MAINTENANCE MANUAL

AUDIO BOARD 19D901696G2

FOR

TMX-8310, TMX-8510, & TMX-8712

TABLE OF CONTENTS

DESCRIPTION

Audio Board 19D901696G2 (A3) provides all audio and tone processing for the receiver and transmitter in the TMX-8310, TMX-8510, and TMX-8712 trunked radios. The board interfaces through the Logic Board (A1) where all control signals are obtained.

The Audio Board is located under the top cover of the radio and is mounted above the Logic Board. The board plugs into the Logic Board by an 18 pin connector. Refer to the combination manual for a complete mechanical layout and interconnection diagram.

The Audio Board contains 3 main paths: a receiver audio path, a tone path, and a transmitter audio path. Refer to Figure 1 for a block diagram of the receiver audio path and the tone path. Figure 2 provides a block diagram of the transmitter audio path.

CIRCUIT ANALYSIS

RECEIVER AUDIO PATH

The unfiltered receiver audio from the RF Board (VOL HI) is passed through the receiver audio path which consists of a sidetone cancellation circuit, a noise reject filter, a busy tone notch filter, a de-emphasis filter, muting gates, and a 1 watt audio amplifier.

VOL HI first feeds the sidetone cancellation circuit which is required in duplex operation only. R624 adjusts the amount of cancellation and will not affect the operation of a non-duplex radio. The circuit reduces the transmitted audio heard over the handset caused by transmitted audio modulation of the synthesizer VCO.

The sidetone cancellation circuit consists of an audio delay circuit U607-B, SIDETONE NULL adjustment R624,

and summer/amplifier U607A. Transmitted audio is applied to the audio time delay circuit at R619 and R621.The transmitted audio is delayed by an amount equal to the delay which exists between the TX MOD output and the VOL HI audio. U607-B delays the TX MOD audio about 140us with a gain of 0.3 (-11 dB). This delayed audio is applied to the SIDETONE NULL adjustment R624.

In duplex radios, VOL HI audio consists of received and transmitted audio which is summed by U607-A with the delayed TX MOD audio from the SIDETONE NULL adjustment. Since the transmitted audio present on VOL HI is 180 degrees out of phase with the delayed TX MOD audio, the transmitted audio will be cancelled at U607-A.

The receiver audio from U607-A feeds the noise reject filter U606A. This 200 Hz high pass active filter provides rejection of low frequency noise and has a gain of 2 (6 dB) above 300 Hz.

The noise reject filter output from U606A feeds the tone path (see the tone path description below) and Voice Mute FET switch Q602. This switch is closed in the receive mode with the control line in the high (+5 V) state. This switch is muted when in the idle or standby mode, when in the transmit mode (non-duplex), or when tone alerting only is desired.

The output of the Voice Mute switch is fed to the busy tone notch filter consisting of U601-A, B, C, and D. This filter removes the busy tone (3051 Hz) or the alternate busy tone (2918 Hz) from the receive audio. This filter also provides some of the receiver de-emphasis.

The SIGNALING TONE line is summed into the receiver audio in the busy tone notch filter at U601-D. The tones on this line are used to alert and signal the listener of many events (see the Operator's Manual supplied with the radio). The tones originate on the Logic Board and are generated by the microprocessor and a latch chip with a resistor ladder network to form a 5-bit digital to analog converter (DAC).

The busy tone notch filter output feeds U606-C which is a 2 pole low pass active filter providing additional noise rejection above 3 kHz.

The filtered receiver audio from U606-C feeds a second muting switch, Q605. This switch provides additional muting when the RX MUTE line is low while the radio is in idle or standby mode or while transmitting (non-duplex).

The output of the RX Mute switch feeds a 4 level volume control consisting of Q603 and Q604. The Volume UP/DOWN button on the handset causes the handset's microprocessor to send serial data to the Logic Board's microprocessor. The Logic Board changes the state of the VOL BIT 0 and VOL BIT 1 lines which control Q603 and Q604.

Audio amplifier U602 can deliver 1 watt into an 8 ohm load with a voltage gain fixed at 20 (26 dB). The amplifier allows driving an 8 ohm speaker directly. The handset attenuates this level before driving the earpiece.

TONE PATH

The tone path obtains receiver audio from the noise reject filter U606-A. The path consists of a busy tone bandpass filter, a busy tone filter bypass switch, and a tone limiter.

