

PRODUCTION CHANGES

Changes in the equipment to improve or to simplify circuits are identified by a "Revision Letter", which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for descriptions of parts affected by these revisions.

REV. A - PHONE REMOTE CONTROL BOARD 19A704686P8

To improve operation, changed D5 from a 3.3 V Zener (1N5226) to a 3.6 V Zener (1N5227), R42 from 330K to 390K, and R88 from 27K to 100K. Also added R33 and R63. (PWB from Rev. B to C).

REV. B - PHONE REMOTE CONTROL BOARD 19A704686P8

Part no longer available. U4 was J19/130-0278. Deleted R28. R26 was 100 ohms (J19/312-0010), R27 was 10 ohms (J19/312-0038), C12 was 0.047 uF (J19/362-0009) and C13 was 68 uF (J19/360-2686).

Maintenance Manual

PHONE REMOTE CONTROL BOARD 19A704686P8 (5-Function Remote Control)

TABLE OF CONTENTS

	<u>Page</u>
DESCRIPTION	1
CIRCUIT ANALYSIS	2
ADJUSTMENT PROCEDURE	3
TROUBLESHOOTING PROCEDURE	4
OUTLINE DIAGRAM	5
SCHEMATIC DIAGRAM	6
ADJUSTMENT LOCATIONS	8
PARTS LIST	9
PRODUCTION CHANGES	Back Cover
Table 1 - Function And Tone Frequencies	1
Table 2 - Update Sequences	1
Table 3 - Tone Control Frequency And Function	3
Figure 1 - Control And Function Tones	2
Figure 2 - Update Sequence For SF5	2

SPECIFICATIONS *

LINE TERMINATING IMPEDANCE	600 Ohms
LINE LEVEL (Line to Transmitter)	-20 to + 11 dBm
DISTORTION (300-1000-3000 Hz)	
Transmit	Less than 3%
Receive	Less than 5%
FREQUENCY RESPONSE	+ 1, -3dB from 300 to 3000 Hz, excluding 2175 Hz notch
2175 Hz NOTCH FILTER	-40dB
TEMPERATURE RANGE	-30°C to + 75°C (-22°F to + 153°F)

* These specifications are intended for use during servicing. Refer to the appropriate Specification Sheet for the complete specifications.

DESCRIPTION

Tone Remote Control Board 19A704686P8 is used in EDACS® Desk Top and Wall Mount stations to provide five-function remote control operation. The board accepts and generates the proper tone sequences and levels required for remote control operation. Remote Controllers and stations are connected to each other through four-wire lines.

CONTROL FUNCTIONS

The Tone Remote Control Board provides a maximum of five control functions. The functions are accomplished by applying up to three tones in sequence from the Remote Controller. These tones are detected by the Tone Remote Control Board. The function tone frequencies generated by the Remote Controller are listed in Table 1.

Table 1 - Function And Tone Frequencies

FUNCTION	TONE FREQUENCY
SF1 Selection	1950 Hz
SF2 Selection	1850 Hz
SF3 Selection	1350 Hz
SF4 Selection	1250 Hz
SF5 Selection	1050 Hz
Hold & Secur-It	2175 Hz

The station responds by applying an update tone sequence to the Remote Controller. This is accomplished by sending a 2175 Hz Secur-It tone (interpreted as a logical 1) or nothing (interpreted as a logical 0) down the control line to the Remote Controller. The sequence is always preceded by a minimum of 60 milliseconds of Secur-It tone to alert the Remote Controller that a valid update sequence follows. The sequences used by the station for indicating different updates are listed in Table 2.

Table 2 - Update Sequences

FUNCTION	UPDATE SEQUENCE
SF1 Selection	0-0-0-1-1
SF2 Selection	0-0-1-0-1
SF3 Selection	0-0-1-1-1
SF4 Selection	0-1-0-0-1
SF5 Selection	0-1-0-1-1
Reset all remotes	0-1-1-0-1

NOTE

Each bit is 50 milliseconds in length. Presence of + 10 dBm of 2175 Hz indicates a logical 1, absence indicates a logical 0.

TONE CONTROL SEQUENCE

The functions selected by the Remote Controller are accomplished through a sequence of two or three tones sent at the proper level for detection by the Tone Remote Control Board. When a non-transmit function is selected at the Remote Controller, the Secur-It tone frequency of 2175 Hz is transmitted for a period of 125 milliseconds at a level equal to normal voice peaks. In the case of a 0 VU line level, the Secur-It tone is transmitted at a level of + 10 dBm. At the end of this 125 millisecond period, the tone is changed to the selected function frequency. This function tone is transmitted for a period of 40 milliseconds at a level of 10 dB below the Secur-It tone burst. If the function is valid, the station signals the update sequence to the Remote Controller. The Remote Controller level and timing sequence is shown in Figure 1. An example of the update sequence is shown in Figure 2.

When a transmit function is selected at the Remote Controller, the Secur-It tone is transmitted followed by a 40 ms burst of the SF1-SF5 transmit function tone. This is followed by the 2175 Hz tone transmitted at a level 30 dB below Secur-It tone level, referred to as the Hold Tone.

At this time, the station updates the remotes and begins sending Hold Tone down the line to the Remote Controller. During the next five seconds, the presence of Hold Tone on the line disables all parallel Remote Controllers. The station makes a request for an open channel to the trunked system. If there is no open channel, the station will stop generating Hold Tone. If there is an open channel, the station will send a minimum of 60 milliseconds of Secur-It tone to the Remote Controllers to indicate clear-to-send.

The Remote Controller then allows voice audio to be mixed with the Hold Tone. The Hold Tone remains on in the presence of voice as long as the PTT switch is operated at the Remote Controller. However, if there is a user on the system with a higher priority than the Remote Controller, the station will stop transmission of Hold Tone. When the Remote Controller detects a lack of Hold Tone on the line, it stops sending voice and Hold Tone audio to the Tone Remote Control Board and gives the user a busy signal.

