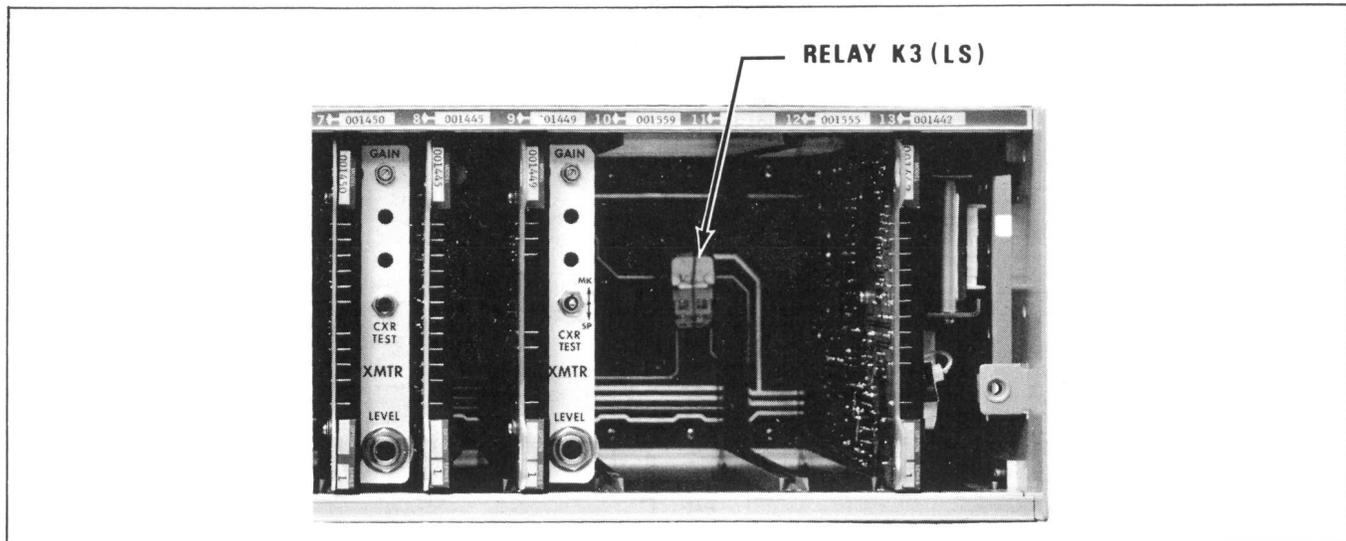


Figure 9 - Relay K3 (LS)

1. Making a local telephone call quickly determines if the voice transmitting and receiving circuits are functioning. If the operate pair is on a connector number:
 - a. On the console press pushbutton TK to activate the handset, then press HK. (All other pushbuttons must be unoperated.) If dial tone is heard, the receiving circuit is operating properly.
 - b. Dial the operator. If a conversation can be held, the transmitting circuit is working.
 2. If trouble is experienced with either of the above circuits, check or change the associated relays shown in Figure 10. Also, refer to the relay actuation table at the end of this procedure. The location and designation of all the relays are shown in Figure 11. Part numbers for all relays are listed in Paragraph 5 of this practice.
 3. If the voice circuits check satisfactorily, but the tone pad is inoperative:
 - a. Check or replace relay K1.
 - b. Check for 48-volt output at the power supply. If the 001443 AC Power Supply is provided, measure between its test points E (-) and GND (+). If the 001442 DC Power Supply is used, measure between its test points K (-) and GND (+).
 - c. Check or replace the tone pad. (Factory assistance may be required.)
 4. If the test operator experiences loop failure during DIAL THRU or IN-DIAL operation, check or replace relays K3, K5 and K6 and pushbutton HK.

NOTE: Relay K6 also controls actuation and modulation of the dial-thru transmitter. (Refer to paragraph 3.08.)
 5. If excessive code-channel carrier or modulation is heard during operation of any pushbutton other than TK or HK, the 001555 Band Stop Filter Card should be replaced.
- Table 3 lists the conditions under which each of the relays on Card 001559 is energized.

3.08 DIAL-THRU/IN-DIAL CHANNEL - Figure 12 shows the cards involved in dial-thru and in-dial operation. Follow this procedure when troubleshooting:

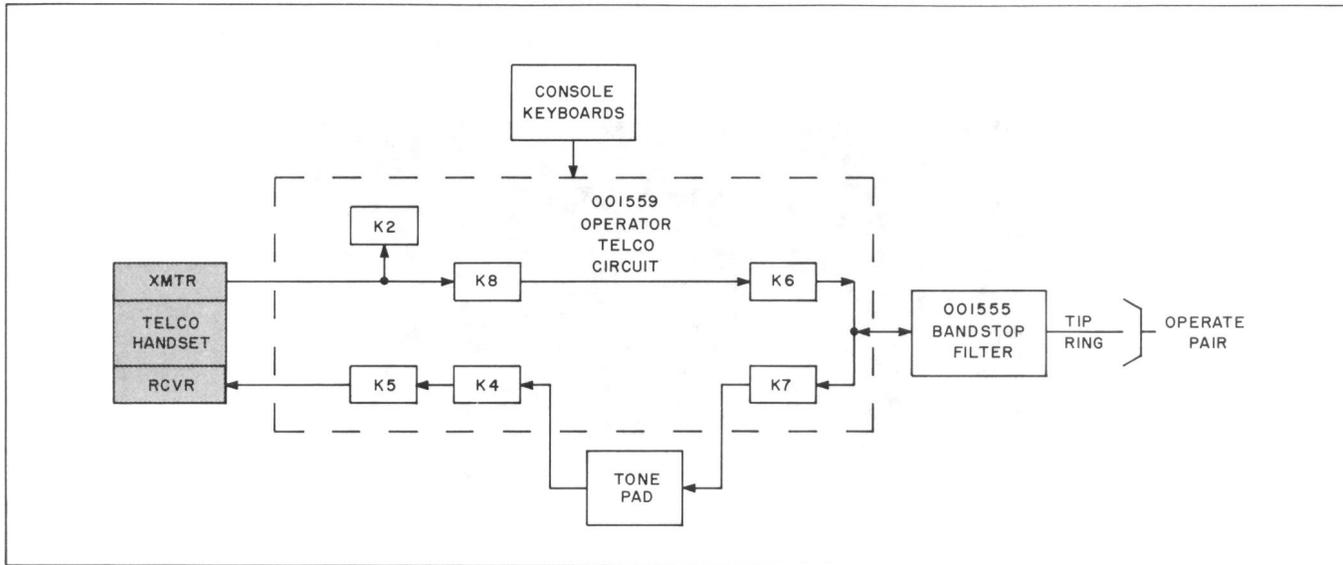


Figure 10 -Block Diagram of Components Comprising Master Station's Voice and Telco Circuits

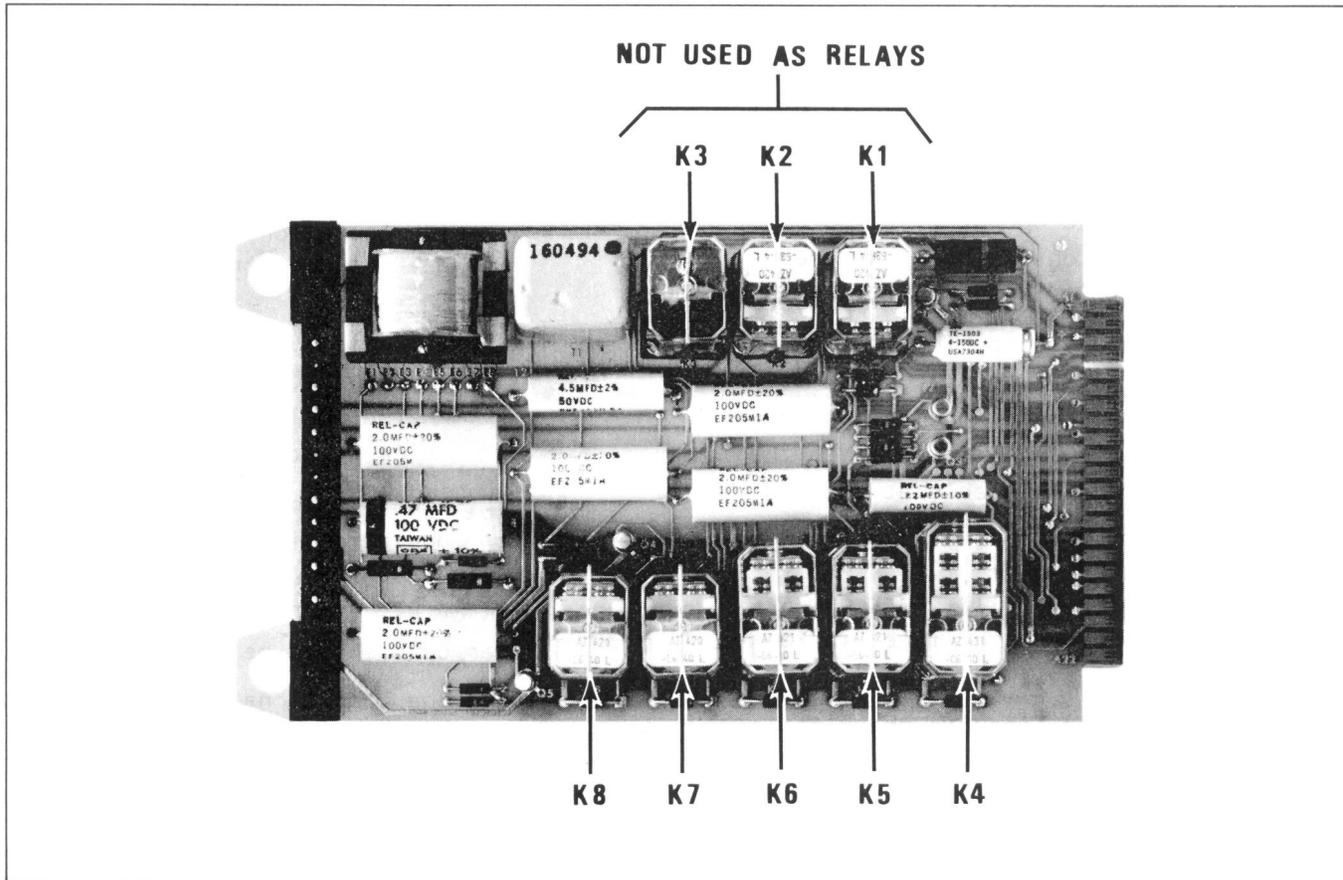


Figure 11 - Card 001559—Component Arrangement

TABLE 3
CARD 001559
RELAY ACTUATION CONDITIONS

Relay	Conditions for Actuation
K1	Any tone pad button pressed
K2	Carbon-button transmitter plugged into handset jack
K3	Used as coil only—no armature
K4	TONE SIG pushbutton pressed
K5 & K6	(a) DIAL THRU pushbutton pressed (b) BCO/3WO, DIAL TONE and IN-DIAL pushbuttons pressed
K7 & K8	TK pushbutton pressed—all other pushbuttons reset

NOTE: Some of the above pushbuttons are electronically interlocked.

1. Press the DIAL THRU pushbutton (or IN-DIAL, BCO/3WO and DIAL TONE pushbuttons) on the console.
2. Connect a headset between test points C and GND on the dial-thru transmitter card (001449), listening for a steady tone signal. If there is a tone, the transmitter is operating. Then check or substitute relay K4 on Card 001559 and relay K3 (Fig. 9) on the motherboard. If no tone is heard, perform these steps:
 - a. Check for proper transmitting level. If necessary, readjust the GAIN potentiometer.
 - b. Reset all pushbuttons and operate the CXR TEST switch on the front of the transmitter card to MK (up) and then to SP (down). The transmitter should transmit two tones, Mark and Space, the higher of the two at MK. If it does not, replace it.
3. Repeat step 1 and dial the digit "0" on the console's rotary dial. Listen for two-tone frequency shifting. If shifting occurs, the modulation and dial-control circuits are operational. If shifting does not occur, follow these steps, in the given sequence, until the trouble is located:
 - a. Perform step 2b above to see if the transmitter is at fault.
 - b. Check or change relay K6 on Card 001559 (Figure 11.)
 - c. Substitute Cards 001557 and 001445 (one at a time) with spares. These two cards drive relay K6.

3.09 OPTIONAL RETURN CHANNEL - Since the return channel is used for tone signaling supervision, it is generally not "active" unless prior input-switching at the remote station has actuated the return channel transmitter. (See Figure 24.) The corresponding circuitry involved at the master station is shown in Figure 13, and the troubleshooting procedure is as follows:

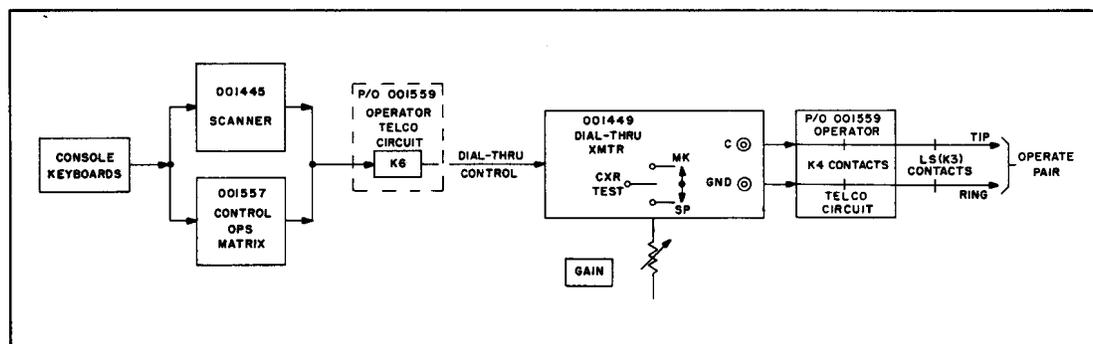


Figure 12 - Block Diagram of Components Comprising Master Station's Dial-Thru/In-Dial Channel

1. Connect a headset between TB2-1 (tip) and TB2-2 (ring) at the rear of the master station.
2. On the console press the TONE SIG pushbutton.
3. Listen in the headset for the initial 2805 Hz carrier signal from the code transmitter, followed several seconds later by another carrier signal about 400 Hz lower in frequency. The second signal is the return channel tone returned from the remote station, and can be either a Mark or a Space. If this tone is present, the return channel receiver should actuate relay K1 (CP) and, if the tone is a Space, relay K2 (FR). If supervision lamps have been provided on the console, they should light. The relays (Fig. 14) are inside the console, on the right side near the front. By listening carefully you can hear them when they energize. Alternatively, connect an ohmmeter

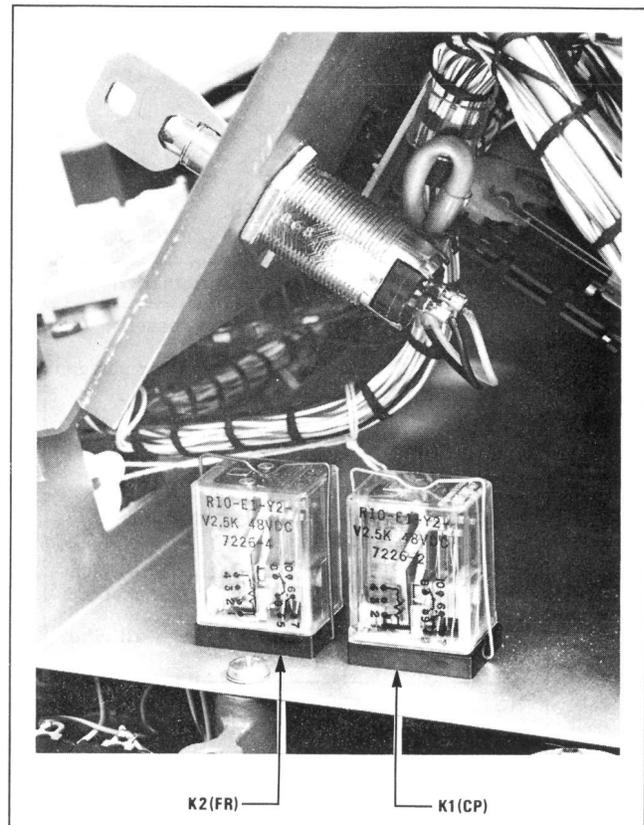


Figure 14 - Supervision Relays, K1 (CP) and K2 (FR)