Received busy tones are passed through busy tone bandpass filter U606-D. This active bandpass filter has a Q of 10 centered at approximately 3 kHz. Both the 2918 Hz and 3051 Hz busy tones are passed while rejecting all other audio to reduce voice blocking of the tone. FET switch Q601 provides a shorted path around the bandpass filter to allow detection of the signalling tones at 604.2 to 2792.4 Hz.

When the radio is in the channel acquisition mode, the BUSY TONE FILTER SW control line is high (+5 V) to turn on Q601 to bypass the bandpass filter. This allows the signalling tones to be coupled directly to the tone limiter U605-A. U605-A is a comparator which provides a limited signal at the tone frequency to the microprocessor on the Logic Board. The microprocessor software decodes the limited tones. The pull up resistor for the comparator output is provided by the microprocessor port.

After all tone signalling has been completed, the BUSY TONE FILTER SW line goes low and Q601 turns off. The tone path is now through the bandpass filter which separates the busy tone from the voice signal. The busy tone is then limited by U605-A and passed to the microprocessor for detection.

TRANSMITTER AUDIO PATH

The audio board provides all transmitter audio processing. The TX AUDIO input signal is amplified, pre-emphasized, limited, and low pass filtered. Processed transmit audio and tones leave the Audio Board to feed the deviation

adjust pot and synthesizer VCO on the RF Board.

The TX AUDIO input signal is nominally 25 mVrms at 1 kHz to produce 3 kHz deviation. The input impedance is 180 ohms.

U301-A provides the 6 dB/octave pre-emphasis and amplitude limiting. C301, C304, and R301-A through D provide the pre-emphasis. C303 controls the cut-off point for the high frequency pre-emphasis above 3 kHz. Voltage divider R301-F, G, H, and J provides the 4 volt operating reference bias for U301-A and the limiter reference voltages for D301-A and B. C302 filters audio and noise from the 4 volt bias. When the TX AUDIO input signal is at a level such that the output of U301-A does not exceed 4 Vp-p, the gain at 1 kHz is 30 dB at U301-A pin 1. When the audio level tries to exceed 4 Vp-p, diodes D301-A and B conduct on the negative and positive half cycles providing 100% negative feedback to reduce the gain of U301-A to 0.

The output of U301-A is fed through voltage divider R302-A and B. The divider and C307 provide one pole of RC filtering to FET switch Q301. This muting FET is controlled by the MIC MUTE line from the microprocessor. Here a logical high turns the gate on and a logical low mutes the mic audio. This gate allows muting the voice signal in the receive mode and when only tones are to be transmitted.

The switched voice signal feeds amplifier U301-B which forms a two pole low pass filter making a post limiter filter with a total of 18 dB/octave of filtering to the limited voice signal. Two other inputs exist at U301-B which sums the signalling tone input and the busy tone input with the voice signal. The busy tone is generated by the microprocessor as a 5 Vp-p square wave. The signalling tones are generated by a 5 bit DAC. This signal level is also 5 Vp-p. One of the three post limiter filter poles provide filtering for these tones. R306 and R308 fix the amplitude of these tones relative to the voice signal.

The post limiter filter output is fed to a second muting switch Q302. This switch allows additional muting when in the receive mode and is controlled by the DPTT line from the microprocessor. In the transmit mode, this line is low which turns Q303 off and allows the gate of Q302 to go high to pass the transmit audio.

The output of muting switch Q302 is fed to the TX MOD output line to feed the deviation pot and synthesizer VCO on the RF Board. The output is also fed to the sidetone cancellation circuit for the receiver audio (see Receiver Audio Path circuit description above). The combined voice/busy tone audio is adjusted in level to produce the following ratio of deviation:

Limited voice deviation of 3.5 kHz
Busy tone deviation of 1.0 kHz
Signalling tone deviation of 3.0 kHz.

The signalling tones are transmitted with no voice present. Their levels are set for optimum system performance. The voice and busy tone are transmitted simultaneously. The summation of these signals can produce a maximum deviation of 4.5 kHz.

SUPPLY REGULATORS

The Audio Board receives 13 volts from the A+ Filtered line on the Logic Board. This voltage feeds regulator U603, amplifier U602, and op amps U601. The regulator supplies 8 volts to all ICs except U601 and U602. A regulated 5 volt bias supply is provided by regulator U604, operating from the regulated 8 volts.

