

series 2500, 503 & 502  
COMMAND CONTROL CENTER

# TONE CONTROL MODULE

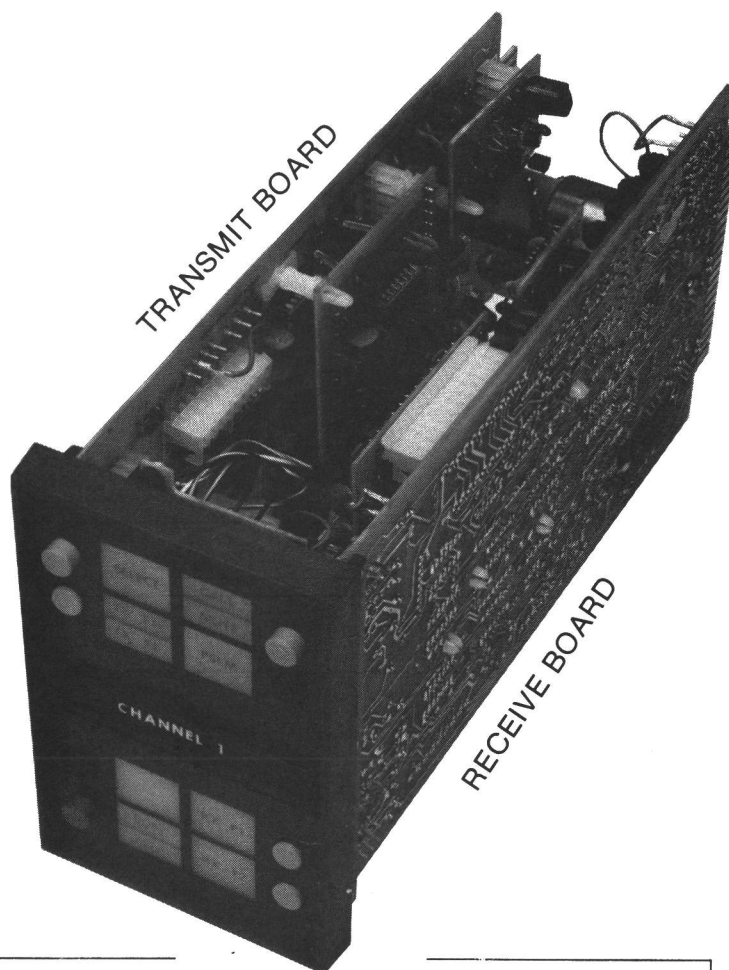
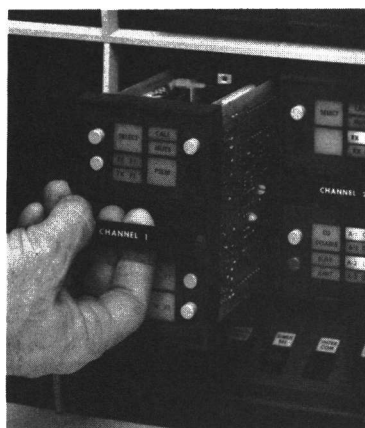


Figure 1-1

## SPECIFICATIONS\*

Frequency Response	+1 to -3 db, 0.3 to 10 kHz (1 kHz reference)
Compression (Receive Audio)	Output increases less than 3 db with input 30 db above compression threshold.
Input, Output Impedance	600 ohms
<b>Tone Accuracy</b>	
Secur-it Tone	2175 Hz $\pm$ 0.15 %
Function Tones	$\pm$ 8 Hz
Line Driver Output	+12 dbm max with less than 1% distortion
<b>Power:</b>	
V <sub>CC</sub> (13.5 volts)	total I <sub>CC</sub> = 170 mA, max
24-Volt Supply	I <sub>24</sub> = 5 mA
Lamp Current	35 mA per lamp, max

\* These specifications are intended primarily for the use of the serviceman.  
Refer to the appropriate Specification Sheet for the complete specifications.

## TABLE OF CONTENTS

SPECIFICATIONS .....		cover
DESCRIPTION .....		1
Combination Nomenclature .....		2
Tone Control Frequency and Function .....		2
OPERATION & CIRCUIT ANALYSIS .....		3
Receive Circuit .....		3
Receive Board .....	SEC/53224-001	3
Production Change - T/R Module .....		3
Transmit Audio Circuit .....		3
Receive Audio Circuit .....		3
4-Wire Audio Kit .....	SEC/53393-001	7
Line Compensation Kit .....	SEC/53392-001	7
Receive Logic Circuit		
Selected & Unselected Audio Gates .....		7
Total Mute .....		8
Partial Mute Logic Circuit .....		8
Two Frequency Receive Kit .....	SEC/53513-001	8
Two Separate Receivers Kit .....	SEC/53510-001	8
Frequency 1, Frequency 2 w/PSLM kit .....	SEC/53511-001	8
Auxiliary Tone Functions		
AUX 1 ON/OFF Kit .....	SEC/53506-001	8
AUX 2 ON/OFF Kit .....	SEC/53507-001	8
Tone Sequence Logic .....		9
Auxiliary Switch Contacts .....		9
TRANSMIT CIRCUIT .....		10
Transmit Board .....	SEC/53207-001	10
Audio Flow .....		10
Control Tone Logic .....		10
Two Frequency Transmit Kit .....	SEC/53509-001	10
Repeater Disable Kit .....	SEC/53508-001	10
Channel Guard ON/OFF Kit .....	SEC/53503-001	10
Select .....		12
Simul-Select Reset .....		12
Transmit Audio Logic .....		12
Parallel Transmit .....		13
Parallel Transmit Indicator Kit .....	SEC/53512-001	13
Take Over .....		13
Channel Guard Monitor .....		13
Voter Switch .....		13
Auxiliary Key Kit .....	SEC/53533-001	13
TONE CONTROL OPTIONS .....		14
Tone Option Type I .....	SEC/53171-001	14
Tone Option Type II .....	SEC/53175-001	14
Tone Option Type III .....	SEC/53238-001	15
Auxiliary Key .....	SEC/53319-001	15
Tx F2 Tone Gate .....	SEC/53208-001	15
Parallel Tone Transmit Indicator .....	SEC/53233-001	16
SERVICE SHEETS		
Module Face Assembly, Lamp Board & Fuse Board .....		17
Receive Board .....	(EARLIER) SEC/53224-001	18
Receive Board .....	(LATER) SEC/53224-001	20
Transmit Board .....	SEC/53207-001	22
Option Boards		
Tone Option Type I .....	SEC/53171-001	24
Tone Option Type II .....	SEC/53175-001	24
Tone Option Type III .....	SEC/53238-001	25
AUX Key .....	SEC/53319-001	26
Tx F2 Tone Gate .....	SEC/53208-001	27
Parallel Tone Transmit Indicator .....	SEC/53233-001	28
Optional Function Kits Parts List .....		29
Troubleshooting Table .....		33

## FIGURES

Figure 1-1	- Typical Tone Control Module .....	cover
Figure 1-2	- Combination Nomenclature .....	1
Figure 1-3	- Tone Control Frequency vs Function .....	2
Figure 2-1	- Receive Circuit Block Diagram .....	4
Figure 2-2	- Transmit Circuit Block Diagram .....	11
Figure 2-3	- Option Circuit Boards Types I, II & III .....	14
Figure 2-4	- Option Circuit Boards .....	16
Figure 3-1	- Module Face Assembly, Lamp Board & Fuse Board .....	17
Figure 3-2	- Receive Board Assembly Diagram & Parts List ..... (EARLIER)	18
Figure 3-3	- Receive Board Circuit Schematic ..... (EARLIER)	19
Figure 3-4	- Receive Board Assmebly Diagram & Parts List ..... (LATER)	20
Figure 3-5	- Receive Board Circuit Schematic ..... (LATER)	21
Figure 3-6	- Transmit Board Assembly Diagram & Parts List .....	22
Figure 3-7	- Transmit Board Circuit Schematic .....	23
Figure 3-8	- Tone Option Type I .....	24
Figure 3-9	- Tone Option Type II .....	24
Figure 3-10	- Tone Option Type III .....	25
Figure 3-11	- Auxiliary Key Option .....	26
Figure 3-12	- Tx F2 Tone Gate Option .....	27
Figure 3-13	- Parallel Tone Transmit Indicator Option .....	28

**CAUTION**

The Electrostatic Sensitive Devices used in this equipment can be destroyed by static discharges. Before handling one of these devices, the serviceman should discharge himself by touching the case of a bench test instrument that has a 3-prong power cord connected to an outlet with a known good earth ground. When soldering or de-soldering an Electrostatic Sensitive Device, the soldering iron should also have a 3-prong power cord connected to an outlet with a known good earth ground or a battery-operated soldering iron should be used.

**WARNING**

No one should be permitted to handle any portion of the equipment that is supplied with high voltage; or to connect any external apparatus to the units while the units are supplied with power. KEEP AWAY FROM LIVE CIRCUITS.

## DESCRIPTION

This manual supplements the basic Maintenance Manual for console, LBI30300, when the console includes Tone Control modules.

Channel modules for the console are of three types: Tone control, DC control and E & M signaling. This manual covers Tone control modules.

A Tone module with typical controls is shown in Figure 1-1. As shown in the inset, the channel identification bar also serves as a recessed handle for withdrawing the module from the port. Standard controls supplied as a minimum include:

**SELECT** Activates module; routes Receive audio to the Select speaker; enables the module for keying by the transmit bar on the central control lip; deactivates previously selected channel modules.

**CALL** Display flashes when Receive audio is present.

**MUTE** When depressed, mutes the Receive audio on its channel, and illuminates the display. The level is adjustable.

**XMIT** Display illuminates (in red) when adjacent red pushbutton is activated keying its transmitter, or when the transmit bar on the control lip is pushed and the SELECT function is activated.

Other available control functions, such as Two-Frequency Transmit (2F Tx) and Channel Guard ON/OFF, are listed in the Combination Nomenclature Table, Figure 1-2. Note the exception to the basic table for modules with repeater control, two-frequency receive with PSLM or two separate receivers.

Receive Board SEC/53224-001 and Transmit Board SEC/53207-001 are the principal circuit boards of the Tone control module. In addition, six standard option boards are available:

OPTION	CIRCUIT BOARD
Tone Option Type 1	SEC/53171-001
Tone Option Type 2	SEC/53175-001
Tone Option Type 3	SEC/53238-001
Auxiliary Key	SEC/53319-001
Tx F2 Tone Gate	SEC/53208-001
Tone Parallel Transmit	SEC/53233-001

1st digit	2nd digit	3rd digit	4th digit	5th digit	6th digit	7th digit	8th digit	9th digit	10th digit
MODULE CONTROL SYSTEM	CHANNEL MARKING	TRANSMIT CONTROL	RECEIVE CONTROL	OPTION	OPTION	OPTION	SYSTEM	PORT LOCATION	SLOT LOCATION
<b>T</b> 2-Wire Tone Control	<b>8</b> Standard	<b>A</b> 1F Tx	<b>A</b> 1F Rx	<b>2</b> Standard	<b>2</b> Standard	<b>A</b> Standard	<b>8</b> Standard	<b>2</b> Port 2	<b>1</b> Slot 1
<b>J</b> 4-Wire Tone Control	<b>9</b> Custom	<b>B</b> 2F Tx	<b>B</b> 2F Rx	<b>6</b> Aux 2 ON-OFF	<b>3</b> Channel Guard	<b>B</b> Timed Mute	<b>9</b> Special	<b>3</b> Port 3	<b>2</b> Slot 2
		<b>C</b> PTx IND & 2F Tx			<b>4</b> Aux 1 ON-OFF	<b>C</b> Freq. Comp. Network		<b>4</b> Port 4	<b>3</b> Slot 3
		<b>D</b> PTx IND & 1F Tx			<b>5</b> CG and Aux 1	<b>D</b> Timed Mute and Freq.Comp.		<b>5</b> Port 5	<b>4</b> Slot 4
								<b>6</b> Port 6	<b>5</b> Slot 5
								<b>9</b> Spare	<b>9</b> Spare

Figure 1-2 - Combination Nomenclature



Deviations from Basic Module	3rd digit	4th digit	5th digit	6th digit
Modules with Repeater Control	not Applicable	not Applicable	<b>2,6</b> not Applicable Substitute: <b>8</b> Repeater Disable	Also Available: <b>6</b> AUX 2 ON-OFF <b>7</b> AUX 1 and AUX 2
Modules with PSLM or Two Receivers		<b>A, B</b> not Applicable Substitute: <b>T</b> 2F Rx with PSLM <b>U</b> Two Receivers	<b>6</b> not Applicable	<b>2,3</b> are only Applicable Options

Option circuit boards plug into either the Receive or Transmit board.

Optional function kits are available for installing options in the field. Kit parts are included in the Service Sheets section, and installation and operation are discussed in the Operation and Circuit Analysis section.

Each module also includes fuse and lamp PC boards, a face assembly and miscellaneous hardware. Assembly diagrams, circuit schematics and parts lists are included in the Service Sheets section.

The console provides up to 12 different remote and repeater base station tone-controlled functions. The frequency corresponding to each function is shown in Figure 1-3.

Figure 1-2A - Combination Nomenclature

FUNCTION*	TONE FREQUENCY (HERTZ)	TONE DURATION (MILLISECONDS)
Rx Channel Guard Disable (Reset by PTT)	2050	40
Tx -Freq. No. 1	1950	40
Tx -Freq. No. 2	1850	40
Rx -Freq. No. 1 or Receiver No. 1	1750	40
Rx -Freq. No. 2 or Receiver No. 2	1650	40
Channel Guard Enable or Minimum Squelch or Repeater Enable	1550	40
Channel Guard Disable or Maximum Squelch or Repeater Disable	1450	40
Aux. Function 1 ON	1350	40
Aux. Function 1 OFF	1250	40
Aux. Function 2 ON	1150	40
Aux. Function 2 OFF or PSLM or Sim. Monitor	1050	40
Tx Hold	2175	**

\* All functions but Transmit F1 and Transmit Hold are optional.

\*\* Transmit Hold is transmitted at 30 dB below the Secur-it tone level as long as PTT switch is depressed.

Figure 1-3 - Tone Control Frequency and Function

## OPERATION & CIRCUIT ANALYSIS

### RECEIVE CIRCUIT

SEC/53224-001  
RECEIVE BOARD

The Receive Board includes all circuitry necessary to receive audio from the telephone lines. A block diagram is shown in Figure 2-1; the circuit schematic is shown in Figure 3-3.

#### Production Change - T/R Module

Since the maintenance manual for the tone control transmit/receive module was first produced, several revisions have been made in the transmit and receive boards. The most extensive changes were the addition of open collector transistor buffer circuits to improve parallel operation of consoles, and revision of the amplifier for gated TX Audio. Several other minor revisions such as component value changes have been made.

To aid the service technician in maintaining the tone module an addendum containing material lists, schematics, and pictorial assembly drawings for the transmit and receive boards has been attached to the original maintenance manual. The basic theory of operation and technical information in the manual is valid, but the updated schematics and parts lists should be used for detailed troubleshooting.

#### Transmit Audio Circuit

Gated Transmit audio from the Tone Transmit Board comes in on pin V, and is connected through C47 directly to the base of Q15, the first stage of the line driver amplifier. The second stage, Q21, drives transformer T1. The Transmit audio pair, Tx AUD HI and Tx AUDIO LO, are taken from the secondary windings of T2. The two lines are connected to a terminal block on the back of the Transmit/Receive Mother Board. (Refer to Maintenance Manual LBI30300.)

R67 and R68 are current-limiting resistors. VR3, VR16, and VR17 protect against line surges.

For two-wire audio systems, the audio is coupled through transformer T1 and capacitor C17 to the Receive audio circuit. While receiving in two-wire operation, Q5 is gated ON by TXAE, which is at logic high level. This high base drive saturates Q5 and prevents noise or transients from the Tone Transmit board from reaching the compressor amplifier.

An unbalanced Transmit audio output can also be made available, at pin 7, by adding capacitor C27. The audio is routed to solder pad E12 on the T/R Mother Board (SEC/53251-001).

### Receive Audio Circuit

For receive board, 53224-0001, Revision F and later, the following description applies.

Receive audio is coupled from the wiper of R1 through R89, R25, C18, and R26 to pin 2 of U2, a dual operational amplifier. First stage gain is determined by the ratio of R27 to the total resistance of R25, R26, and R89. DC bias for U2, as well as for U10, U11, and U12, is set by the voltage divider composed of R103 and R104. C37 provides high-frequency roll-off for the first stage of U2.

First stage output at pin 1 is directly coupled to the second stage through R29. The output of the second stage is coupled through C20 and R105, then rectified and filtered by CR7, CR8, and C19. The discharge rate of the rectified voltage on C19 is determined primarily by R79. The DC voltage on C19 is applied to the emitter follower/common emitter pair Q17 and Q18.

When the input signal is below the threshold of compression, both Q17 and Q18 are turned off and the shunt impedance of Q18 is very high. As the receive audio approaches the threshold of compression, the rectified voltage on C19 increases and begins to turn on Q17 and Q18. As Q18 begins to conduct, its collector impedance decreases, shunting part of the input signal to ground and effectively reducing the gain of the first stage of U2.

As a result, the amplitude of the audio signal at U2-1 is almost constant for input levels above the threshold of compression.

The audio signal at U2-1 is coupled through C24 to the call lamp control circuitry, and through C21 to the audio monitoring circuits. C24 couples the compressed receive audio to R10, the call lamp sensitivity control. With R10 set for minimum sensitivity, the call lamp will flash for input signals approximately equal to the threshold of compression. With R10 set for maximum sensitivity, the call lamp will flash for input signals 20 dB below threshold of compression.

The signal at the wiper of R10 is amplified with a gain of approximately 83 by U11A. The positive peaks are detected by CR30 and filtered by C50. When the input signals are large enough to raise the voltage on C50 above the reference voltage at pin 6 of U11, the output at U11-7 switches high. This output is gated with (TXAE + X-MUTE) at U6-13, inverted, and applied to U4-4 to enable the call lamp oscillator if the console is not in the transmit mode. Positive feedback through R83 provides about 4 dB of hysteresis for the call lamp comparator.

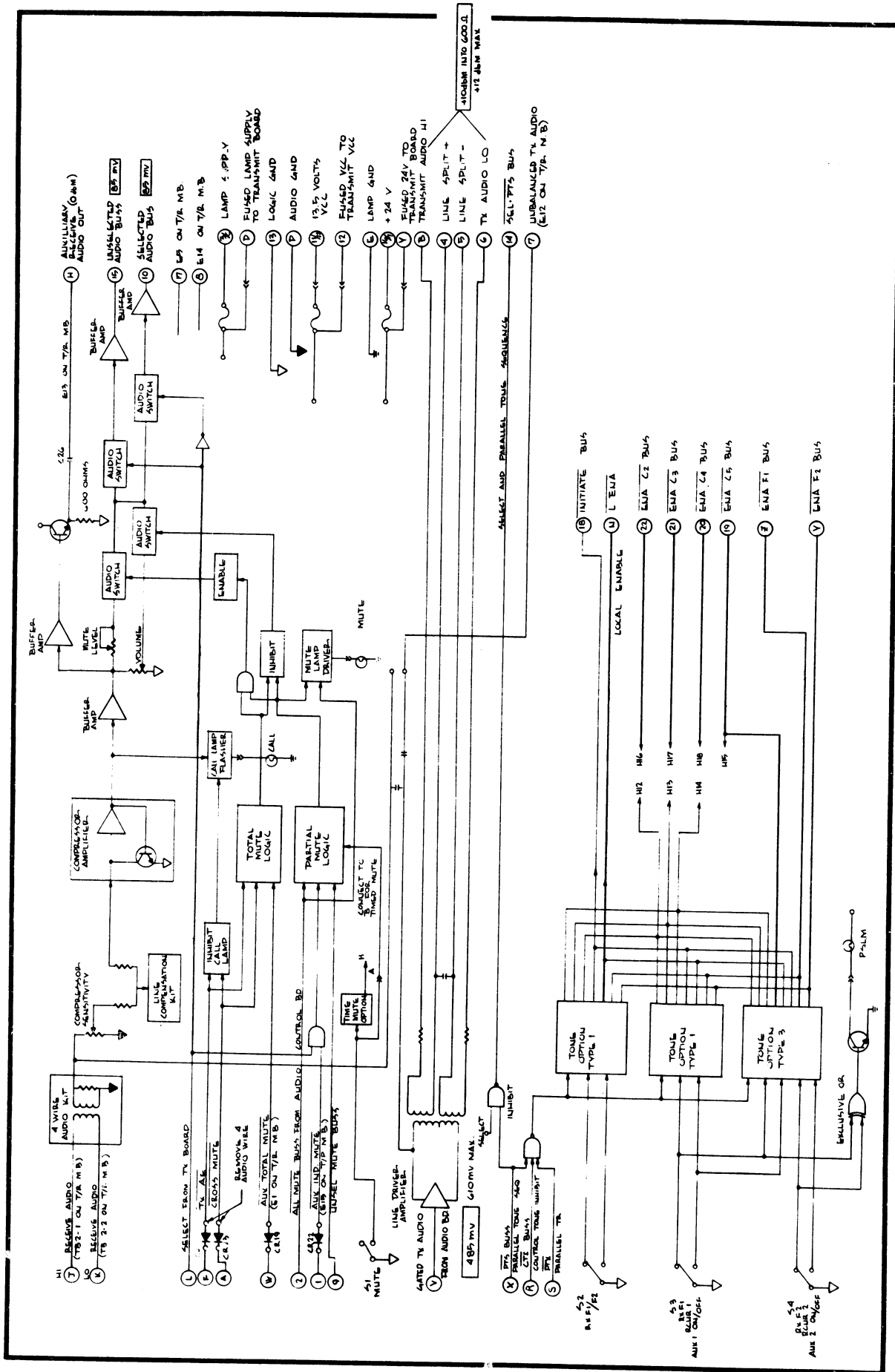


Figure 2-1 - Receive Circuit Block Diagram

The compressed audio at U2-1 is also coupled through C21 and R59 to U10-6, the input to an amplifier with a nominal gain of 4.5. The output at U10-7 is coupled through C23 to the internal volume control, the mute circuits, and ultimately to the selected and unselected audio amplifiers. It is also coupled, through C30, to the combination of U10 and Q16, an amplifier that provides approximately 0 dBm into a 600 ohm load. This output is independent of the select and mute circuits.

