MAINTENANCE MANUAL
AUDIO PA BOARD
P29/5000055000

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DESCRIPTION

The PA Board's main functions are to provide an interface with the external line input/outputs and to provide amplifiers to drive the speakers. The C3 Maestro Audio Tower has room for up to 2 PA boards.

The PA Board contains:

- 2 600-ohm balanced (RJ11) inputs
- 2 600-ohm balanced (RJ11) outputs
- 2 relay closure output circuits
- 2 optically-isolated digital input circuits
- 2 amplifiers
- the circuitry to drive the remote Volume Controller Box (VCB).

CIRCUIT ANALYSIS

The PA Board contains circuitry to drive concurrently 2 of all of its inputs and 2 of all of its outputs. The first of these circuits, "Line A", is described below in detail. The other circuits are duplicates of the Line A.

The backplane provides the power for the PA Board. The 12-volt regulator U6 receives 15 volts DC (±0.1). Output from U6 goes to the VBIAS circuit U8 and Q3. The audio amplifiers receive 15 volts DC (±0.1) directly from the backplane. The 12-volt regulator is a low-drop-out type. In an emergency, the board can function with a power input of +12 volts DC, although maximum speaker output may be reduced somewhat. The PA Board contains no 5-volt DC power and no logic circuitry.

Four-wire, 600-ohm balanced line inputs are provided through two RJ11 jacks and are conditioned by two components: a voltage protector and C1. The voltage protector (BR5) clamps excessive voltage differentially. In addition, C1 provides for AC-coupling of the signal, which prevents problems from DC on the line input.

Input is then sent to a 1:1 transformer, the secondary of which is bridged by a 600-ohm resistor, which provides the 600-ohm input impedance expected by the external circuitry. The output of the transformer is further limited by bridge BR1, which clamps excessive voltages.

The differential signal is then sent to U9D. Its output is adjusted by pot R51 to the nominal system level of 2.2 volts (±0.1) peak-to-peak, which represents "0 dB" reference in this system. The signal is then sent to a 300-Hz high pass filter circuit which passes only voice audio and reduces such problems as 60-Hz hum. The output of this filter is called "Line A In". The output is biased up to a 6-volt DC (±0.1) level before it is routed to both the backplane (to go to the Matrix Board) and to jumper JP1 (located on the PA Board).

Jumper JP1 enables the user to select whether the audio input to the amplifier comes from the Matrix Board or from the line audio input on the PA Board. Audio is received from the Matrix Board with JP1 in the default (A) position and from the LINE input with JPI in the B position. Users can "wrap" their line input directly to the speaker if desired.

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Signals for the line outputs originate on the Matrix Board. The first of these, called "Line A out," is sent to the PA Board via the backplane and is level-adjusted via pot R96, located on the PA Board. "Line A out" is then AC-coupled into the differential driver circuit to provide sufficient drive level for the external signal.

The output is sent across bridge BR3 (which protects the op-amp outputs from momentary overvoltages) to 1:1 transformer T3. C3 AC-couples the transformer's output to external attachments to provide protection against external DC on the output lines. Another surge protector, BR7, provides further protection by clamping transients differentially. As part of initial adjustments, levels are adjusted for a 2.2-volt peak-to-peak (±0.1) input from the Matrix Board and a 2.2-volt peak-to-peak (±0.1) output to the RJ11 with a 600-ohm load across the output (this represents a zero dBm output). If the impedance of the external attachments is other than 600 ohms, the output level should be readjusted according to the procedures outlined in the Maintenance Section of this manual.

The user selects amplifier input with jumper JP1. Amplifier input normally comes from the Matrix Board via the backplane and is called "PA SPK 1". The signal is sent to transconductance amplifier U5, which functions as the volume control to drive the speaker amplifier. Pin 1 acts as a control device for U5. The higher the current flow into pin 1, the more the pin allows the signal to flow from U4 to U5. This dependency allows the use of an external pot to control this DC level with relative immunity to external signals. This arrangement also simplifies the volume control circuit.

Pot R6 allows for a "Minimum Audio Level". The main purpose of the pot is to provide a minimum DC level to U5, pin 1 Properly adjusted, R6 ensures that the amplifier circuit functions even if the VCB is disconnected.

A Resetable Thermal Fuse provides power supply voltage and short-circuit protection to the VCB. An RC network filters DC control voltage returning from the VCB before delivering it to the transconductance amplifier.

The audio signal is finally delivered to a low pass filter to band-limit audio to communications quality. A divider network of R16 and RIS AC-couples and scales input to the amplifier to provide for future level adjustment.