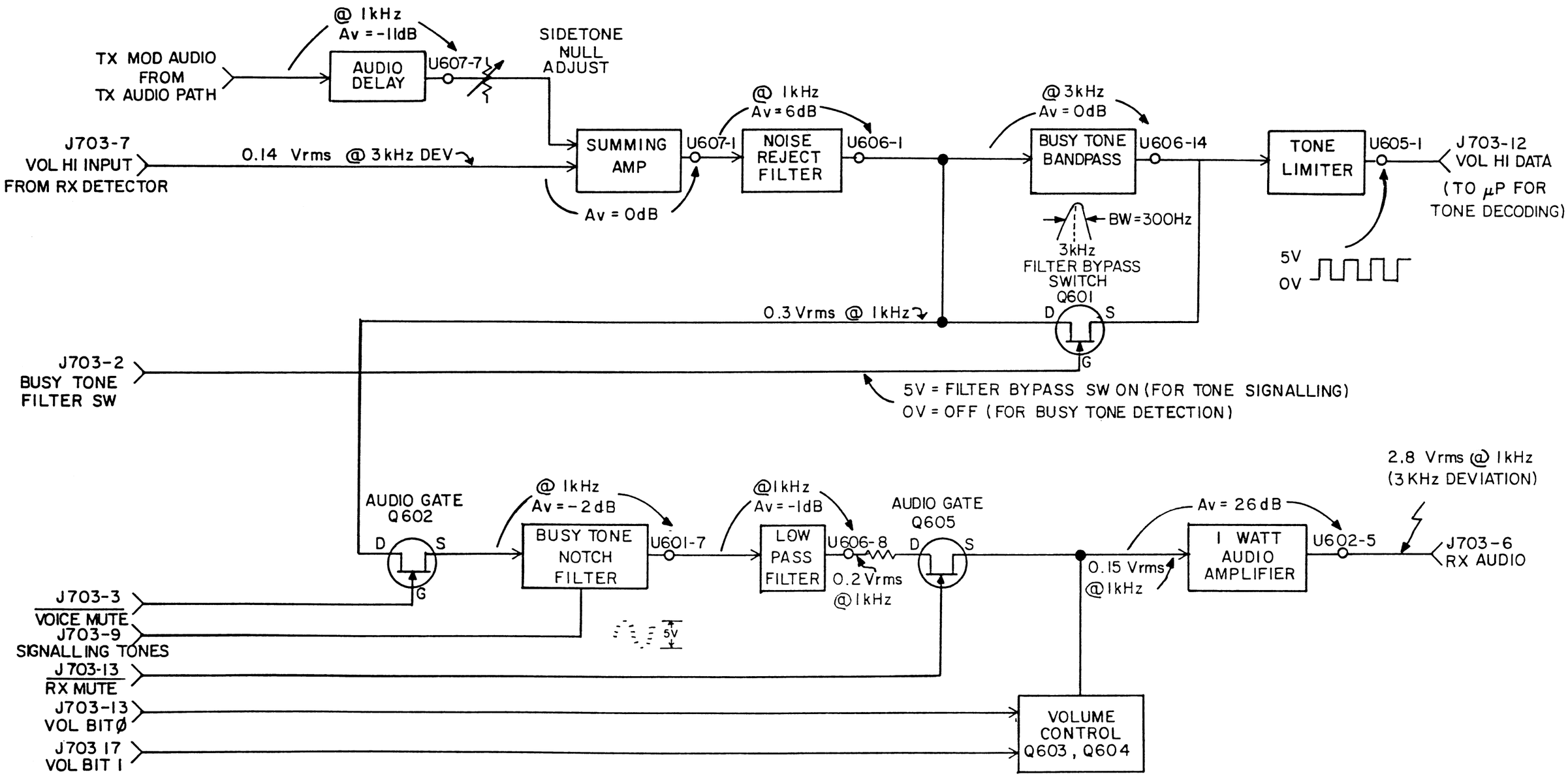
SERVICE NOTES

Refer to the block diagrams, Figures 1 and 2, for proper signal levels and gains for the various audio paths.

Note the state of the FET switches for muting. These switches are controlled by the Logic Board. If a mute line is high (+5 V) you may ground that pin and monitor the results. However, if a mute line is low, the line may not be forced high unless the line is disconnected from the Logic Board.

All bias points (+5 V) shown on the Audio Board schematic diagram are generated by regulator U604. None of the operational amplifier circuits will operate properly without this voltage.

When measuring signal levels, remember that the inverting (-) input ports are "virtual grounds." Little or no measurable AC voltages will be present at these ports.