Compressed receive audio from U10-7 is coupled to the CW end of R2, the volume control. In the non-mute condition, audio is conducted from the wiper of R2 through C5 and FET switch Q7 to the select/unselect switches Q3 and Q4. However, if a partial mute condition exists, Q7 is turned off and audio is conducted through the MUTE LEVEL pot, R3, and Q1. In this condition the audio is attenuated by the series impedance of R3. If a total mute condition exists, then both Q1 and Q7 are turned off, and no audio is coupled to the select/unselect gates.

As shipped from the factory, audio to the MUTE LEVEL pot is taken from the top of R2 as shown. Under this condition the audio is reduced by a fixed amount below full volume when the partial mute circuit is activated. Sometimes it may be more desirable to reduce the audio by a fixed amount below adjusted volume. To achieve this, the PCB run between solder pads F and M can be cut

and J201 can be installed between solder pads V and M.

The audio is conducted through either the selected audio gate, Q3, or the unselected audio gate, Q4, to one section of U12. These amplifiers, with a nominal gain of 8, couple the audio through summing resistor R86 or R44 to the selected audio or unselected audio buss.

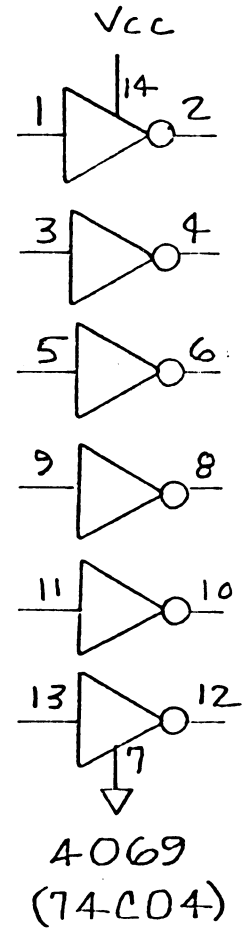
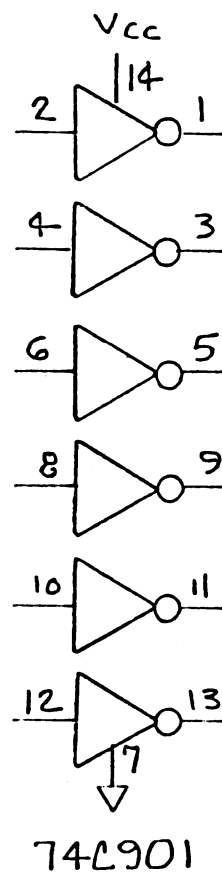
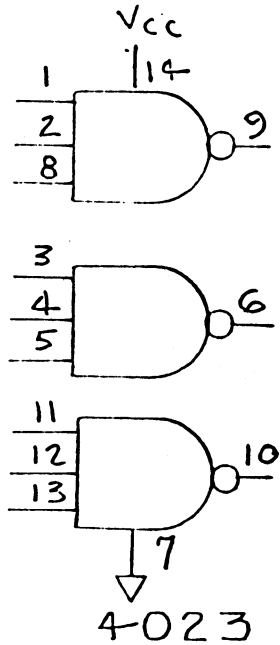
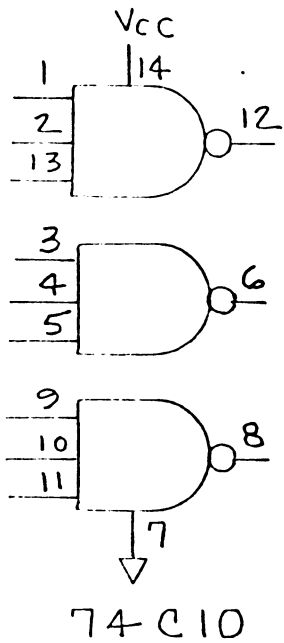
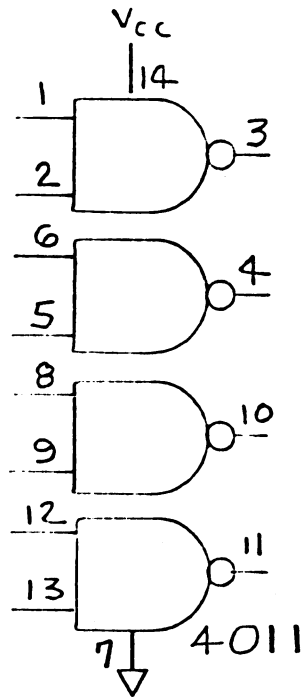
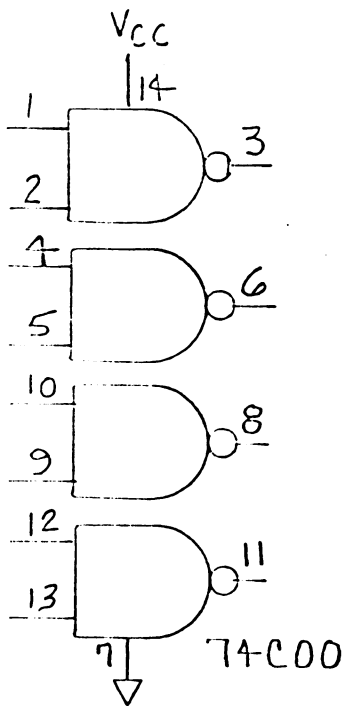
The other difference between Rev. F and previous boards involves the call lamp inhibit signal from Q24. In the later boards, Q24 is turned on for approximately 100 milliseconds by the differentiated positive-going edge of TXAE, just as in earlier boards. However, in the later boards, the collector is connected through R48 to the positive side of C50. Therefore, as long as Q24 is turned on, C50 is clamped at a level of approximately half the voltage at U11-1, keeping the comparator output at U11-7 low and inhibiting the call lamp oscillator. As soon as the 100 millisecond period is over, Q24 turns off, allowing the call lamp detector and comparator to respond normally to receive audio.

One final change involves the digital logic used in the control circuits on the receive board. Prior to Revision F, logic circuits used were of the 74C COMS series. At Revision F, a change was made to the more widely available 4000 series buffered CMOS devices. A summary of the affected devices is as follows:

Ref. Des.	Logic Function	Prior to Rev. F	Rev. F & Later
U1	Hex Non-Inverting Buffer	74C902 (SEC/50709-0902)	Deleted Completely
U3, U6	Quad 2-input NAND Gate	74C00 (SEC/50709-0400)	4011 (SEC/50704-0011)
U5	Hex Inverter	74C04 (SEC/50709-0004)	4069* (SEC/50704-0069)
U7	Quad 2-input Exclusive-OR GATE	74C86 (SEC/50709-0086)	4070* (SEC/50704/0070)
U8	Hex Inverting Buffer	74C901 (SEC/50709-0901)	4069 (SEC/50704-0069)
U9	Triple 3-input NAND Gate	74C10 (SEC/50709-0010)	4023 (SEC/50704-0023)

\*Note that the 4069 and 4070 are pin compatible with the 74C04 and 74C86, respectively, and can, therefore, be substituted in boards without board layout changes. The other devices are not pin compatible, and, therefore, can not be interchanged. The 74C00 cannot be directly replaced with the 4011; the 74C901 cannot be replaced directly with the 4069; the 74C10 cannot be replaced directly with the 4023.

Pin connection differences between the 74C and 4000 series devices are shown on page 6.



Receive audio is coupled through T1 and C17 to R1, the sensitivity adjustment pot of the compressor amplifier. The signal is then conducted from the wiper terminal of the pot through R89, R25, C18 and R26 to pin 6 of U2, the input to the first stage of the compressor amplifier. Integrated circuit U2 is a quad, high-gain op amp. The first-stage gain of the compressor amplifier is determined by the ratio of the resistance to R27 to the total resistance of R25, R26 and R89. R31 fixes the DC bias, and C37 provides a negative feed-back loop to prevent oscillations.

The output of the first stage of the compressor amplifier is connected through C6 to the second stage. The Receive audio is amplified further and fed to the rectifier circuit consisting of CR7, CR8 and C19. When the rectified audio reaches the compression threshold level, Q17 conducts and turns the Automatic Gain Control transistor, Q18, ON. This reduces the amplitude of the audio input to the compressor amplifier.

The base of Q19 is also driven by the rectified audio signal. When the signal level goes high, Q19 turns ON and cuts off Q20. This raises the pin-12 input to gate U6 to the high logic level, and since the other input is also high, the output of U6 switches to the low level. The low-level output is inverted, and used to drive the Call lamp flasher circuit.

While transmitting, the TXAE signal is low. When Push-to-Talk is deactivated, TXAE goes high. The positive-going signal propagates through two stages of U5 and is differentiated by C25-R37, causing Q9 to momentarily saturate. Since the collector of Q9 is connected to the rectifier circuit of the compressor amplifier (through R98), the momentary conduction of Q9 discharges C19 and thereby "resets" the compressor.

Transistor Q24 is also driven by a differentiated pulse derived from the changing TXAE signal. The collector signal of Q25 is conducted through U6 and U5 to the input of U4 to inhibit the Call lamp during the first instant after reset.

Two of the U2 amplifier stages, input 11/output 10 and input 8/output 9, serve as tandem buffer amplifiers for the compressor output. The second buffer drives Q16, an emitter follower, to provide an Auxiliary Receive audio output signal. Note that C26 must be in place to connect the signal to pin H of the PC board. This 600-ohm output is connected to solder pin E13 on the T/R Mother Board.

The output at pin 10 of U2 is also coupled to the Mute Level and Volume adjust pots. The Mute Level pot is connected to the Partial Mute gate, Q1, and the Volume adjust pot is connected to the Total Mute gate, Q7. The outputs of the mute gates are tied together and connected to the Selected

and Unselected audio gates, Q3 and Q4, respectively. (See the logic circuit discussion below.) The output of the Unselected audio gate drives buffer-amplifier Q10, Q11, and provides the Unselected audio output. The output of the Selected audio gate drives buffer-amplifier Q12, Q13, and provides the Selected audio output. The Unselected audio outputs of all channel modules are connected together and to the Unselected Speaker amplifier. The Selected audio outputs are similarly connected to the Selected Speaker amplifier.

Four-wire audio control and line compensation are provided by adding and removing certain PC board components:

#### SEC/53393-001 Kit 4-Wire Audio

For 4-wire audio, make the following changes to the Receive board. Install T2 (SEC/51431-001), change R71 (1.2K ohms) to 620 ohms (SEC/51016-621) and R55 (1.2K ohms) to 620 ohms (SEC/51016-621) and remove R101, R102, Q25, C17, C28, CR18 and CR23.

Receive audio is conducted to board pins J and K through pins 1 and 2 of TB2. Audio is coupled to the receive circuits directly from the secondary of T2. C17 is removed to isolate Transmit audio from Receive audio. CR18 and CR23 are removed to prevent muting of the Receive audio during a transmit function. Q25 is no longer needed since the Transmit audio is isolated from the Receive audio.

#### SEC/53392-001 Kit Line Compensation

This option compensates for telephone line losses in the 1000 to 3000 Hz range. It should be used when attenuation in the 2500- to 3500-Hz range is more than 10 dB below the 400- to 600-Hz level.

For line compensation, install the following parts on the Receive board: L1, R92 and C45. L1 and C45 constitute a parallel resonant circuit which reflects a high impedance at approximately 3000 Hz. Lower frequencies are attenuated to a level set by R92.

#### Receive Logic Circuit: Selected and Unselected Audio Gates

The Select signal is generated on the Transmit Board (SEC/53207-001), and comes in to the Receive Board on pin L. The Select signal goes high when a module is selected. It is inverted by one inverter of U5, and then cuts off Q5 causing its collector to pull up to 24 volts. This turns Q3 ON, and audio is conducted to the Selected audio buss. The Select signal also drives the base of Q6, causing it to saturate and its collector to go low. This turns Q4 OFF,

which isolates the audio from the Unselected audio buss. When the module is not selected, Q4 is ON and Q3 is OFF, thereby routing the Receive audio to the Unselected audio buss.

#### Receive Logic Circuit: Total Mute

Total Mute is controlled by three logic signals: AUX TOT MUTE, CROSS MUTE and TXAE.

Auxiliary Total Mute (AUX TOT MUTE) is available on a per channel basis at solder terminal E1 on the Transmit/Receive Mother Board, and comes in to the Receive board on pin W. It is diode isolated from the logic, and will total-mute the Receive audio when E1 is grounded. Note that CR19 must be installed.

When E1, AUX TOT MUTE, is grounded, pin 5 of U6 goes high and pin 6 goes low. This causes output pins 6 and 3 of U3 to go high, which, in turn, saturate Q2 and Q8. This cuts off both the Partial Mute gate (Q1) and the Total Mute gate (Q7), thereby completely inhibiting the audio.

CROSS MUTE and TXAE are two-wire audio system logic signals. Both signals are generated on the DC Transmit Board, and both are normally high. When a parallel console is keyed, the CROSS MUTE signal goes low. The CROSS MUTE signal is logically "ANDed" by U6 with AUX TOT MUTE, and the sequence of operation is the same as for the AUX TOT MUTE function described above. TXAE goes low when Push-to-Talk is activated, and the same logic sequence as described above occurs because TXAE is also "ANDed" with AUX TOT MUTE. Note that CR18 and CR23 must be installed for two-wire audio.

Diodes CR18 and CR23 serve as AND gate input diodes for CROSS MUTE and TXAE. When both signals are present, pin 6 of U6 goes high. The U6 output is inverted and applied to U5 to provide a CALL lamp enable signal if audio is present.

#### Partial Mute Logic Circuit

The Partial Mute logic is controlled by four separate logic functions: ALL MUTE, AUX IND MUTE, UNSEL MUTE and LOCAL MUTE.

ALL MUTE is a normally-high logic signal generated on the Audio/Control Board (SEC/53209-001). It can be timed or untimed. When ALL MUTE goes low, pins 1, 8, 9 and 13 of U3 also go low. If there is no total mute signal, pins 5 and 6 of U3 are high (pins 8 & 9 are low), and output pin 4 is low. This cuts Q8 OFF and enables the Partial Mute gate Q1. Since pin 1 of U3 is also low, output pin 3 is high. This turns on Q2 which disables audio gate Q7. This causes the audio to be routed through the Partial Mute gate. Pin 13 of U3 is also pulled low with a Partial Mute signal. This

causes output pin 11 to go high and turn on the MUTE lamp.

Auxiliary Individual Mute, AUX IND MUTE, - sometimes called auxiliary partial mute - is available on a per channel basis at solder terminal E15 on the T/R Mother Board. It is diode-isolated from the logic by CR22, and will partial-mute the Receive audio when a ground is applied to E15. This ground effects the same partial mute logic described in the preceding paragraph, because AUX IND MUTE is diode "ANDed" with the ALL MUTE signal.

Unselect Mute (UNSEL MUTE) is a normally-high signal generated on the Audio/Control Board. It can be timed or untimed. When UNSEL MUTE goes low, the sequence of operation is the same as for partial mute operation. If UNSEL MUTE is low, then pin 11 of U5 is low, pin 10 is high, and pin 10 of U6 is high. If the module is not selected, then pin 9 of U6 is also high and pin 8 is low, causing partial mute operation.

Local mute is generated by the Mute switch, S1, on the module. The switch function can be momentary, timed or AA (Alternate Action) for nontimed mute. If the cathode of CR20 is jumper-wired to B, S1 functions as a momentary switch.

If the Timed Mute option, Module Timed Mute Kit SEC/53517-001, is installed, the Partial Mute will be timed. (Refer to Maintenance Manual LBI30300 for the circuit analysis of the Timed Mute circuit.) Partial Mute is standard if S1 is installed as an AA switch by jumper-wiring the cathode of CR11 to A.

#### SEC/53513-001 Kit Two Frequency Receive

Receive F1/F2 (Rx F1/F2) is accomplished by installing an alternate-action switch for S2, the appropriate Tone option board and jumper wires. See the table below.

#### SEC/53510-001 Kit Two Separate Receivers

or

#### SEC/53511-001 Kit Frequency 1, Frequency 2 with PSLM

To provide these functions, S3 and S4 (AA switches) are installed along with the appropriate Tone option board and jumper wires. See the table below.

#### SEC/53506-001, SEC/53507-001 Kits Auxiliary Tone Functions: Aux 1 ON/OFF, Aux 2 ON/OFF

To provide these functions, S2 and S4 (AA switches) are installed along with the appropriate Tone options and jumper wires. See table on the next page.

FUNCTION	SWITCH			SOCKET		Jumper wire from to	
	S2	S3	S4	J1	J3		
Rx F1, Rx F2 with PSLM	PSLM Indicator Only	Rx F1	Rx F2		Type 2 Tone Option	H12	H16
RCVR 1 RCVR 2 RCVRS 1 & 2	RCVR 1 & 2 Indicator Only	RCVR 1	RCVR 2		Type 2 Tone Option	H12	H16
AUX 1 ON/OFF AUX 2 ON/OFF		AUX 1 ON	AUX 2 ON		Type 3 Tone Option	H18	H12
Rx F1/F2	Rx F1 Rx F2			Type 1 Tone Option		H14	H16
Rx F1/F2 AUX 1 ON/OFF AUX 2 ON/OFF	Rx F1 Rx F2	AUX 1 ON	AUX 2 ON	Type 1 Tone Option	Type 3 Tone Option	H14 H18	H16 H12

### Tone Sequence Logic

The different Tone options generate different logic commands. (See the discussion below under Tone Control Options.)

Option output commands are buffered by inverters U7, U8 and U9. Inverter outputs are selectively connected, using isolation diodes, to provide output functions. The L ENA function appears at pin N (L ENA buss) whenever any switch is activated, as does INITIATE, which is brought out of the board on pin 18, the INITIATE buss.

Jumpers H12 through H18 are used to select the proper frequencies for the desired functions. See the table above. These signals, ENA C2-ENA C5, ENA F1 and ENA F2, are buffered by U1 then connected to the board edge pins. When S3 and S4 are used for Rx F1 and Rx F2 or for RCVR 1 and RCVR 2, exclusive OR gate U7 causes Q14 to turn on when both switches are out or when both switches are in. This generates a PSLM "on" indication or RCVR 1 & 2 indication.

PTS, CTI and PTX functions are "ANDed" together by U9 (inputs 3, 4 and 5). Whenever one or more of these signals go low, all Tone Sequence logic is inhibited.

The SELECT signal and the inverted PTS are "ANDed" by U6 to provide logic signal SEL-PTS, which is brought out on buss pin 14.

### Auxiliary Switch Contacts

If S3 and S4 are not used the following pins are available.

S3 - N.O.	Top of Switch	-----
S3 - comm.	Top of Switch	Remove JS3.
S3 - N.C.	Top of Switch	Remove J102
S4 - N.O.	Top of Switch	-----
S4 - comm.	Top of Switch	Remove JS4.
S4 - N.C.	Top of Switch	Remove J103

The following auxiliary outputs are available for using these contacts.

*	**	
E14	pin 8 - always available	
E1	pin W - Remove CR19. (If AUX TOT MUTE not used.)	
E15	pin 1 - Remove CR22. (If AUX IND MUTE not used.)	
E13	pin H - Remove C26. (If AUX Rx AUD not used.)	
E12	pin 7 - Remove C27 and C28. (If UNBAL Tx AUD not used.)	
E5	pin 17- always available	

\* On the Mother Board

\*\* On Receive board



## TRANSMIT CIRCUIT

SEC/53207-001  
TRANSMIT BOARD

The Tone Control Transmit board contains: (1) audio and logic circuitry to process audio for transmission over telephone lines, (2) audio and logic circuitry to process and gate control tones for base station keying and (3) logic circuitry that generates control signals for the console itself. A block diagram is shown in Figure 2-2; the circuit schematic is shown in Figure 3-5.