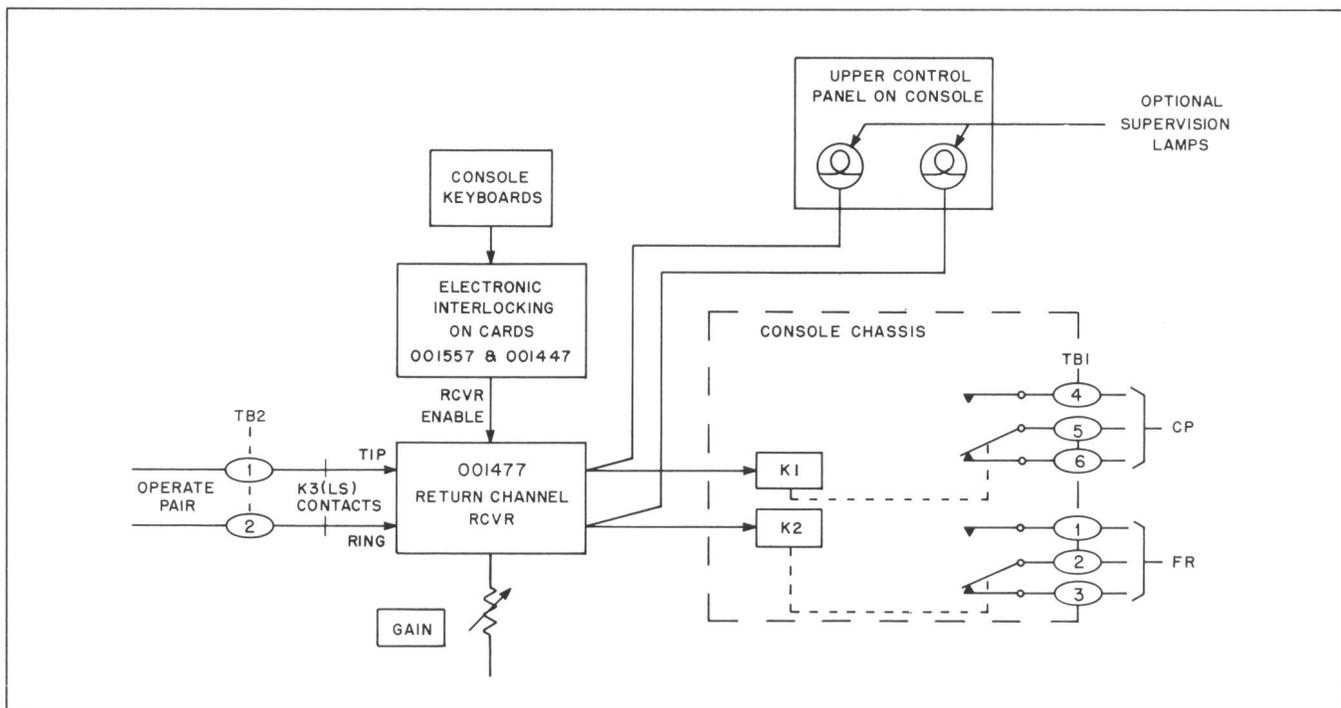


Figure 13 - Block Diagram of Components Comprising Master Station's Optional Return Channel

across their contacts, which terminate at TB1 on the rear of the console.

4. If the tone is being received but the relays or lamps are not actuated, follow these steps, in the given sequence, until the trouble is found:
 - a. Check or substitute relay K3 (Figure 9) on the motherboard.
 - b. Check for proper receiving level. If necessary, readjust the GAIN potentiometer.
 - c. Substitute Card 001477 with a spare, again checking for relay or lamp operation.
 - d. Substitute a spare for Cards 001557 and 001447, one card at a time.
 - e. If step c does not solve the problem, check or replace the relays or lamps. (Relay replacement requires removal of the station's plastic cover, but lamp replacement further necessitates elevation of the subpanel.

3.10 POWER SUPPLY - If trouble is suspected in the power supply, these preliminary checks can be made and may prevent unnecessary troubleshooting:

1. Turning the console's turnkey 90 degrees to the right should cause the associated PWR lamp to light. If it does not, check:
 - a. The 115 VAC wall outlet or the 48 VDC input at terminals 11 (-) and 12 (+) of TB2 at the rear of the station.
 - b. Fuse F1, which is near TB2.
2. If the PWR lamp does light, check the individual power supply outputs. Refer to paragraph 4.04 for power supply test points and voltage tolerances, and to paragraphs 2.13 and 2.14 for power distribution.

3.11 REMOTE STATION TROUBLESHOOTING -

Like the master station, the remote station can be separated into sections to facilitate troubleshooting. Each section is analyzed individually in accordance with the block diagram accompanying it. In this way, a trouble ultimately can be traced to the malfunctioning card or relay. (The procedures assume removal of the remote station's two front covers.) Prior to card or relay substitution, however, measure all power supply voltages (paragraph 3.17).

CAUTION

Never remove or insert cards while power is applied; always remove the fuse first.

3.12 CODE CHANNEL - Figure 15 is a block diagram of the circuits that comprise the remote station's code channel, and the relays they drive. The procedure for troubleshooting this section is as follows:

1. Connect a headset between test points D (or E) and GND on the 001483 Code Receiver Card. If a rhythmic clicking is heard, the receiver has sufficient carrier level and is delivering information to the receiver logic and buffer card; in which case, proceed with step 2. If clicking is not heard:
 - a. Connect the headset between terminals 9 (OPR T) and 8 (OPR R) on TBD at the back of the station. (It will be necessary to remove the upper rear cover.) Listen for a modulated tone - warbled, or fluctuating.
 - b. Check for adequate carrier level. If necessary, readjust the GAIN potentiometer.
 - c. If the carrier level is satisfactory and modulation is present, replace the receiver card.

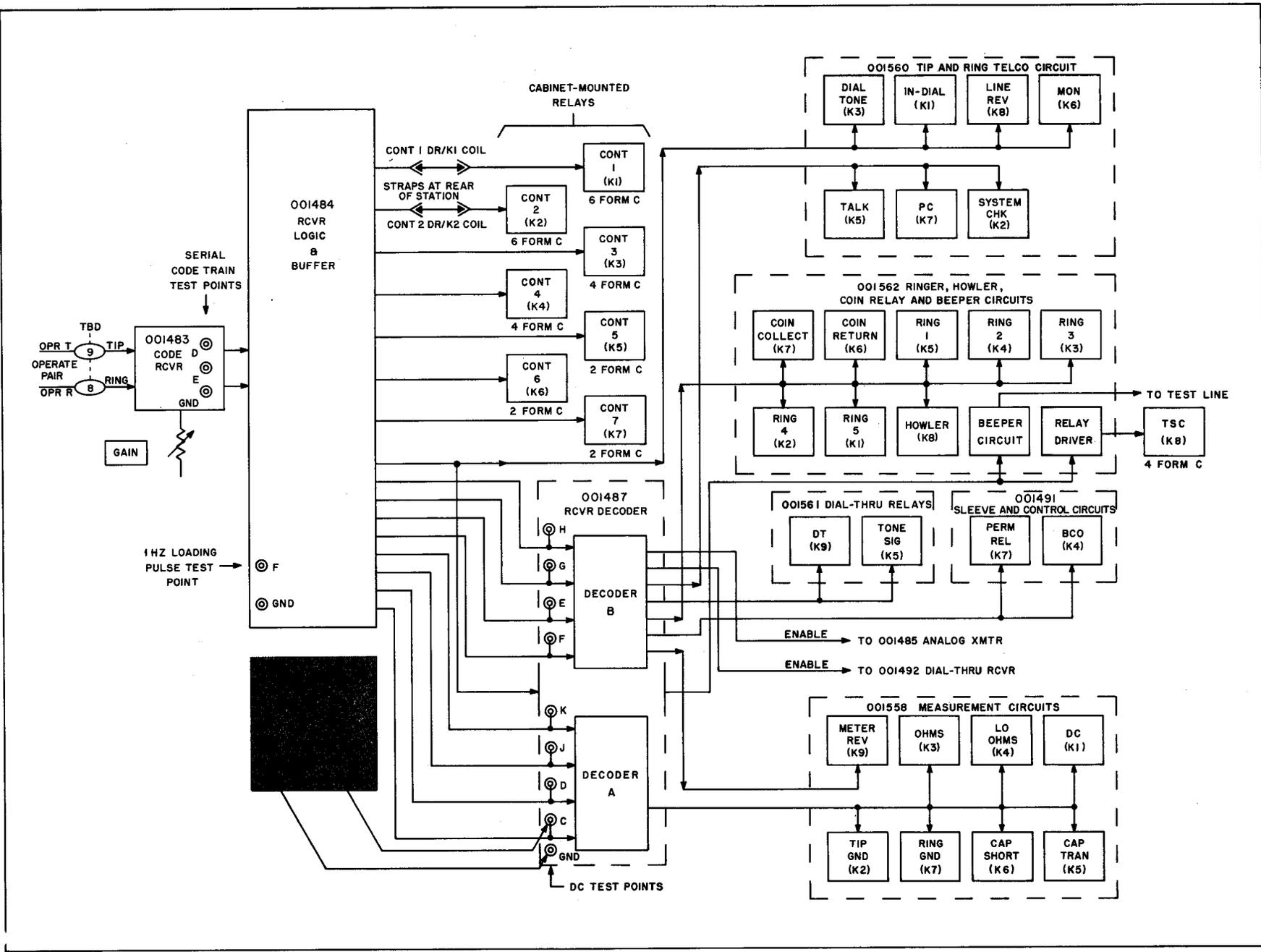


Figure 15 - Block Diagram of Components Comprising Remote Station's Code Channel

2. Connect the headset between test points F and GND on Card 001484, listening for clicks occurring at a rate of one each second (1 Hz). If this signal is present, go to step 3, for the card is loading information into its buffer. (The buffer drives control relays 1 through 7 and supplies information to the receiver decoder.) If the signal is absent, replace Card 001484.
3. If the buffer is loading normally and one of the master station's CONT (1-7) pushbuttons is operated, the corresponding control relay (Figure 16) should operate. If it does not:
 - a. Substitute Card 001484 with a spare.
 - b. Check or replace the relay.
 - c. If relay K1 or K2 is involved, check that the appropriate strapping connections have been made on TBL and TBM - located behind the station's lower rear cover.
 - d. Check the security switches (located behind the station's upper rear cover) for proper settings.
4. With the buffer loading normally and with a pushbutton other than CONT 1-7 having been operated, further analysis should be made to determine the exact cause of the trouble - whether it be a relay, a relay driver or a faulty code. This can best be done by using a 20,000 ohm/volt d-c voltmeter to check the coding at the d-c test points on Card 001487 while referring to Figure 15 and to Table 4. Each measurement must be referenced to GND. (See the typical voltmeter connection in the figure.) A reading of +0.2 to +0.8 VDC represents
 - a logic 0; +3.5 to +5 VDC, a logic 1.
5. An example of how a problem might be analyzed is as follows:
 - a. Assume that the ring dc volts measurement is malfunctioning, and that the code leaving the master station has been checked and is correct.
 - b. In Table 4 find the operated pushbutton, in this case RING DC VOLTS, at the master station.
 - c. Observe the corresponding code structure at the test points on Card 001487:

H	G	E	F	K	J	D	C
0	0	0	0	0	1	0	0
 - d. If the above code is incorrect, replace Card 001484. If this does not correct the fault, replace Card 001487.
 - e. If this code is present, see if the proper relays are energized. For the measurement being considered, K5 and K7 on Card 001558 should be energized. The relays can best be checked through substitution. The figures showing the location and function of these and all other card-mounted relays are:

Card 001558:	Figure 17
Card 001560:	Figure 18
Card 001562:	Figure 19
Card 001491:	Figure 20
Card 001561:	Figure 21
 - f. If the trouble remains undiagnosed, refer to the Analog Channel procedure (para. 3.13).

— WARNING —

A potential of 120 VDC is present on Card 001558. Therefore, when working on or near this card, exercise caution to avoid injury.

TABLE 4

CODING STRUCTURE VS RELAY OPERATION

Master Station Pushbutton Operated		Code Generated at 001487 Test Points								Relays Energized	Master Station Pushbutton Operated		Code Generated at 001487 Test Points								Relays Energized
		H	G	E	F	K	J	D	C				H	G	E	F	K	J	D	C	
DC VOLTS	SLEEVE	0	0	0	0	1	1	1	1	001558: K1, K4, K7; 001560: K7	RING 1	0	1	1	1	0	0	0	0	001562: K5; 001560: K7	
	RING	0	0	0	0	0	1	0	0	K1, K7	RING 2	1	0	0	0	0	0	0	0	K4	
	TIP	1	1	1	1	0	0	0	1	K1, K2, K9	RING 3	1	0	0	1	0	0	0	0	K3	
	LOOP	0	0	0	0	0	1	1	1	K1	RING 4	1	0	1	0	0	0	0	0	K2	
AC VOLTS	RING	0	0	0	0	1	0	0	0	K7	RING 5	1	0	1	1	0	0	0	0	K1	
	TIP	0	0	0	0	1	1	0	1	K2	HWL	1	1	0	0	0	0	0	0	001562: K8; 001560: K7	
LO OHMS	RING	0	0	0	0	0	1	0	1	K3, K4, K7	DIAL THRU	1	1	0	1	0	0	0	0	001561: K8, K9	
	TIP	0	0	0	0	0	0	1	0	K2, K3, K4	TONE SIG	1	1	1	0	0	0	0	0	001561: K5, K9	
	LOOP	0	0	0	0	1	1	1	0	K3, K4	METER REV	1	1	1	1	0	0	0	0	001558: K9	
HI OHMS	RING	0	0	0	0	0	1	1	0	K3, K7	SYSTEM CHK	0	0	0	1	0	0	0	0	001560: K2	
	TIP	0	0	0	0	0	0	1	1	K2, K3	IN-DIAL (with BCO/3WO & DIAL TONE)	0 at test point C on 001560								001560: K1; 001561: K4, K8, K9	
	LOOP	0	0	0	0	1	0	0	1	K3	LINE REV	0 at test point F on 001560								001560: K8	
CAPACITANCE	RING	0	0	0	0	1	1	0	0	K5-K8	DIAL TONE	0 at test point A on 001560								001560: K3, K6; Cabinet: K8	
	TIP	0	0	0	0	1	0	1	1	K2, K5, K6, K8											
	LOOP	0	0	0	0	1	0	1	0	001558: K5, K6, K8 001560: K7											
MON		0	0	0	0	0	0	0	0	001560: K6; Cabinet: K8											
TALK		0	0	1	0	0	0	0	0	001560: K4, K5, K7; Cabinet: K8	CONT 1	NOTE Control 1 thru Control 7 are operated by transistor drivers on Card 001484.								Cabinet: K1 (if strapped)	
PERM REL		0	0	1	1	1	1	1	1	001560: K7; 001491: K7 (sleeve ground: K6, K8, K9)	CONT 2									Cabinet: K2 (if strapped)	
BCO/3WO		0	1	0	0	0	0	0	0	001491: K4	CONT 3									K3	
CC		0	1	0	1	0	1	0	0	001562: K7; 001558: K1, K7, K9; 001560: K7	CONT 4									K4	
CR		0	1	1	0	0	1	0	0	001562: K6; 001558: K1, K7	CONT 5									K5	
										CONT 6	K6										
										CONT 7	K7										