RC-6070A

Figure 1 - RX Audio and Tone Paths

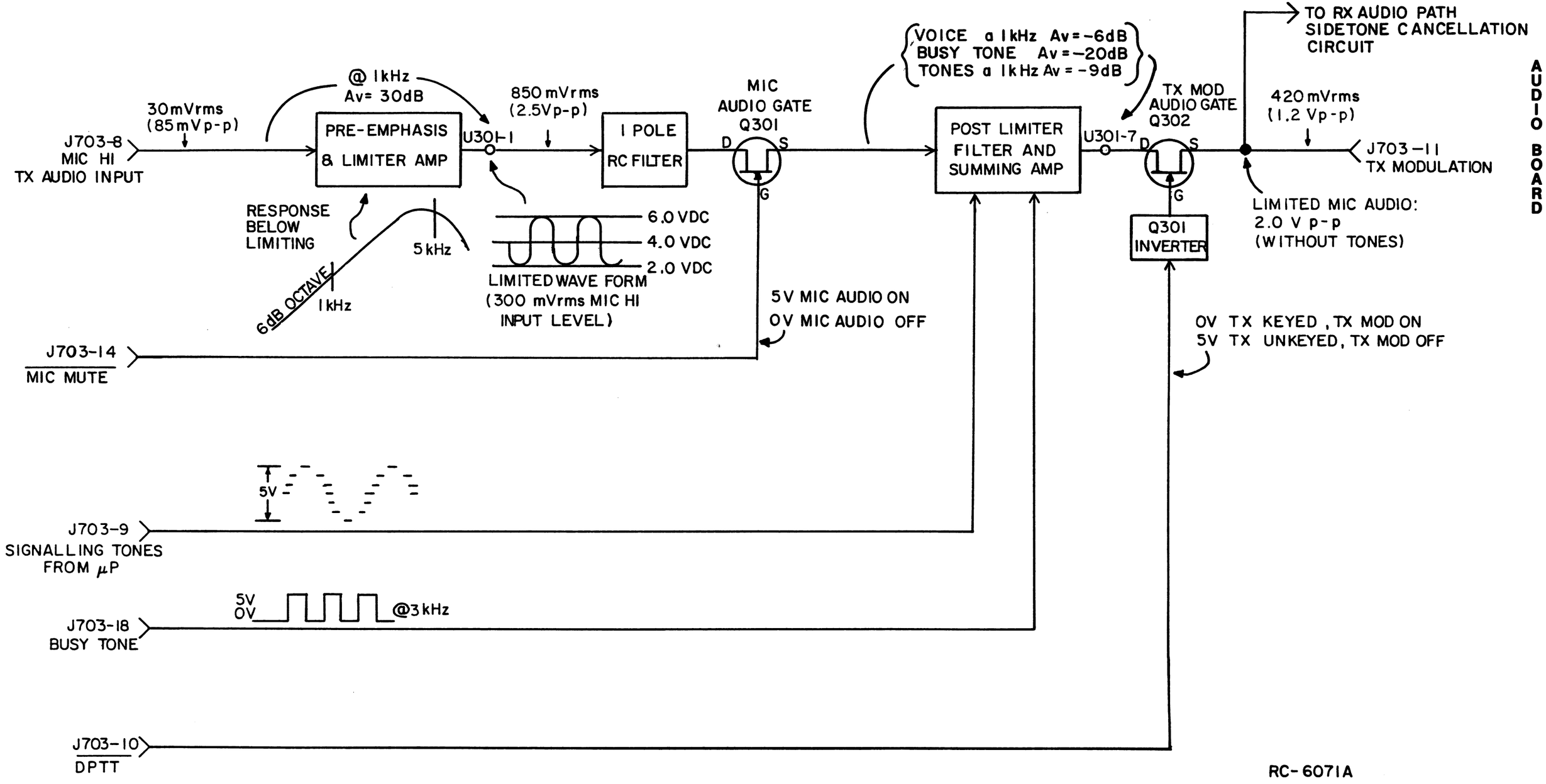
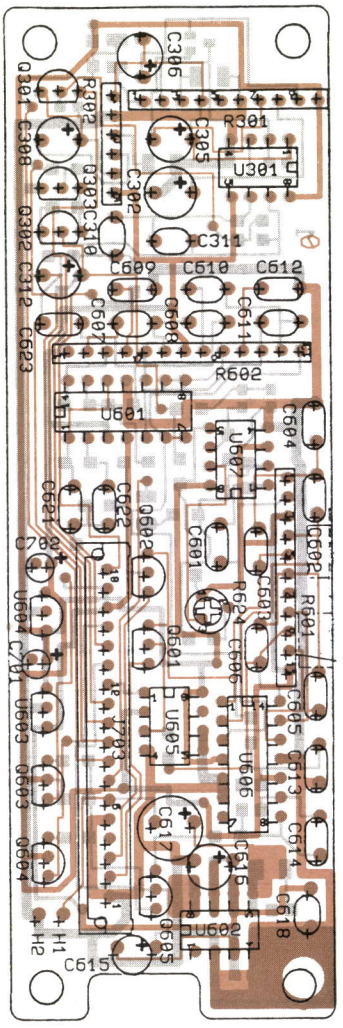