## AUDIO FLOW

The normal control tones (all but the 1850 Hz, F2 tone (come into the Tone Transmit board on pin S, and are conducted through C32 and R60 to the first stage of amplifier, Q12. The gain of this stage is approximately R59/R60. The output, at the collector of Q12, is fed to FET audio switch, Q13. The gate of Q13 is switched by logic signal ENA NORM TONE from U5 pin 6. (See Tone Sequence Logic above.) From Q13, the tones are routed through R90, the control tone level-adjust potentiometer, to the next stage of amplification, Q9. The gain of this summing amplifier is approximately R44/R48. The signal from the emitter of Q9 is then conducted, through pin 18, (Gated Tx AUD) to the line driver amplifier on the Tone Receive board.

The F2 tone is conducted to the Tx F2 Tone Gate option from pin 22 on the Tone Transmit board. (The Tx F2 option, SEC/53208-001, circuit analysis is given below.) Then, the F2 tone (1850 Hz) is gated into the tone sequence through summing resistor R48. From this point, the F2 audio flow is the same as described for the normal control tones.

## CONTROL TONE LOGIC

FET Q13, the gate for normal control tones, is on when its input is high, or the ENA NORM TONE signal at U5 pin 6 is low. For U5 pin 6 to go low, both pins 4 and 5 must be high. Pin 4 is high as long as ENA Tx F2 TONE at U6 pin 12 is high. U5 pin 5 is high as long as either U6 pin 10 (Tx KEY) is low or as long as U6 pin 11, U6 pin 9 or L ENA is low. In an idle condition, U5 pin 4 is high, and U6 pins 9, 10 and 11 also are high. When Push-to-Talk (PTT) is activated and the module is selected, Tx KEY will go low, enabling the normal control tone path. When a non-transmit function that calls for a control tone sequence is activated, the L ENA signal from the options will go low enabling the normal control tone gate.

SEC/53509-001 Kit  
Two Frequency Transmit

For two-frequency transmit operation, install the appropriate switch in the S2 position, strap J107 to V, and install the Tx F2 Tone gate option in the appropriate socket.

The F1 frequency, 1950 Hz, is a normal control tone that is generated in the control tone sequence at the Tone board, SEC/53197-001. (Refer to the Tone board circuit analysis in LBI30300.) The tone will flow as described in the Audio Flow paragraph above.

The F2 (1850 Hz) flow is the same as described in the Audio Flow paragraph above. When PTT is activated and the Tx F1/F2 switch is in the "on" position (Tx F2), the 40-millisecond T2 logic signal at pin M of the tone transmit board will go high. This causes the ENA Tx F2 TONE signal to go low for 40 milliseconds which, in turn, disables the normal control tone gate for 40 milliseconds. The same signal at U6 pin 12 will enable the Tx F2 tone gate option and insert 40 milliseconds of 1850 Hz tone in the function tone location of the control tone sequence. When the S2 position is relaxed (Tx F1), the Tx F2 tone gate is disabled via jumper J107.

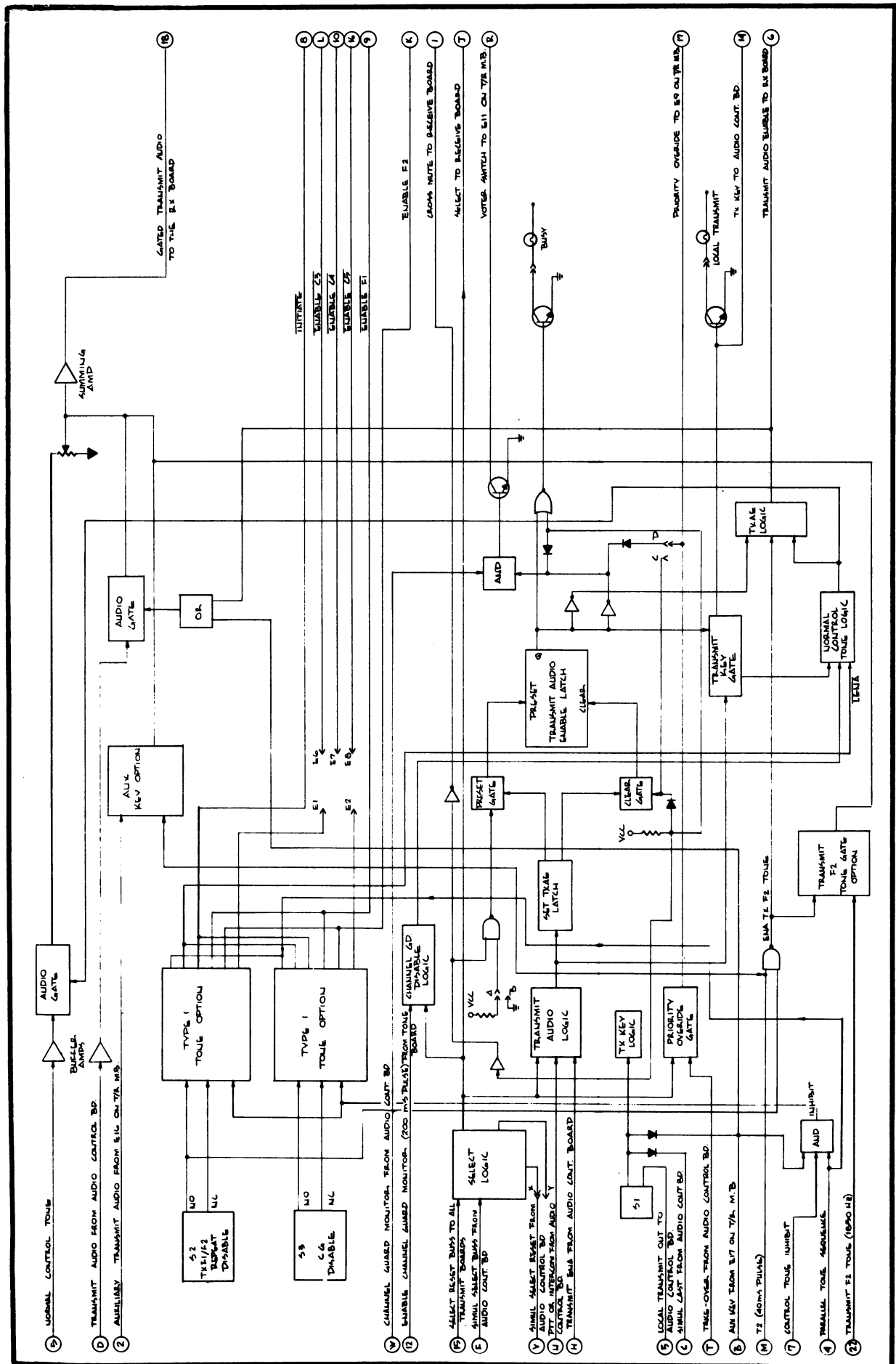
SEC/53508-001 Kit  
Repeater Disable

This is a non-transmit function and a tone sequence will appear on the line, regardless of any other functions on the module, when the Repeater Disable function is activated. For Repeater Enable (1550 Hz) and Repeater Disable (1450 Hz) install a jumper from E1 to E6, an AA (Alternate Action) switch in the S2 location and a Tone Option Type 1 board in J1. When the Repeater Disable and the Channel Guard ON/OFF functions are used together, Repeater Enable frequency becomes 1150 Hz and the Repeater Disable tone becomes 1050 Hz. In this case, a jumper is connected from E1 to E8, instead of E1 to E6.

SEC/53503-001 Kit  
Channel Guard On/Off

This is a non-transmit function and a tone sequence will appear on the line regardless of any other functions on the module when the Channel Guard (CG) function is activated. For Channel Guard "On" (1550 Hz) and Channel Guard "Off" (1450 Hz), install a jumper from E2 to E6, install the appropriate switch in the S3 location and install a Type I Tone Option board in J2.

When any S2 or S3 switch is activated with a Tone module in place, the ENA F1 or ENA F2 signals go low for about 200 milliseconds. Also, the INITIATE signal and L ENA are low for 200 milliseconds. These signals are routed to the Tone board (SEC/53197-001) to initiate the appropriate sequence.



**Figure 2-2 - Transmit Circuit Block Diagram**

Select

The Select switch, S1, is momentary. Its NC and NO contacts are used to toggle pins 13 and 10 of de-bounce latch U8. Pin 8 is connected to the clock input of the Select flip-flop, U3. U3 toggles with each positive-going input.

When the Select switch is pushed, pin 8 of U8 goes high and clocks the Select flip-flop. When S1 is released, the de-bounce latch returns to its idle state. Thus, whenever the Select switch is pushed, the Select flip-flop, U3, changes state. The Q output of U3 drives the Transmit audio logic. The  $\bar{Q}$  output is inverted and drives the Select lamp. It is also connected to board pin J, the Select output, which goes to the Receive board.

The pin 10 output of U8, the de-bounce latch, is also connected to differentiating circuit C28, R45. The resulting pulse is inverted, and creates a momentary low at the anode of CR17. This occurs whenever the Select button is pushed.

The momentary low also appears at the RESET buss, pin 15, and is connected to pin 15 on all other Transmit boards through the T/R Mother Board. The signal provides an electrical interlock on all modules for the Select function. If module A is selected (module B idle) and the Select button on module B is pushed, a momentary low will appear on pin 15 of the module A Transmit board. The momentary low will produce a momentary high at pin 9 of inverter U10. This causes pin 6 of U4 to go low momentarily, which clears the Select flip-flop and "un-selects" module A. (In an idle condition with Simul-Select OFF and module A selected, pins 3 and 5 of U4 are high.)

The Simul-Select ( $\overline{SS}$ ) input at pin F is generated on the Audio/Control board and bussed to all modules. When the Simul-Select button is pushed,  $\overline{SS}$  goes low disabling all of the interlock circuits on all of the modules. This allows simultaneous selection of modules.

Simul-Select Reset

Simul-Select Reset,  $\overline{SSR}$ , is a built-in strapping option that allows one or more T/R modules to serve as "preferred lines". When Simul-Select is turned OFF, a preferred line is automatically selected and all other modules are deactivated.

The Simul-Select Reset signal is generated on the Audio/Control Board, and is bussed to all modules. It is a momentary low signal that occurs when the Simul-Select switch is de-energized.  $\overline{SSR}$  comes in to the Transmit Board on pin V, and is inverted, filtered, reinverted and applied to J103. R42 and C22 serve as the filtering components.

For a "non-preferred" line J103 is connected to X, and the momentary  $\overline{SSR}$  signal clears the Select flip-flop, U3, thereby unselecting the module when the Simul-Select switch is de-energized.

For a "preferred line" J103 is connected to Y, and the Select flip-flop is preset when the Simul-Select switch is de-energized. This causes the module to be selected.

TRANSMIT AUDIO LOGIC

There are five ways to transmit audio through a tone T/R module. When a channel is selected, Push-to-Talk (PTT), Inter-Com (IC) and the Alert tone will enable the Transmit audio function. When a module is either selected or unselected, local Transmit (S4 on the module) or Simul-Cast will enable Transmit audio.

Push-to-Talk and Inter-Com are initiated at the common control lip (see Maintenance Manual LBI30300) and "ORed" together on the Audio/Control board. The resulting logic signal, PTT + IC, is distributed to all modules. PTT and Alert Tone are also "ORed" together on the Audio/Control board. This "ORed" function is the Transmit Enable ( $\overline{TX\ ENA}$ ) signal that is bussed to all T/R modules. If a module is selected and PTT + IC goes low, pin 3 of U8 will go low. This causes pin 11 of U4 to go high, which, in turn, causes pin 12 of U4 (preset gate) to go low and preset the Transmit Audio Enable latch, U3.

The output of U3,  $\overline{TX\ AE}$ , is inverted by U2, and drives U6 pin 5. This signal is inverted by U5 and drives the base of Q7. R26 and C13 provide a delay to mask any false triggers created by noise transients. When the collector of Q7 is high, audio gate Q10 is ON.

The Transmit audio signal is generated on the Audio/Control board and bussed to pin D of all Transmit boards. The signal is connected to gate Q10 through a buffer amplifier, Q14. The gain of this buffer amplifier is approximately R86/R85. When Q10 is ON, the audio is amplified by Q9 and Q11. The level is adjusted by Audio Level adjust pot, R91. From board pin 18, the audio goes to the line driver amplifier on the Tone Receive board.

When a module is selected, and  $\overline{TX\ ENA}$  goes low, the same sequence as described above for PTT + IC occurs, and a Transmit Audio Enable signal is produced.

Local Transmit,  $\overline{LTx}$ , is generated by pushing the red button (S4) on the module.  $\overline{LTx}$  is diode coupled (CR20, CR22) with  $\overline{SC}$ , the Simul-Cast function generated on the Audio/Control board. When the local Transmit button is pushed, pin 9 of U9 and pin 10 of U4 go low and cause pin 8 of U9 and pin 8 of U4 to go high. This produces a  $\overline{TX\ AE}$  function independent of Select.

The output of U9 (pin 8) carries the LTX + SC + SEL·Tx ENA function. This function is "ANDed" with TX AE by U7 to produce a Transmit Key signal. The Tx KEY signal is inverted, and diode coupled to board pin 14. The Tx KEY signal is connected to all other Transmit Key outputs, and to the Audio/Control board. The Tx KEY signal is also used to enable the normal control tone at U6 pin 10.

The TX AE logic signal is also brought to pin 6 of the Receive board (from the T/R Mother Board) where it is used to mute the Receive audio, while transmitting, in two-wire systems.

#### Parallel Transmit

A Parallel Transmit (PTx) signal is available at E10 on the T/R Mother board on a per channel basis. The PTx input/output signal serves several functions.

If it is pulled low by a parallel console, pin 12 of U11 will go low. The other input at U11, TX AE, will also be low - if the console is not transmitting - and the output of U11 will go high. This will light the Busy lamp.

The PTx signal is also connected to pin 3 of U13, where it is inverted and then supplied as an input to the preset gate of the TX AE latch. If PTx is low, and J104 is connected to A for a "non-priority" console (see the discussion of Take Over below) then the preset gate is disabled and TX AE is suppressed.

PTx also drives the Cross Mute circuit on the Receive board. When PTx goes low, pin 4 of U13 goes high, and pin 6 of U13, which is connected to board pin 1, goes low. The CROSSMUTE Signal goes to the Receive board to mute the Receive audio in parallel systems.

#### SEC/53512-001 Kit Parallel Transmit Indicator

By installing jumpers H27, H28 and H29, and option board SEC/53233-001, the Secur-it tone or the Hold tone of a parallel console will turn on the Busy lamp on the module face.

#### Take Over

If a T/R module is selected, and the Take Over button on the common control lip is pushed, the TAKE OVER signal from the Audio/Control board goes low. This causes pin 1 and 2 of U9 to go high, pin 3 to go low and the Priority Override input/output, PRIORITY OVERRIDE, at E9 of the T/R Mother board, to go low.

When a priority console is required, the T/R module is jumper-wired for priority,

and the Take Over switch installed. When J104 is strapped to B - for priority console operation - the preset gate of the TX AE latch is always enabled. When J106 is strapped to D (Priority Console), the PRIORITY OVERRIDE at board pin 17 goes low when the priority console is keyed.

If the Center is a non-priority console, J106 is strapped to C and J104 is strapped to A on all modules. J106 connects the Priority Override signal to the clear gate, U9, of the TX AE latch, and to the PTx signal through CR15. When the Priority Override signal of a non-priority console goes low, the Transmit audio is disabled, and the Parallel Transmit signal goes low. (See the discussion of Parallel Transmit above.)

Strapping J104 to A enables the preset gate of the TX AE latch, but it can still be disabled by PTx.

#### Channel Guard Monitor

The Channel Guard Monitor signal, CG MON, is generated on the Audio/Control board, and distributed to pin W of all Transmit boards through the T/R Mother board.

CG MON is reset by PTT. (See the circuit analysis of the Audio Control Board in Maintenance Manual LBI30300.) When CG MON goes low, pin 9 of U6 goes high. If the module is selected, and PTx is not low, the CG MON tone sequence (2050 Hz) will appear at the control pair. CG MON on the common control lip will transmit the desired tone sequence on all selected channels.

#### Voter Switch

If a module is selected, TX AE is activated or CG MON on the common control lip is activated, U7 pin 8 goes high and causes Q2, the Voter Switching transistor, to turn ON. Transistor Q2 provides an open-collector output capable of sinking 500 mA at 1.4 volts. The Q2 collector is connected to board pin R, and from there to E11 on the T/R Mother board.

#### SEC/53533-001 Kit Auxiliary Key

The AUX Tx AUD signal is an auxiliary audio input available at E16 on the T/R Mother Board on a per module basis. The audio arrives at the transmit board on pin 2, and is coupled to AUX Key option pin 7. (See the SEC/53319-001 circuit analysis below.)

The AUX KEY input at pin B goes to option card pin 4. The T2, 40-millisecond signal goes to pin 5 on the option board.

The audio then goes to summing resistor R89 and then to the transmit audio gates.

## TONE CONTROL OPTIONS

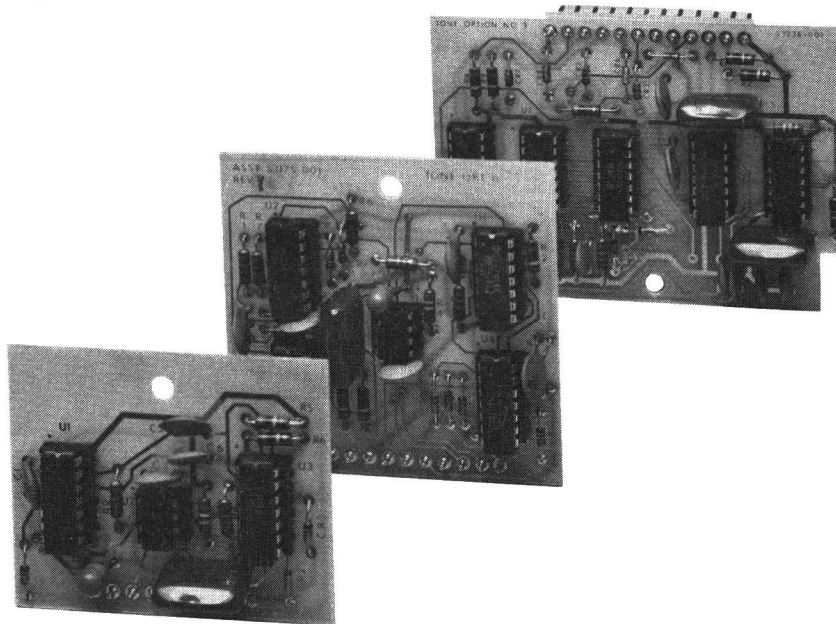


Figure 2-3 - Option Circuit Boards Types I, II &amp; III

Six plug-in PC board options are available: Tone Option Type I, Type II and Type III; Auxiliary Key Option; Transmit F2 Tone Gate; and, Parallel Tone Transmit Indicator. An assembly diagram, parts list and circuit schematic for each option is included in the Service Sheets section, Figures 6 through 11.

SEC/53171-001  
Tone Option Type I

The normally closed and normally open contacts of an Alternate Action DPDT switch are connected to pins 3 and 7 of the option board. If the switch is in the "out" position, pin 3 of U3 is high and pin 6 is low. When the switch is depressed, this cross-coupled latch changes state. The high-going signal at U3 pin 6 is differentiated by C6 - R4 causing pin 13 of U1 to go low momentarily. The same transistion will occur when the switch is deactivated and the high-going signal at U3 pin 3 is differentiated by C5 - R2. If the inhibit signal at pin 6 of the option card is not present, the momentary signal of U1 pin 13 is inverted by U1 (in pin 9/out pin 10) and again by U1, pins 2 and 1. This momentary signal at U1 pin 1 will trigger the timer.

R3 and C4 set the time constant of the timer output to 200 milliseconds. If the switch is depressed and stays in, U3 pin 9 is enabled and U3 pin 8 (ENA F2 at pin 1 of

the option) will go low for 200 milliseconds. If the switch goes to the out position, U3 pin 11 (ENA F2 at pin 1 of the option card) will go low for 200 milliseconds. U1 pin 4 will go low for 200 milliseconds whenever there is a change of state on the switch.

When pin 6 (INHIBIT) is high, the timer is disabled.