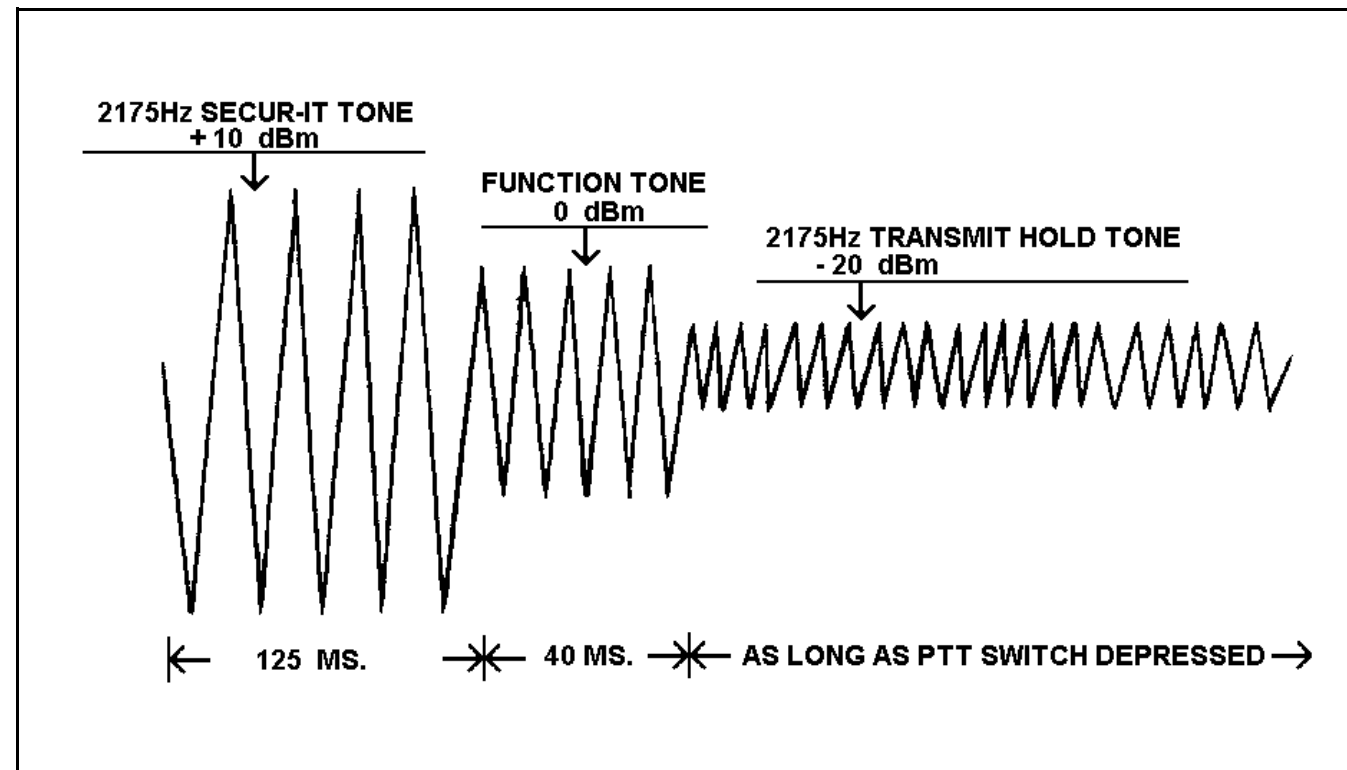


Figure 1 - Control and Function Tones

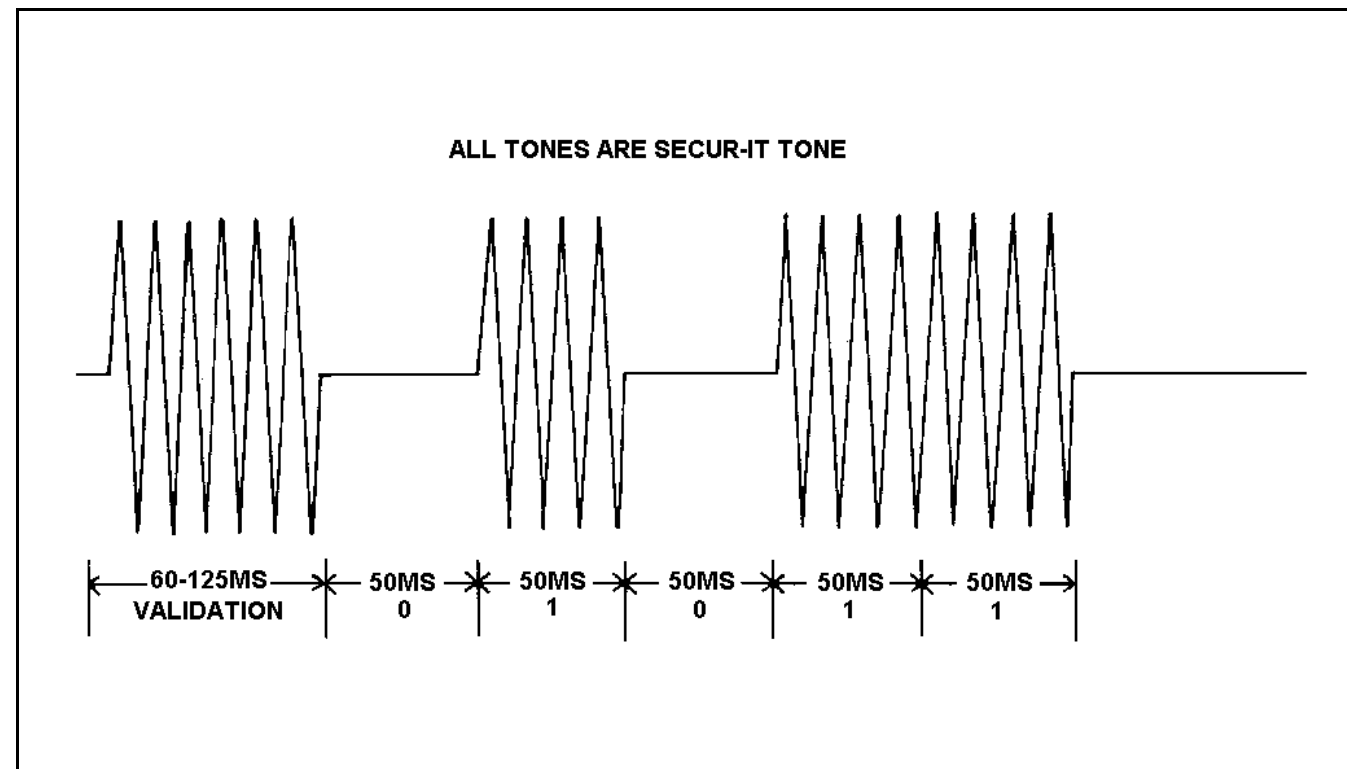


Figure 2 - Update Sequence For SF5

CIRCUIT ANALYSIS

The Tone Remote Control Board provides the transmit and receive select function, transmitter keying, and 2175 Hz generator control lines for the station. The board also provides an intercom audio path to return all transmit audio from the Remote Controller back to the receive audio of the Remote Controller. An audio path is also available between the Remote Controller and the station.

TRANSMIT AUDIO

Audio and control tones from the Remote Controller are applied to the Tone Remote Control Board at TB1-3 and TB1-4 (TX AUDIO). The audio and tones are coupled through transformer T1 to the input of line pre-amplifier U3-5. An impedance-matching resistor (R14) across the secondary of T1 matches the input impedance to 600 ohms. The pre-amplifier input is set by R16. Telephone line surge protection is provided by SG1 and SG2.

Audio Componder

The output of audio pre-amp U3-7 feeds the compander (compressor-expander) circuitry. The compression circuit is comprised of audio amplifier U3-2, -3 and compressor-expander U1. The gain of amplifier U3 is controlled by the impedance of the gain cell within U1. This is accomplished by applying the line receive signal to the active rectification circuit through U1-3. This circuit produces a dc level for the internal variable gain cell that is tied to U1 pins 5 and 7. The attack time (5 milliseconds) for the gain cell is set by C28, and the release time (2.5 seconds) is set by C30. The voltage on U1-2 is proportional to the amount of signal that is on the line (0.2 to 1.75 Vdc). This voltage is also sensed by comparator U5 which shuts off analog gate U11D in the absence of a good receive signal. This prevents white noise from being amplified and placed on the output. Potentiometer R57 sets the cutoff level of the comparator.

TX Audio 2175 Hz Notch Filter

The output of the compander (U3-1) is coupled to the input of a notch filter, comprised of U2 and associated components. The notch filter removes the 2175 Hz frequency from the audio signal, preventing the Secur-It and Hold Tones from being transmitted. The depth of this notch is 40 dB below a reference set at 1000 Hz and 0 dBm on the line. Potentiometers R72 and R73 set the center of the notch. These potentiometers are factory set and sealed and should not require adjustment.

MICROPHONE AUDIO

The output of the 2175 Hz notch filter (U2-1) passes through bilateral switch U1 1B into the mic audio driver (U1 7-6). When the bilateral switch control pin (U1 1-5) is pulled to 10 volts, audio is allowed to pass from pin 3 to 4 of U11. This gate may be controlled by the Hold Tone detection circuitry. However, if H1-H3 is removed, the bilateral switch will always pass line audio to the mic audio driver. Potentiometer R82 sets the level of audio at MIC AUDIO (P1-1).

RECEIVE AUDIO

Audio from the station receiver is applied to the Tone Remote Control Board through RX AUDIO (P1-9). The receive audio is coupled through a passive lowpass filter (R35, R36, C3, and C21) which provides 6 dB/octave de-emphasis. The filter output is applied to the input of op-amp U9-2. The audio then passes through the 2175 notch filter (U8) preventing falsing of the Remote Controller.