Figure 2 - Transmitter Audio Path Block Diagram

COMPONENT SIDE

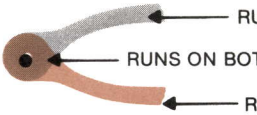


(19D901696, Sh. 2, Rev. 1)
(DP 902163, Component Side, Rev. 0)
(DP 902163, Solder Side, Rev. 1)

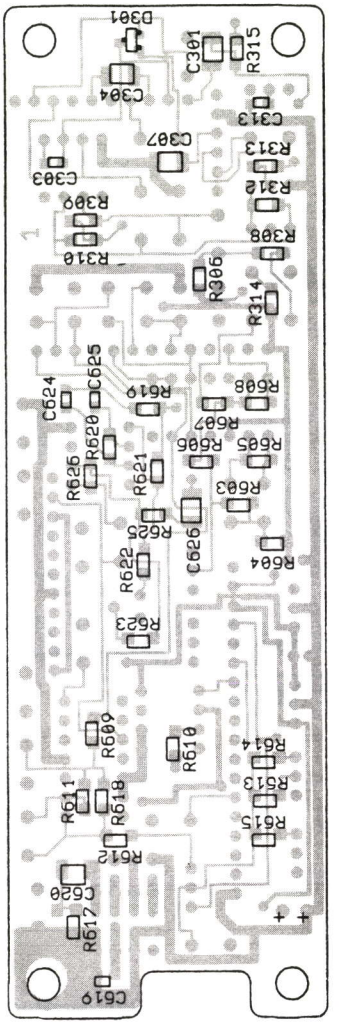
LEAD IDENTIFICATION
FOR D301

BACK SIDE OF BOARD

BEND C617 ↑
IN THIS DIRECTION

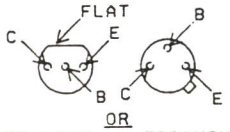


SOLDER SIDE



(19D901696, Sh. 2, Rev. 1)
(DP 902163, Solder Side, Rev. 1)

LEAD IDENTIFICATION
FOR Q303



OR

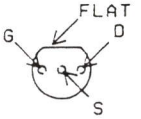
IN-LINE TRIANGULAR

TOP VIEW

NOTE: LEAD ARRANGEMENT, AND NOT CASE SHAPE, IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.

VIEW OF BACKSIDE OF BOARD

LEAD IDENTIFICATION
FOR Q601-Q605,
Q301 & Q302

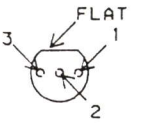


IN-LINE

TOP VIEW

NOTE: CASE SHAPE IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.