The power amplifier consists of two IC amplifiers operated in a bridged output mode. Circuits U1 and U2 have internal short circuit protection and thermal shutdown. Since they are bridged, **THE SPEAKER LEADS CANNOT BE CONNECTED TO GROUND**.Connecting a speaker lead to ground will short-circuit one of the amplifiers and reduce output by 1/2. Therefore, care must be taken in measurements made on this circuit; i.e., do not connect a grounded oscilloscope lead to any of the amplifiers' screw terminal outputs. The amplifiers' screw terminal outputs are purposely not labeled to help prevent any of the terminals from being connected to ground or to another amplifier.

Relay drive commands originate on the Matrix Board and are sent to the PA Board via the backplane.

Pulldown resistor R80 normally prevents Q1 from having enough voltage on the base to turn on and activate relay K1. When the PC sends a command to turn on the relay, voltage from the Matrix Board causes QI to conduct, which activates K1. This design enables the CCS to control external items such as door latches, etc., which are controlled through a set of removable screw terminals.

Digital inputs provide a means for binary input to the system from external equipment. When a DC voltage of 5 to 16 volts is input at the screw terminals (ST3), the opto-isolator (U11, U12) turns on and provides an input back to the Console Logic Board through the DB37 cable. Inputs are current-limited by R88 and polarity-protected by D5.

TESTING THE PA BOARD

Listed below are the test procedures for the CCS PA Board. In the event of a problem, refer to the same item number in the "Problem Resolution" section.

Required tools: 30 MHz 2-channel oscilloscope, 15 volts DC power supply, audio signal source, 0.1 µf capacitor, 8-ohm speakers, 600-ohm resistor, test leads

Setup procedure:

- Position the board so that the backplane connector is to the right and the RJ11 jacks are to the left. Place jumpers on position "B" on JPI and JP2.
- Connect the speakers to J1 (one speaker to J1-1, J1-2 and the other speaker to J1-3, J1-4).
- Adjust R6 "Min Audio Level" pot to full counter-clockwise.
- Inputs to this board are expected to be at a nominal level of 2.2 volts (±0.1) peak-to-peak. Outputs from this board to the RJ11 jacks are at a nominal level of 2.2 volts (±0.1) peak-to-peak. Accordingly, the line amplifiers and receivers will be adjusted for unity gain. The amplifiers' output is 5 watts or less.

Test procedures:

1. **Power**
   - Connect the ground lead of the scope to the ground of the board (U6, TP36).
   - Apply 15 volts DC to input regulator U6, TP35. The connections are: pin 1, ground; pin 2, output; pin 3, input.
   - Verify that U6, TP16, has 12 volts DC (±0.1) output.
   - Verify that U6, TP17, has 5 volts DC (±0.1) output.
   - Verify that U6, TP18, has 6 volts DC (±0.1) output.
   - Verify at least 12 volts DC on U6, TP1.
2. **Line A input**
   - Apply a 2.2-volt (±0.1) peak-to-peak 1 kHz sine wave across BR5, TP8 and TP9, which are labeled on the PCB. Since the signal will flow just as well in either direction, you can connect to TP8 and TP9 in either order. The polarity of the signal does not matter.
   - Measure across BR5, TP29 to TP30, to verify that the signal is actually 2.2 volts (±0.1) peak-to-peak (this is a 600-ohm load).
   - Connect the scope lead to U9, TPl4.
   - Adjust R51 "Level Adjust" for 2.2 volts (±0.1) peak-to-peak on the scope.
   - Verify that the signal is a clean sine wave on the scope.
3. **Line A amplifier**
   - With the signal still applied as described in item #2 above, adjust R6 clockwise to confirm amplifier operation. There will be a very slow response to any adjustment of R6.
   - When you hear clean sound, adjust R6 to avoid excessive volume when you begin testing.
4. **Line B input**
   - Apply a 2.2-volt (±0.1) peak-to-peak 1 kHz sine wave across BR6, TP10 and TP11, which are labeled on the PCB. Since the signal flows just as well in either direction, you can connect to pins 1 and 3 in either order. The polarity of the signal does not matter.
   - Measure across BR6, TP31 to TP32, to verify that the signal is actually 2.2 volts (±0.1) peak-to-peak (this is a 600-ohm load).
   - Connect the scope lead to U10, TP15.
   - Adjust R61 for 2.2 volts (±0.1) peak-to-peak on the scope.
   - Verify that the signal is a clean sine wave on the scope.
5. **Line B amplifier**
   - With the signal still applied as in item #4 above, adjust R5 clockwise to confirm amplifier operation. There will be a very slow response to any adjustment of R5.
   - When you hear clean sound, adjust R5 to avoid excessive volume when you begin testing.
6. **Line B output**
   - Apply a 2.2-volt (±0.1) peak-to-peak 1 kHz sine wave through a 0.1 µf capacitor to TP24. The ground lead of the signal source should be connected to ground at TP36.
   - Verify the 2.2-volt (±0.1) signal level before proceeding.
   - Connect a 600-ohm resistor across the scope probe and the scope ground. This is to place the expected 600-ohm load on the circuit.
   - Connect the scope probe and ground lead to BR4, TP25 and TP26, which are labeled on the PCB. Since the signal flows just as well in either direction, you can connect to TP25 and TP26 in either order. The polarity of the signal does not matter.
   - Adjust R102 for 2.2 volts (±0.1) peak-to-peak on the scope.
   - Verify that the signal is a clean sine wave on the scope.
7. **Line A output**
   - Apply a 2.2-volt (±0.1) peak-to-peak 1 kHz sine wave through a 0.1 µf capacitor to TP23. The ground lead of the signal source should be connected to ground on the board.
   - Verify the 2.2-volt (±0.1) signal level before proceeding.
   - Connect a 600-ohm resistor across the scope probe and the scope ground. This is to place the expected 600-ohm load on the circuit.