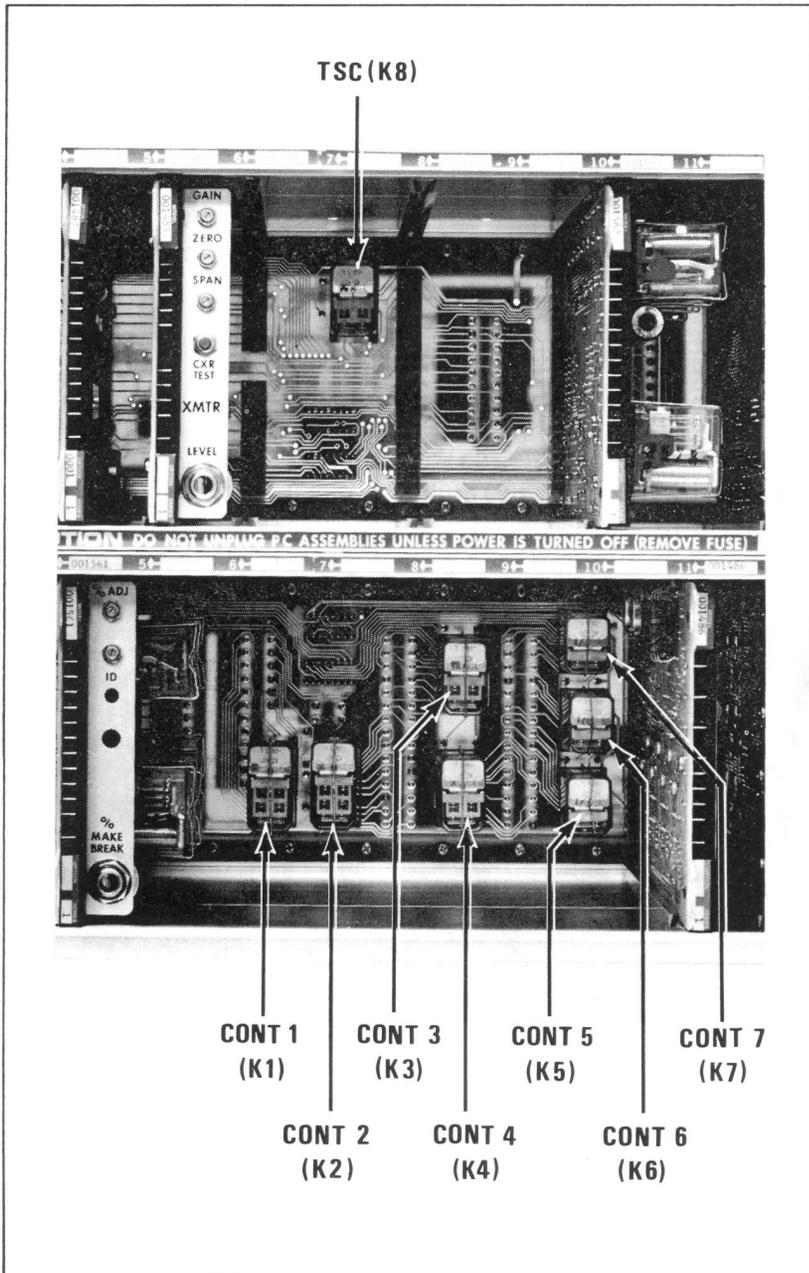


Figure 16 - Control Relays K1 (CONT 1) thru K7 (CONT 7) and K8 (TSC)