SEC/53175-001  
Tone Option Type II

The normally closed and the normally open contacts of S3 (Rx F1) are hooked to pins 11 and 10, respectively, of the option board. When S3 is "out", pin 1 of the debounce latch U5 is low and pin 5 is high. This "one" sets pin 3 and "zero" sets pin 6. When S3 is pushed, the positive going signal is differentiated by C2 - R8, thereby creating a momentarily low at U2 pin 10. While the inhibit signal at pin 9 of the option board is normally low, a momentary high will appear at U2 pin 13. When S3 is deactivated, the high-going signal at U5 pin 3 is differentiated by C8 - R5 causing the momentary signal to ripple through to pin 13 of U2.

The same sequence will occur for the circuitry attached to S4 (Rx F2) through card option pins 2 and 3. The momentary pulses generated by any changes of state at S3 and S4 are "ORed" together by CR1 and

CR2. This signal is inverted by U1 (pins 13 and 11) to create a trigger pulse for the timer input of U3. R4 and C5 create a 200 millisecond time constant for the output of U3, which will toggle for 200 milliseconds whenever it sees a trigger pulse on pin 2.

Whenever either S3 or S4 is closed, pin 3 of U1, an exclusive OR gate, will be high. This enables pin 3 of U4, or the ENA C2 signal at pin 6 of the option, to go low for 200 milliseconds. This cannot happen when both switches are "in" or when both switches are "out". The high signal at U1 pin 3 is inverted by U1 pins 5 and 4 to prevent U4 pin 6, the ENA C5 signal at pin 1 of the option board, from toggling.

When conditions are correct for U4 pin 3 to toggle (see above), U1 pin 10 will also toggle for 200 milliseconds. If S3 is "in", U4 pin 13 will be high, and U4 pin 11 will toggle with the output of U1 pin 10. This causes the ENA F1 signal at pin 5 of the option card to go low for 200 milliseconds. If S3 is "out" and S4 is "in", U4 pin 8 will toggle when the output of U1 pin 10 changes. This causes the ENA F2 signal at pin 4 of the option board to go low for 200 milliseconds.

Whenever the switch positions go to either both in or both out, pins 4 and 5 of U4 go high for 200 milliseconds. This causes the ENA C5 and the ENA F2 signals to go low for 200 milliseconds. (PSLM).

Whenever pin 9 (INHIBIT) is high, the timers will be disabled.

#### SEC/53238-001 Tone Option Type III

The normally closed and normally open contacts of S3 on the Tone Control Receive Board (SEC/53224-001) are connected to pins 11 and 10, respectively on the option board. When the switch is normally closed (out position), U1 pin 11 is high and U1 pin 3 is low. When the switch is depressed, this cross-coupled de-bounce latch changes state. The high-going signal at U1 pin 3 is differentiated by C2 - R3. The resulting "spike" appears at U2 pin 6. Since U2 pin 5 is low, U2 pin 4 goes low momentarily. While the inhibit signal at board pin 9 is low, U2 pin 1 will momentarily go high. This momentary signal is inverted by U4 (pin 11 in/ pin 10 out) and then triggers the NE 555 IC timer. The same sequence occurs when S3 is deactivated. The high going signal at U1 pin 11 is differentiated by C8 - R5 causing a trigger pulse to ripple through to the timer.

R6 and C5 create a 200-millisecond time constant for the timer output. U1 pin 4 is connected directly to the cross-coupled latch on the input, while pin 5 is connected to the timer output. This causes the ENA F1 signal at pin 5 to go low for 200 milli-

seconds only when S3 is depressed. The ENA F2 signal at pin 4 goes low for 200 milliseconds only when the switch goes from the "in" to the "out" position.

The timer output is inverted by U1 pins 1 and 2, causing the ENA CN signal to toggle with either transition of the switch.

The circuit connected to switch S4 is identical in operation to the circuit just discussed. The outputs of both timers are diode "ORed" by CR4 and CR5 so that when either switch changes state, the ENA signal at pin 7 goes high for 200 milliseconds. Also, the output of the S4 timer, which is inverted by U4 (in pin 5/out pin 6) and will cause the ENA C5 signal to go low for 200 milliseconds whenever S4 changes position.

When board pin 9 (INHIBIT) is at high logic level, the timers are disabled.

#### SEC/53319-001 Aux Key Option

Refer to the transmit board schematic in the Service Sheets section.

When AUX KEY goes low, U1 pin 4 goes high and pin 1 goes low. This causes differentiating circuit C2-R3 to set the toggle flip-flop of U2 to a high at pin 11 and a low at pin 8. Also, when U1 pin 4 goes high, U2 pin goes high waiting for pin 5 to go high.

When AUX KEY goes low, a tone sequence has begun. When the tone sequence is over - after about 165 milliseconds - T2 will go low. When T2 goes low, U1 pin 13 goes high causing U1 pin 10 to go low. When U1 pin 10 goes low, the toggle flip-flop is reset and U2 pin 5 goes high. With both inputs high, U2 pin 6 goes low and cuts off Q3. The AUX Tx AUD can now flow through buffer amplifier Q1, through audio gate Q2 and on to the gated Transmit audio output pin on the transmit board. Note that the Auxiliary audio can be transmitted only after a complete tone sequence is transmitted. Note also that the input impedance is set by either R18 (620 ohms) or R17 (22K ohms).

#### SEC/53208-001 Transmit F2 Tone Gate

The F2 tone, 1850 Hz, is always present at pin 1 of the option connector. When the F2 function tone is called for, a logic low appears at pin 4 for 40 milliseconds. This turns Q1 off, which raises the gate voltage of Q3 to 24 volts and turns it on. The F2 tone can now flow through buffer-amplifier Q2 to output pin 3. The buffer-amplifier gain is approximately R5/R2.

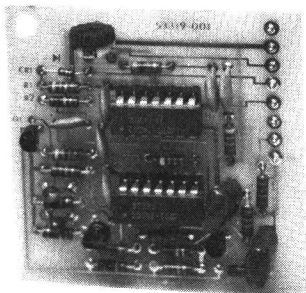
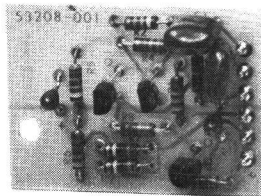
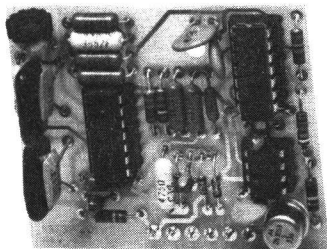
*AUX Key**Parallel Tone Transmit Indicator**Tx F2 Tone Gate*

Figure 2-4 - Option Circuit Boards

## SEC/53233-001

Parallel Tone Transmit Indicator

Installation of straps H27, H28 and H29 on the Tone Control Receive Board, SEC/53224-001, connects Receive audio to this option board. The audio is conducted through R14 to pin 12 of U1, the first stage of amplification.

The output of this stage is connected to input pin 3 of band-pass amplifier U1. The gain of this amplifier is highest at 2175 Hz, the Secur-It Tone and Hold tone frequency. Its output then feeds another band-pass amplifier, U1 pin 6, through sensitivity-adjust pot R1. The output at U1 pin 4 is then detected by CR1, CR2 and C9.

The detector output drives comparator U1 (pin 13) which has some hysteresis. When the detector output reaches a sufficient level, U1 pin 9 will go high. At this time, the timer output is low causing U2 pin 4 to go low, and U2 pin 10 to go high and light the Busy lamp.

Should the 2175 Hz on the Receive audio disappear for a moment, the comparator output will go low causing U2 pin 1 to go high. This signal is differentiated by C6 - R15, and causes the timer to trigger.

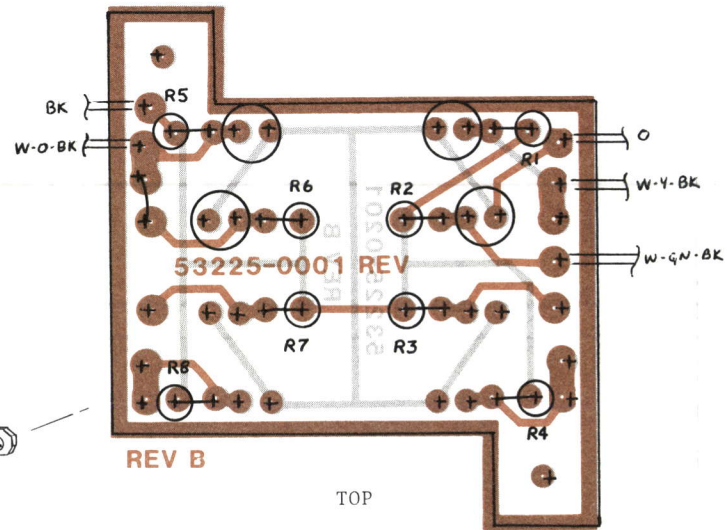
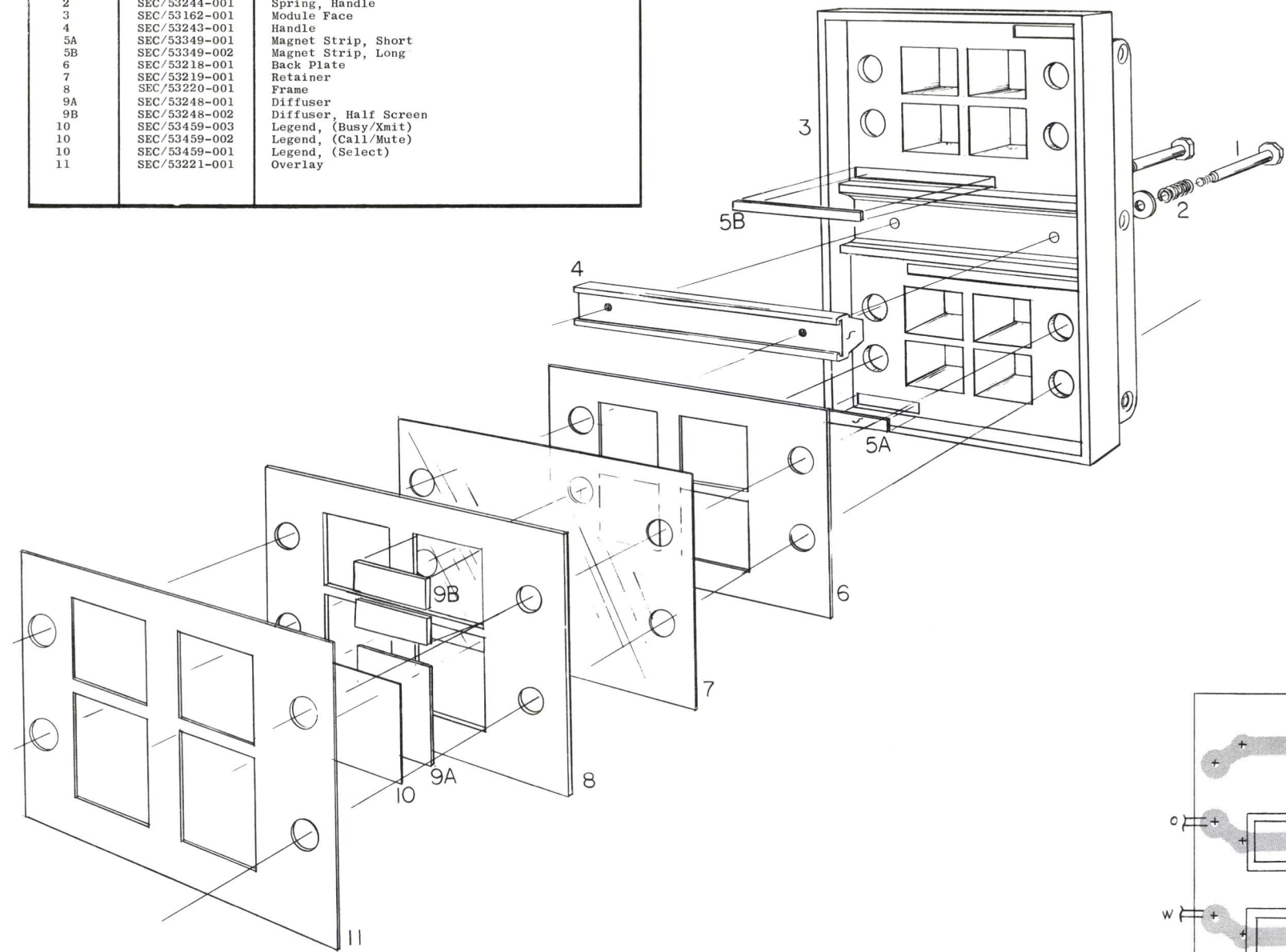
The timer circuit will cause the Busy lamp to remain "on" for approximately one second after the 2175 Hz is gone.

GENERAL ELECTRIC COMPANY • MOBILE COMMUNICATIONS DIVISION  
WORLD HEADQUARTERS • LYNCHBURG, VIRGINIA 24502 U.S.A.

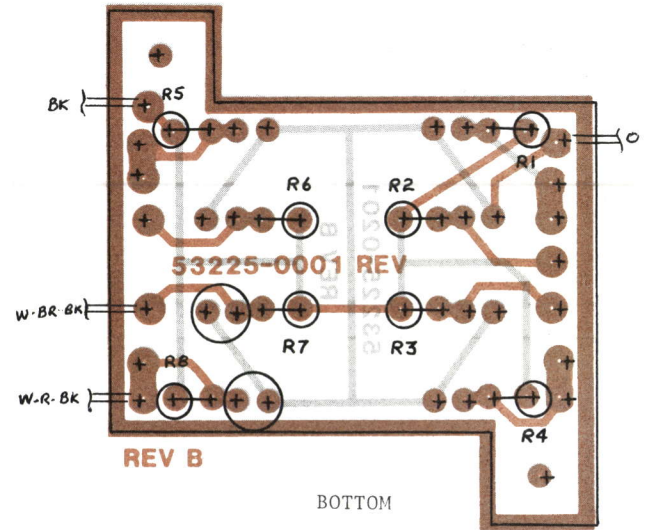
**GENERAL**  **ELECTRIC\***  
U.S.A.



ITEM	GE PART NO.	DESCRIPTION
1	SEC/53241-001	Stud, Handle
2	SEC/53244-001	Spring, Handle
3	SEC/53162-001	Module Face
4	SEC/53243-001	Handle
5A	SEC/53349-001	Magnet Strip, Short
5B	SEC/53349-002	Magnet Strip, Long
6	SEC/53218-001	Back Plate
7	SEC/53219-001	Retainer
8	SEC/53220-001	Frame
9A	SEC/53248-001	Diffuser
9B	SEC/53248-002	Diffuser, Half Screen
10	SEC/53459-003	Legend, (Busy/Xmit)
10	SEC/53459-002	Legend, (Call/Mute)
10	SEC/53459-001	Legend, (Select)
11	SEC/53221-001	Overlay



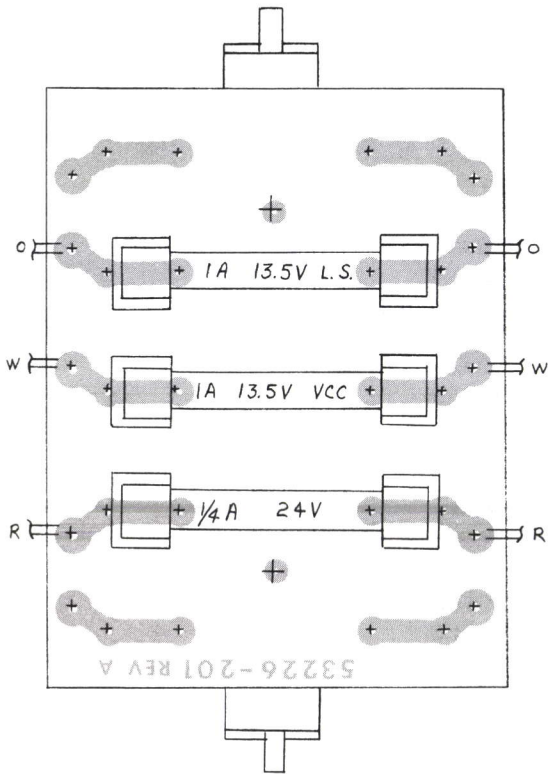
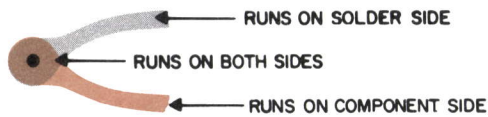
(53225-TAB-2, Rev. D)  
(53225-0001 Rev. B)  
(53225-0201, Rev. B)



(53225-TAB-1, Rev. D)  
(53225-0001 Rev. B)  
(53225-0201, Rev. B)

SYMBOL	GE PART NO	DESCRIPTION
R1-R8	SEC/51016-202	RESISTORS
		2K ohms.
	SEC/25569-003	SOCKETS, JACKS, RECEPTACLES
		Socket, Pin.
	SEC/50507-020	MISCELLANEOUS
	SEC/50551-003	Lamp, 18V, T-1 3/4.
	SEC/50551-002	Color Filter, Amber Lens Cap.
		Color Filter, Red Lens Cap.

SYMBOL	GE PART NO	DESCRIPTION
	SEC/24135-003	SOCKETS, JACKS, RECEPTACLES
		Receptacle.
	SEC/14820-011	MISCELLANEOUS
	SEC/14820-017	Fuse, 1/4A, Fast Blow (24V, +150V, -150V)
	SEC/50503-001	Fuse, 1A, Fast Blow (Vcc, Lamp Supply)
		Fuse Clip.



(53226-301-1, Rev. 0)  
(53226-201, Rev. A)