LEAD IDENTIFICATION
FOR U603 & U604



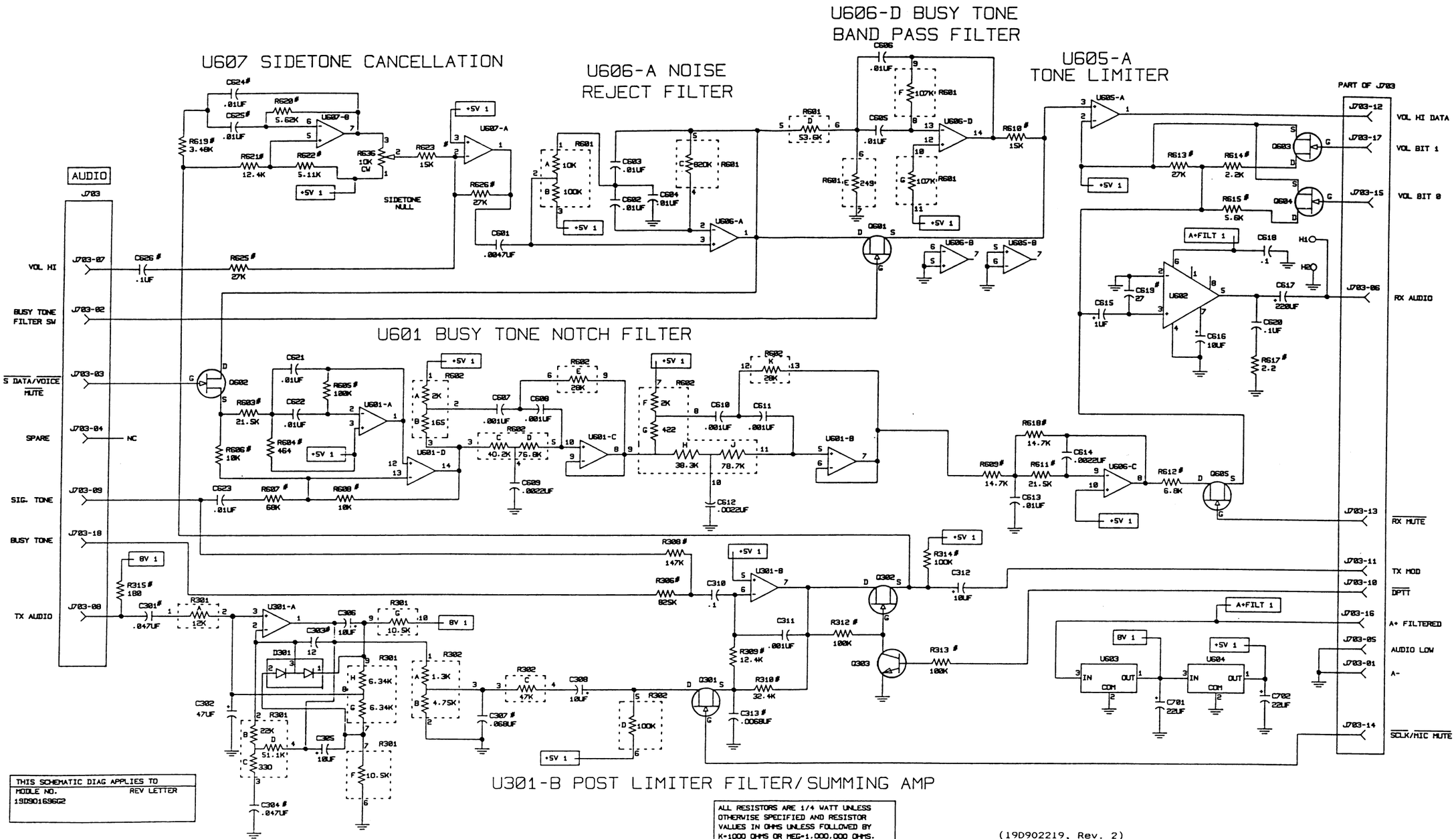
IN-LINE

TOP VIEW

NOTE: CASE SHAPE IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.

AUDIO BOARD

19D901696G2



THIS SCHEMATIC DIAG APPLIES TO	
MODLE NO.	REV LETTER
19D901696G2	

PWR & GND CONNECTIONS		
DEVICE	VCC PIN NO.	GND PIN NO.
U301	8 (8V)	4
U601	4 (A+FILT)	11
U606	4 (8V)	11
U605	8 (8V)	4
U607	8 (8V)	4

ALL RESISTORS ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1.000.000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF=MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH=MILLIHENRYS OR H=HENRYS.

NOTE: # INDICATES CHIP COMPONENTS LOCATED ON SOLDER SIDE OF PRINTED WIRE BOARD

(19D902219, Rev. 2)

AUDIO BOARD
19D901696G2

PARTS LIST

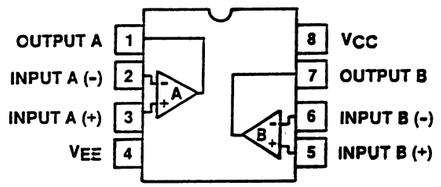
AUDIO BOARD
FOR
TMX-8310, TMX8510, TMX8712
19D901696G2
ISSUE 2