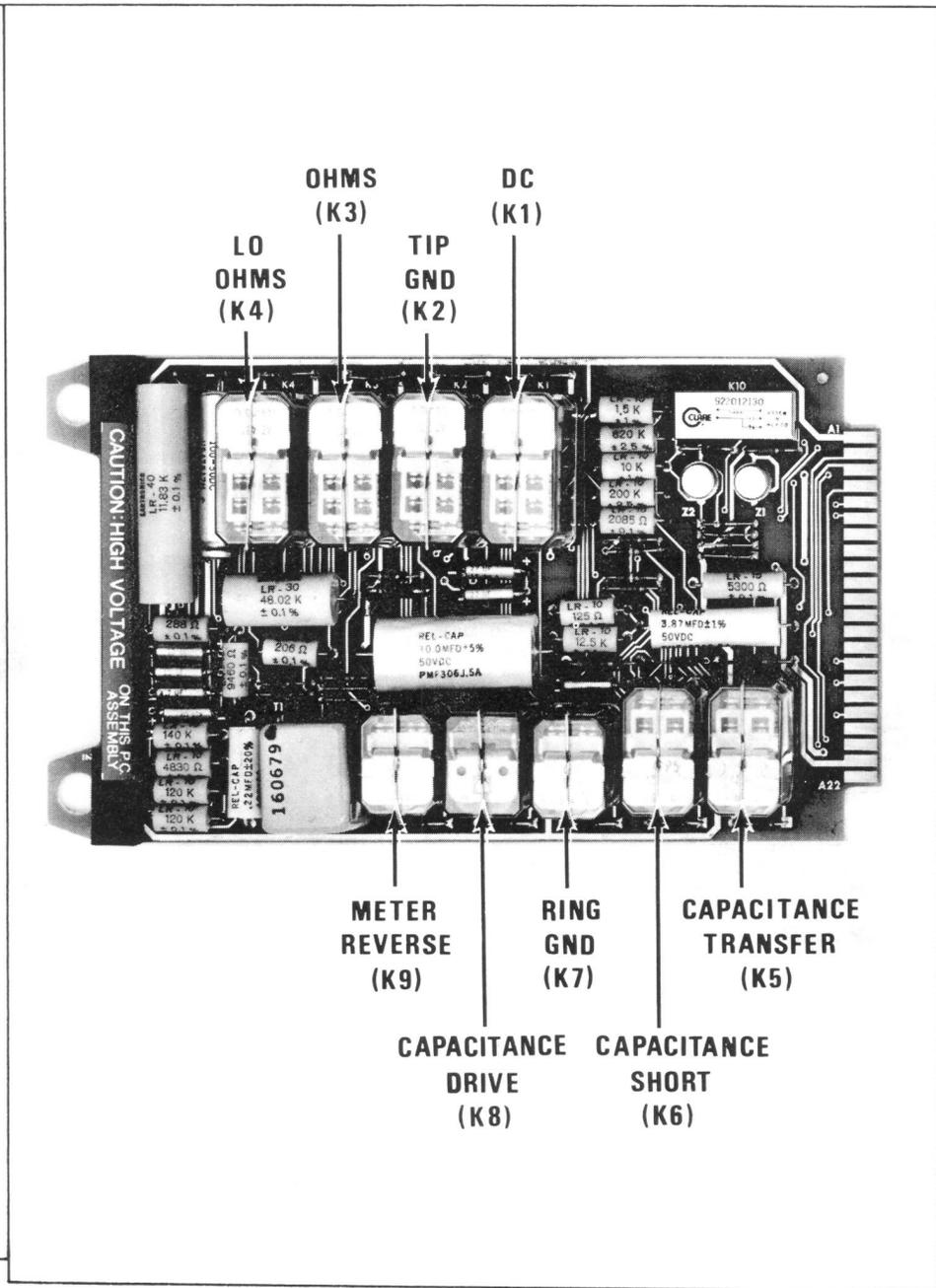


Figure 17 - Card 001558—Component Arrangement

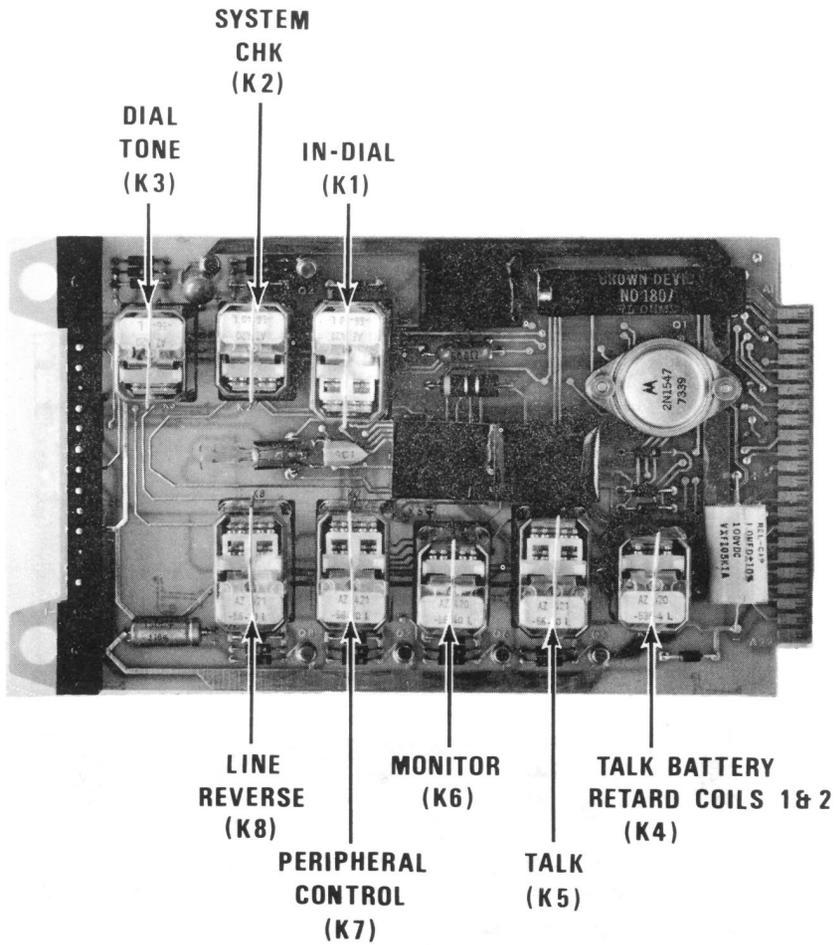


Figure 18 - Card 001560—Component Arrangement

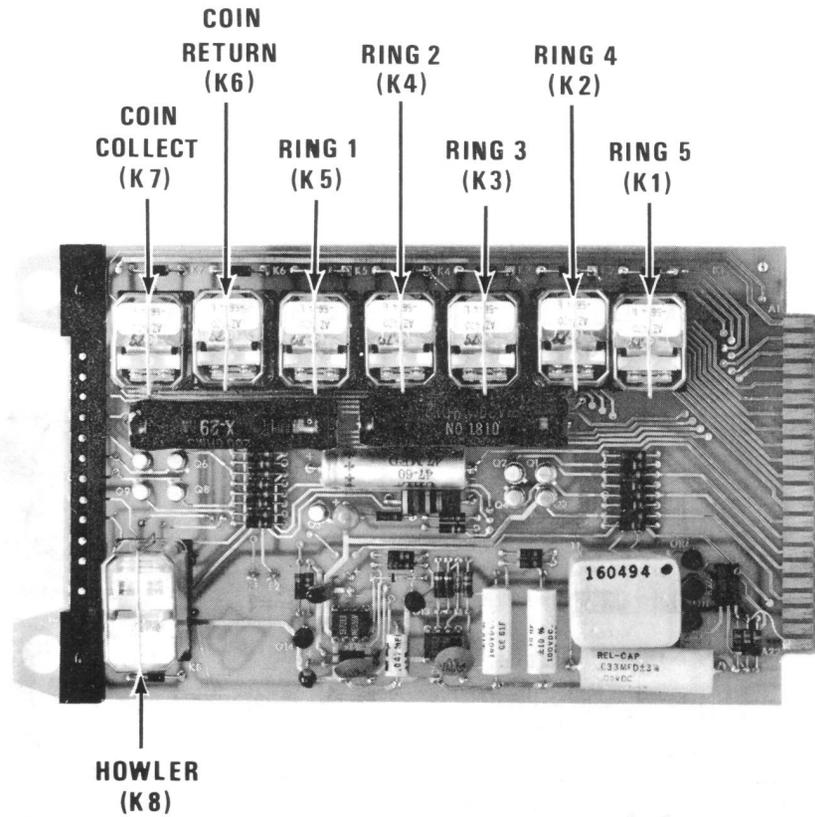


Figure 19 - Card 001562—Component Arrangement

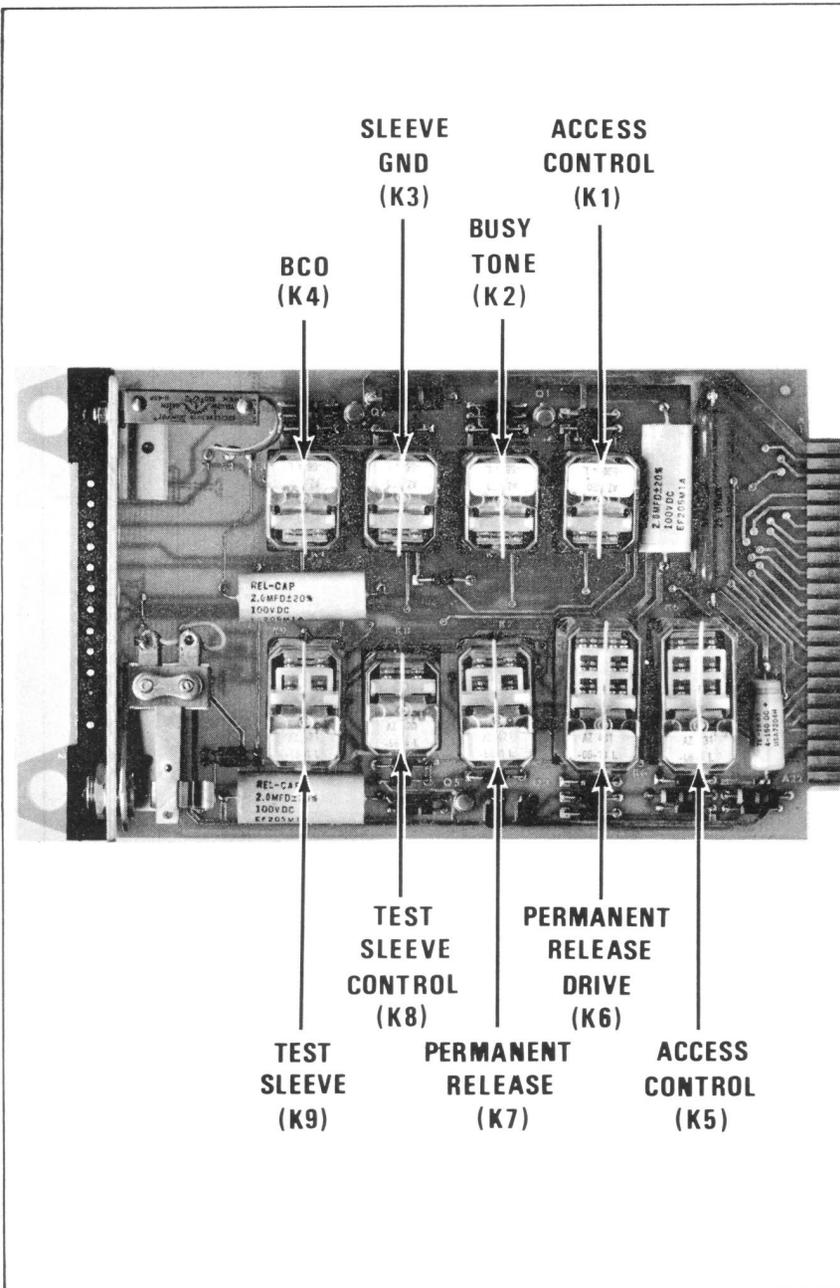


Figure 20 - Card 001491—Component Arrangement

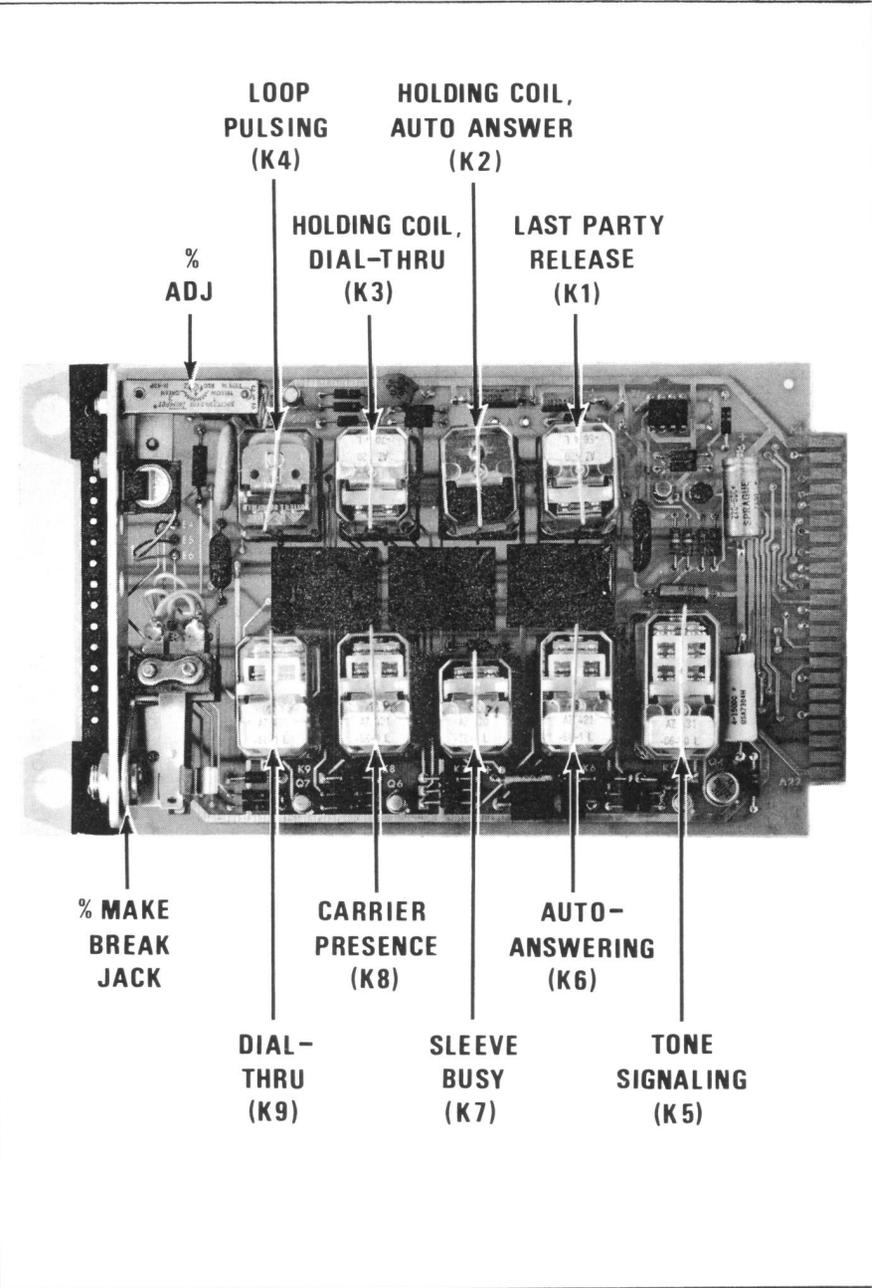


Figure 21 - Card 001561—Component Arrangement

3.13 ANALOG CHANNEL - The analog channel is used to send measured data to the master station for display on the meter. If it has been determined that the code channel is working satisfactorily, then the 001485 Analog Transmitter should be examined for possible failure. The procedure for troubleshooting the transmitter is as follows, and is referenced to Figure 22:

1. Make certain that the master station has no pushbuttons operated.
2. On the transmitter, connect one lead of a headset to test point AN COM. Then connect the other lead to test points:
 - D, checking for clicking at approximately 100 pps.
 - E, checking for clicking at approximately 2 pps.
 - C, listening for a 4250 Hz tone.
 - A, listening for a 2125 Hz tone after pressing the CXR TEST pushbutton.
3. If any of these four signals is not present, replace the transmitter.

4. If all four signals are heard, connect the headset between terminals 9 (OPR T) and 8 (OPR R) on TBD at the back of the station. (It will be necessary to remove the upper rear cover.)
5. Again press the CXR TEST pushbutton. Listen for a 2125 Hz tone. If none is heard:
 - a. Check or substitute relay K8 on the motherboard. (See Fig. 16).
 - b. Check the carrier level. Re-adjust the GAIN potentiometer if necessary.
 - c. Replace the transmitter (Card 001485) with a spare. If carrier still is not heard, substitute Card 001487 with a spare. The latter generates the "transmitter enable" signal.
 - d. As a final check, substitute a spare for Card 001558. If still no tone, the incoming telco circuits from the master station may be faulty.

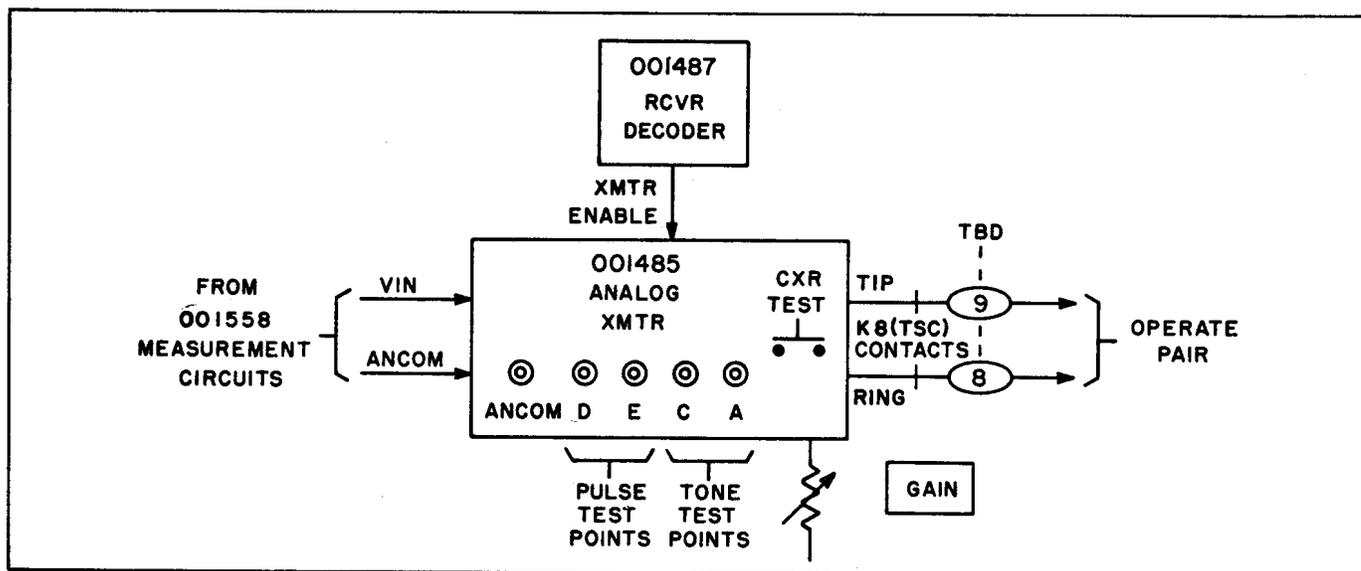


Figure 22 - Block Diagram of Components Comprising Remote Station's Analog Channel

3.14 TELCO CONTROL CIRCUITS - Three cards - 001560, 001562,

and 001491 - are associated with the telco control circuits. (The cards and their relays are shown in Figures 18 thru 20.) The particular card and relay suspected of having malfunctioned may be located by using Table 4 and the three figures. Generally, if the code is correct and the relay does not energize, suspect the relay or its driver. Or if the proper relays are energized, but the proper response is not obtained, suspect the relay contacts or the discrete components on the card. Some of the relays on Cards 001560 and 001491, however, are not driven by codes from the receiver decoder. These, together with their functions, are listed in Table 5 and shown in Figures 18 and 20. Also located on Card 001560 is the current-limiting circuit used with the "permanent release" function. Any problem related to this function warrants substitution of the card.

3.15 DIAL-THRU/IN-DIAL CHANNEL - Dial-thru and in-dial operations share circuitry of the 001492 Dial-Thru Receiver and 001561 Dial-Thru Relay Cards. The pertinent circuits are shown in

the block diagram of Figure 23. Follow this procedure when troubleshooting:

1. Connect a headset between test points E and GND on Card 001492, listening for a tone signal of approximately 1600 Hz. (The master station's DIAL THRU pushbutton must be pressed.) If the signal is not heard:
 - a. Remove the remote station's two rear covers and check that

TABLE 5
TELCO CONTROL RELAYS AND
THEIR FUNCTIONS

Relay Designation	Function
Card 001560	
K4	Talk battery retard coil
Card 001491	
K2 & K5	Access Control
K1	Access control line relay
K3	Sleeve control
K6 K8 K9	Permanent release, if sleeve is grounded.

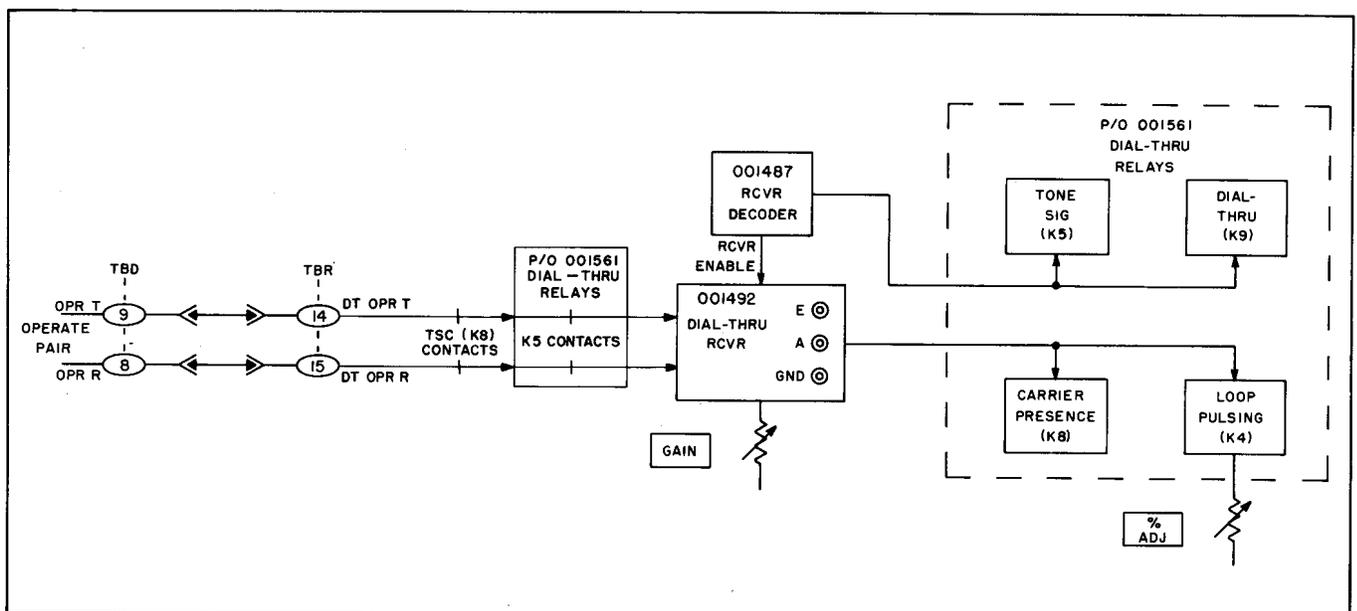


Figure 23 - Block Diagram of Components Comprising Remote Station's Dial-Thru/In-Dial Channel

straps have been connected between TBD-9 and TBR-14 and between TBD-8 and TBR-15.

These connect the input terminals of the receiver to the tip and ring leads of the remote station's operate pair.

- b. Connect the headset between TBR-14 and TBR-15, again listening for the tone signal. If the tone is present, check that its level is adequate, readjusting the GAIN potentiometer if necessary.
 - c. If the tone level is normal, check or substitute relay K5 on card 001561 and relay K8 (Figure 16) on the motherboard. If still no signal is heard at test point E, replace Card 001492.
2. If tone is heard at test point E, have the master station's rotary dial operated. You should then hear modulation in the form of two-tone (Mark-Space) shifting.
 3. Connect the headset between test points A and GND, listening for clicking at the dial pulse frequency when the master station's dial is operated. If clicking is not heard, substitute Cards 001492 and 001487 with spares to determine which is at fault.
 4. If the above checks are satisfactory, remove Card 001561 from the card cage, place it in a 001261 Card Extender, and insert the extender into the card cage. Then check the operation of the following relays (see Fig. 21):
 - a. K4 should 'follow' the master station's dial pulses, generated when the rotary dial is operated. If it does not,

replace it. (It may be necessary to adjust the % make-break of the loop pulses.)

- b. K8 should respond to the presence of dial-thru carrier. If it does not, but the incoming carrier level is adequate, replace it. (Also, it may be necessary to check or to change the setting of the carrier presence threshold.)
 - c. K9 should respond to the dial-thru code generated in the code channel (see Table 4). If K9 fails to energize, the problem may be with Card 001487 or with the relay itself.
5. If replacement or substitution at step 4 fails to reveal the source of the problem, suspect the discrete components on Card 001561; substitution should then rectify the problem.

Several relays on Card 001561 are only indirectly involved with dial-thru operation. Table 6 lists these relays and their functions. See Figure 21 for their location.

TABLE 6
RELAYS INDIRECTLY
INVOLVED IN DIAL-THRU OPERATION

Relay Designation	Function
K1	Last-party-release loop switching—operates for 1 second after 2805 Hz code channel tone has been removed from line for about 10 seconds.
K2	Holding coil for dial-thru automatic answering
K3	Holding coil for dial-thru output
K5	Tone signaling applications; operates on incoming TONE SIG code
K6	Automatic answering for dial-thru; operates on incoming sleeve ground
K7	Sleeve-checking of test selector

3.16 OPTIONAL RETURN CHANNEL - The optional 001494 Return Channel Transmitter is used in tone signaling applications to send "supervision" information to the master station. As shown in Figure 24, terminals 8 and 9 of TBF must be connected into a switching network that provides a ground to the transmitter's RC CONT and RC DRIVE inputs. Ground applied to TBF-9 causes the transmitter to turn on and generate its Mark frequency (2500 Hz); ground applied to TBF-8 switches the frequency to Space (2430 Hz). To troubleshoot the transmitter, follow this procedure:

1. Connect a headset between TBD-8 and TBD-9 on the back of the remote station. (Removal of the upper rear cover is necessary.)
2. With the RC CONT input (TBF-9) alone switched to ground, listen for a 2500 Hz tone; with both TBF-9 and TBF-8 at ground, listen for a tone-shift to 2430 Hz.
3. If neither tone is heard, operate the transmitter's CXR TEST switch to MK, then to SP. If the tones still are not heard:
 - a. Check or substitute relay K8 (Figure 16) on the motherboard.
 - b. Substitute Cards 001562, 001487

and 001484, one at a time, with a spare.

- c. Check that the transmitter's output level is set properly. It may be necessary to readjust the GAIN potentiometer.
- d. Replace the transmitter.