When the RUS line (P1-12) is high, the receive audio is coupled through bilateral switch U10C. Potentiometer R66 is set so that normal audio from the receiver will be transmitted to the Remote Controller at 0 dBm. This audio is summed and coupled to line driver U4. The output of driver U4-5 is coupled through R26 to transformer T2. Output from T2 goes directly to the line through TB1-5 and TB1-2 (RX Audio). Transient protection is provided by SG4 and SG3.

When the RUS line (P1-12) is low, the intercom audio from the Remote Controller is returned to the Remote Controller through switch U10B. Potentiometer R65 sets the received audio level from TB1-3 and TB1-4 so that it is sent to the Remote Controller at 0 dBm. This audio is summed and applied to line driver U4.

CONTROL TONES

Control tones (and voice) are coupled through TB1-3 and TB1-4 (TX AUDIO), and audio transformer T1. The output of transformer T1 feeds input pre-amplifier U3-5. The output of the pre-amplifier (U3-7) is coupled to potentiometer R17 which sets the Secur-It, function, and Hold Tone detection levels (input to band-pass filter U7-6).

Secur-It Tone

Output from R17 is routed through a 2175 Hz band-pass filter (U7-6). The center frequency of this filter is set by SET potentiometer R1 1. The output of this filter (U7-8) is rectified by D1 and D2 which are used to detect the presence of the Secur-It tone. This dc level is fed to the input of tone-detection comparator U5-5. The output of the comparator (U5-7) will cause the SEC-DET line (P1 - 11) to go low when the 2175 Hz tone is detected.

Half of dual monostable multivibrator U27 is controlled by the output from comparator U5-7 and is used as a validation timer. The Tone Remote Control Board Secur-It tone validation timer is triggered by the positive edge of the comparator detection (U27-4). The validation time is set at 100 milliseconds by R136 and C91. After 100 milliseconds, the validation timer output (U27-7) goes high. This leaves 25 milliseconds of the 125 millisecond Secur-It tone left; both AND gate inputs (U29-4 and U29-5) are high. This causes the AND gate output (U29-6) to go high and set latch U22. When the Secur-It tone stops and the function tone begins, the output of the inverter (U31F-12) will be high. At this time the output of AND gate U29-8, will also go high allowing function tone audio to enter the detectors. This will remain the case until the latch (U22-7) is reset.

Function Tones

Low-frequency receive audio signals are removed by high-pass filter U6-5. This filter allows frequencies greater than 1000 Hz to pass (function tones start at 1050 Hz) to the function-tone detectors. The function tone audio is not applied to the function-tone detectors until a valid Secur-It tone burst is detected. Once a valid Secur-It tone is detected, audio is allowed to pass into the bank of function-tone detectors through bilateral switch U11C.

The function tones are decoded by phase-locked-loop decoders U12 thru U16. The detection frequency is set by the capacitor across pins 13 and 14, and the resistance between pin 12 and ground. The decoder tones and functions are listed in Table 3.

Tone adjust potentiometers R127, R117, R105, R109, and R121 are set at the factory and should need no further adjustment. However, if one of the decoders or associated circuitry is replaced, adjust the decoders as directed in the alignment procedure.

When one of the function tones is decoded, pin 6 of the selected decoder goes high. This high is applied to latch (U22 or U23) which causes its output to go high. This in turn is applied to the input of drivers Q3 thru Q7 which control the SF1 thru SF5 lines (P2- 1 thru -5). When detection is lost, the inverter

output (U31C-6) will go high. Since both inputs to the AND gates U29 are high, the output (U29-1) will also go high. This will then cause the OR gate output (U32-11) to go high and reset the latch (U22-7). When this latch output goes low (U22-9), bilateral switch U1 1C will again prevent audio from being applied to the function-tone decoders.

Table 3 - Tone Control Frequency And Function

DECODER	FUNCTION	TONE FREQUENCY
U14	SF1	1950 Hz
U13	SF2	1850 Hz
U12	SF3	1350 Hz
U15	SF4	1250 Hz
U16	SF5	1050 Hz

Transmit Hold Tone

The Hold Tone (2175 Hz at -20 dBm) keys the transmitter as long as the tone is applied to the Tone Remote Control Board, or until a higher priority user needs the transmitter.

The end of the Secur-It tone causes monostable multivibrator U27 to begin a 39 millisecond timing pulse. This disables audio from entering the Hold Tone detector during the function tone detection. During this period, the monostable output (U27-9) remains low ensuring the AND gate output (U29-3) stays low. Since the AND gate output is low, bilateral switch U1 1A will stop passing audio.

After the function tone is decoded, a rising voltage triggers the monostable multivibrator (U28-12) causing a pulse on OR gate U32-2. This causes the OR gate output (U24-4) to pulse and reset the flip-flop (U22 pin 11).

The Hold Tone detection is achieved using the same 2175 Hz band-pass filter (U7) used in detecting the Secur-It tone. Since this filter allows only 2175 Hz to pass, the output can be rectified and fed into a comparator. The band-pass filter is fed into U6-2 to amplify the low level tone for rectification. Diodes D3 and D4 and capacitor C96 perform the rectification. The comparator output (U30 pin 7) goes high during detection. The REM PTT line (P1-4) will then be pulled low by transistor Q1.

During Hold-Tone detection, the Clear pin of the monostable multivibrator (U28-3) will be held low. This keeps the monostable (U28) from causing the function-tone-decoding reset pulse. When the Hold Tone detection is lost, the monostable output (U18-6) pulses causing a reset of the flip-flop (U22-11). The board will then be ready to accept another sequence from the Remote Controller.

2175 Hz Generator

The source of the 2175 Hz tone, which is sent back to the Remote Controller is U26. The tone output level is adjusted by R98 and the tone center frequency is set by R99. When LOCAL PTT (P1-6) is low, bilateral switch U10A stops the 2175 Hz tone from reaching the Remote Controller. When LOCAL PTT is high and HANDSHAKE (P1-7) is low, then -20 dBm of 2175 Hz (Hold Tone) is sent to the Remote Controller. When HANDSHAKE and LOCAL PTT are high, then + 10 dBm of 2175 Hz (Secur-It tone) are transmitted to the Remote Controller. The HANDSHAKE line controls bilateral switch U10D which sets the level of 2175 Hz tone. The LOCAL PTT line controls bilateral switch U10A which keys the 2175 Hz tone sent to the Remote Controllers.

ADJUSTMENT PROCEDURE

The Tone Remote Control Board should be checked and adjusted when the system is installed. The tone decoder and filter adjustments are set at the factory and should not require adjustment unless the tone filters, decoders, generators or associated circuitry are replaced.

Make sure all connections to the base station and Remote Controller are complete, and that the tone panel and base station have been properly aligned before adjusting the Tone Remote Control Board.

EQUIPMENT REQUIRED

1. Ac voltmeter with dBm scale
2. Deviation monitor
3. Frequency counter for function decoders
4. Audio generator

RECEIVE AUDIO (R66)

1. Apply a 1000 Hz tone with a \pm 3 kHz deviation to the station receiver that is strong enough to fully quiet the receiver.
2. Adjust RECEIVE TO LINE control R66 for 0 dBm across terminals TB1-2 and TB1-5.

LINE PRE-AMP (R17)

Key the Remote Controller with the largest loss (usually farthest from the station) to activate the base station transmitter. If the station transmitter does not key, adjust TONE

DETECTION LEVEL control R17 and key the Remote Controller.

TX AUDIO SQUELCH (R57)

1. Measure the comparator output U5-1 with a voltmeter.
2. With no audio on the line from the Remote Controller, adjust COMPRESSION CUTOFF control R57 clockwise until the comparator output voltage goes low. Turn the potentiometer 1/8-turn more.

INTERCOM AUDIO (R65)

1. Apply 1000 Hz at 0 dBm to TB1-3 and TB1-4 input.
2. Adjust INTERCOM LEVEL control R65 for 0 dBm at TB1-2 and TB1-5 output.