MODULE FACE ASSEMBLY, LAMP  
BOARD AND FUSE ASSEMBLY

Figure 3-1



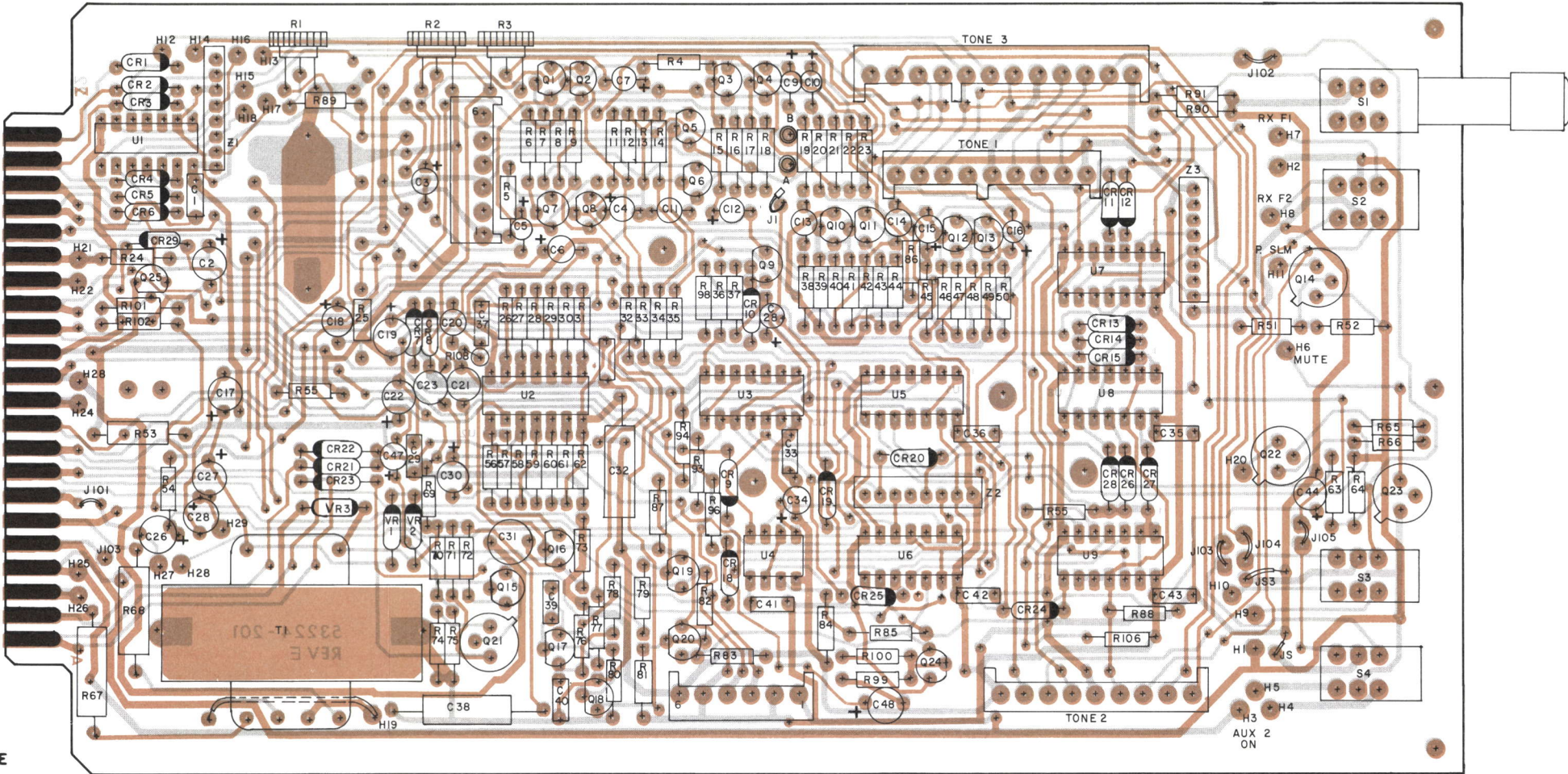
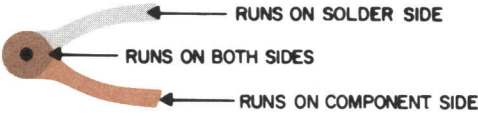
SYMBOL	G.E. PART NO.	DESCRIPTION
CAPACITORS		
C1, C24, C29, C33, C34, C35, C36, C40-C43, C46	SEC/25853-008	.01 uF, 10 V, Ceramic disc
C2, C11, C12, C44, C34	SEC/50183-685	6.8 uF, 35 V, Tantalum Electrolytic
C5, C7-C10, C13-C16, C18, C20, C47	SEC/25076-105	1.0 uF, 35 V, Tantalum Electrolytic
C6, C17, C21, C23, C26, C27, C28, C30	SEC/25076-225	2.2 uF, 35 V, Tantalum Electrolytic
C19, C35, C48	SEC/25076-335	3.3 uF, 35 V, Tantalum Electrolytic
C22	SEC/25078-107	100 uF, 20 V, Tantalum Electrolytic
C31	SEC/25076-226	22 uF, 35 V, Tantalum Electrolytic
C32, C38	SEC/15424-107	100 uF, 16 V, Aluminum Electrolytic
C37, C39	SEC/25501-221	220 pF, 500 V, Mica
DIODES/RECTIFIERS		
CR1-CR15, CR18-CR29	SEC/15104-011	1N4148, Silicon, Small signal
DIODES/VOLTAGE REGULATORS		
VR1, VR2	SEC/24376-015	12 V, 1W, 1N4742A, Zener
VR3	SEC/24379-048	14 V, 1W, 5%, Zener
INTEGRATED CIRCUITS		
U1	SEC/50709-902	74C902 CMOS
U2	SEC/50705-001	LM3900 Quad Amp
U3, U6	SEC/50709-400	74C00 CMOS
U4	SEC/50701-001	NE555 Timer
U5	SEC/50709-004	74C04 CMOS
U7	SEC/50709-086	74C86 CMOS
U8	SEC/50709-901	74C901 CMOS
U9	SEC/50709-010	74C10 CMOS
INDUCTORS, TRANSFORMERS		
T1	SEC/51426-001	Transformer
POTENTIOMETERS		
R1	SEC/51100-8503	50 Kohms, 1W, 5%
R2	SEC/51100-8502	5 Kohms, 1W, 5%
R3	SEC/51100-8105	1 Mohms, 1W, 5%
SWITCHES		
RESISTORS		
(Resistors are 1/4W, 5% carbon composition unless otherwise described.)		
R4, R5, R21, R106	SEC/51016-104	100 Kohms
R22, R23, R27, R82, R8, R9	SEC/51016-105	1 Mohm
R6, R7, R15, R17, R80, R28	SEC/51016-185	1.8 Mohms
R8, R9, R16, R18, R38, R44, R45, R86	SEC/51016-223	22 Kohms
R11-R14, R36, R52, R64, R66, R88, R90, R91, R99-R102	SEC/51016-103	10 Kohms
R19, R20, R51, R63, R65	SEC/51016-472	4.7 Kohms
R24, R43, R50, R73, R76	SEC51016-101	100 Ohms

SYMBOL	G.E. PART NO.	DESCRIPTION
R25, R77, R89, R26	SEC/51016-512	5.1 Kohms
R29	SEC/51016-204	200 Kohms
R30, R87,	SEC/51016-395	3.9 Mohms
R31, R58, R78	SEC/51016-224	220 Kohms
R32-R35	SEC/51016-333	33 Kohms
R37, R41, R48	SEC/51016-153	15 Kohms
R39, R46	SEC/51016-822	8.2 Kohms
R40, R47, R81	SEC/51016-623	62 Kohms
R42, R49, R54	SEC/51016-621	620 Ohms
R53	SEC/51017-100	10 Ohms, 1/2W
R56	SEC/51016-334	330 Kohms
R57	SEC/51016-154	150 Kohms
R60, R79	SEC/51016-564	560 Kohms
R61	SEC/51016-684	680 Kohms
R67, R68	SEC/51018-100	10 Ohms, 1W
R62, R69	SEC/51016-100	10 Ohms
R55, R71	SEC/51016-122	1.2 Kohms
R70	SEC/51016-823	82 Kohms
R72, R83	SEC/51016-133	13 Kohms
R74	SEC/51016-560	56 Ohms
R75	SEC/51016-243	24 Kohms
R84, R59	SEC/51016-273	27 Kohms
R85	SEC/51016-203	20 Kohms
R93-R96	SEC/51016-102	1 Kohm
R98	SEC/51016-473	47 Kohms
R105	SEC/51016-302	3 Kohms

SYMBOL	G.E. PART NO.	DESCRIPTION
RESISTOR NETWORKS		
Z1-Z3	SEC/51014-7104	100 Kohms
SOCKETS/JACKS/RECEPTACLES		
For U1-U3, U5-U9	SEC/25290-008	IC Socket, 8-pin
For U8	SEC/25290-014	IC Socket, 14-pin
—	SEC/24135-003	Strapping receptacle
For H1-H29, J102, A, B	SEC/24134-0001	Pin, Solid
SWITCHES		
S1	SEC/51316-002	DPDT, Alternate Action
—	SEC/51317-008	Button Switch, gray
TRANSISTORS		
Q1, Q3, Q4, Q7	SEC/51205-3458	2N3458, N-Channel FET
Q2, Q5, Q6, Q8-Q13, Q15, Q16, Q17, Q24, Q25	SEC/51205-3904	2N3904, Silicon NPN
Q18-Q20	SEC/51205-5210	2N5210, Silicon NPN
Q21	SEC/51205-3053	2N3053, Silicon NPN
Q14, Q22, Q23	SEC/51205-3053	2N3053, Silicon NPN
MISCELLANEOUS		
For Q21	SEC/20345-001	Transistor, Pad
For Q14, Q22, Q23, Q21	SEC/20345-001	Transistor, Pad

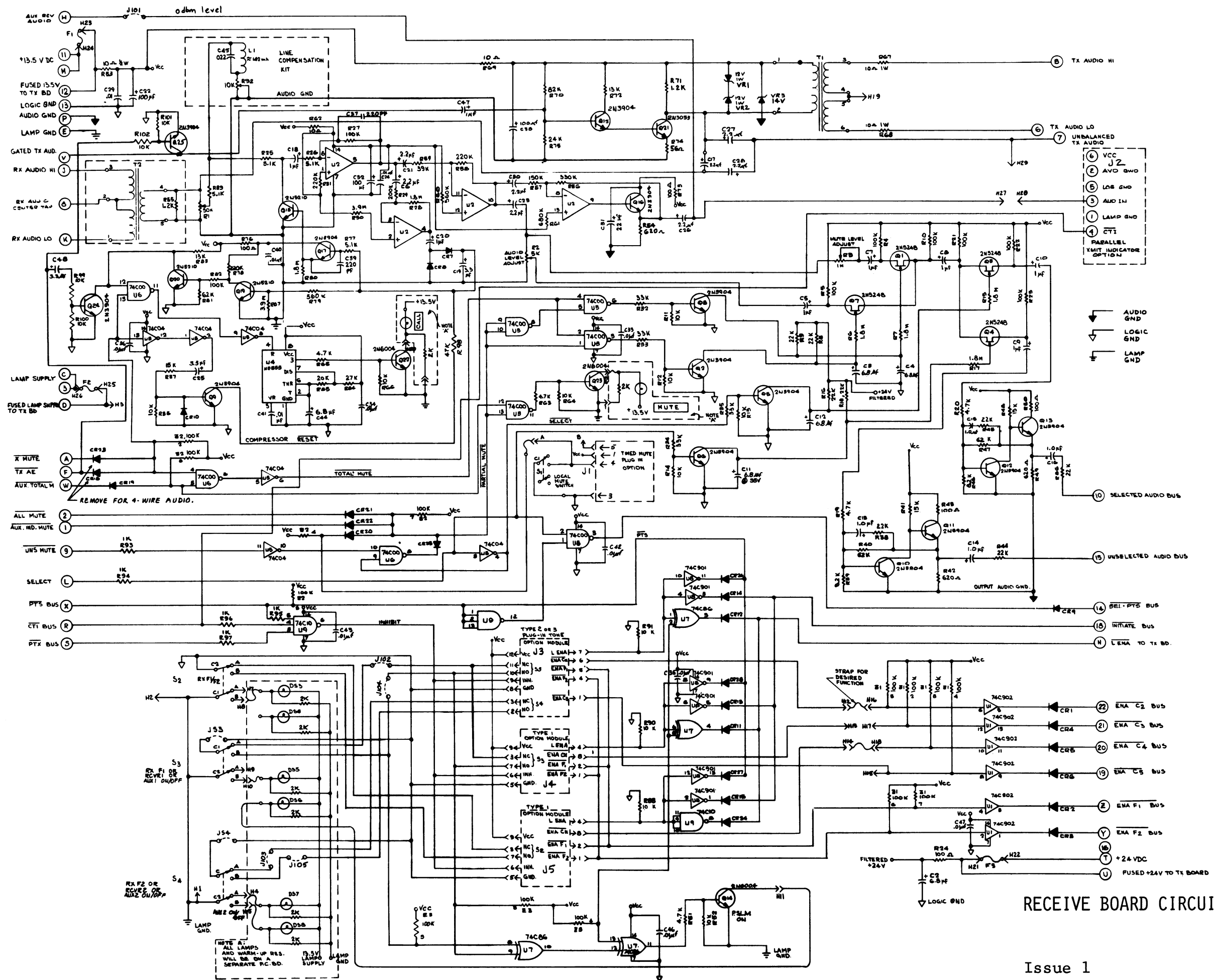
RECEIVE BOARD ASSEMBLY DIAGRAM

Figure 3-2



(D53224-301, Rev. E & Earlier)  
(53224-001, Rev. 0 & Earlier)  
(53224-201, Rev. E & Earlier)





RECEIVE BOARD CIRCUIT SCHEMATIC

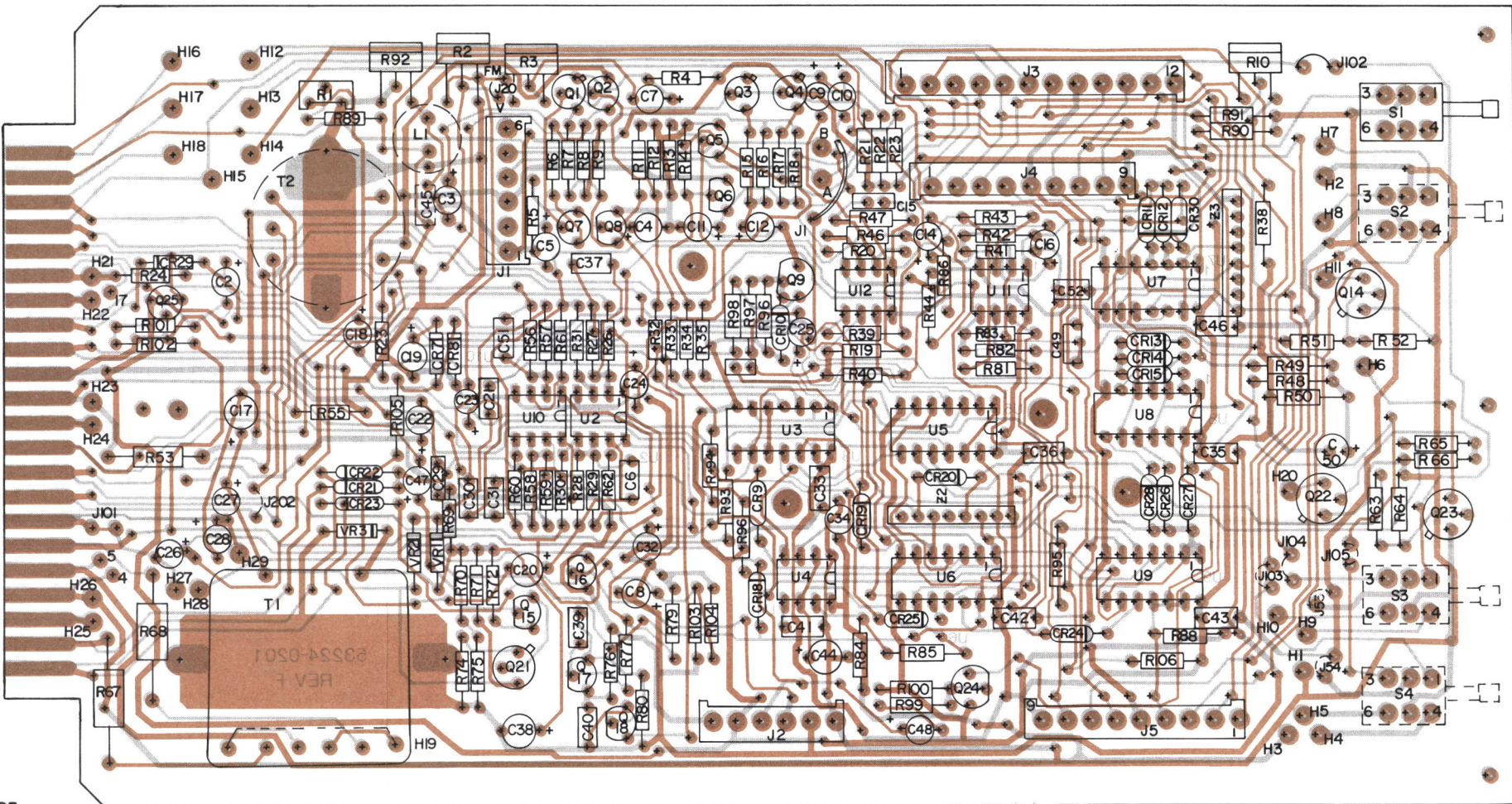
Figure 3-3

Issue 1

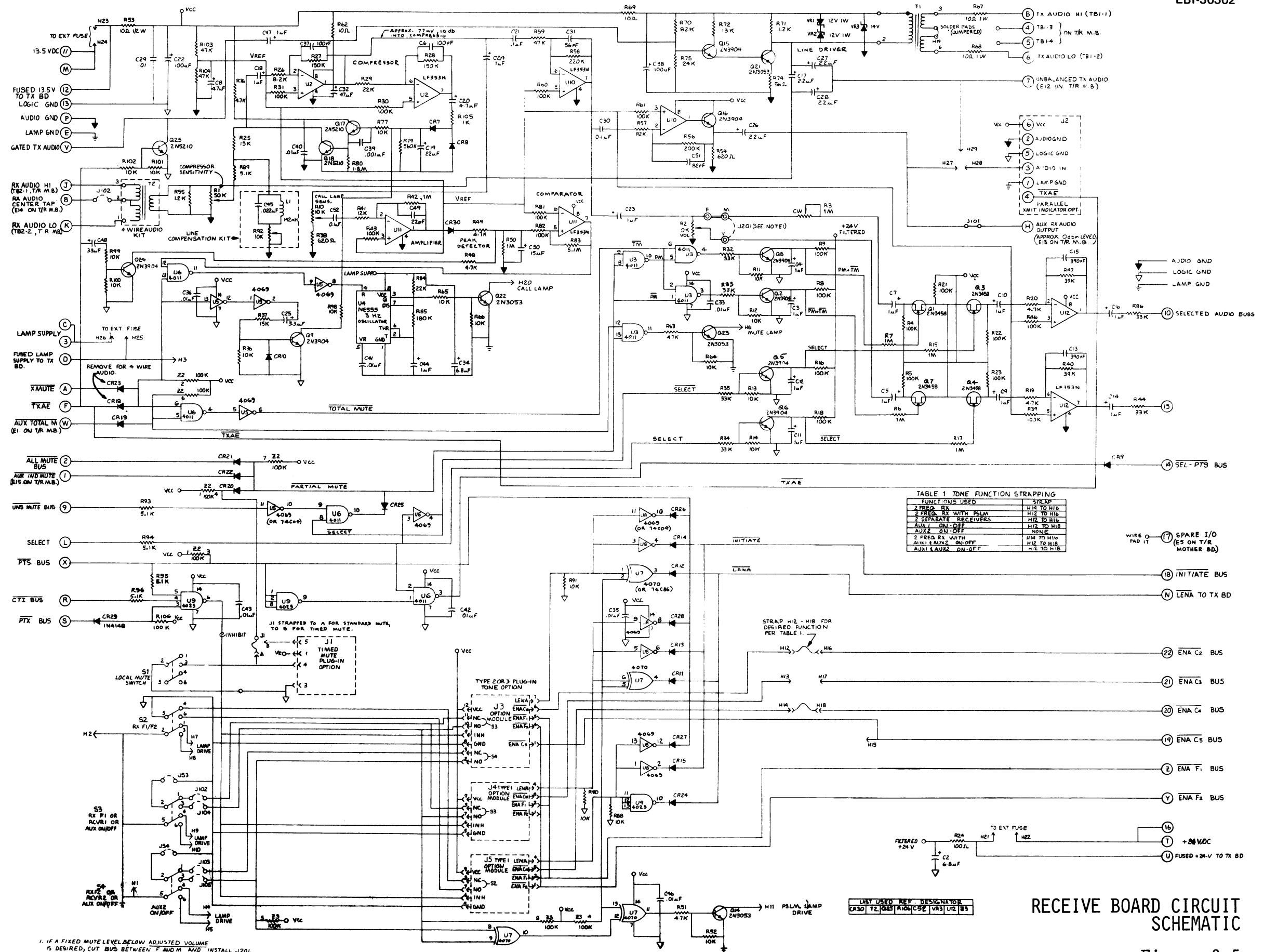
19



SYMBOL	G.E. PART NO.	DESCRIPTION	SYMBOL	GE PART NO.	DESCRIPTION	SYMBOL	GE PART NO.	DESCRIPTION
U2, U10, U11, U12	53224-0201	P.C. Board	R6, R7, R15, R17, R42, R50	51016-0105	Resistor, 1M, ¼W, 5%	R85	51-16-0184	Resistor, 180K, ¼W, 5%
U3, U6	51705-0353	Integrated Circuit LF353N	R11-R14, R36, R52, R64-R66, R77, R88, R90, R91, R98-R102	51016-0103	Resistor, 10K, ¼W, 5%	R89, R93;R96	51016-0512	Resistor, 5.1K, ¼W, 5%
U4	50704-0011	Integrated Circuit 4011	R19, R20, R48, R49, R51, R63, R76	51016-0472	Resistor, 4.7K ¼W, 5%	R105	51016-0102	Resistor, 1K, ¼W, 5%
U5, U8	50701-0001	Integrated Circuit 555 Timer	R24	51016-0101	Resistor, 100 ohms, ¼w, 5%	R41	51016-0123	Resistor, 12K, ¼W, 5%
U7	50704-0069	Integrated Circuit 4069	R25, R37	51016-0153	Resistor, 15K,¼W, 5%	R83	51016-0515	Resistor, 5.1M, ¼W, 5%
U9	50704-0070	Integrated Circuit 4070	R26	51016-0822	Resistor, 8.2K, ¼W, 5%	T1	51426-0001	Transformer, Audio, TX
for U2, U4, U10-U12	50704-0023	Integrated CIrcuit 4023	R27, R28	51016-0154	Resistor, 150K, ¼W, 5%	S1	51316-0002	Switch, 2PDT, Alternate Action
for U3, U5-U9	25290-0008	I. C. Socket, 8 Pin	R29, R84	51016-0223	Resistor, 22K, ¼W, 5%	For S1	51317-0008	Button, Switch, Grey
	25290-0014	I. C. Socket, 14 Pin	R32-35, R44, R86	51016-0333	Resistor, 33K, ¼W, 5%		24135-0003	Receptacle, Strapping
Q1, Q3, Q4, Q7	51205-3458	Transistor, FET, 2N3458	R56	51016-0204	Resistor, 200K, ¼W, 5%	For Jumpers	15176-0001	Wire, AWG 24, Brown
Q2, Q5, Q6, Q8	51205-3904	Transistor, NPN, 2N3904	R53	51017-0100	Resistor, 10 ohms, ¼W, 5%	For Jumpers	15176-0001	Wire, Solid, White
Q9, Q15, Q16, Q24	51205-5210	Transistor, NPN 2N5210	R54, R38	51016-0621	Resistor, 620 ohms, ¼W, 5%		53224-0101	Schematic
Q17, Q18, Q25	51205-3053	Transistor, NPN 2N3053	R55, R71	51016-0122	Resistor, 1.2K, ¼W, 5%		53224-0101	Pictorial Assembly
Q14, Q21-23			R58	51016-0224	Resistor, 220K, ¼W, 5%		T53224	Test Specifications
For 2N3053's	20345-0001	Pad, Transistor 20345-0001	R57, R70	51016-0823	Resistor, 82K, ¼W, 5%			
CR7-15, CR18-30	15104-0011	Diode, IN4148	R59, R103, R104	51016-0473	Resistor, 47K, ¼W, 5%			
VR1, VR2	24376-0015	Diode, Zener, 12v, IN4742A	R62, R69	51016-0100	Resistor, 10 ohms, ¼W, 5%			
V3	24379-0048	Diode, Zener, 14, IN5244B	R67, R68	51018-0100	Resistor, 10 ohms, 1W, 5%			
			R72	51016-0133	Reisitor, 13K, ¼W, 5%			
			R74	51016-0560	Resistor, 56 ohms, ¼W, 5%			
			R75	51016-0243	Resistor, 24K, ¼W, 5%			
			R79	51016-0564	Resistor, 560K, ¼W, 5%			
			R80	51016-0185	Resistor, 1.8M, ¼W, 5%			
			R40, R47	51016-0393	Resistor, 39K, ¼W, 5%			
C29, C33, C35, C36	25853-0008	Capacitor, .01uf, 100v						
C2, C34	50183-0685	Capacitor, 6.8uf, 35V						
C3-5, C7, C9-12, C14	50183-0105	Capacitor, 1uf, 35V						
C16, C18, C23, C24, C44, C47	50145-0101	Capacitor, 100pf, 500V						
C6, C37	50155-4391	Capacitor, 390pf, 500V						
C13, C15	50161-5104	Capacitor, .1uf, 50V						
C21, C30, C52	50183-0225	Capacitor, 2.2uf, 35V						
C17, C26-28	25078-0226	Capacitor, 22uf, 20V						
C19	50183-0475	Capacitor, 4.7uf, 35V						
C20	25078-0107	Capacitor, 100uf, 20V						
C22, C38	50183-0335	Capacitor, 3.3uf, 35V						
C25, C48	25078-0476	Capacitor, 47uf, 20V						
C32, C8	14922-0017	Capacitor, .001uf, 1KV						
C39	50155-4560	Capacitor, 56pf, 500V						
C31	50145-0220	Capacitor, 22pf, 500V						
C49	25078-0156	Capacitor, 15uf, 20V						
C50	50155-4820	Capacitor, 82pf, 500V						
C51								
Z2, Z3	51014-7104	Network, Resistor, 100K						
R1	51184-0503	Potentiometer, 50K, Non-Linear						
R2, R10	51100-8103	Potentiometer, 10K						
R3	51100-8105	Potentiometer, 1M						
R4, R5, R8, R9, R16, R18, R21, -23, R30, R31, R39, R43, R46, R60, R61, R81, R82, R106	51016-0104	Resistor, 100K, ¼W, 5%						