3.17 POWER SUPPLY - To obtain d-c isolation, a chopper power supply is used at the remote station. The supply (Card 001495) operates in conjunction with various d-c regulators (Card 001486). If you suspect a problem in the power supply circuits, make these checks:

WARNING

120 VDC is present on Cards 001486 and 001495. Therefore, use extreme care to avoid injury when working on or near them.

1. Check for 48 VDC input by measuring between terminals 2 (+) and 3 (-) of TB1 at the rear of the remote station. (Removal of the station's lower rear cover is necessary to permit access to the terminal block.)
2. Check fuse F1, which is located at the front of the station, to the

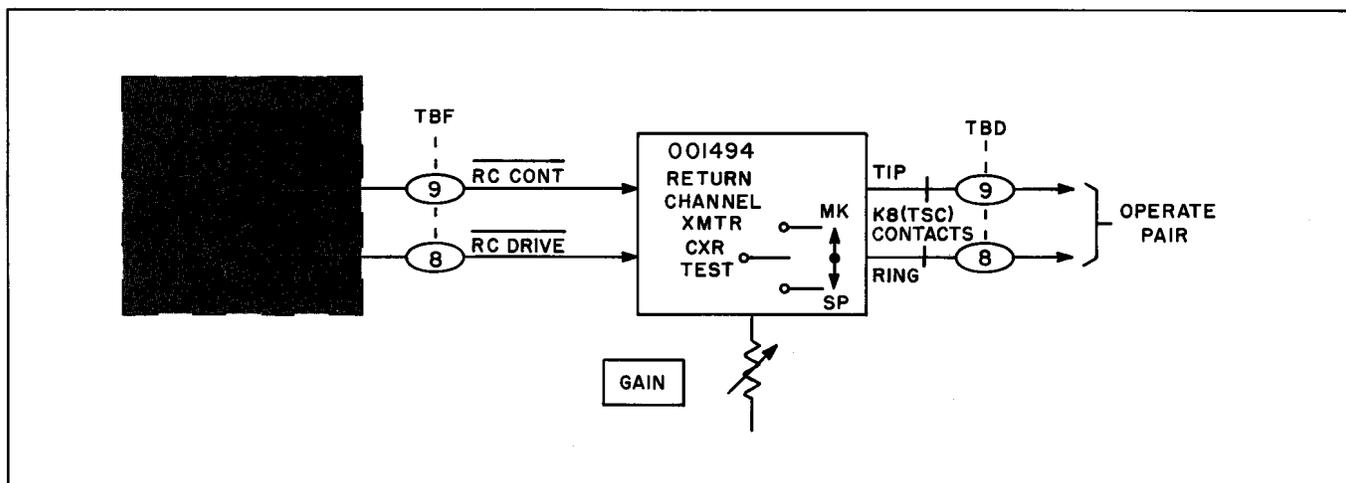


Figure 24 - Block Diagram of Components Comprising Remote Station's Optional Return Channel

right of the cards.

3. If input power is present and the fuse is intact, carefully measure the individual power supply and regulator outputs. For the proper test points to use and the voltages to be measured at them, refer to paragraph 4.04.
4. Should any of the individual output voltages measure abnormal, momentarily remove fuse F1, unplug all cards containing circuits driven by that voltage, re-insert the fuse and recheck the voltage. (Refer to paragraphs 2.27 and 2.28 for power distribution.) Persistence of the abnormal voltage indicates a defective power supply
5. Again remove the fuse, re-insert all cards, replace Cards 001486 and 001495 (both are treated as a unit), then re-insert the fuse. If the problem recurs, factory technical assistance will be required.

4. PERIODIC CHECKS AND ADJUSTMENTS

4.01 The procedures contained in the following paragraphs serve two purposes. Primarily, they describe routine checks and adjustments that should be conducted periodically in order to keep the CL-612A System trouble-free and operating within acceptable tolerances. Secondly, in the event of an equipment malfunction, they provide the troubleshooter with an additional tool that can be used to supplement the troubleshooting procedures in Paragraph 3. Throughout the following paragraphs, it is assumed that the appropriate equipment covers have been removed to allow access to the plug-in cards, which in most of the procedures must be placed in a card extender.

CAUTION

Never remove or insert a card while power is applied; always remove the fuse first.

4.02 TEST EQUIPMENT AND TOOLS REQUIRED -

Table 7 lists the test equipment and tools recommended for checking and adjusting the system. Where applicable, the table gives the recommended manufacturer's designation for each item together with the item's application. Preferably, all test equipment should be battery-operated.

CAUTION

If a-c operated test equipment is used, it should be isolated from ground to prevent possible shorting of the CL-612A.

4.03 CHECK AND ADJUSTMENT PROCEDURES -

Table 8 provides a schedule of recommended checks and adjustments for the system. The listed time intervals are only typical; in the field they will depend upon operating environment, office maintenance routines, and so forth.

4.04 POWER SUPPLY AND CARD VOLTAGE MEASUREMENTS -

Table 9 lists the voltages that should appear at the test points on the master- and remote-station power supply cards. Unless specified otherwise, all voltages are referenced to the GND (ground) test points, one of which is located on each card. The power supply voltages listed in Table 9 are distributed to the various cards that comprise the master and remote stations. On most of these cards are test points where individual voltage measurements can be made. Table 10 lists the cards having voltage test points. The cards are listed in numerical sequence. All voltages are d-c, have the same tolerances specified in Table 9, and are referenced to GND (ground) unless otherwise specified.

TABLE 7

TEST EQUIPMENT AND TOOLS REQUIRED FOR PERIODIC CHECKS AND ADJUSTMENTS

Name	Manufacturer's Designation	Application
Multi-range DC Voltmeter having sensitivity of 20,000 Ω/V	Simpson Model 260 or equivalent*	Power supply and discriminator voltage measurements; return-channel carrier presence (CXP) ohmmeter check
Digital Voltmeter	Data Technology Corp. DT-360 or equivalent	12- and 120-volt power supply voltage measurements
Electronic Voltmeter (dBm-meter)	Hewlett-Packard 403A or 0-dB (1-mw, 600 Ω) equivalent	Level and CXP adjustments
Electronic Counter	Hewlett-Packard 5326C or equivalent	Oscillator frequency measurements
Pulse-Signaling Test Set	Northeast Electronics 26B or equivalent	Dial-thru receiver % make-break adjustment
Card Extenders	Badger 001261	All tests and adjustments requiring access to card components and pins
Telephone Plugs, Two-Wire	Western Electric (WECO) 310 or equivalent*	All adjustments (e.g., CXP and % make-break) requiring connection to phone jacks
Tuning Tools, Non-metallic	Badger 220224 or equivalent*	Oscillator and discriminator adjustments
1/16-inch screwdrivers	*	All adjustments except oscillator and discriminator
Insulated test clips	*	All connections to test points and terminals

*A test kit, Badger 001546, is available from the factory. The kit includes a VOM, 24 k Ω headset, test cords and connectors, and adjustment tools.

TABLE 8

PERIODIC CHECKS AND ADJUSTMENTS

Check or Adjustment	Interval
Power supply voltages	1 year
Transmitter and receiver levels	1 year
Analog channel calibration	1 year
All transmitter frequencies	As required
All receiver discriminators	As required
Dial-thru receiver % make-break	2 years
Analog receiver damping	Upon replacement of Card 001476
Carrier presence (threshold)	As required

CAUTION

At no time should any remote station voltage designated with an "M" be referenced to GND; these must be referenced to AN COM, which must never be grounded.

4.05 TRANSMITTER FREQUENCY ADJUSTMENTS -

A. 001450 CODE TRANSMITTER - To check and, if necessary, to adjust the frequency of the 001450 Code Transmitter, proceed as follows:

1. After removing the fuse, remove Card 001450 from the master station's card cage. Plug it into a 001261 Card Extender, and slide the latter into the card cage. Then re-insert the fuse.
2. Connect a counter between test points C (F0) and GND, with the counter's ground lead to GND.
3. Press and hold the card's CXR TEST pushbutton, reading the frequency displayed on the counter. If the frequency is off more than ± 3 cycles from 5610 Hz (i.e., below 5607 Hz or above 5613 Hz), perform the following steps:
 - a. Using a nonmetallic tuning tool, adjust the OSCILLATOR ADJ

TABLE 9
POWER SUPPLY VOLTAGES

Power Supply	Test Point	Voltage
001480 Master Station		
001442 (DC input)	D (-12 V)	-12 VDC, ± 0.10 VDC
	E (+12 V)	+12 VDC, ± 0.03 VDC
	F (+7.5 V)	+7.2 VDC to +9 VDC
	K (-48 V)	-44 VDC to -56 VDC
001443 (AC input)	A (-12 V)	-12 VDC, ± 0.03 VDC
	C (+12 V)	+12 VDC, ± 0.03 VDC
	E (-48 OP)	-50 VDC to -65 VDC
	G (-48 REL)	-38 VDC to -56 VDC
	J (+7.5 V)	+7.2 VDC to +9 VDC
001481 Remote Station		
001495	D (-48 V)	48 VDC, nominal, referenced to test point GND
	K (-4 PRBS)	-4 VDC, $\pm 20\%$, referenced to -48 VDC power input at pin B20 of Card 001495 (measurement requires use of card extender)
001486 (Regulators)	A (-120 M)	-120 VDC, ± 0.3 VDC, referenced to test point L (AN COM)
	G (-12 M)	-12 VDC, ± 0.03 VDC referenced to test point L
	H (+12 M)	+12 VDC, ± 0.03 VDC, referenced to test point L
	J (-12 L)	-12 VDC, ± 0.10 VDC, referenced to test point GND
	K (+12 L)	+12 VDC, ± 0.10 VDC, referenced to test point GND

slug (Figure 25) for a counter reading of precisely 5610 Hz, which is twice the actual oscillator frequency. (The CXR TEST pushbutton must be operated during this step.)

CAUTION

DO NOT force the slug; it is fragile and easily damaged.

- b. Disconnect the counter, remove the fuse, remove the card extender from the card cage, return the card to its proper position, then re-insert the fuse.

TABLE 10
VOLTAGE TEST POINTS ON PLUG-IN CARDS

Card Number	Test Points	DC Voltages
001480 Master Station		
001445 & 001447	L	+4.8 to +5.2
001449	H	+12
	J	-12
001450	C	+12
	J	-12
	K	+7.2 to +9
001476	L	+4.8 to +5.2
	J	-12
	K	+12
001477	L	+4.8 to +5.2
	H	+7.2 to +9
	J	-12
001557	K	+12
	L	+4.8 to +5.2
	L	+4.8 to +5.2
001481 Remote Station		
001483	H	+7.2 to +9
	J	-12 L
	K	+12 L
	L	+4.8 to +5.2
001484	L	+4.8 to +5.2
001485	H	+12 M
	J	-12 M
	K	+7.2 to +9
	L	+4.8 to +5.2
001487	L	+4.8 to +5.2
001491	K	-48
001492	H	+7.2 to +9
	J	-12 L
	K	+12 L
	L	+4.8 to +5.2
001494	H	+12 L
	J	-12 L
001558	F	-120 M
	J	-12 M
	L	-48
001560	K	-48
001561	K	-48
	L	+7.2 to +9
001562	L	-48

- B. ANALOG TRANSMITTER - To check, and, if necessary, to adjust the frequency of the 001485 Analog Transmitter, proceed as follows:

- After removing the fuse, remove Card 001485 from the remote station's card cage (Figure 4), plug

it into a 001261 Card Extender, and slide the latter into the card cage. Then re-insert the fuse.

2. Connect a counter between test points A (F XMIT) and AN COM, with the counter's return lead to the latter.

CAUTION

Make certain that the counter is ungrounded.

3. Press and hold the card's CXR TEST pushbutton, reading the frequency displayed on the counter. If the frequency is off more than ± 3 cycles from 4250 Hz (i.e., below 4247 Hz or above 4253 Hz), perform the following steps:

- a. Using a nonmetallic tuning tool, adjust the OSCILLATOR ADJ slug (Figure 26) for a counter reading of precisely 4250 Hz, which is twice the actual oscillator frequency. (The CXR TEST pushbutton must be operated during this step.)

CAUTION

DO NOT force the slug; it is fragile and easily damaged.

- b. Disconnect the counter, remove the fuse, remove the card extender from the card cage, return the card to its proper position, then re-insert the fuse.

- C. DIAL-THRU TRANSMITTER - Check and, if necessary, adjust the frequency of the 001449 Dial-Thru Transmitter as follows:

1. After removing the fuse, remove Card 001449 from the master station's card cage (Figure 1A),

plug it into a 001261 Card Extender, and slide the latter into the card cage. Then re-insert the fuse.

2. Connect a counter between test points C (F XMIT) and GND, with the counter's ground lead to GND.

3. Operate the card's CXR TEST switch to SP, holding it there. Read the frequency displayed on the counter. If the frequency is off more than ± 3 cycles from 1580 Hz (i.e., below 1577 Hz or above 1583 Hz), perform the following steps:

- a. Using a nonmetallic tuning tool, adjust the OSCILLATOR ADJ slug (Figure 27) for a counter reading of precisely 1580 Hz. (Keep the CXR TEST switch at SP during this step.)

CAUTION

Forcing the slug may cause damage.

- b. Operate the CXR TEST switch to MK. The counter should indicate 1650 Hz, ± 5 Hz.
- c. Disconnect the counter, remove the fuse, remove the card extender from the card cage, return the card to its proper position, then re-insert the fuse.

- D. RETURN CHANNEL TRANSMITTER - Check and, if necessary, adjust the frequency of the 001494 Return Channel Transmitter as follows:

1. After removing the fuse, remove Card 001494 from the remote station's card cage (Figure 4), plug it into a 001261 Card Extender, and slide the latter into the card cage. Then re-insert the fuse.