TX MIC AUDIO (R82)

1. Apply a 1000 Hz tone into the microphone jack of the Remote Controller with the largest line loss (usually farthest from the station).
2. Set the Remote Controller line output for 0.77 Vrms as measured across the audio pair at the Remote Controller.
3. Key the base station transmitter from the Remote Controller and adjust MIC DEVIATION LEVEL control R82 for \pm 4.5 kHz deviation.

FUNCTION DECODERS

NOTE

The following adjustments are not normally required for the initial installation.

Perform the adjustment on each tone detector (U12 thru U16). Pin numbers in the procedure refer to U12 thru U16. The decoder potentiometer refers to R105 for U12, R117 for U13, R127 for U14, R109 for U15, or R121 for U16.

1. Remove the 0.1 microfarad capacitor from pin 10 to ground.
2. Jumper pins 2 and 10 together. Pin 3 should now oscillate near the detection frequency.

3. Connect a frequency counter to pin 3 and adjust the proper decoder potentiometer for the correct frequency to be decoded.
4. After making the adjustments, remove jumper from pin 2 to pin 10. and replace the 0.1 microfarad capacitor from pin 10 to ground.

2175 HZ GENERATOR

1. Attach the frequency counter to U26-2 and measure the signal frequency.
2. Adjust potentiometer R99 until output frequency is 2175 Hz.
3. Enable 2175 Hz Secur-It tone from the panel by letting LOCAL PTT and HANDSHAKE float high.
4. Adjust potentiometer R98 until + 10 dBm of 2175 Hz is measured on the line between TB1-2 and TB1-5.
5. Remove the frequency counter.

NOTCH FILTER (R72 & R73)

1. Feed a 2175 Hz signal to TB1-3 and TB1-4. The input level should not exceed 1.2 Volts rms.
2. Adjust R72 for a minimum meter reading on U2-1.
3. Adjust R73 for a minimum meter reading on U2-1.
4. While metering the output at U2-1, adjust both R72 and R73 for more attenuation of the 2175 Hz tone.

BAND-PASS FILTER (R11)

1. Feed a 2175 Hz signal to TB1-3 and TB1-4, with the signal level no greater than 1.2 Volts rms.
2. Adjust R11 for a maximum level of 2175 Hz tone at U7-8.

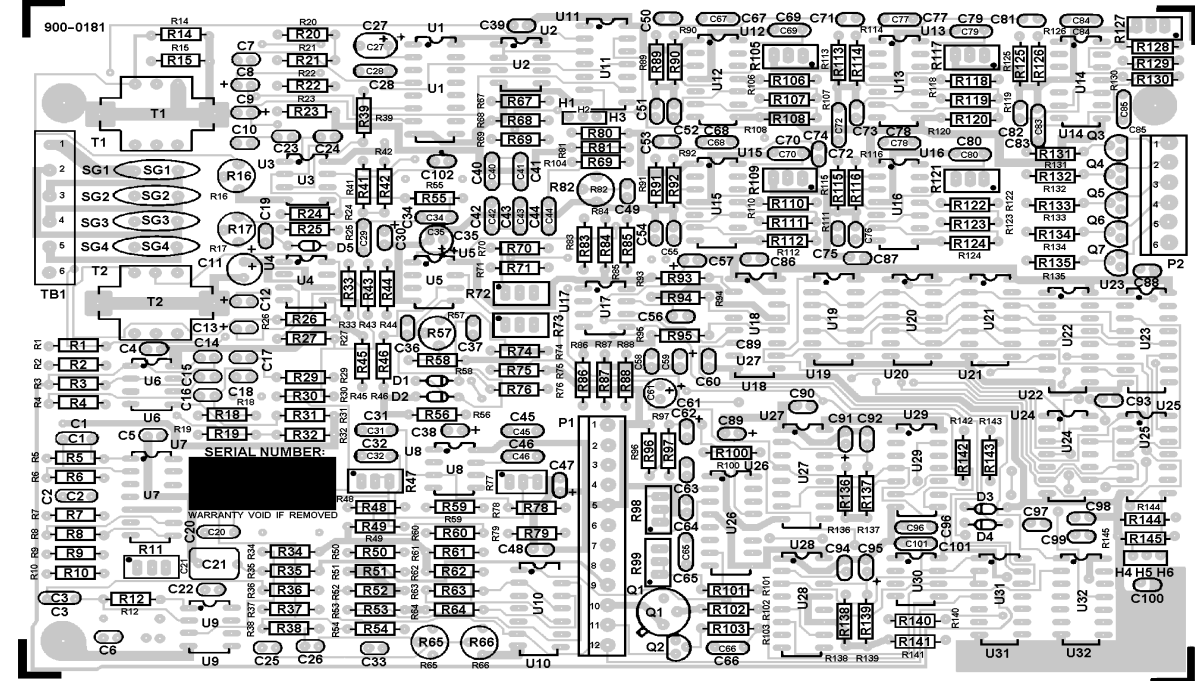
TROUBLESHOOTING PROCEDURE

Before troubleshooting the Tone Remote Control Board, check all connections to the Remote Controllers and base stations. Make sure that the station, Tone Remote Control Board, and Remote Controller have been properly adjusted.

SYMPTOM	PROCEDURE
No audio from base station to Remote Controller(s)	<ol style="list-style-type: none"> 1. Check U9. Pins 1-3 & 5-7 should be at 5 Vdc. Audio should appear on pin 1. 2. Check U8. Pins 1-3 & 5-7 should be at 5 Vdc. Audio should appear on both pins 1 and 7. 3. Check U10. Audio should pass from pin 8 to 9 when pin 6 is high. 4. Check U4. Audio should appear on pin 5.
2175 Hz tone is transmitted	<ol style="list-style-type: none"> 1. Over-deviating mic audio. Adjust R82 so that voice audio does not exceed full system deviation. 2. Check adjustment procedure for 2175 Hz notch filter.
Secur-It tone not detected	<ol style="list-style-type: none"> 1. Line pre-amp not adjusted properly (R17). 2. Check U7. Pins 1, 2, 3, 5, 6, 7, 8, 9, and 10 should have 5 Vdc present. There should be Secur-It tone audio on pins 1, 7, and 8. 3. Band-pass filter R11 not adjusted properly. 4. Check U5. Pin 6 will have 1.8 Vdc present. Output pin should go high when Secur-It tone audio is present. 5. Check transistor Q2.
No function tone detected	<ol style="list-style-type: none"> 1. Line pre-amp not adjusted properly (R17). 2. Check U6. Pin 5, 6, and 7 will have 5 Vdc present. There should be audio on pin 7. 3. Check gate U11C. Function tone audio should be present on pin 8. If not, then check the control circuitry.
Transmit hold tone not detected	<ol style="list-style-type: none"> 1. Check gate U11A. When pin 13 goes high, audio should flow from pin 1 to pin 2. 2. Check U6. Pin 1, 2, and 3 should have 5 Vdc present. Hold tone will be present on pin 1. 3. Check U30. When hold tone is applied, pin 7 should go high. 4. Q1 is not functioning properly.