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C301	19A702052P122	Ceramic: 0.047 uF ±5%, 50 VDCW.
C302	19A701534P9	Tantalum: 47 uF ±20%, 6.3 VDCW.
C303	19A702061P17	Ceramic: 12 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM/°C.
C304	19A702052P122	Ceramic: 0.047 uF ±5%, 50 VDCW.
C305 and C306	19A701534P7	Tantalum: 10 uF ±20%, 16 VDCW.
C307	19A702052P124	Ceramic: 0.068 uF ±5%, 50 VDCW.
C308	19A701534P7	Tantalum: 10 uF ±20%, 16 VDCW.
C310	19A700121P106	Ceramic: 0.1 uF ±20%, 50 VDCW.
C311	T644ACP210J	Polyester: .0010 uF ±5%, 50 VDCW.
C312	19A701534P7	Tantalum: 10 uF ±20%, 16 VDCW.
C313	19A702052P112	Ceramic: 6800 pF ±5%, 50 VDCW.
C601	T644ACP247K	Polyester: .0047 uF ±10%, 50 VDCW.
C602 thru C606	T644ACP310J	Polyester: .010 uF ±5%, 50 VDCW.
C607 and C608	T644ACP210J	Polyester: .0010 uF ±5%, 50 VDCW.
C609	T644ACP222J	Polyester: .0022 uF ±5%, 50 VDCW.
C610 and C611	T644ACP210J	Polyester: .0010 uF ±5%, 50 VDCW.
C612	T644ACP222J	Polyester: .0022 uF ±5%, 50 VDCW.
C613	T644ACP310J	Polyester: .010 uF ±5%, 50 VDCW.
C614	T644ACP222J	Polyester: .0022 uF ±5%, 50 VDCW.
C615	19A701534P4	Tantalum: 1 uF ±20%, 35 VDCW.
C616	19A701534P7	Tantalum: 10 uF ±20%, 16 VDCW.
C617	19A703314P2	Tantalum: 220 uF, -10+50%, 10 VDCW.
C618	19A700121P106	Ceramic: 0.1 uF ±20%, 50 VDCW.
C619	19A702061P33	Ceramic: 27 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM/°C.
C620	19A702052P26	Ceramic: 0.1 uF ±10%, 50 VDCW.
C621 thru C623	T644ACP310J	Polyester: .010 uF ±5%, 50 VDCW.
C624 and C625	19A702052P114	Ceramic: 0.01 uF ±5%, 50 VDCW.
C626	19A702052P26	Ceramic: 0.1 uF ±10%, 50 VDCW.
C701 and C702	19A704879P4	Electrolytic: 22 uF ±20%, 50 VDCW.
		- - - - - - - - - - DIODES - - - - - - - - - -
D301	19A700053P2	Silicon: fast recovery; (2 diodes in series).
		- - - - - - - - - - JACKS - - - - - - - - - -
J703	19A704874P1	Connector: sim to Elco 00-9021-18-12-00-339.
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q301	19A134137P7	N-Type: Field Effect.
Q302	19A700060P4	N-Type: Field Effect.
Q303	19A700023P2	Silicon: NPN; sim to 2N3904.
Q601 thru Q605	19A134137P7	N-Type: Field Effect.

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R301	19A704885P3	Resistive Network: ±2%, 1/8 w.
R302	19A704885P4	Resistive Network: ±2%, 1/8 w.
R306	19A702931P489	Metal film: 825K ohms ±1%, 200 VDCW, 1/8 w.
R308	19A702931P417	Metal film: 147K ohms ±1%, 200 VDCW, 1/8 w.
R309	19A702931P310	Metal film: 12.4K ohms ±1%, 200 VDCW, 1/8 w.
R310	19A702931P350	Metal film: 32.4K ohms ±1%, 200 VDCW, 1/8 w.
R312 thru R314	19B800607P104	Metal film: 100K ohms ±5%, 200 VDCW, 1/8 w.
R315	19B800607P181	Metal film: 180 ohms ±5%, 200 VDCW, 1/8 w.
R601	19A704885P1	Resistive Network: ±2%, 1/8 w.
R602	19A704885P2	Resistive Network: ±2%, 1/8 w.
R603	19A702931P333	Metal film: 21.5K ohms ±1%, 200 VDCW, 1/8 w.
R604	19A702931P165	Metal film: 464 ohms ±1%, 200 VDCW, 1/8 w.
R605	19A702931P401	Metal film: 100K ohms ±1%, 200 VDCW, 1/8 w.
R606	19B800607P103	Metal film: 10K ohms ±5%, 200 VDCW, 1/8 w.
R607	19B800607P683	Metal film: 68K ohms ±5%, 200 VDCW, 1/8 w.
R608	19B800607P103	Metal film: 10K ohms ±5%, 200 VDCW, 1/8 w.
R609	19A702931P317	Metal film: 14.7K ohms ±1%, 200 VDCW, 1/8 w.
R610	19B800607P153	Metal film: 15K ohms ±5%, 200 VDCW, 1/8 w.
R611	19A702931P333	Metal film: 21.5K ohms ±1%, 200 VDCW, 1/8 w.
R612	19B800607P682	Metal film: 6.8K ohms ±5%, 200 VDCW, 1/8 w.
R613	19B800607P273	Metal film: 27K ohms ±5%, 200 VDCW, 1/8 w.
R614	19B800607P222	Metal film: 2.2K ohms ±5%, 200 VDCW, 1/8 w.
R615	19B800607P562	Metal film: 5.6K ohms ±5%, 200 VDCW, 1/8 w.
R617	19B800607P2R2	Metal film: 2.2 ohms ±5%, 200 VDCW, 1/8 w.
R618	19A702931P317	Metal film: 14.7K ohms ±1%, 200 VDCW, 1/8 w.
R619	19A702931P253	Metal film: 3480 ohms ±1%, 200 VDCW, 1/8 w.
R620	19A702931P273	Metal film: 5620 ohms ±1%, 200 VDCW, 1/8 w.
R621	19A702931P310	Metal film: 12.4K ohms ±1%, 200 VDCW, 1/8 w.
R622	19A702931P269	Metal film: 5110 ohms ±1%, 200 VDCW, 1/8 w.
R623	19B800607P153	Metal film: 15K ohms ±5%, 200 VDCW, 1/8 w.
R624	19B800779P10	Variable: 10K ohms ±25%, 100 VDCW, .3 w.
R625 and R626	19B800607P273	Metal film: 27K ohms ±5%, 200 VDCW, 1/8 w.
		- - - - - - - - INTEGRATED CIRCUITS - - - - - - - -
U301	19A700086P4	Linear: DUAL Op Amp; sim to 4558.
U601	19A704883P1	Linear: QUAD Op Amp; sim to Motorola MC3303P.
U602	19A705647P1	Linear: Low Voltage Audio Power Amplifier; sim to National LM386N-4.
U603	19A704073P2	Linear: Positive 8 Volt Regulator.
U604	19A704971P1	Linear: Positive 5 Volt Regulator; sim to Motorola MC78L05ACP.
U605	19A134764P2	Linear: Voltage Comparator; sim to LM393N.
U606	19A704883P1	Linear: QUAD Op Amp; sim to Motorola MC3303P.
U607	19A700086P4	Linear: DUAL Op Amp; sim to 4558.