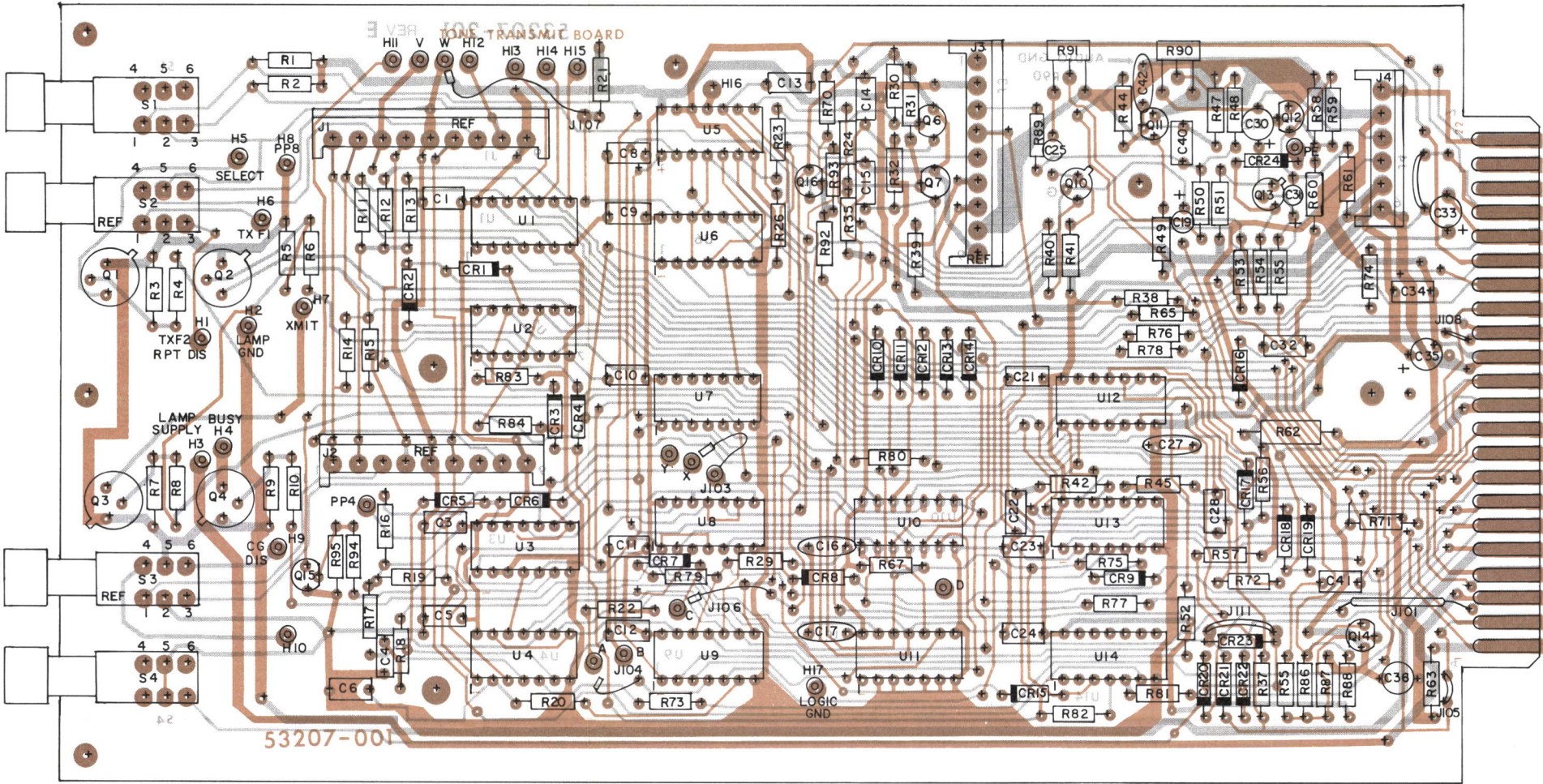
## RECEIVE BOARD CIRCUIT SCHEMATIC

Figure 3-5



SYMBOL	GE PART NO.	DESCRIPTION
----- CAPACITORS -----		
C1-C3,C5, C8-C12, C16,C17, C21,C23, C24,C27, C28,C34, C42 C4,C6,C22 C13-C15, C32,C40, C41 C19,C25, C30,C31, C33 C36 C35	SEC/25853-008 SEC/14922-017  SEC/50102-007  SEC/25076-105 SEC/50183-685 SEC/25078-107	.01 uF, 100 V, Ceramic disc .001 uF, Ceramic disc  .1 uF, 100 V, polyester  1.0 uF, 35 V, Tantalum Electrolytic 6.8 uF, 35 V, Tantalum Electrolytic 100 uF, 20 V, Tantalum Electrolytic
----- DIODES/RECTIFIERS -----		
CR1-CR24	SEC/15104-011	1N4148, Silicon, Small signal
----- INTEGRATED CIRCUITS -----		
U1 U2,U12 U3 U4,U6,U14 U5,U7-U9 U10,U13 U11	SEC/50709-902 SEC/50709-901 SEC/50709-074 SEC/50709-010 SEC/50709-400 SEC/50709-004 SEC/50709-002	74C902 CMOS 74C901 CMOS 74C74 CMOS 74C10 CMOS 74C00 CMOS 74C04 CMOS 74C02 CMOS
----- POTENTIOMETERS -----		
R90,R91	SEC/51100-8103	10 K ohms, 1/2 W, 5%
----- RESISTORS -----		
(Resistors are 1/4 W, 5%, carbon composition unless otherwise described.)		
R1,R11- R17,R19, R21,R22, R29,R33, R38,R39, R41,R51, R55-R57, R67,R53 R3,R7, R9,R83, R92,R93, R84,R30, R31,R94, R95 R4,R8, R10 R5,R32, R48,R50, R89 R6,R23, R35,R60, R85,R47 R18,R20, R42,R52, R65,R70- R82,R37 R24 R26,R59, R86 R40,R54 R44 R45 R49 R58,R87 R61,R88 R62 R63 R79,R75	SEC/51016-104  SEC/51016-103 SEC/51016-302  SEC/51016-223  SEC/51016-333  SEC/51016-102 SEC/51016-683  SEC/51016-473 SEC/51016-105 SEC/51016-124 SEC/51016-273 SEC/51016-332 SEC/51016-682 SEC/51016-362 SEC/51017-100 SEC/51016-101 SEC/51016-472	100 K ohms  10 K ohms 3 K ohms  22 K ohms  33 K ohms  1 K ohm 68 K ohms  47 K ohms 1.0 M ohm 120 K ohms 27 K ohms 3.3 K ohms 6.8 K ohms 3.6 K ohms 10 ohms, 1/2 W 100 ohms 4.7 K ohms
----- SOCKETS -----		
For U1- U14	SEC/25290-014	IC Socket, 14-pin

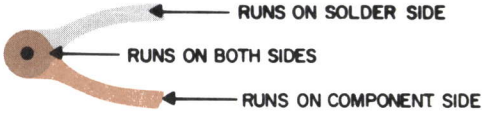
SYMBOL	GE PART NO.	DESCRIPTION
----- SWITCHES -----		
S1,S4 ----	SEC/51315-002 SEC/51317-002 SEC/51317-008	DPDT, Momentary Button for Switch S4, red Button for Switch S1, gray
----- TRANSISTORS -----		
Q1,Q3, Q4 Q2 Q6,Q7, Q9,Q11, Q12,Q14 Q15,Q16, Q10,Q13	SEC/51205-3053 SEC/51205-3053  SEC/51205-3904 SEC/51205-5248	2N3053, Silicon NPN 2N3053, Silicon NPN  2N3904, Silicon NPN 2N5248, N-Channel FET
----- MISCELLANEOUS -----		
For Q2 ----	SEC/20345-001 SEC/24135-003	Mounting Pads Strapping pins
For Q1, Q3,Q4	SEC/20345-001	Transistor, Pads



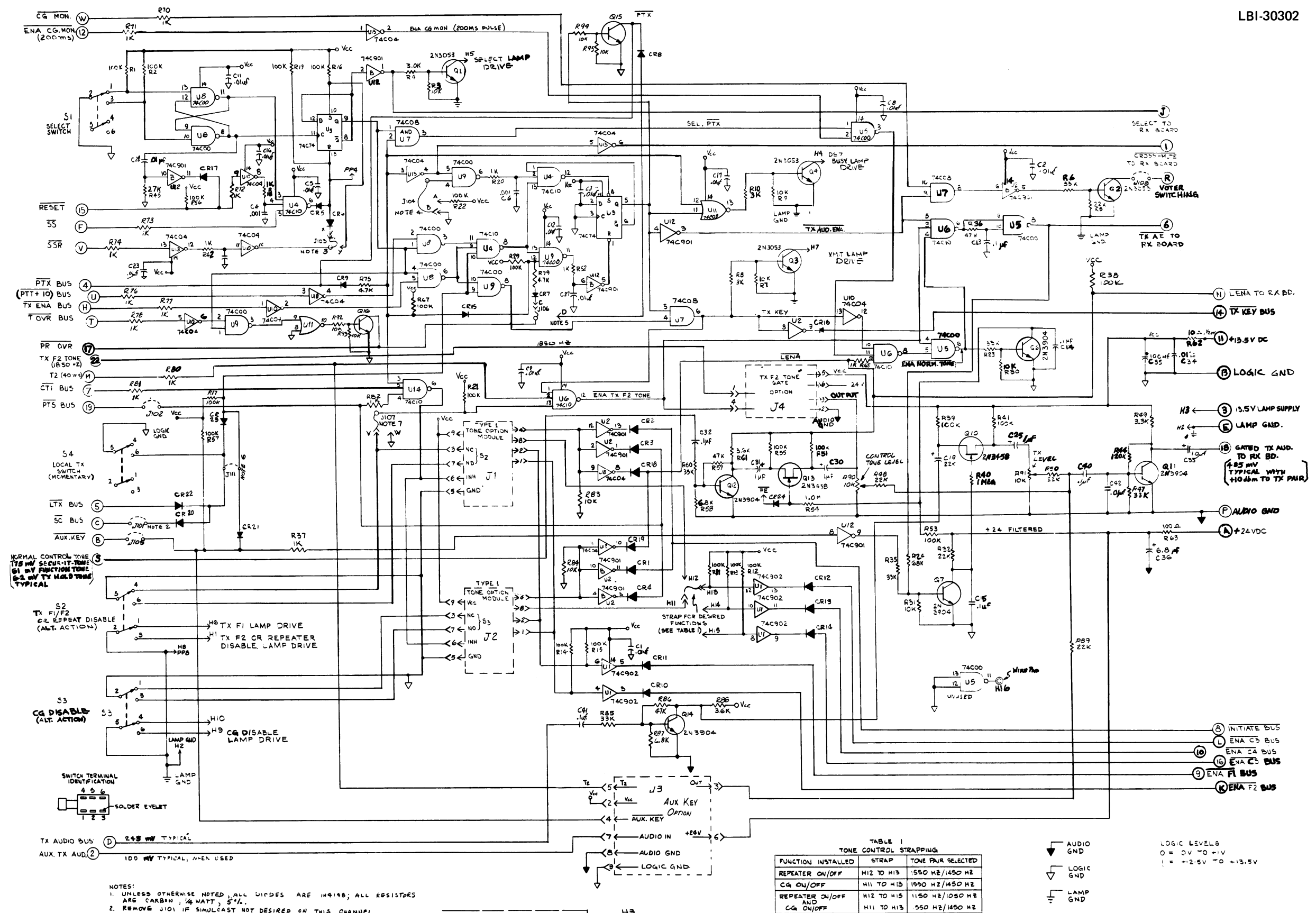
(D53207-0301, Rev. D3)  
 (53207-001, Rev. 0)  
 (53207-201, Rev. E)

TRANSMIT BOARD ASSEMBLY DIAGRAM

Figure 3-6

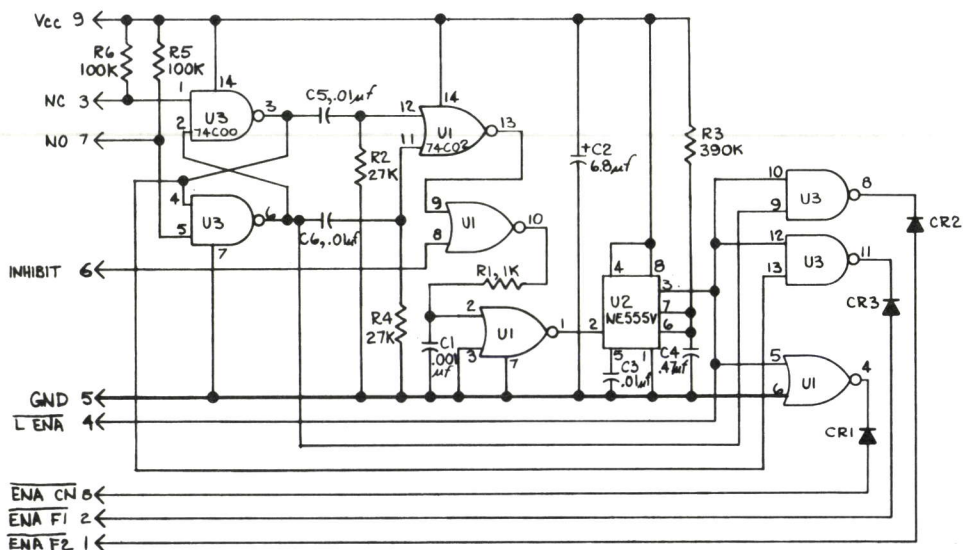






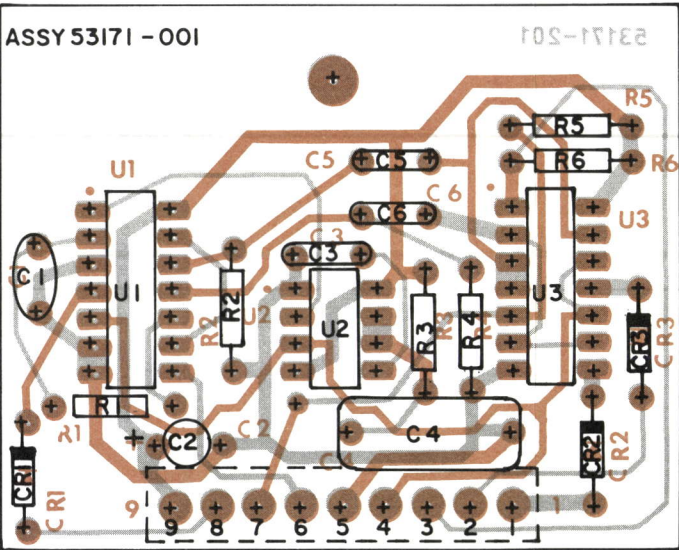
TRANSMIT BOARD CIRCUIT SCHEMATIC

Figure 3-7



(B53171-101, Rev. 0)

Figure 3-8

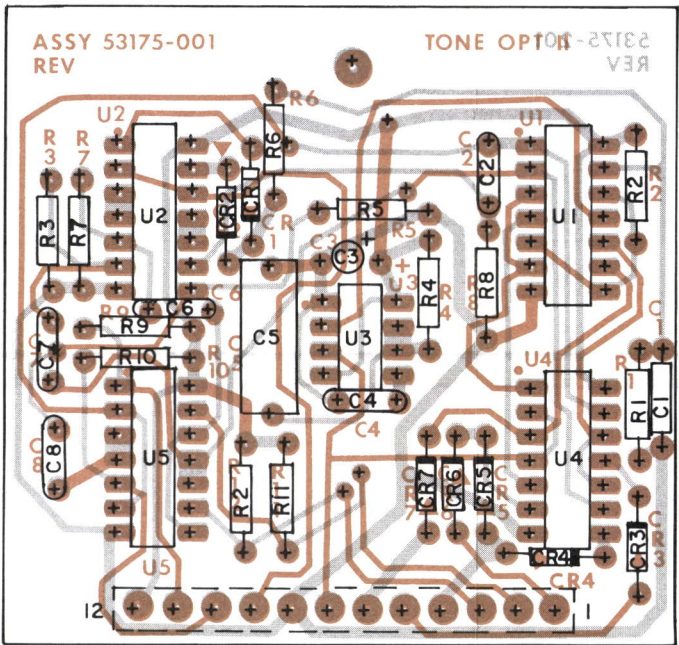
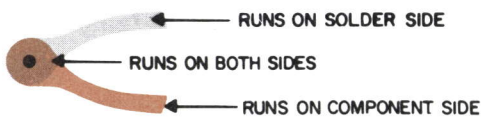


(B53171-001, Rev. 01)  
(53171-001, Rev. 0)  
(53171-201, Rev. 0)

SYMBOL	GE PART NO.	DESCRIPTION
-----ASSEMBLIES-----		
—	SEC/53175-001	Printed Circuit Board
-----CAPACITORS-----		
C1	SEC/14922-017	.001 uF, 1000 V, Ceramic disc
C2, C4, C6, C7, C8	SEC/25853-002	.01 uF, 100 V, Ceramic disc
C3	SEC/25076-685	6.8 uF, 35 V, Tantalum Electrolytic
C5	SEC/50102-011	.47 uF, 50 V, Polyester, dipped
-----DIODES/RECTIFIERS-----		
CR1-CR7	SEC/15104-011	1N4148, Silicon, small signal
-----INTEGRATED CIRCUITS-----		
U1	SEC/50709-086	74C86 CMOS
U2	SEC/50709-002	74C02 CMOS
U3	SEC/50701-001	NE555, Timer
U4, U5	SEC/50709-400	74C00 CMOS
-----RESISTORS-----		
(Resistors are ¼W, 5%, carbon composition.)		
R1	SEC/51016-473	47 Kohms
R2, R9-R12	SEC/51016-104	100 Kohms
R3, R5, R7, R8	SEC/51016-273	27 Kohms
R4	SEC/51016-394	390 Kohms
R6	SEC/51016-102	1 Kohm
-----SOCKETS, JACKS, RECEPTACLES-----		
—	SEC/50403-012	Connector, 12-pin
—	SEC/25290-008	IC socket, 8-pin
—	SEC/25290-014	IC socket, 14-pin