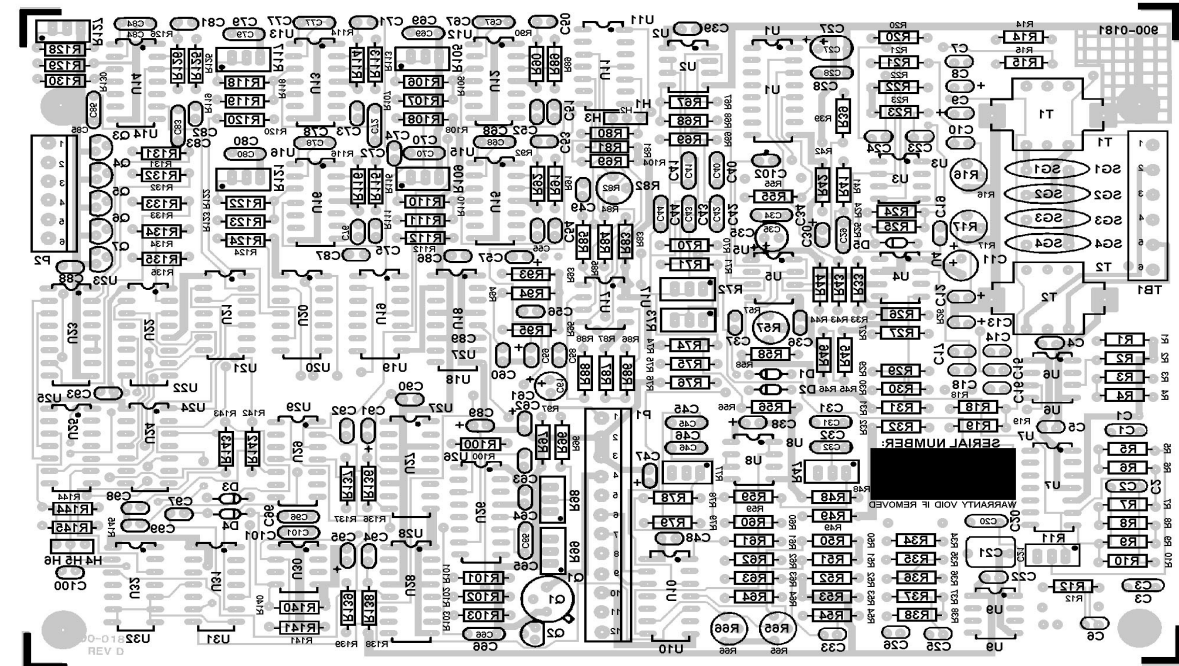
SYMPTOM	PROCEDURE
No transmit audio	<ol style="list-style-type: none"> 1. Check gate U11B. With pin 5 high there should be audio passing from pin 3 to pin 4. 2. Check U17. Pins 5, 6, and 7 should be at 5 Vdc. Audio should be present on pin 7. 3. Make sure Q1 brings the REM PTT line low during Remote Controller PTTing. If not, make sure transmit hold tone detected. 4. Check setting of MIC DEVIATION LEVEL control R82. It may be misadjusted (set too low). 5. Make sure the Remote Controller receives the update handshake.
No intercom audio	<ol style="list-style-type: none"> 1. Check the gate U10B. When pin 5 is high audio should pass from pin 3 to pin 4. 2. Check setting of INTERCOM LEVEL adjust R65. It may be misadjusted (set too low).
Remote Controller fails to update or transmit	<ol style="list-style-type: none"> 1. Make sure Secur-It and function tones are decoded. 2. Check the gate U10A. When pin 13 is high 2175 Hz should pass from pin 1 to pin 2. 3. Check the gate U10D. When pin 12 is high and pin 13 is high the audio on pin 10 and pin 11 should be the same level. 4. Check the setting of tone generator U26 (R98 and R99). It may be misadjusted (level may be too low or frequency may be off). 5. Watch the HANDSHAKE and LOCAL PTT lines during the update sequence. They should toggle and there should be tones on the line driver (U4). 6. Check the Remote Controller band-pass filter adjustments.
The audio from the Remote Controller fades	<p>Check the setting of the TX audio squelch control R57 (COMPRESSION CUT OFF).</p>

COMPONENT SIDE



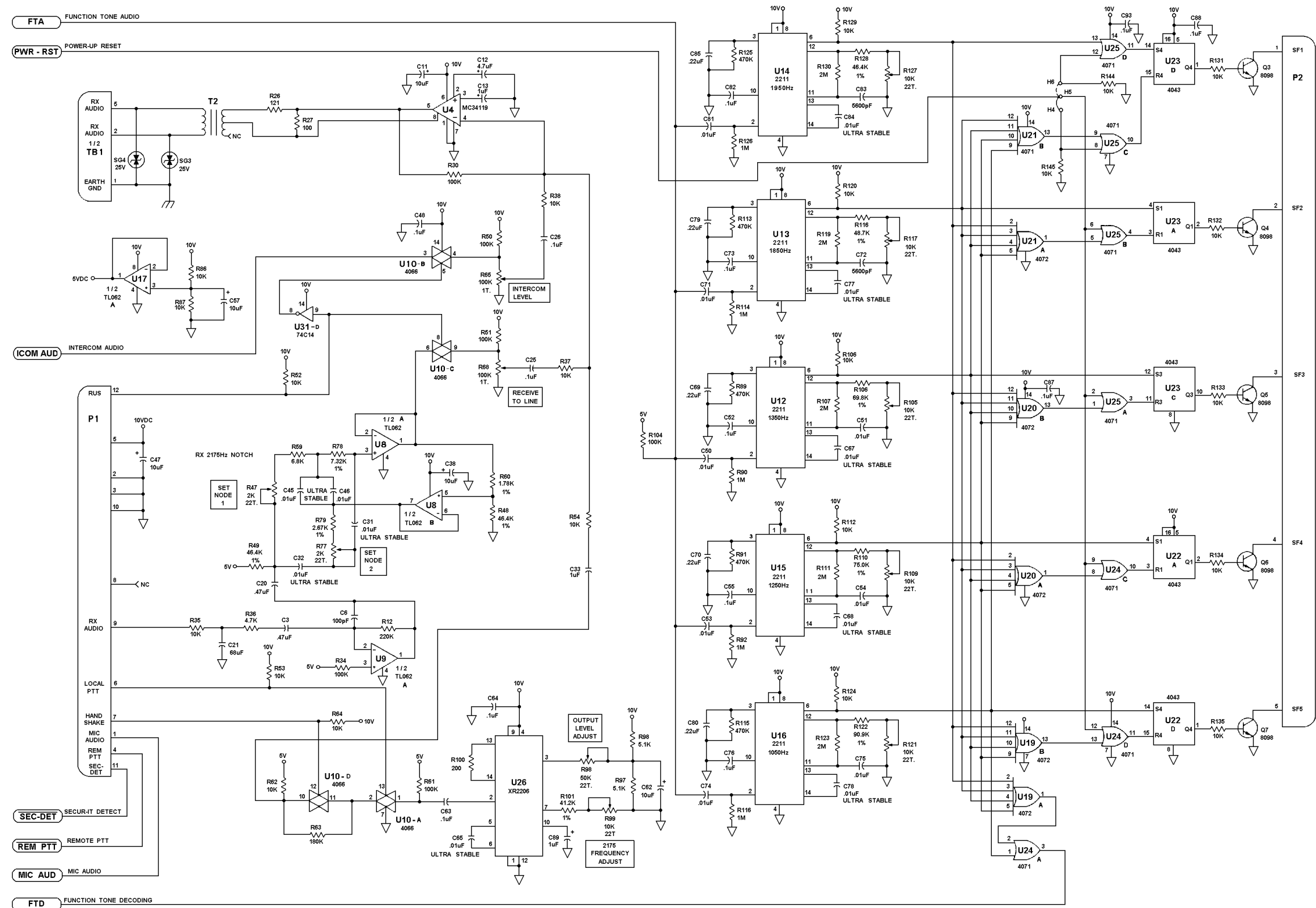
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SOLDER SIDE