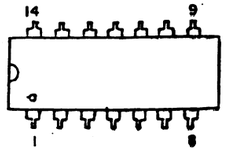
*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

(U301, U607)
OPERATIONAL AMPLIFIER
19A700086P4

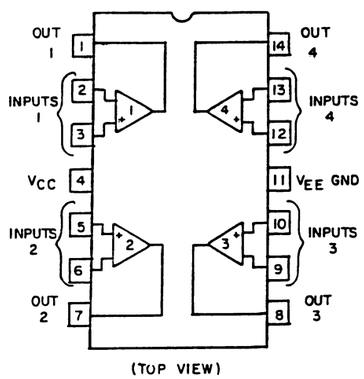


RC-5758

(U601, U606)
QUAD OP AMPLIFIER
19A704883P1



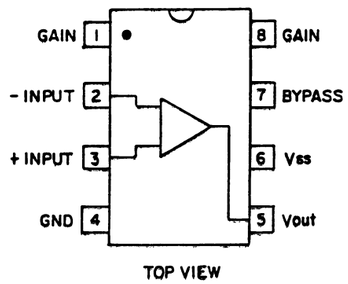
PIN CONNECTIONS



(TOP VIEW)

RC-6048A

(U602)
AUDIO POWER AMPLIFIER
19A705647P1



TOP VIEW

RC-8045

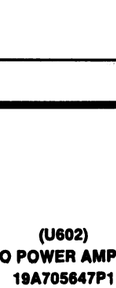
(U603)
VOLTAGE REGULATORS
19A704073P2

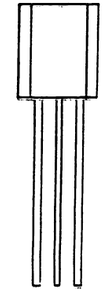
BOTTOM VIEW

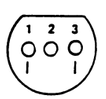
PIN 1- OUTPUT
PIN 2- GROUND
PIN 3- INPUT

RC-5289A

(U604)
VOLTAGE REGULATOR
19A704971P1







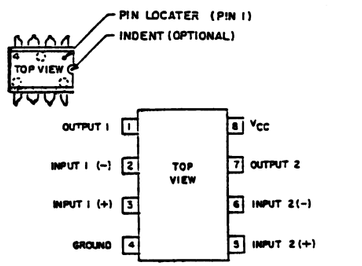
BOTTOM VIEW

PIN INDENTIFICATION

PIN 1 ADJUST
PIN 2. OUTPUT
PIN 3. INPUT

RC-5854A

LINEAR VOLTAGE COMPARTOR
(U602)
19A134764P2



RC-5285