TONE OPTION TYPE I &  
TONE OPTION TYPE II

Figure 3-8 & 3-9



(B53175-001, Rev. 01)  
(53175-001, Rev. 0)  
(53175-201, Rev. 0)

SYMBOL	GE PART NO.	DESCRIPTION
-----ASSEMBLIES-----		
—	SEC/53171-001	Printed Circuit Board
-----CAPACITORS-----		
C1	SEC/14922-017	.001 uF, 1000 V, Ceramic disc
C2	SEC/25076-685	6.8 uF, 35 V, Tantalum Electrolytic
C3, C5, C6	SEC/25853-002	.01 uF, 100 V, Ceramic disc
C4	SEC/50102-011	0.47 uF, 50 V, Polyester, dipped
-----DIODES/RECTIFIERS-----		
CR1-CR3	SEC/15104-011	1N4148, Silicon, Small signal
-----INTEGRATED CIRCUITS-----		
U1	SEC/50709-002	74C02 CMOS
U2	SEC/50701-001	NE555 Timer
U3	SEC/50709-400	74C00 CMOS
-----RESISTORS-----		
(Resistors are ¼W, 5%, carbon composition)		
R1	SEC/51016-102	1 Kohm
R2, R4	SEC/51016-273	27 Kohms
R3	SEC/51016-394	390 Kohms
R5, R6	SEC/51016-104	100 Kohms
-----SOCKETS, JACKS, RECEPTACLES-----		
—	SEC/50403-009	Connector, 9-pin
—	SEC/25290-008	IC Socket, 8-pin
—	SEC/25290-014	IC Socket, 14-pin

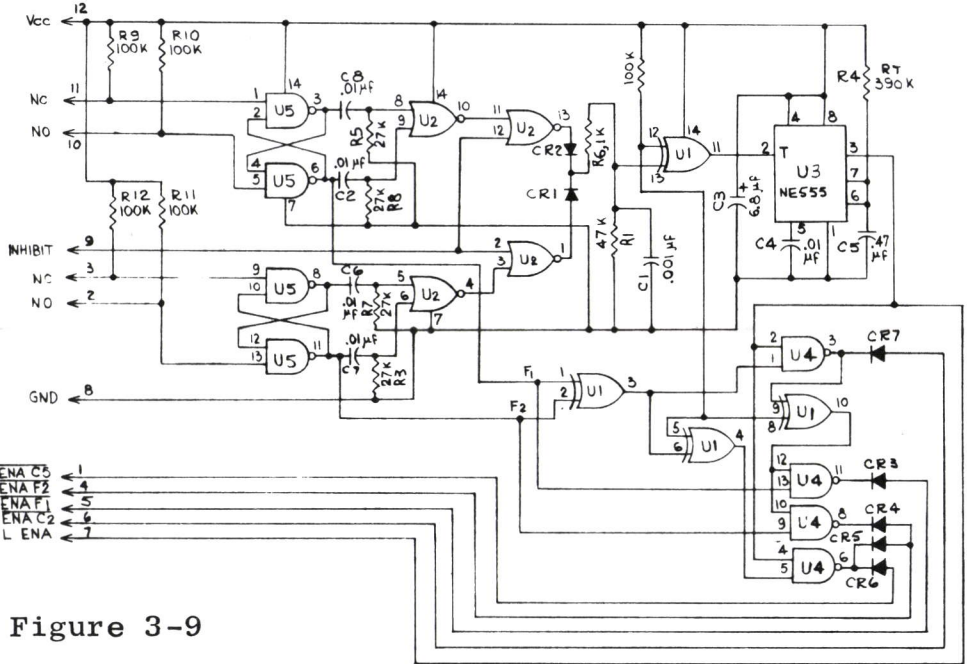
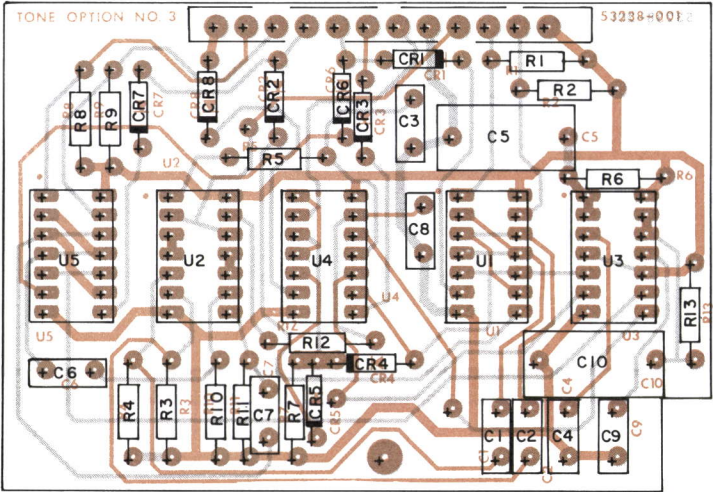
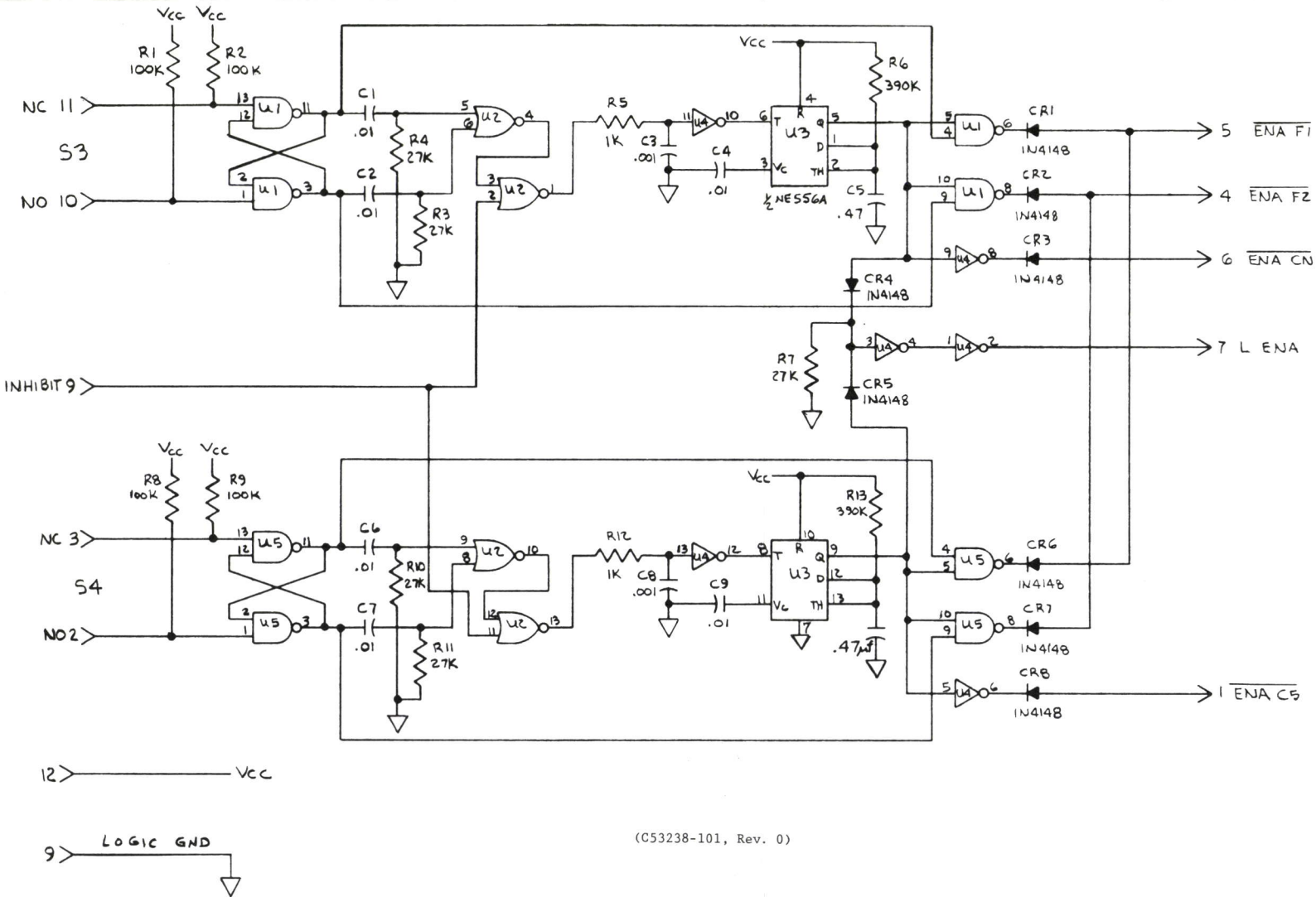


Figure 3-9

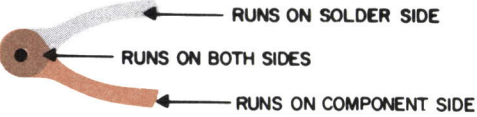
(B53175-101, Rev. 0)



SYMBOL	GE PART NO	DESCRIPTION
----	SEC/53238-001	----- ASSEMBLIES ----- Printed Circuit Board
		----- CAPACITORS -----
C1,C2,C4, C6,C7,C9, C3,C8 C5,C10	SEC/25853-008 SEC/14922-017 SEC/50102-011	.01 uF, 100 V, Ceramic disc .001 uF, 1000 V, Ceramic disc .47 uF, 50 V, Dipped polyester
		----- DIODES/RECTIFIERS -----
CR1-CR8	SEC/15104-011	1N4148, Silicon, Small signal
		----- INTEGRATED CIRCUITS -----
U1,U5 U2 U3 U4	SEC/50709-400 SEC/50709-002 SEC/50733-001 SEC/50709-004	74C00 CMOS 74C02 CMOS NE555A, Timer 74C04 CMOS
		----- RESISTORS ----- (Resistors are 1/4 W, 5%, carbon composition.)
R1,R2, R8,R9 R3,R4,R7 R10,R11 R5,R12 R6,R13	SEC/51016-104 SEC/51016-273 SEC/51016-102 SEC/51016-394	100 K ohms 27 K ohms 1 K ohm 390 K ohms
		----- SOCKETS, JACKS, RECEPTACLES -----
----	SEC/50403-012 SEC/25290-014	Connector, 12-pin IC Socket, 14-pin



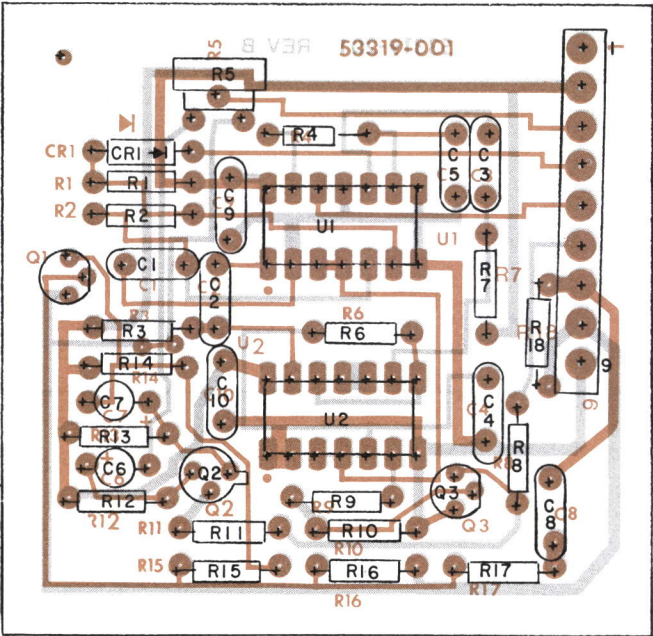
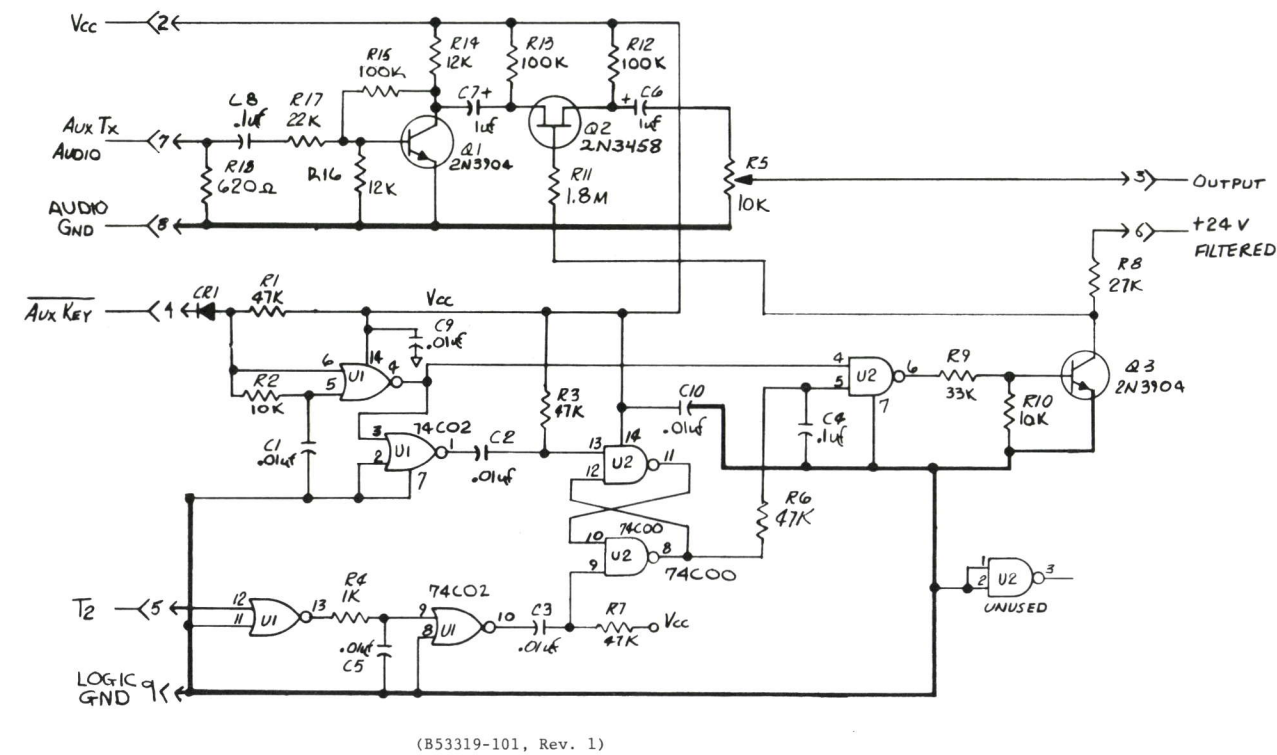
(B53238-301, Rev. 01)  
(53238-001, Rev. 0)  
(53238-201, Rev. 0)



TONE OPTION TYPE III

Figure 3-10



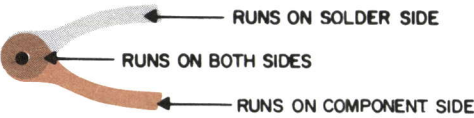


(53319-0301, Rev. A)  
(53319-0001, Rev. B)  
(53319-0201, Rev. 0)

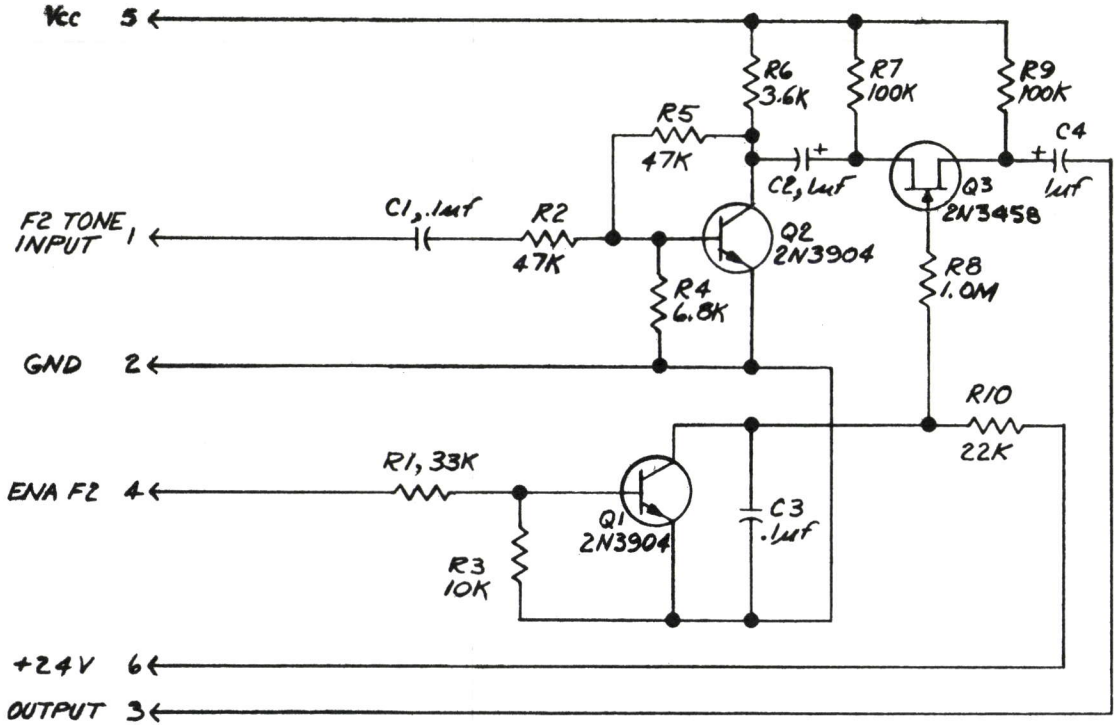
SYMBOL	GE PART NO	DESCRIPTION
----- ASSEMBLIES -----		
----	SEC/53319-001	Printed Circuit Board
----- CAPACITORS -----		
C1,C2,C3	SEC/25853-008	.01 uF, 100 V, Ceramic disc
C5,C9,C10	SEC/50102-007	0.1 uF, 50 V, Polyester dipped
C4,C8	SEC/50183-105	1.0 uF, 35 V, Tantalum Electrolytic
C6,C7		
----- DIODES/RECTIFIERS -----		
CR1	SEC/15104-011	1N4148, Silicon, Small signal
----- INTEGRATED CIRCUITS -----		
U1	SEC/50709-002	74C02 CMOS
U2	SEC/50709-400	74C00 CMOS
----- RESISTORS -----		
(Resistors are 1/4 W, 5%, carbon composition.)		
R1,R3, R6,R7	SEC/51016-473	47 K ohms
R2,R10	SEC/51016-103	10 K ohms
R4	SEC/51016-102	1 K ohm
R8	SEC/51016-223	27 K ohms
R9	SEC/51016-333	33 K ohms
R11	SEC/51016-105	1.0 M ohms
R12,R13, R15	SEC/51016-104	100 K ohms
R14,R16	SEC/51016-123	12 K ohms
R17	SEC/51016-223	22 K ohms
R18	SEC/51016-621	620 ohms
----- POTENTIOMETERS -----		
R5	SEC/51100-8103	10 K ohms
----- SOCKETS, JACKS, RECEPTACLES -----		
----	SEC/50403-009	Connector, 9-pin
----	SEC/25290-014	IC Socket, 14-pin
----- TRANSISTORS -----		
Q1,Q3	SEC/51217-002	2N3904, Silicon NPN
Q2	SEC/51205-3458	2N3458, N-channel FET

AUX KEY OPTION

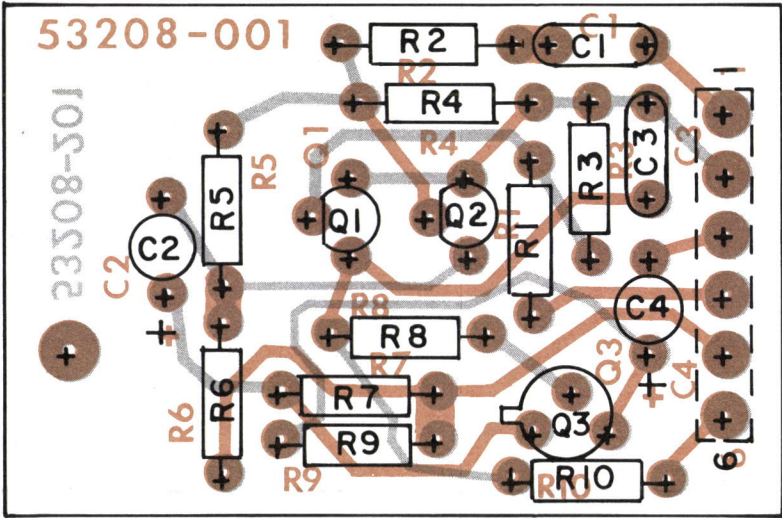
Figure 3-11



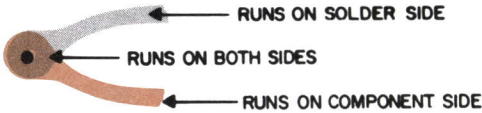
SYMBOL	GE PART NO	DESCRIPTION
----	SEC/53208-001	----- ASSEMBLIES ----- Printed Circuit Board
C1,C3 C2,C4	SEC/50102-007 SEC/50183-105	----- CAPACITORS ----- 0.1 uF, 50 V, Dipped Polyester 1 uF, 35 V, Tantalum Electrolytic
R1 R2,R5 R3 R4 R6 R7,R9 R8 R10	SEC/51016-333 SEC/51016-473 SEC/51016-103 SEC/51016-682 SEC/51016-362 SEC/51016-104 SEC/51016-105 SEC/51016-223	----- RESISTORS ----- (Resistors are 1/4 W, 5%, carbon composition.) 33 K ohms 47 K ohms 10 K ohms 6.8 K ohms 3.6 K ohms 100 K ohms 1.0 M ohms 22 K ohms
----	SEC/50403-006	----- SOCKETS, JACKS, RECEPTACLES ----- Connector, 6-pin
Q1,Q2 Q3	SEC/51217-002 SEC/51205-3458	----- TRANSISTORS ----- 2N3904, Silicon NPN 2N3458, N-channel FET