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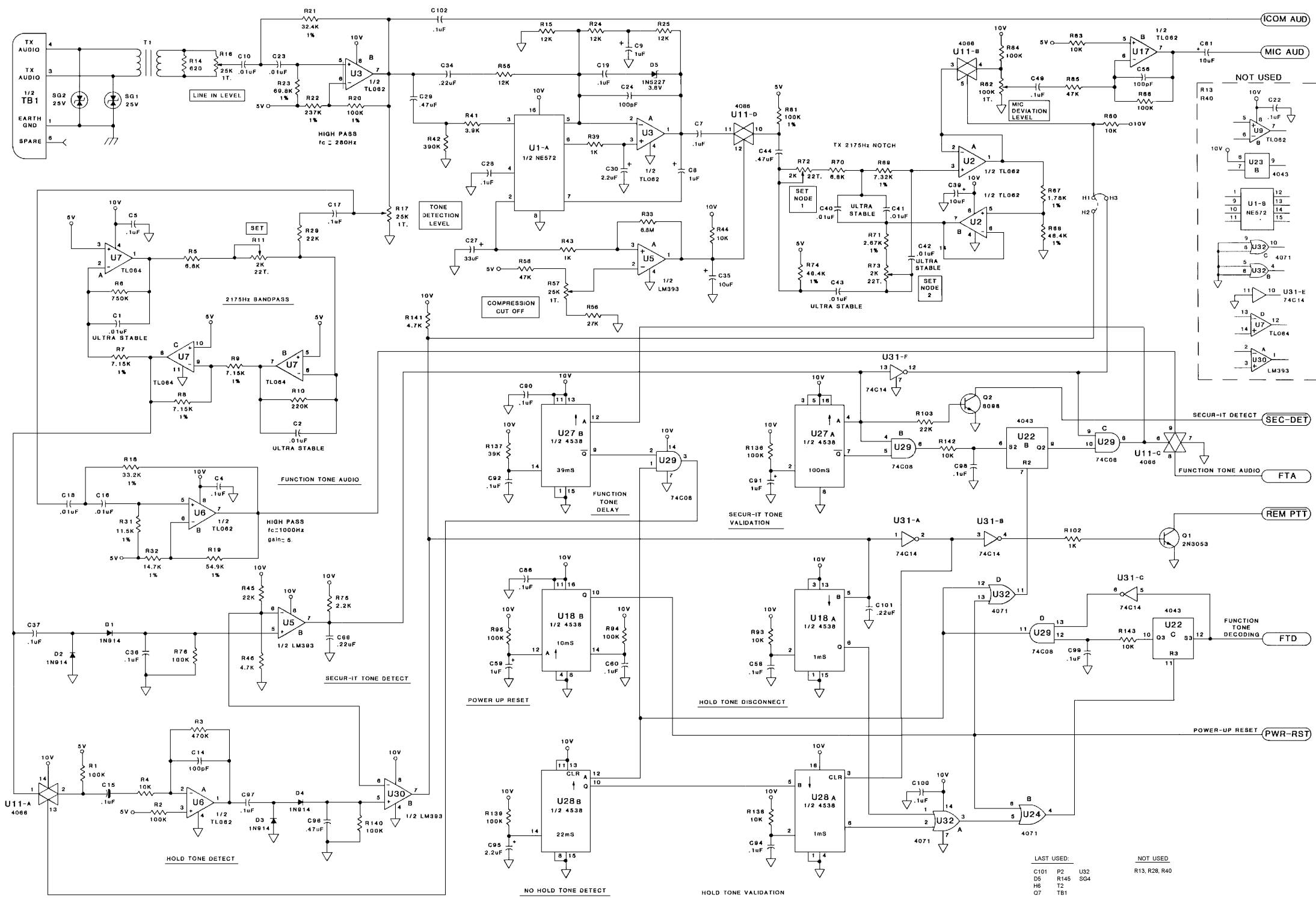
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19A704686P8



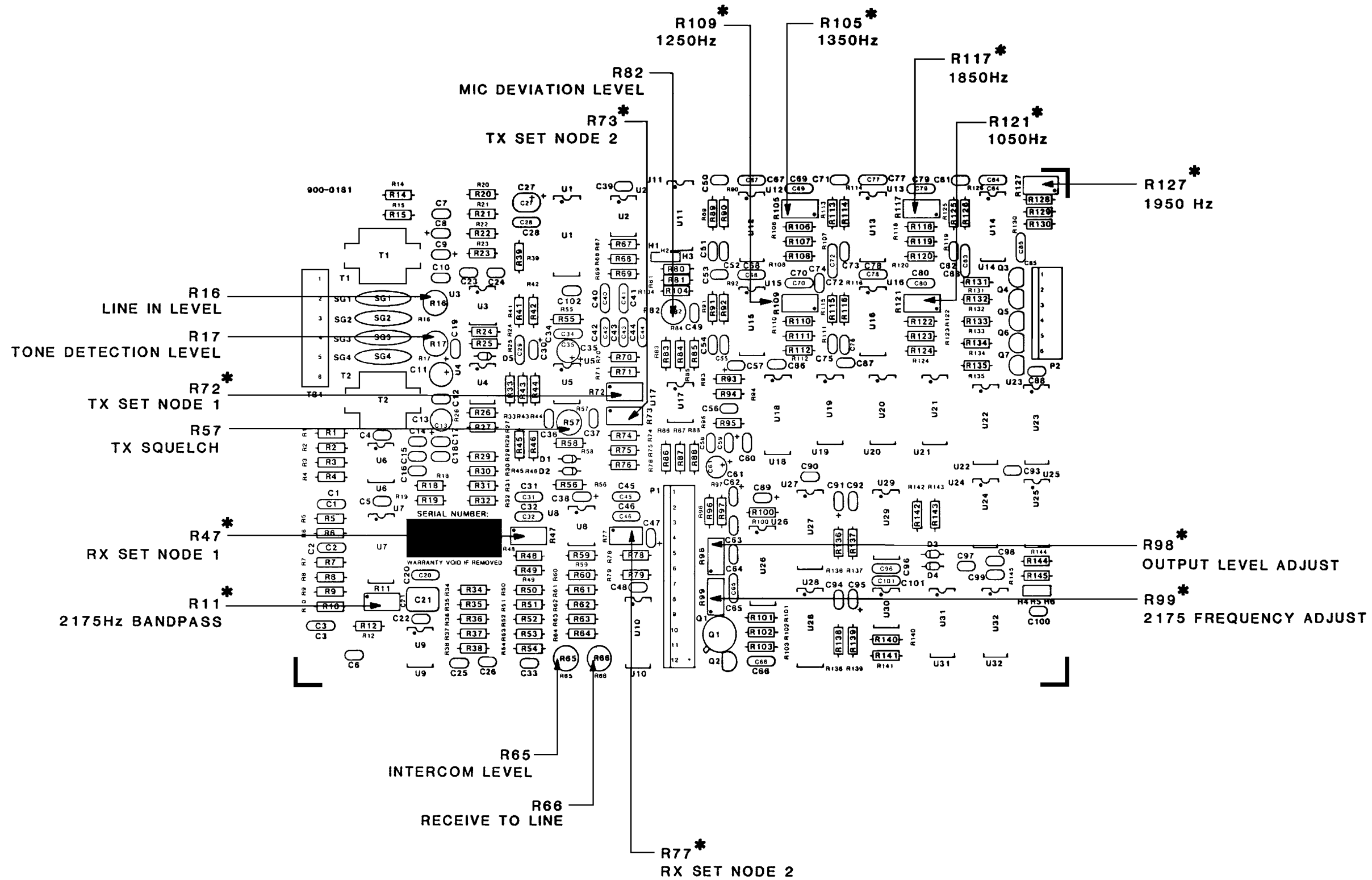
TONE REMOTE CONTROL BOARD

19A704686P8

(4172-S-00, Sh. 1, Rev. D)



TONE REMOTE CONTROL BOARD
19A704686P8
(4172-S-00, Sh. 2, Rev. D)



TONE REMOTE CONTROL BOARD
19A704686P8

PARTS LIST

LBI-38119D

TONE REMOTE CONTROL BOARD
19A704686P8
(J19/101-0181)