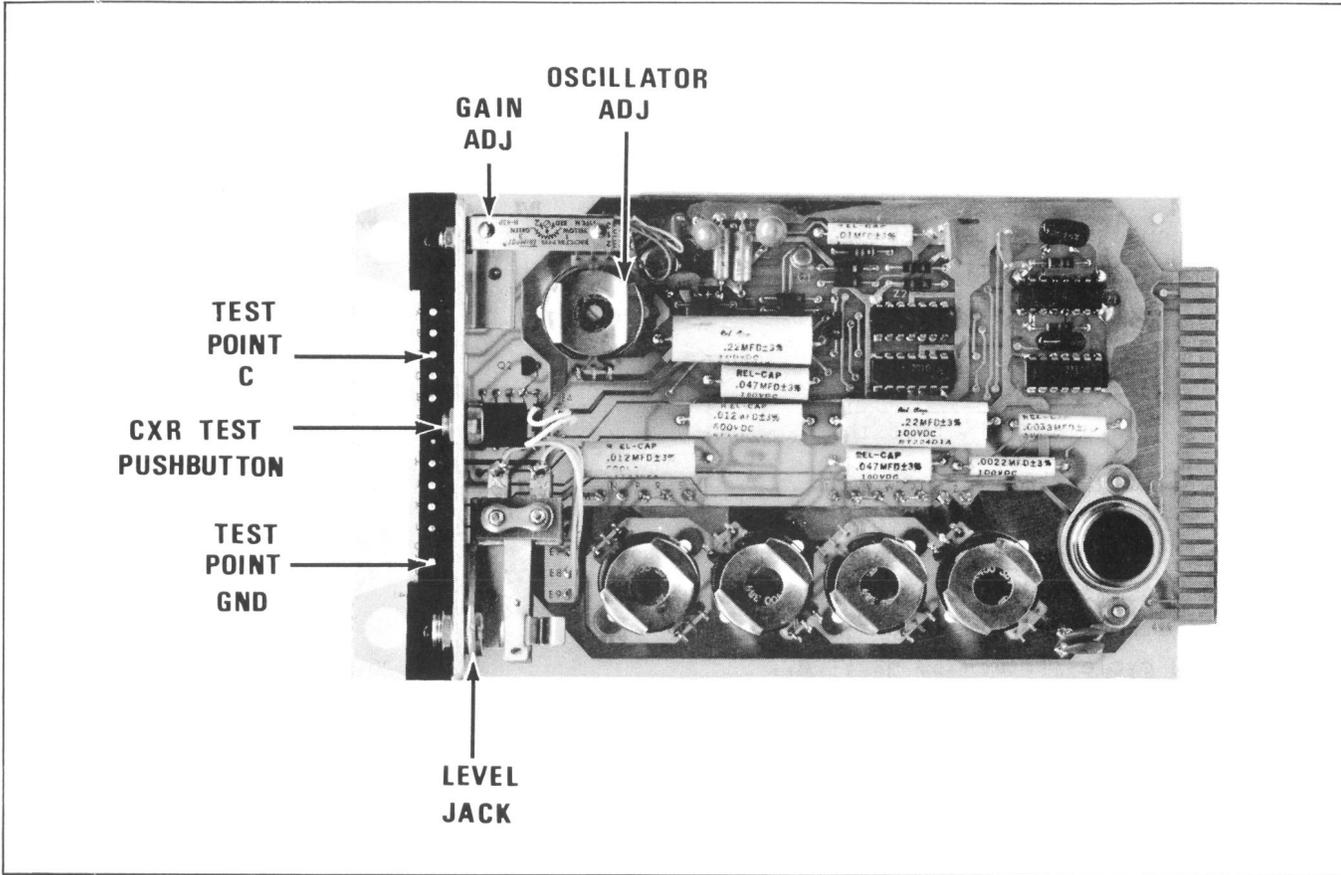


Figure 25 - Card 001450—Component Arrangement

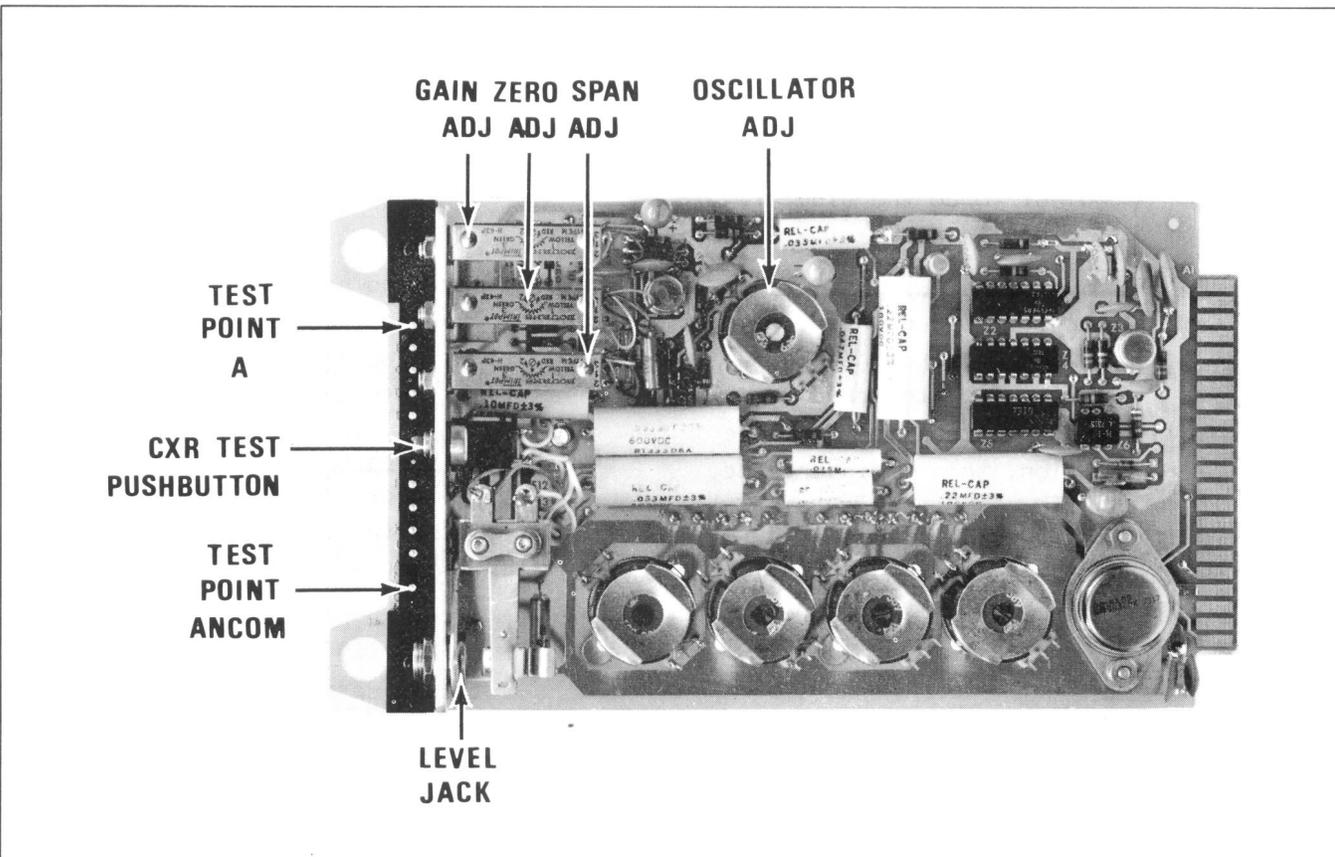


Figure 26 - Card 001485—Component Arrangement

2. Connect a counter between test points C (F XMIT) and GND, with the counter's ground lead to GND.
3. Operate the card's CXR TEST switch to SP, holding it there. Read the frequency displayed on the counter. If the frequency is off more than ± 3 cycles from 2430 Hz (i.e., below 2427 Hz or above 2433 Hz), perform the following steps:

- a. Using a nonmetallic tuning tool, adjust the OSCILLATOR ADJ slug (Figure 28) for a counter reading of precisely 2430 Hz. (Keep the CXR TEST switch at SP during this step.)

CAUTION

Avoid forcing the slug, for it can be easily damaged.

- b. Operate the CXR TEST switch to MK. The counter should indi-

cate 2500 Hz, ± 5 Hz.

- c. Disconnect the counter, remove the fuse, remove the card extender from the cabinet, return the card to its proper position, then reinsert the fuse.

4.06 RECEIVER DISCRIMINATOR ADJUSTMENTS -

- A. CODE RECEIVER - Check and, if necessary, adjust the code receiver's discriminator by performing these steps:

1. After removing the fuse, remove Card 001483 from the remote station's card cage (Figure 4), plug it into a 001261 Card Extender, and slide the latter into the card's position in the cage. Then re-insert the fuse.
2. Connect a 20,000 ohm/volt d-c voltmeter between test points

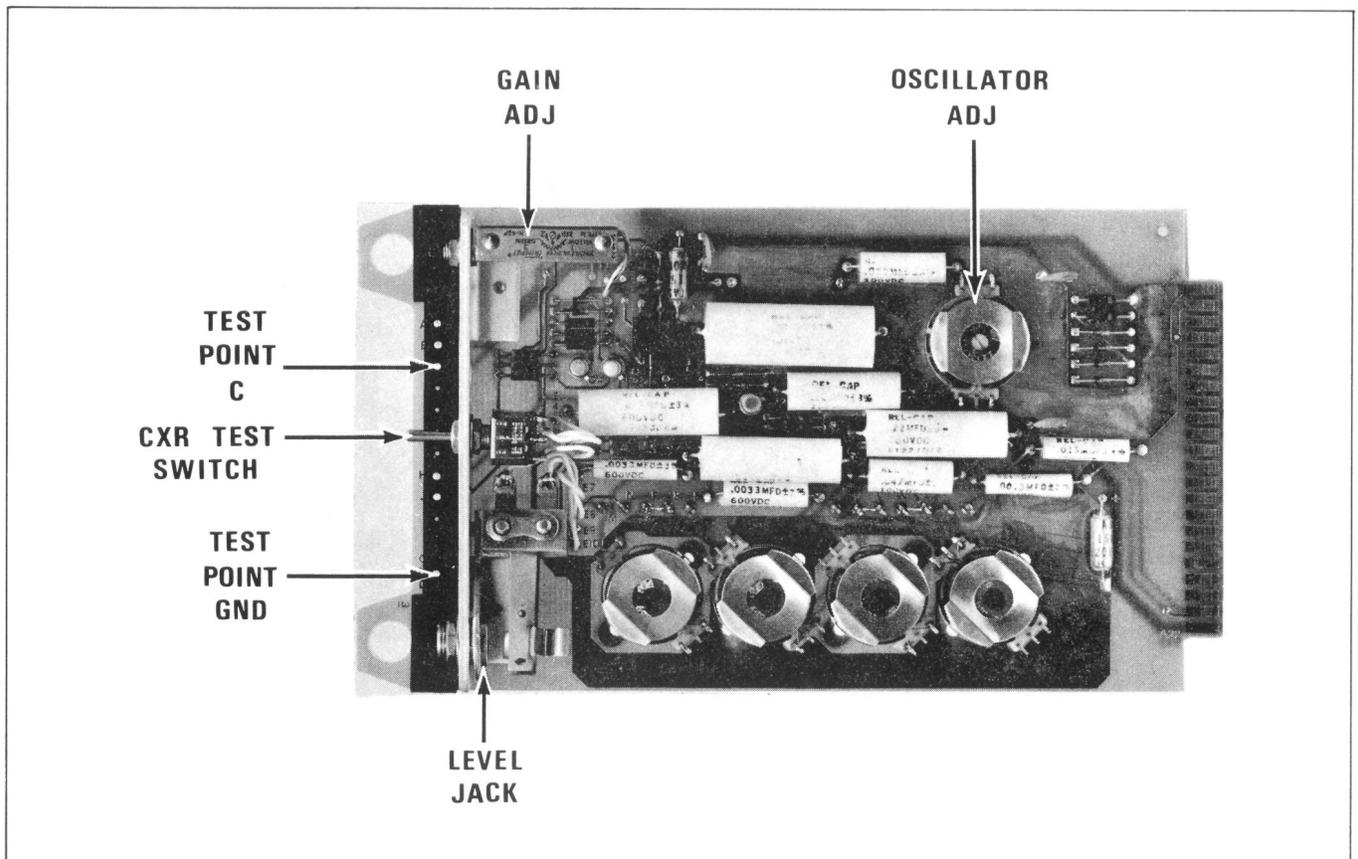


Figure 27 - Card 001449 - Component Arrangement

A (CXR NULL) and GND.

3. Have a CXR TEST pushbutton on Card 001450 at the master station pressed and held during step 4.
4. Using a nonmetallic adjustment tool, carefully adjust the DISCRIMINATOR ADJ slug (Figure 29) for a minimum reading, typically 0.1 VDC.

CAUTION

Forcing the slug may damage it.

5. Disconnect the voltmeter, remove the fuse, remove the card extender from the card cage, return the card to its proper position, then re-insert the fuse.

- B. ANALOG RECEIVER - Check and, if necessary, adjust the analog receiver's discriminator by performing these steps:

1. After removing the fuse, remove Card 001476 from the master station's card cage (Figure 1A), plug it into a 001261 Card Extender, and slide the latter into the card's position in the cage. Then re-insert the fuse.
2. Connect a 20,000 ohm/volt d-c voltmeter between test points A (DISC) and GND.
3. Have a CXR TEST pushbutton on Card 001485 at the remote station pressed and held during step 4.
4. Using a nonmetallic adjustment tool, carefully adjust the DISCRIMINATOR ADJ slug (Figure 30) for a minimum reading, typically 0.1 VDC.

CAUTION

Forcing the slug may damage it.