(B53208-101, Rev. A)



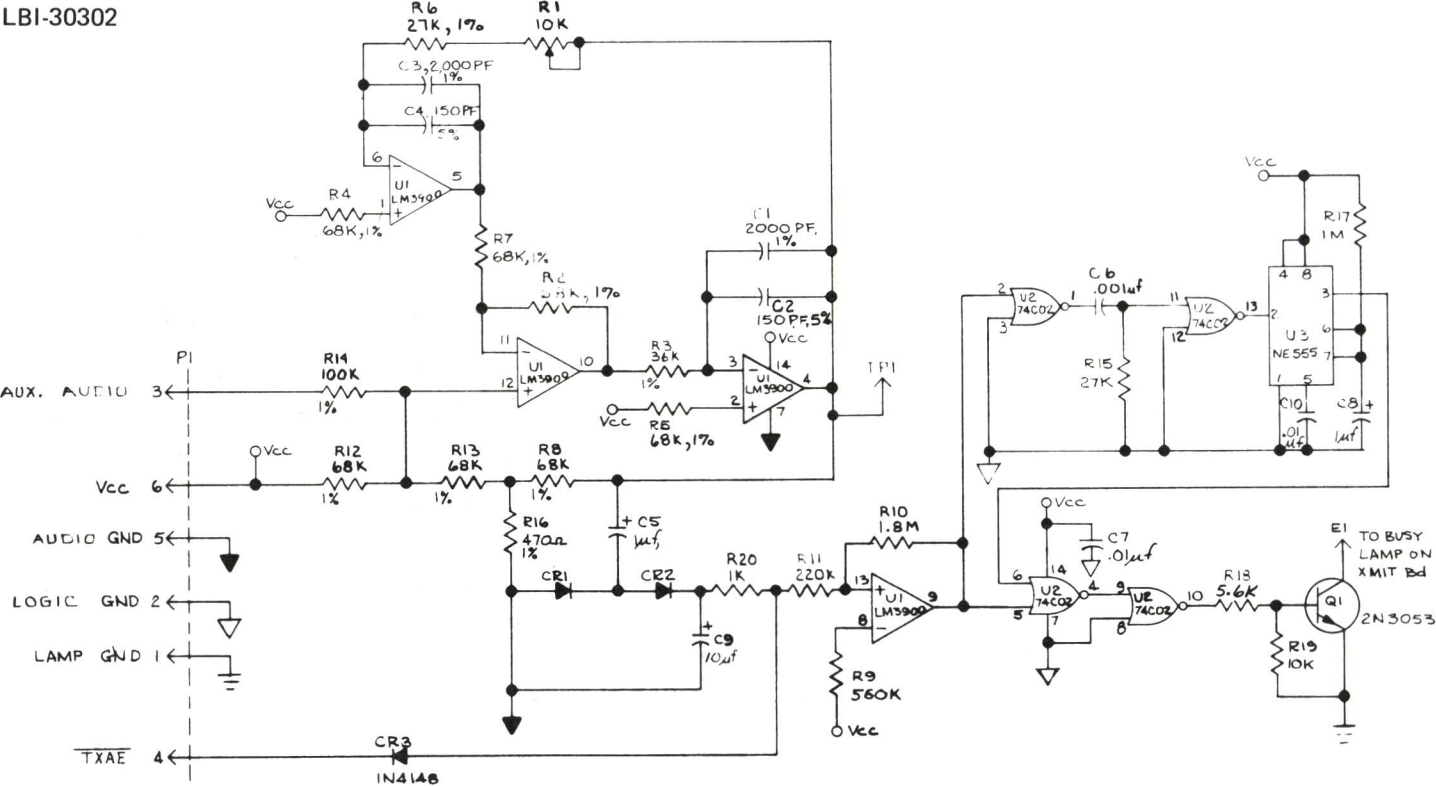
(B53208-301, Rev. 02)  
(53208-001, Rev. 0)  
(53208-201, Rev. 0)



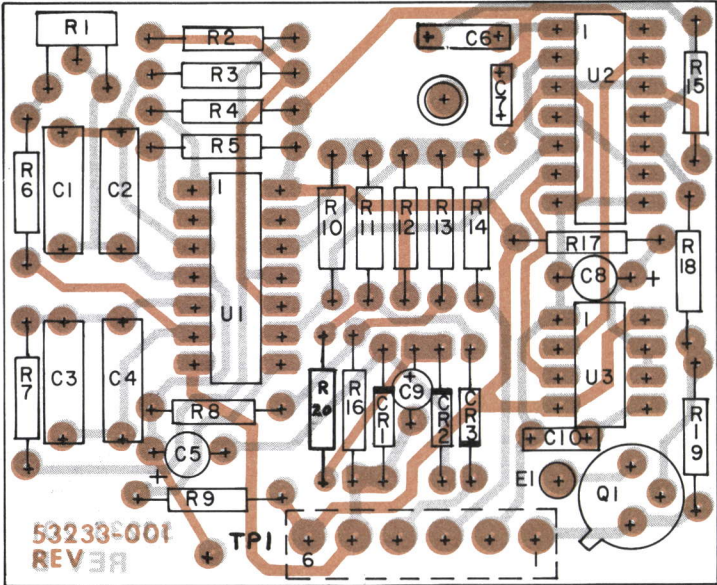
Tx F2 GATE OPTION

Figure 3-12





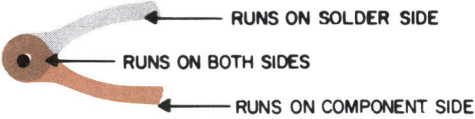
(C53233-101, Rev. E)



(B53233-001, Rev. B)  
(53233-001, Rev. B)  
(53233-201, Rev. B)

PARALLEL TONE TRANSMIT  
INDICATOR OPTION

Figure 3-13



SYMBOL	GE PART NO	DESCRIPTION
----- ASSEMBLIES -----		
----	SEC/53233-001	Printed Circuit Board
----- CAPACITORS -----		
C1,C3	SEC/14921-024	2000 pF, +1%, 500 V, Mica
C2,C4	SEC/50105-8151	150 pF, +5%, 100 V, Ceramic, Temp. Comp., N470
C5,C8	SEC/25076-105	1 uF, 35V, Tantalum Electrolytic
C6	SEC/14922-017	.001 uF, 1000 V, Ceramic disc
C7,C10	SEC/25853-008	.01 uF, 100 V, Ceramic disc
C9	SEC/25076-0106	10 uF, 35 V, Tantalum
----- DIODES/RECTIFIERS -----		
CR1-CR3	SEC/15104-011	1N4148, Silicon, Small signal
----- INTEGRATED CIRCUITS -----		
U1	SEC/50705-001	LM3900 Quad OP AMP
U2	SEC/50709-002	74C02 CMOS
U3	SEC/50701-001	NE555, Timer
----- RESISTORS -----		
(Resistors are 1/4 W, 5%, carbon composition, unless otherwise described.)		
R2,R4,R5, R7,R8, R12,R13	SEC/25864-681	68.1 K ohms, 1%, Metal film
R3	SEC/25864-365	36.5 K ohms, 1%, Metal film
R6	SEC/25864-274	27.4 K ohms, 1%, Metal film
R9	SEC/51016-564	560 K ohms
R10	SEC/51016-185	1.8 M ohms
R11	SEC/51016-224	220 K ohms
R14	SEC/25865-100	100 K ohms, 1%, Metal film
R15	SEC/51016-273	27 K ohms
R16	SEC/25862-475	475 ohms, 1%, Metal film
R17	SEC/51016-105	1 M ohm
R18	SEC/51016-562	5.6 K ohms
R19	SEC/51016-103	10 K ohms
R20	SEC/51016-0102	1 K ohm
----- POTENTIOMETERS -----		
R1	SEC/51100-8103	10 K ohms, 1/2 W
----- SOCKETS, JACKS, RECEPTACLES -----		
----	SEC/50403-006	Connector, 6-pin
----	SEC/25290-008	IC Socket, 8-pin
----	SEC/25290-014	IC Socket, 14-pin
----- TRANSISTORS -----		
Q1	SEC/51205-3053	2N3053, Silicon NPN

QTY	GE PART NO.	DESCRIPTION
----- SEC/53392-001 ----- LINE COMPENSATION KIT -----		
1	SEC/50102-003	Capacitor, .022 uF, 50 V, (C45 on the schematic for Receive board SEC/53224-001)
1	SEC/50304-002	Inductor, 142 mH, (L1 on the schematic for Receive board SEC/53224-001)
1	SEC/51100-8103	Potentiometer, 10 Kohms, (R92 on the schematic for Receive board SEC/53224-001)
----- SEC/53393-001 ----- 4-WIRE AUDIO KIT -----		
1	SEC/50550-001	Lightning Arrestor
2	SEC/51016-621	Resistor, 620 ohms, 1/4W, 5%, carbon composition (R55 and R71 on the schematic for SEC/53224-001 Receive board.)
1	SEC/50542-007	Terminal block, 7-Terminal
1	SEC/51431-001	Transformer, Rx (T2 on the schematic for SEC/53224-001 Receive board)
----- SEC/53503-001 ----- CHANNEL GUARD ON-OFF KIT -----		
1	SEC/53171-001	Tone Option Type 1 Assembly
1	SEC/50427-009	Connector, 9-pin
2	SEC/50507-020	Lamp
1	SEC/53459-101	Legend
1	SEC/25511-008	Stand-off, plastic
3	SEC/24135-003	Strapping pin
1	SEC/51316-002	Switch, DPDT, Alternate Action
1	SEC/51317-008	Switch, button, gray
3"	SEC/15176-001	Wire, brn, AWG 24
3"	SEC/15176-916	Wire, wht-brn-bl, AWG 24
----- SEC/53504-001 ----- AUX 1 ON-OFF AND AUX 2 ON-OFF KIT -----		
1	SEC/53238-001	Tone Option Type 3 Assembly
1	SEC/50427-012	Connector, 12-pin
4	SEC/50507-020	Lamp
1	SEC/53459-124	Legend
1	SEC/53459-125	Legend
1	SEC/25511-008	Stand off, plastic
4	SEC/24135-003	Strapping pin
2	SEC/51316-002	Switch, DPDT, Alternate Action
2	SEC/51317-008	Switch, button, gray
3"	SEC/19523-009	Wire, buss, solid, AWG 22 insulated
3"	SEC/15176-914	Wire, wht-br-yel, AWG 24
3"	SEC/15176-915	Wire, wht-br-grn, AWG 24
----- SEC/53505-003 ----- FORM "C" SWITCH KIT -----		
1	SEC/53459-123	Legend, SW ON
1	SEC/24135-003	Strapping pin
1	SEC/51315-002	Switch, Momentary action
1	SEC/51316-002	Switch, Alternate Action
1	SEC/51317-008	Switch, button, gray
3"	SEC/15176-901	Wire, AWG 24, wht-bk-br
1'	SEC/15176-902	Wire, AWG 24, wht-bk-rd
1'	SEC/15176-903	Wire, AWG 24, wht-bk-o
1'	SEC/15176-904	Wire, AWG 24, wht-bk-y
6"	SEC/19523-009	Wire, solid AWG 22, insulated, wht

## OPTIONAL FUNCTION KITS

QTY	GE PART NO.	DESCRIPTION
----- SEC/53506-001 ---- AUX 1 ON-OFF KIT -----		
1	SEC/53238-001	Tone Option Type 3 Assembly
1	SEC/50427-012	Connector, 12-pin
2	SEC/50507-020	Lamp
1	SEC/53459-124	Legend
1	SEC/25511-008	Stand off, plastic
3	SEC/24135-003	Strapping pin
1	SEC/51316-002	Switch, DPDT, Alternate Action
1	SEC/51317-008	Switch, button, gray
3"	SEC/19523-009	Wire, buss, solid AWG 22, insulated
3"	SEC/15176-915	Wire, wht-brn-grn, AWG 24
----- SEC/53507-001 ---- AUX 2 ON/OFF KIT -----		
1	SEC/53238-001	Tone Option Type 3 Assembly
1	SEC/50427-012	Connector, 12-pin
2	SEC/50507-020	Lamp
1	SEC/53459-125	Legend
1	SEC/25511-008	Stand off, plastic
1	SEC/24135-003	Strapping pin
1	SEC/51316-002	Switch, DPDT, Alternate Action
1	SEC/51317-008	Switch, button, gray
3"	SEC/19523-009	Wire, buss, solid AWG 22
3"	SEC/15176-914	Wire, wht-brn-yel, AWG 24
----- SEC/53508-001 ---- REPEATER DISABLE KIT -----		
1	SEC/53171-001	Tone Option Type 1 Assembly
1	SEC/50427-009	Connector, 9-pin
2	SEC/50507-020	Lamp
1	SEC/53459-102	Legend
1	SEC/25511-008	Stand off, plastic
3	SEC/24135-003	Strapping pin
1	SEC/51316-002	Switch, DPDT, Alternate Action
1	SEC/51317-008	Switch, button, gray
3"	SEC/15176-001	Wire, brn, AWG 24
3"	SEC/15176-913	Wire, brn-wht-orn, AWG 24
----- SEC/53509-001 ---- 2 FREQUENCY TX KIT -----		
1	SEC/53171-001	Tone Option Type 1 Assembly
1	SEC/53208-001	Tx F2 Tone Gate Assembly
1	SEC/50427-006	Connector, 6-pin
1	SEC/50427-009	Connector, 9-pin
2	SEC/53248-002	Diffuser
2	SEC/50507-020	Lamp
1	SEC/53459-112	Legend
2	SEC/25511-008	Stand off, plastic
4	SEC/24135-003	Strapping pin
1	SEC/51316-002	Switch, DPDT, Alternate Action
1	SEC/51317-008	Switch, button, gray
3"	SEC/15176-001	Wire, brn, AWG 24
3"	SEC/15176-901	Wire, wht-blk-brn, AWG 24
3"	SEC/15176-902	Wire, wht-blk-rd, AWG 24

## OPTIONAL FUNCTIONS KITS

QTY	GE PART NO.	DESCRIPTION
----- SEC/53510-001 ---- 2 SEPARATE RECEIVERS KIT -----		
1	SEC/53175-001	Tone Option Type 2 Assembly
1	SEC/50427-012	Connector, 12-pin
6	SEC/50507-020	Lamp
1	SEC/53459-108	Legend
1	SEC/53459-109	Legend
1	SEC/53459-110	Legend
1	SEC/25511-008	Stand off, plastic
5	SEC/24135-003	Strapping pin
2	SEC/51316-002	Switch, DPDT, Alternate Action
2	SEC/51317-008	Switch, button, gray
5"	SEC/19523-009	Wire, buss, solid AWG 22, insulated
3"	SEC/15176-001	Wire, brn, AWG 24
3"	SEC/15176-908	Wire, wht-blk, gy, AWG 24
3"	SEC/15176-910	Wire, wht-brn-blk, AWG 24
3"	SEC/15176-912	Wire, wht-brn-rd, AWG 24
----- SEC/53511-001 ---- 2 FREQUENCY RECEIVE w/PSLM KIT -----		
1	SEC/53175-001	Tone Option Type 2 Assembly
1	SEC/50427-012	Connector, 12-pin
6	SEC/50507-020	Lamp
1	SEC/53459-001	Legend
1	SEC/53459-106	Legend
1	SEC/53459-107	Legend
1	SEC/25511-008	Stand off, plastic
5	SEC/24135-003	Strapping pin
2	SEC/51316-002	Switch, DPDT, Alternate Action
2	SEC/51317-008	Switch, button, gray
5"	SEC/19523-009	Wire, buss, solid AWG 22, insulated
3"	SEC/15176-001	Wire, brn, AWG 24
3"	SEC/15176-905	Wire, wht-blk-grn, AWG 24
3"	SEC/15176-906	Wire, wht-blk, blu, AWG 24
3"	SEC/15176-907	Wire, wht-blk-vio, AWG 24
----- SEC/53512-001 ---- PARALLEL TX INDICATOR KIT -----		
1	SEC/53233-001	Parallel Tone Transmit Indicator Assembly
1	SEC/50427-006	Connector, 6-pin
1	SEC/25511-008	Stand off, plastic
3	SEC/24135-003	Strapping pin
3"	SEC/15176-001	Wire, brn, AWG 24
5"	SEC/15176-009	Wire, wht, AWG 24
----- SEC/53513-001 ---- 2 FREQUENCY RECEIVE KIT -----		
1	SEC/53171-001	Tone Option Type 1 Assembly
1	SEC/50427-009	Connector, 9-pin
2	SEC/53248-002	Diffuser
2	SEC/50507-020	Lamp
1	SEC/53459-104	Legend
1	SEC/25511-008	Stand off, plastic
4	SEC/24135-003	Strapping pin
1	SEC/51316-002	Switch, DPDT, Alternate Action
1	SEC/51317-008	Switch, button, gray
3"	SEC/19523-009	Wire, buss, solid AWG 22 insulated
3"	SEC/15176-001	Wire, brn, AWG 24
3"	SEC/15176-903	Wire, wht-blk-orn, AWG 24
3"	SEC/15176-904	Wire, wht-blk-yel, AWG 24

## OPTIONAL FUNCTION KITS

QTY	GE PART NO.	DESCRIPTION
-----	SEC/53517-001	----- MODULE TIMED MUTE KIT -----
1	SEC/53194-001	Timed Mute Board Assembly
1	SEC/50427-006	Connector, 6-pin
1	SEC/25511-008	Stand off, plastic
1	SEC/51315-002	Switch, momentary
-----	SEC/53533-001	----- AUX KEY OPTION KIT -----
1	SEC/53319-001	Aux Key Assembly
1	SEC/50427-008	Connector, 8-pin
1	SEC/25511-008	Stand off, plastic

OPTIONAL FUNCTION KITS

**SYMPTOM:**

No audio to either the Selected or Unselected speaker amplifier.

**PROCEDURE:**

1. Check volume controls.
2. Check mute control status.
3. Check fuses.
4. Check for audio at pins 10 and 15 on the Receive board. If audio is present on pin 10 (Selected Audio) when the module is selected, refer to the Speaker Amplifier trouble-shooting procedure in Maintenance Manual LBI-30300. If audio is present on pin 15 (Unselected Audio) when the module is not selected, refer to the same procedures.
5. Check setting of the compressor sensitivity adjustment pot, R38.
6. Check internal volume control setting, potentiometer R27.

**SYMPTOM:**

No audio to the line.

**PROCEDURE:**

1. Key the mic and check for audio at pin D of the Transmit board. If none, refer to the Audio/Control board trouble-shooting procedure in Maintenance Manual LBI-30300.
2. Check fuses.
3. Check level-adjust pot, R14 on the Transmit board.
4. Check for audio at pin V of the Receive board.
5. Check for +24 volts at the collector of Q2 on the Transmit board while the mic is keyed.
6. Check pin 6 of U9 on the Transmit Board. The voltage should be at logic high with local transmit activated, or with Select and Push-To-Talk activated.

**SYMPTOM:**

No control tones on line.

**PROCEDURE:**

1. Connect an oscilloscope probe to pin S of the Tone Control Transmit board. Activate a Push-To-Talk function. If the control tone sequence is not present, refer to the Tone Control board (SEC/53197-001) troubleshooting procedures in Maintenance Manual LBI-30300.
2. While a PTT function is activated, measure the collector voltages of Q6 and Q7. Each voltage should be approximately 24 volts.
3. Check control tone level-adjust pot R90 for proper setting.
4. Check line-level adjust pot R91.



**CAUTION**  
OBSERVE PRECAUTIONS  
FOR HANDLING  
ELECTROSTATIC  
SENSITIVE  
DEVICES

TROUBLESHOOTING TABLE