ISSUE 3

SYMBOL	PART NO.	DESCRIPTION
----- CAPACITORS -----		
C1 and C2	J19/362-0019	Ultra stable: .01 uF, 50 V.
C3	J19/362-0002	Monolythic: .47 uF.
C4 and C5	J19/362-0001	Monolythic: .1 uF.
C6	J19/362-0016	Monolythic: 100 pF.
C7	J19/362-0001	Monolythic: .1 uF.
C8 and C9	J19/390-0003	Tantalum: 1 uF, 35 V.
C10	J19/362-5103	Monolythic: .01 uF, + or - 2%.
C11	J19/360-0004	Electrolytic: 10 uF, 16 V.
C12	J19/390-0004	Tantalum: 4.7 uF, 35 VDCW.
C13	J19/390-0003	Tantalum: 1 uF, 35 VDCW.
C14	J19/362-0016	Monolythic: 100 pF.
C15	J19/362-0001	Monolythic: .1 uF.
C16	J19/362-0003	Monolythic: .01 uF.
C17	J19/362-0001	Monolythic: .1 uF.
C18	J19/362-0003	Monolythic: .01 uF.
C19	J19/362-0001	Monolythic: .1 uF.
C20	J19/362-0002	Monolythic: .47 uF.
C21	J19/380-0011	Mylar: .68 uF, 50 V.
C22	J19/362-0001	Monolythic: .1 uF.
C23	J19/362-5103	Monolythic: .01 uF, + or - 2%.
C24	J19/362-0016	Monolythic: 100 pF.
C25 and C26	J19/362-0001	Monolythic: .1 uF.
C27	J19/390-2336	Tantalum: 33 uF, 16 V.
C28 and C29	J19/362-0002	Monolythic: .47 uF.
C30	J19/390-0005	Tantalum: 2.2 uF, 35 V.
C31 and C32	J19/362-0019	Ultra stable: .01 uF, 50 V.
C33	J19/362-0001	Monolythic: .1 uF.
C34	J19/362-5224	Monolythic: .22 uF, 50 V.
C35	J19/360-0004	Electrolytic: 10 uF, 16 V.
C36 and C37	J19/362-0001	Monolythic: .1 uF.
C38	J19/390-0010	Tantalum: 10 uF, 16 V.
C39	J19/362-0001	Monolythic: .1 uF.
C40 thru C43	J19/362-0019	Ultra stable: .01 uF, 50 V.
C44	J19/362-0002	Monolythic: .47 uF.
C45 and C46	J19/362-0019	Ultra stable: .01 uF, 50 V.
C47	J19/390-0010	Tantalum: 10 uF, 16 V.
C48 and C49	J19/362-0001	Monolythic: .1 uF.
C50 and C51	J19/362-0003	Monolythic: .01 uF.
C52	J19/362-0001	Monolythic: .1 uF.
C53 and C54	J19/362-0003	Monolythic: .01 uF.
C55	J19/362-0001	Monolythic: .1 uF.
C56	J19/362-0016	Monolythic: 100 pF.
C57	J19/360-0004	Electrolytic: 10 uF, 16 V.
C58	J19/362-0001	Monolythic: .1 uF.
C59	J19/390-0003	Tantalum: 1 uF, 35 V.
C60	J19/362-0001	Monolythic: .1 uF.
C61	J19/360-0004	Electrolytic: 10 uF, 16 V.
C62	J19/390-0010	Tantalum: 10 uF, 16 V.
C63 and C64	J19/362-0001	Monolythic: .1 uF.
C65	J19/362-0019	Ultra stable: .01 uF, 50 V.
C66	J19/362-5224	Monolythic: .22 uF, 50 V.
C67 and C68	J19/362-0019	Ultra stable: .01 uF, 50 V.
C69 and C70	J19/362-5224	Monolythic: .22 uF, 50 V.

SYMBOL	PART NO.	DESCRIPTION
C71	J19/362-0003	Monolythic: .01 uF.
C72	J19/370-0016	Ceramic: 5600 pF.
C73	J19/362-0001	Monolythic: .1 uF.
C74 and C75	J19/362-0003	Monolythic: .01 uF.
C76	J19/362-0001	Monolythic: .1 uF.
C77 and C78	J19/362-0019	Ultra stable: .01 uF, 50 V.
C79 and C80	J19/362-5224	Monolythic: .22 uF, 50 V.
C81	J19/362-0003	Monolythic: .01 uF.
C82	J19/362-0001	Monolythic: .1 uF.
C83	J19/370-0016	Ceramic: 5600 pF.
C84	J19/362-0019	Ultra stable: .01 uF, 50 V.
C85	J19/362-5224	Monolythic: .22 uF, 50 V.
C86 thru C88	J19/362-0001	Monolythic: .1 uF.
C89	J19/390-0003	Tantalum: 1 uF, 35 V.
C90	J19/362-0001	Monolythic: .1 uF.
C91	J19/390-0003	Tantalum: 1 uF, 35 V.
C92 thru C94	J19/362-0001	Monolythic: .1 uF.
C95	J19/390-0005	Tantalum: 2.2 uF, 35 V.
C96	J19/362-0002	Monolythic: .47 uF.
C97 thru C100	J19/362-0001	Monolythic: .1 uF.
C101	J19/362-5224	Monolythic: .22 uF, 50 V.
C102	J19/362-0001	Monolythic: .1 uF.
----- DIODES -----		
D1 thru D4	J19/110-0001	Silicon: 1N914.
D5 *	J19/111-0008	Zener: 3.6 V, 1N5227.
----- CONNECTORS AND PLUGS -----		
H1-H3 and H4-H6	J19/231-1003	Connector: 3-Pin, 22-03-2031 Molex.
P1 and P2	J19/231-1066	Plug: 6-Pin, .156" Centers.
----- TRANSISTORS -----		
Q1	J19/180-0017	Silicon, NPN: 2N3053.
Q2 thru Q7	J19/180-0009	Silicon, NPN: MPS8098.
----- RESISTORS -----		
R1 and R2	J19/312-0003	100K ohms + or - 5%, 1/4 w.
R3	J19/312-0046	470K ohms + or - 5%, 1/4 w.
R4	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R5	J19/312-0018	6.8K ohms + or - 5%, 1/4 w.
R6	J19/312-0073	750K ohms + or - 5%, 1/4 w.
R7 thru R9	J19/311-7151	7.15K ohms + or - 1%, 1/4 w.
R10	J19/312-0012	220K ohms + or - 5%, 1/4 w.
R11	J19/352-0004	Potentiometer: 2K ohms, 22-Turn.
R12	J19/312-0012	220K ohms + or - 5%, 1/4 w.
R14	J19/312-0045	620 ohms + or - 5%, 1/4 w.
R15	J19/312-0021	12K ohms + or - 5%, 1/4 w.
R16 and R17	J19/351-1253	Potentiometer: 25K ohms, 1-Turn.
R18	J19/311-0021	33.2K ohms + or - 1%, 1/4 w.
R19	J19/311-5492	54.9K ohms + or - 1%, 1/4 w.
R20	J19/311-1003	100K ohms + or - 1%, 1/4 w.
R21	J19/311-3242	32.4K ohms + or - 1%, 1/4 w.
R22	J19/311-2373	237K ohms + or - 1%, 1/4 w.
R23	J19/311-6982	69.8K ohms + or - 1%, 1/4 w.
R24 and R25	J19/312-0021	12K ohms + or - 5%, 1/4 w.
R26	J19/311-1210	121 ohms + or - 1%, 1/4 w.
R27	J19/312-0010	100 ohms + or - 5%, 1/4 w.
R29	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R30	J19/312-0003	100K ohms + or - 5%, 1/4 w.
R31	J19/311-1152	11.5K ohms + or - 1%, 1/4 w.
R32	J19/311-1472	14.7K ohms + or - 1%, 1/4 w.
R33 *	J19/312-0016	6.8K ohms + or - 5%, 1/4 w.
R34	J19/312-0003	100K ohms + or - 5%, 1/4 w.