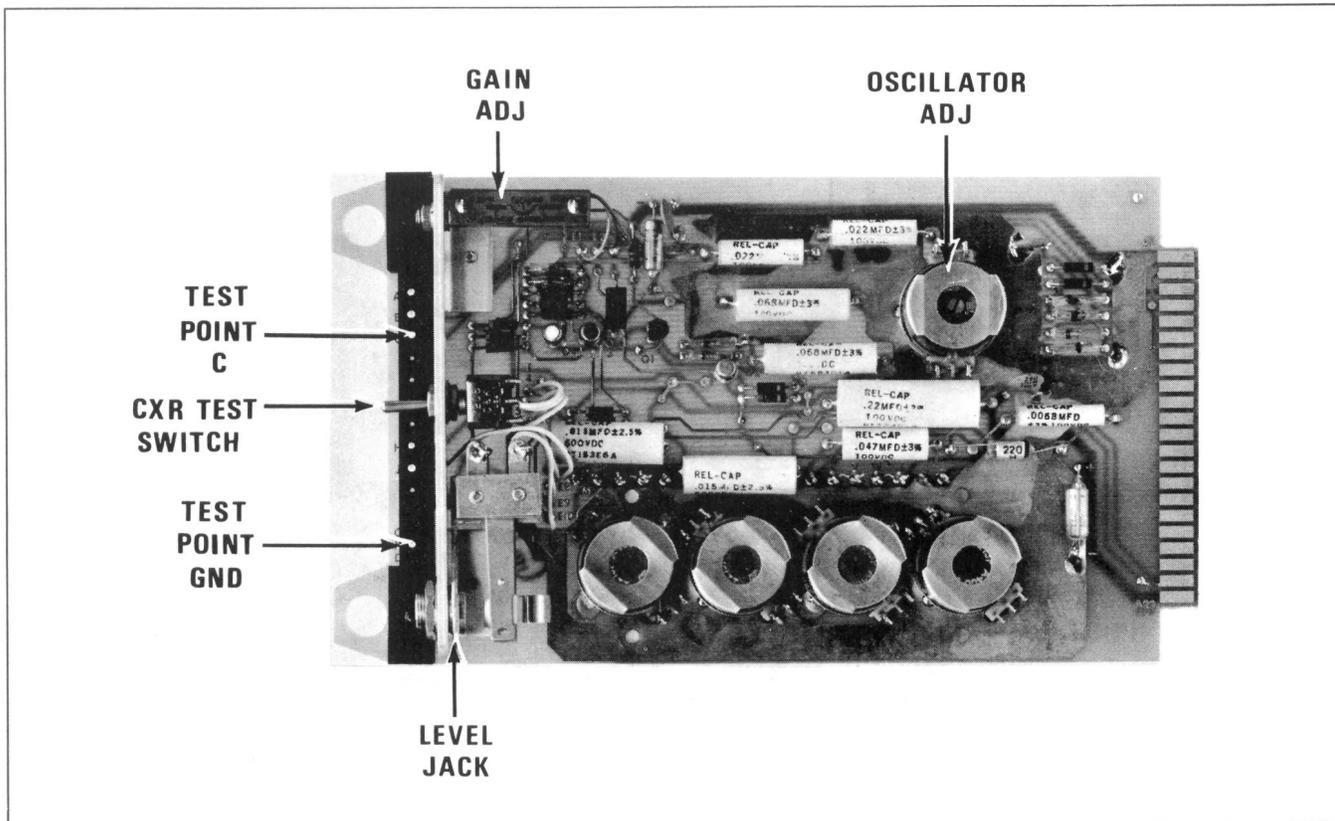


Figure 28 - Card 001494—Component Arrangement

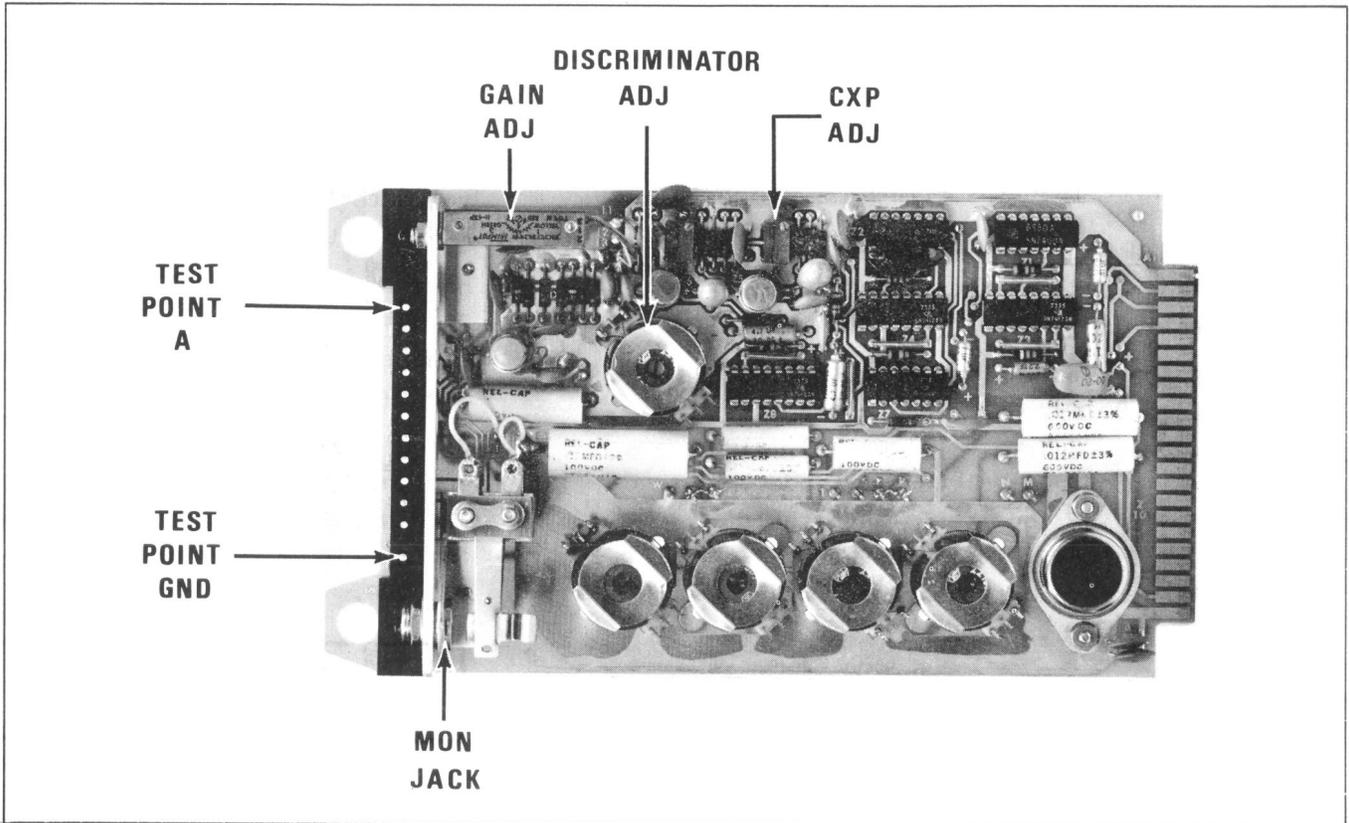


Figure 29 - Card 001483—Component Arrangement

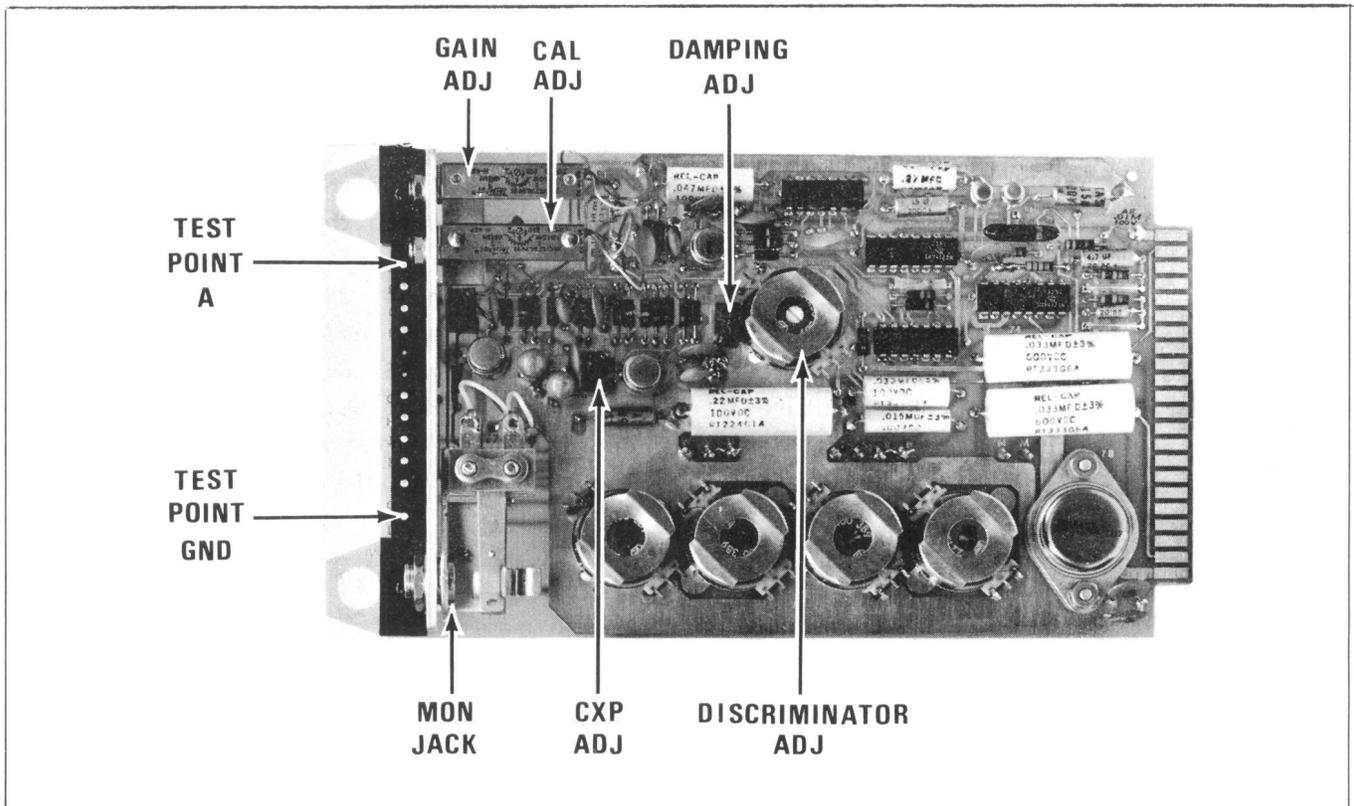


Figure 30 - Card 001476—Component Arrangement

5. Disconnect the voltmeter, remove the fuse, remove the card extender from the card cage, return the card to its proper position, then re-insert the fuse.

C. DIAL-THRU RECEIVER - Check and, if necessary, adjust the dial-thru receiver's discriminator as follows:

1. After removing the fuse, remove Card 001492 from the remote station's card cage (Figure 4), plug it into a 001261 Card Extender, and slide the latter into the card's position in the cage. Then re-insert the fuse.
2. Connect a 20,000 ohm/volt d-c voltmeter between test points C (MAKE NULL) and GND.
3. Have the CXR TEST switch on Card 001449 at the master station operated to SP and held there during step 4.
4. Using a nonmetallic adjustment tool, carefully adjust the DISCRIMINATOR ADJ slug (Figure 31) for a minimum reading, typically 0.1 VDC.

CAUTION

Avoid damaging the slug by not forcing it.

5. Disconnect the voltmeter, remove the fuse, remove the card extender from the card cage, return the card to its proper position, then re-insert the fuse.

D. RETURN CHANNEL RECEIVER - Check and, if necessary, adjust the return channel receiver's discriminator as follows:

1. After removing the fuse, remove Card 001477 from the master station's card cage (Figure 1A), plug it into a 001261 Card Extender,

and slide the latter into the card's position in the cage. Then re-insert the fuse.

2. Connect a 20,000 ohm/volt d-c voltmeter between test points F (MAKE NULL) and GND.
3. Have the CXR TEST switch on Card 001494 at a remote station operated to SP and held there during step 4.
4. Using a nonmetallic adjustment tool, carefully adjust the DISCRIMINATOR ADJ slug (Figure 32) for a minimum reading, typically 0.1 VDC.

CAUTION

DO NOT force the slug, or you may damage it.

5. Disconnect the voltmeter, remove the fuse, remove the card extender from the card cage, return the card to its proper position, then re-insert the fuse.

4.07 CARRIER PRESENCE (THRESHOLD) ADJUSTMENTS - From time to time it may be

necessary to check or to change the carrier presence levels of the receivers. This is the level at which the receiver is intentionally made inoperative and is generally factory-set to -45 dBm. If the gain of the transmitters and receivers has been set as recommended in BSP 662-495-900SW, sufficient margin will exist between the receiver's operating and threshold levels. Generally, the threshold should not be lowered below -45 dBm, but it can be raised.

A. CODE RECEIVER - To check or to alter the code receiver's carrier presence level, proceed as follows:

1. After removing the fuse, remove Card 001483 from the remote station's card cage (Figure 4), plug it into a 001261 Card Extender,

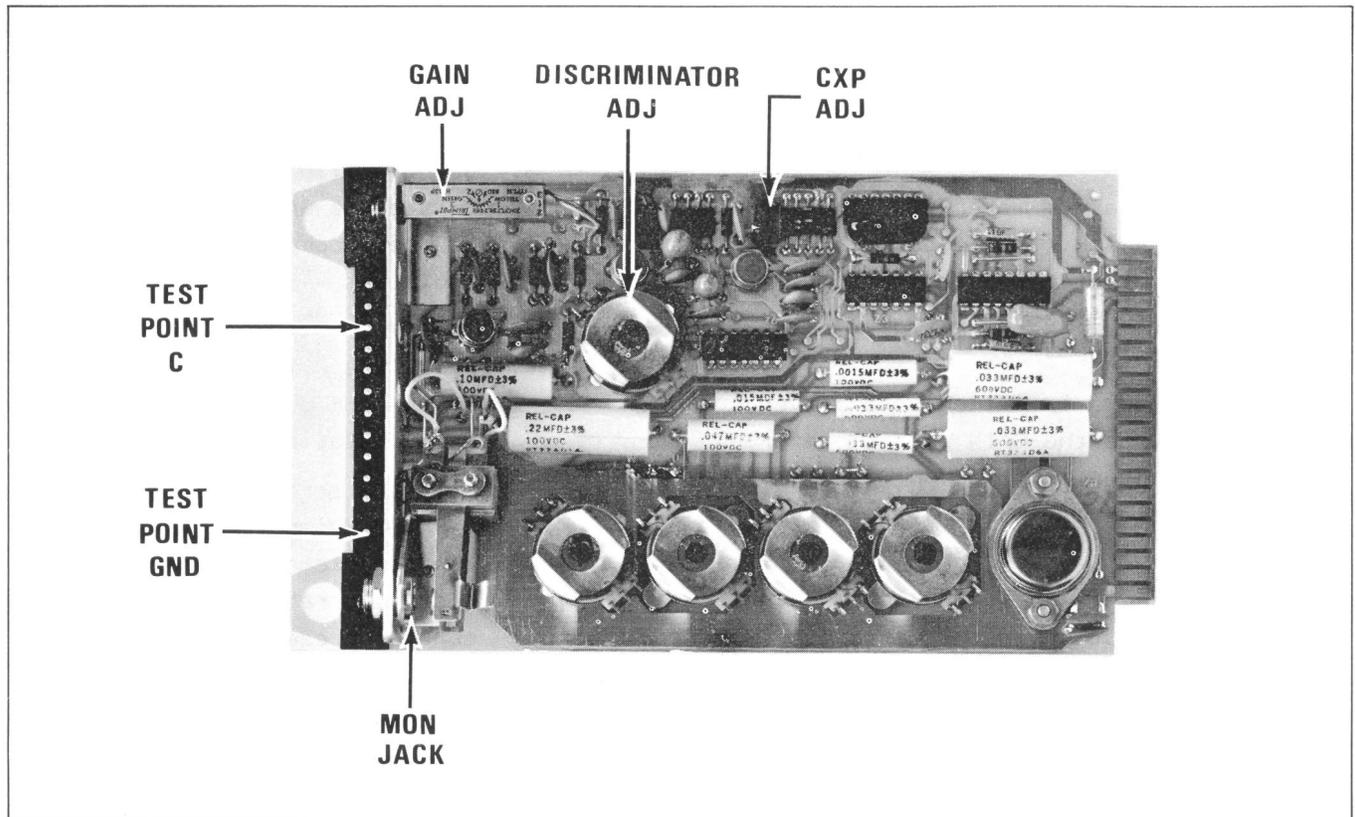


Figure 31—Card 001492—Component Arrangement

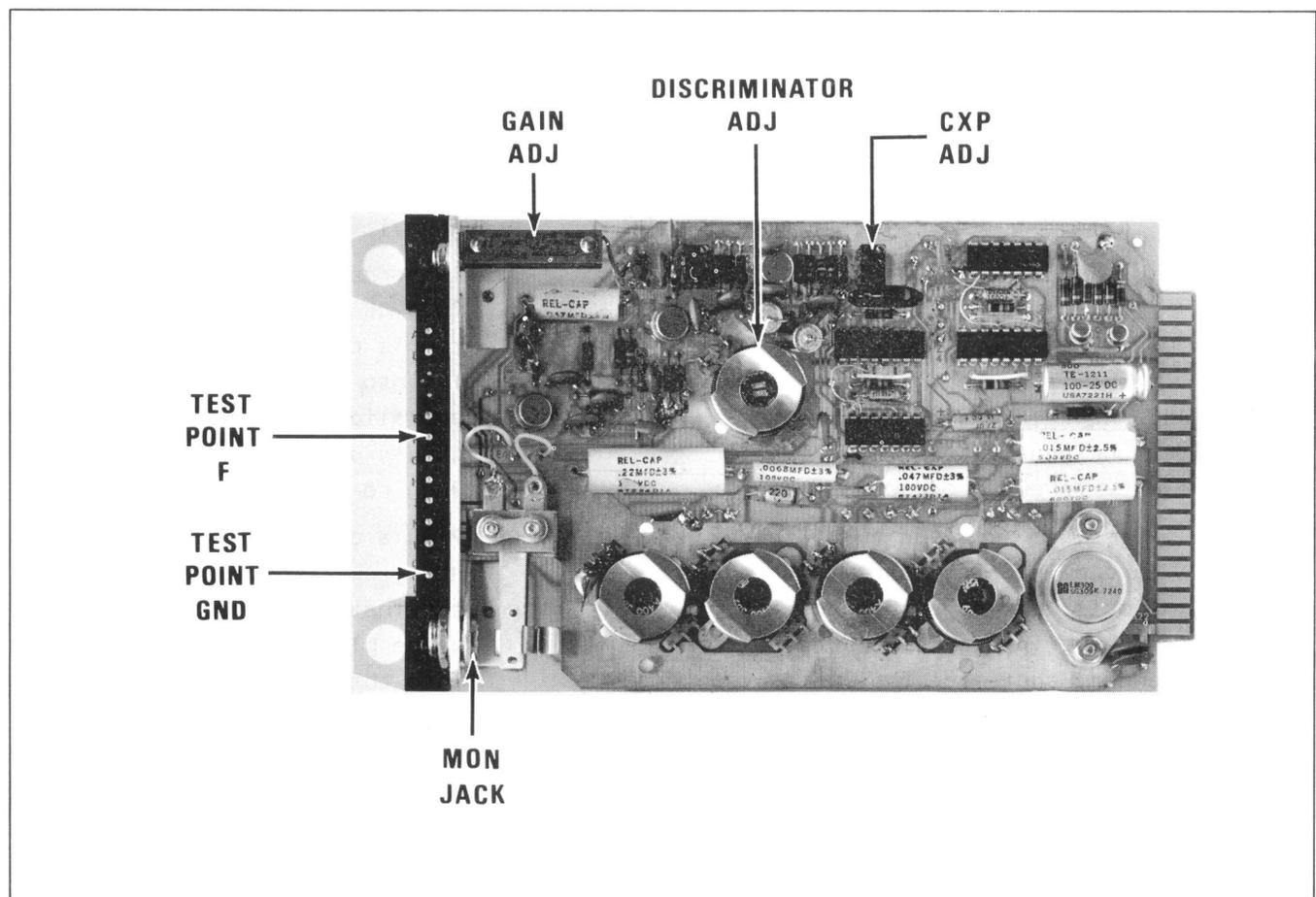


Figure 32—Card 001477—Component Arrangement

and slide the latter into the card's position in the cage. Then re-insert the fuse.