SYMBOL	PART NO.	DESCRIPTION
R35	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R36	J19/312-0040	4.7K ohms + or - 5%, 1/4 w.
R37 and R38	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R39	J19/312-0019	1K ohms + or - 5%, 1/4 w.
R41	J19/312-0070	3.9K ohms + or - 5%, 1/4 w.
R42 *	J19/312-0001	390K ohms + or - 5%, 1/4 w.
R43	J19/312-0019	1K ohms + or - 5%, 1/4 w.
R44 and R45	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R46	J19/312-0036	8.2K ohms + or - 5%, 1/4 w.
R47	J19/352-0004	Potentiometer: 2K ohms, 22-Turn.
R48 and R49	J19/311-4642	46.4K ohms + or - 1%, 1/4 w.
R50 and R51	J19/312-0003	100K ohms + or - 5%, 1/4 w.
R52 thru R54	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R55	J19/312-0021	12K ohms + or - 5%, 1/4 w.
R56	J19/312-0005	27K ohms + or - 5%, 1/4 w.
R57	J19/351-1253	Potentiometer: 25K ohms, 1-Turn.
R58	J19/312-0003	100K ohms + or - 5%, 1/4 w.
R59	J19/312-0018	6.8K ohms + or - 5%, 1/4 w.
R60	J19/311-1781	1.78K ohms + or - 1%, 1/4 w.
R61	J19/312-0003	100K ohms + or - 5%, 1/4 w.
R62	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R63 *	J19/312-0057	180K ohms + or - 5%, 1/4 w.
R64	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R65 and R66	J19/351-1104	Potentiometer: 100K ohms, 1-Turn.
R67	J19/311-1781	1.78K ohms + or - 1%, 1/4 w.
R68	J19/311-4642	46.4K ohms + or - 1%, 1/4 w.
R69	J19/311-7321	7.32K ohms + or - 1%, 1/4 w.
R70	J19/312-0018	6.8K ohms + or - 5%, 1/4 w.
R71	J19/311-0017	2.67K ohms + or - 1%, 1/4 w.
R72 and R73	J19/352-0004	Potentiometer: 2K ohms, 22-Turn.
R74	J19/311-4642	46.4K ohms + or - 1%, 1/4 w.
R75	J19/312-0007	2.2K ohms + or - 5%, 1/4 w.
R76	J19/312-0003	100K ohms + or - 5%, 1/4 w.
R77	J19/352-0004	Potentiometer: 2K ohms, 22-Turn.
R78	J19/311-7321	7.32K ohms + or - 1%, 1/4 w.
R79	J19/311-0017	2.67K ohms + or - 1%, 1/4 w.
R80	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R81	J19/312-0003	100K ohms + or - 5%, 1/4 w.
R82	J19/351-1104	Potentiometer: 100K ohms, 1-Turn.
R83	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R84	J19/312-0003	100K ohms + or - 5%, 1/4 w.
R85	J19/312-0020	47K ohms + or - 5%, 1/4 w.
R86 and R87	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R88 *	J19/312-0003	100K ohms + or - 5%, 1/4 w.
R89	J19/312-0046	470K ohms + or - 5%, 1/4 w.
R90	J19/312-0047	1M ohms + or - 5%, 1/4 w.
R91	J19/312-0046	470K ohms + or - 5%, 1/4 w.
R92	J19/312-0047	1M ohms + or - 5%, 1/4 w.
R93	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R94 and R95	J19/312-0003	100K ohms + or - 5%, 1/4 w.
R96 and R97	J19/312-0024	5.1K ohms + or - 5%, 1/4 w.
R98	J19/352-0002	Potentiometer: 50K ohms, 22-Turn.
R99	J19/352-1103	Potentiometer: 10K ohms, 22-Turn.
R100	J19/312-0039	200 ohms + or - 5%, 1/4 w.
R101	J19/311-4122	41.2K ohms + or - 1%, 1/4 w.
R102	J19/312-0019	1K ohms + or - 5%, 1/4 w.
R103	J19/312-0015	22K ohms + or - 5%, 1/4 w.
R104	J19/312-0003	100K ohms + or - 5%, 1/4 w.
R105	J19/352-1103	Potentiometer: 10K ohms, 22-Turn.
R106	J19/311-6982	69.8K ohms + or - 1%, 1/4 w.
R107	J19/312-0048	2M ohms + or - 5%, 1/4 w.
R108	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R109	J19/352-1103	Potentiometer: 10K ohms, 22-Turn.
R110	J19/311-0023	75.0K ohms + or - 1%, 1/4 w.
R111	J19/312-0048	2M ohms + or - 5%, 1/4 w.
R112	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R113	J19/312-0046	470K ohms + or - 5%, 1/4 w.

SYMBOL	PART NO.	DESCRIPTION
R114	J19/312-0047	1M ohms + or - 5%, 1/4 w.
R115	J19/312-0046	470K ohms + or - 5%, 1/4 w.
R116	J19/312-0047	1M ohms + or - 5%, 1/4 w.
R117	J19/352-1103	Potentiometer: 10K ohms, 22-Turn.
R118	J19/311-4872	48.7K ohms + or - 1%, 1/4 w.
R119	J19/312-0048	2M ohms + or - 5%, 1/4 w.
R120	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R121	J19/352-1103	Potentiometer: 10K ohms, 22-Turn.
R122	J19/311-0002	90.9K ohms + or - 1%, 1/4 w.
R123	J19/312-0048	2M ohms + or - 5%, 1/4 w.
R124	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R125	J19/312-0046	470K ohms + or - 5%, 1/4 w.
R126	J19/312-0047	1M ohms + or - 5%, 1/4 w.
R127	J19/352-1103	Potentiometer: 10K ohms, 22-Turn.
R128	J19/311-4642	46.4K ohms + or - 1%, 1/4 w.
R129	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R130	J19/312-0048	2M ohms + or - 5%, 1/4 w.
R131 thru R135	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R136	J19/312-0003	100K ohms + or - 5%, 1/4 w.
R137	J19/312-0001	390K ohms + or - 5%, 1/4 w.
R138	J19/312-0011	10K ohms + or - 5%, 1/4 w.
R139 and R140	J19/312-0003	100K ohms + or - 5%, 1/4 w.
R141	J19/312-0040	4.7K ohms + or - 5%, 1/4 w.
R142 thru R145	J19/312-0011	10K ohms + or - 5%, 1/4 w.
----- VARISTORS -----		
SG1 thru SG4	J19/300-0004	Varistors: S14K, 25V.
----- TRANSFORMERS -----		
T1 and T2	J19/410-0003	Coupling: 600 ohms.
----- TERMINALS -----		
TB1	J19/231-0002	Electrovert: 6-Position.
----- INTEGRATED CIRCUITS -----		
U1	J19/130-0240	Linear: Dual Compressor/Expander; NE572.
U2 and U3	J19/130-0120	Linear: Dual JFET Op Amp; TL062.
U4	J19/130-0352	Linear: Audio Amplifier; MC34119.
U5	J19/130-0139	Linear: Dual Op Amp; LM393.
U6	J19/130-0120	Linear: Dual JFET Op Amp; TL062.
U7	J19/130-0251	Linear: Quad JFET Op Amp; TL064.
U8 and U9	J19/130-0120	Linear: Dual JFET Op Amp; TL062.
U10	J19/130-0067	Digital: Quad Bilateral Switch; 4066.
U11	J19/130-0062	Linear: PLL Tone Decoder; XR2211.
U12 thru U16	J19/130-0120	Linear: Dual JFET Op Amp; TL062.
U17	J19/130-0094	Digital: Dual Monostable Multi.; CD4538.
U18	J19/130-0269	Digital: Dual 4-Input OR Gate; CD4072.
U19 thru U21	J19/130-0095	Digital: Quad R/S Latch; 4043.
U22	J19/130-0006	Digital: Dual 2-Input OR Gate; CD4071.
U23	J19/130-0060	Linear: Tone Generator; XR2206.
U24 and U25	J19/130-0074	Digital: Quad 2-Input AND Gate; 74C08.
U26	J19	