2. Plug a dBm meter into the card's MON jack. The meter must be terminated in a two-wire telephone plug to allow its insertion into the jack.
 3. Using a 1/16-inch screwdriver, rotate the GAIN potentiometer counterclockwise until the meter indicates -45 dBm (if this is the threshold desired).
 4. Request that the SLEEVE DC VOLTS pushbutton on the master station console's lower keyboard be pressed.
 5. With the screwdriver, adjust the CXP ADJ trimpot (Figure 29) until relay K1 on Card 001558 (Figure 17) just drops out. This is the carrier presence threshold.
 6. Readjust the GAIN potentiometer for the desired operating level, then have the SLEEVE DC VOLTS pushbutton reset.
 7. Disconnect the voltmeter, remove the fuse, remove the card extender, return the receiver card to its proper position, then re-insert the fuse.
- B. ANALOG RECEIVER - To check or to alter the analog receiver's carrier presence level, proceed as follows:
1. After removing the fuse, remove Card 001476 from the master station's card cage (Figure 1A), plug it into a 001261 Card Extender, and slide the latter into the card's position in the cage. Then re-insert the fuse.
 2. Plug a dBm meter into the card's MON jack. The meter must be terminated in a two-wire telephone
- plug to allow its insertion into the jack.
3. Using a 1/16-inch screwdriver, rotate the GAIN potentiometer counterclockwise until the meter indicates -45 dBm (if this is the threshold desired).
 4. Press the RING DC VOLTS and SYSTEM CHK pushbuttons on the master station console.
 5. With the screwdriver adjust the CXP ADJ trimpot (Figure 30) until the console's test meter reading becomes erratic. This is the carrier presence threshold.
 6. Readjust the GAIN potentiometer for the desired operating level, then press the console's two RESET pushbuttons.
 7. Disconnect the voltmeter, remove the fuse, remove the card extender, return the receiver card to its proper position, then re-insert the fuse.
- C. DIAL-THRU RECEIVER - To check or to alter the dial-thru receiver's carrier presence level, proceed as follows:
1. After removing the fuse, remove Card 001492 from the remote station's card cage (Figure 4), plug it into a 001261 Card Extender, and slide the latter into the card's position in the cage. Then re-insert the fuse.
 2. Plug a dBm meter into the card's MON jack. The meter must be terminated in a two-wire telephone plug to allow its insertion into the jack.
 3. Using a 1/16-inch screwdriver, rotate the GAIN potentiometer counterclockwise until the meter indicates -45 dBm (if this is the threshold desired).

4. Request that the CXR TEST switch on Card 001449 at the master station be operated to SP and held there through steps 5 and 6.
 5. With the screwdriver adjust the CXP ADJ trimpot (Figure 31) until relay K8 on Card 001561 (Figure 21) just drops out. This is the carrier presence threshold.
 6. Readjust the GAIN potentiometer for the desired operating level.
 7. Disconnect the voltmeter, remove the fuse, remove the card extender, return the receiver card to its proper position, then re-insert the fuse.
- D. RETURN CHANNEL RECEIVER - To check or to alter the return channel receiver's carrier presence level, proceed as follows:
1. After removing the fuse, remove Card 001477 from the master station's card cage (Figure 1A), plug it into a 001261 Card Extender, and slide the latter into the card's position in the cage. Then re-insert the fuse.
 2. Plug a dBm meter into the card's MON jack. The meter must be terminated in a two-wire telephone plug to allow its insertion into the jack.
 3. Connect an ohmmeter across terminals 4 and 5 of TB1 on the rear of the master station. (It will be necessary to remove the protective metal strip covering the terminal blocks.) These terminals are across the normally open contacts of relay CP (K1).
 4. Using a 1/16-inch screwdriver, rotate the card's GAIN potentiometer counterclockwise until the dBm meter indicates -45 dBm (if this is the threshold desired).
5. Request that the CXR TEST switch on Card 001494 at a remote station be operated to SP and held there through steps 6 and 7.
 6. With the screwdriver, adjust the CXP ADJ trimpot (Figure 32) until the ohmmeter pointer deflects up-scale. This is the carrier presence threshold.
 7. Readjust the GAIN potentiometer for the desired operating level.
 8. Disconnect the voltmeters, remove the fuse and card extender, return the receiver card to its proper position, re-insert the fuse, and then replace the protective metal strip.
- E. PERCENT MAKE-BREAK ADJUSTMENT - To check and adjust the percent make-break ratio of the loop-dialing pulses at the remote station, perform these steps:
1. At the remote station, plug a pulse-signaling test set into the % MAKE BREAK jack on the front of the 001561 Dial-Thru Relay Card (Figure 21). The test set must be terminated in a two-wire telephone plug to permit its insertion into the jack.
 2. At the master station, press the DIAL THRU pushbutton. Then rotate the telephone dial fully clockwise and release it.
 3. The test set should indicate a make-break ratio of 40-60, $\pm 3\%$. If it does not, rotate the %ADJ potentiometer (with a 1/16-inch screwdriver) until it does (or until the make-break ratio meets the particular office's requirements). Repeat step 2 as many times as necessary in order to

complete the adjustment.

4. Reset the DIAL THRU pushbutton and remove the test set.

F. ANALOG RECEIVER DAMPING ADJUSTMENT -

If the 001476 Analog Receiver Card is ever replaced in the field, it may have to be adjusted to provide proper meter damping. The procedure for doing this is as follows:

1. After removing the fuse, put the replacement 001476 Card in a 001261 Card Extender and slide the latter into the card's position in the master station's card cage. Then re-insert the fuse.
2. On the console, press the SYSTEM CHK and RING DC VOLTS pushbuttons. Watch the meter pointer as it swings up-scale, noting whether it undershoots or overshoots the green SYSTEM CHK area.

NOTE: Undershooting is the slowing up of the pointer before it finally stops, and overshooting is simply the case when the pointer passes, then returns to, the final mark. In an extreme case, the pointer may peg.

3. If undershooting occurs, slightly rotate the DAMPING ADJ potentiometer (Figure 30) clockwise; if overshooting occurs, slightly rotate the potentiometer counter-clockwise.
4. On the console, reset and then again press RING DC VOLTS. Once again observe the action of the meter pointer.
5. Repeat steps 3 and 4 as many times as necessary. When proper damping is achieved, the pointer will move

at a uniform rate to the SYSTEM CK registration mark.

6. Because there may be a small amount of interaction between the DAMPING and CAL potentiometers, it may be advisable to recalibrate the analog receiver.
7. Reset the SYSTEM CHK and RING DC VOLTS pushbuttons. Then remove the fuse, remove the extender, restore the card to its proper position, and re-insert the fuse.

5. PARTS REPLACEMENT AND REPAIR

5.01 ORDERING PROCEDURE - In ordering spare or replacement cards, specify their six-digit part number (e.g., 001487) and (where applicable) their four-digit option number (e.g., 0001). Part and option numbers (together with the series number) are marked on the front edge of each card. To order spare or replacement relays and fuses, specify only the six-digit part number (e.g., 160703).

5.02 REPLACEABLE AND RECOMMENDED SPARE PARTS LISTING - Table 11 provides a listing and description of all cards, relays and fuses used in the system. It is recommended that at least one of each item be kept on hand as a maintenance spare. The last column of the table gives the figure reference for each part.

5.03 FACTORY REPAIR SERVICE - To have a defective card repaired, return it to the factory, describing as fully as possible the nature of the malfunction, the operating mode or modes under which failure occurred, the symptoms observed, and any other pertinent details that can possibly guide the factory in making the repair. (If required, factory assistance is available to verify your diagnosis, or to help you isolate the trouble to the defective card.) The factory

maintains a 24-hour turn-around service on all cards except those containing frequency-determining components. The latter generally requires several additional days of "burn-in" time in order to provide the essential stability. Before returning a card, pack it carefully. Skin-packing each card by machine is the method preferred and is the process used at the factory. The plastic-wrapped card should then be sealed in a box measuring 12" x 6" x 3". Since a mechanical wrapping device may not always be accessible, however, an alternative is to place the card in a plastic bag and then to pack it in a slightly oversized box (approximately 12" x 8" x 4"), allowing clearance for foam rubber or other standard packing material.

6. SPECIFICATIONS

6.01 Table 12 provides a listing of the CL-612A System's major electrical and mechanical specifications. The table is broken into four parts. In the first are listed general specifications for the system as a whole. The second and third contain specifications unique to the Model 001480 Master Station and Model 001481 Remote Station, respectively. Finally, the fourth gives ranges for the four basic kinds of test measurements.

TABLE 11
REPLACEABLE AND RECOMMENDED SPARE PARTS

Badger Part No.	Description	Figure Reference	Badger Part No.	Description	Figure Reference
Model 001480 Master Station			160703	Relays K5 & K6: 2.5 k Ω coil, 4 form C contacts, 48 VDC	Fig. 11
001442	48 VDC Power Supply (optional)	Fig. 1A	160705	Relay K4: 1.5 k Ω coil, 6 form C contacts, 48 VDC	" 11
001443	115 VAC Power Supply (optional)	" 1A	Model 001481 Remote Station		
001445	Scanner	" 1A	001483	Code Receiver	Fig. 4
001447	Meter Function Matrix	" 1A	001484	Receiver Logic & Buffer	" 4
001449	Dial-Thru Transmitter	" 1A	001485	Analog Transmitter	" 4
001450	Code Transmitter	" 1A	001486	Power Supply Regulators	" 4
001476	Analog Receiver	" 1A	001487	Receiver Decoder— Option 0001: 2-second permanent release Option 0002: unlimited permanent release	" 4
001477	Return Channel Receiver (optional)	" 1A	001491	Sleeve & Control Circuits	" 4
001555	Band Stop Filter	" 1A	001492	Dial-Thru Receiver	" 4
001557	Control Ops Matrix	" 1A	001494	Return Channel Transmitter (optional)	" 4
001559	Operator Telco Circuit	" 1A	001495	48 VDC Power Supply	" 4
160117	Relays K1 & K2: 2.5 k Ω coil, 2 form C contacts, 48 VDC (optional)	" 14	001555	Band Stop Filter	" 4
160128	GMT Fuse, 1 Amp.		001558	Measurement Circuit	" 4
160355	Relay K3: 2.5 k Ω coil, 4 form C contacts, 48 VDC	Fig. 9	001560	Tip & Ring Telco Circuit	" 4
160669	Relay K3: 700 Ω coil only	" 11	001561	Dial-Thru Relays	" 4
160670	Relays K1 & K2: dual 200/200 Ω coil, 2 form C contacts, 24 VDC	" 11	001562	Ringer, Howler, Coin Relay & Beeper Circuits	" 4
160702	Relays K7 & K8: 2.5 k Ω coil, 2 form C contacts, 48 VDC	" 11	160107	GMT Fuse, 3 Amp.	" 4
			160116	Relay K3: 700 Ω coil, 2 form C contacts, 24 VDC	" 21

TABLE 11 (Continued)

Badger Part No.	Description	Figure Reference	Badger Part No.	Description	Figure Reference
160117	Relays, 2.5 k Ω coil, 2 form C contacts, 48 VDC: K1 & K7 on Card 001561 K3 on Card 001560 K2, K3, K4 & K8 on Card 001491 K1-K7 on Card 001562 K5-K7 on motherboard	Fig. 21 " 18 " 20 " 19 " 16	160668	Relays, 1.5 k Ω coil, 6 form C contacts, 48 VDC: K5 on Card 001491 K1 & K2 on motherboard	Fig. 20 " 16
160355	Relays, 2.5 k Ω coil, 4 form C contacts, 48 VDC: K5 & K6 on Card 001558 K6, K8 & K9 on Card 001561 K7 & K9 on Card 001491 K8 on Card 001562 K3 & K4 on motherboard K8 on motherboard	" 17 " 21 " 20 " 19 " 16 " 16	160669	Relay K2: 700 Ω coil only	" 21
160382	Relay K4: 1 k Ω coil, 2 form A contacts, 6 VDC	" 21	160670	Relays, dual 200/200 Ω coil, 2 form C contacts, 24 VDC: K4 on Card 001560 K1 on Card 001491	" 18 " 20
160464	Relay, 5 k Ω coil, 2 form C contacts, 48 VDC	" 17	160702	Relays, 2.5 k Ω coil, 2 form C contacts, 48 VDC: K7 & K9 on Card 001558 K6 on Card 001560	" 17 " 18
			160703	Relays, 2.5 k Ω coil, 4 form C contacts, 48 VDC: K1, K2, K5, K7 & K8 on Card 001560	" 18
			160705	Relays, 1.5 k Ω coil, 6 form C contacts, 48 VDC: K1-K4 on Card 001558 K6 on Card 001491 K5 on Card 001561	" 17 " 20 " 21

TABLE 12
MAJOR ELECTRICAL AND MECHANICAL SPECIFICATIONS

SYSTEM	
Number of remote stations per master station	Unlimited
Transmission medium	Any voice-grade telephone circuit, either physical or carrier-derived, over any transmission facility
Transmitting levels	0 dBm (max.), adjustable at LEVEL jacks
Receiving levels	-45 dBm (min.) at MON jacks
Input impedance	600-900 Ω ; balanced
Output impedance	600-900 Ω , balanced
Speed of response	Less than 2-second interval between test pushbutton operation and display of measured quantity
Accuracy	3% (over-all) of full-scale reading
001480 MASTER STATION	
Transmission method: Control	Two-state, 180 ^o phase-shift modulation; carrier is generated upon operation of control or measurement pushbuttons
Dial-thru	Two-state frequency shift (FSK), ± 35 Hz
Frequency allocations: Control/measurement Dial-thru	Transmit: 2805 Hz; receive: 2125 Hz; speech: 300 to 2700 Hz 1615 Hz center frequency
Power requirement	Standard 48 VDC office battery or 115 VAC
Dimensions	21-3/4" wide x 21-1/2" deep x 9" high
Weight	40 pounds
001481 REMOTE STATION	
Transmission method: Analog data	Two-state, 180 ^o phase-shift modulation; carrier is generated only when metering data are transmitted
Return channel	Two-state frequency shift (FSK), ± 35 Hz
Frequency allocations: Metering/control Return channel	Transmit: 2125 Hz; receive: 2805 Hz; speech: 300 to 2700 Hz 2465 Hz center frequency
Power requirement	Standard 48 VDC office battery
Mounting	Flush or center
Dimensions	19" wide x 10" deep x 10-1/2" high. (Spacer plates available for mounting station in 23" or 27" racks)
Weight	30 pounds

TABLE 12 (Continued)

TEST MEASUREMENTS	
DC voltage range	0 to 150 VDC
AC voltage range	0 to 150 VAC, rms (ringing and howler voltages measured automatically—the latter on a 0 - 75 VAC scale)
Resistance	High range: 50 k Ω , midscale; low range: 500 Ω , midscale
Capacitance	0 to 5 μ F

MAINTENANCE NOTES