- Connect the scope probe and ground lead to BR3, TP27 and TP28, which are labeled on the PCB. Since the signal flows just as well in either direction, you can connect to TP27 and TP28 in either order. The polarity of the signal does not matter.
- Adjust R96 for 2.2 volts (±0.1) peak-to-peak on the scope.
- Verify that the signal is a clean sine wave on the scope.
- Move jumpers JP1 and JP2 to the "A" position.

PROBLEM RESOLUTION

1. Power

- The 12-volt regulator U6 powers the VBIAS circuit. If U6 fails, the VBIAS circuits will not function. Check U6 for cracks or any other visible signs of damage to the package; such damage will cause the package to fail.
- If the VBIAS circuit is the problem, check for shorts in the transistor Q3 socket or incorrect resistor values in its circuit.
- Verify polarity on all power supply capacitors.

2. Line A input

- Start at the input BR5, TP8 and TP9, and verify input levels.
- Proceed to BR1, TP29 and TP30, and measure across the inputs to the bridge to verify that the transformer is functioning and that the bridge is not short-circuited.
- Measure at U9, TP12. This is the buffer amp for this input.
- Measure at U9, TP14. This is the input to the final amp.
- Likely problem areas are the components in the filter circuit driving U9, pin 10; pot R51; and bridge BR1.

3. Line A Amplifier

- Verify 15 volts DC (±0.1) at U1, TP37, and U2, pin 5.
- Verify signal input on R8.
- Verify that signal is coming out of U5, TP33. If no signal is found, look for a DC voltage on U5, pin 1.
- Adjust R6 to try and maximize the DC level on U5, pin 1. If the DC level cannot be adjusted, check the values and components in the area of R6 and R5.
- U5A is a transconductance amplifier. The more DC current flows into pin 1, the higher the gain of the amplifier.
- Check actual signal input to amplifier U1 at TP6. If at least 1 volt (±0.1) peak-to-peak is present, look for shorts in the U1 or U2 leads or a defective U1 or U2. The amplifier operates in a bridged mode. If a scope ground is connected to either output lead, the output is reduced by half, with the ground lead grounding half of the output.
- Neither U1 nor U2 should be hot when operating at this level or any reasonable level. If either is hot, then either a short circuit exists or a component is defective. U1 and U2 are designed to be short-circuit protected and should have full thermal shutdown when overheated.

4. Line B Input

- With the signal source connected as in the testing procedure, trace the audio signal from beginning to end until the problem is found.
- Start at the input BR6, TP10 and TP11, and verify input levels.
- Proceed to BR2, TP31 and TP32, and measure across the inputs to the bridge to verify that the transformer is functioning and that the bridge is not short-circuited.
- Measure at U10, TP13. This is the buffer amp for this input.
- Measure at U10, TP15. This is the input to the final amp.
- Likely problem areas are the components in the filter circuit driving U10, pin 10; pot R61; and bridge BR2.

5. Line B Amplifier

- Verify 15 volts DC (±0.1) at U3 and U4, TP38.
- Verify signal input on R37, TP5.
- Verify that signal is coming out of U5, TP34. If no signal is found, look for a DC voltage on U5, pin 16.
- Adjust R35 to try and maximize the DC level on U5, pin 16. If the DC level cannot be adjusted, check the values and components in the area of R34 and R35.
- U5B is a transconductance amplifier. (The more DC current flows into pin 16, the higher the gain of the amplifier.)
- Check the low pass filter by observing the signal on TP7. If the signal is less than 1 volt or is distorted, check the values of capacitors and resistors in the low pass filter circuit.
- Check the actual signal input to amplifier TP7. If signal is present, look for shorts in U3 or U4 leads or a defective U3 or U4. The amplifier is operated in a bridged mode. If a scopeground is connected to either output lead, the output is reduced by half, the ground lead grounding half of the output.
- Neither U3 nor U4 should be hot when operating at this level or any reasonable level. If either is hot, then either a short-circuit exists or a component is defective. U3 and U4 are designed to be short-circuit protected and should have full thermal shutdown when overheated.

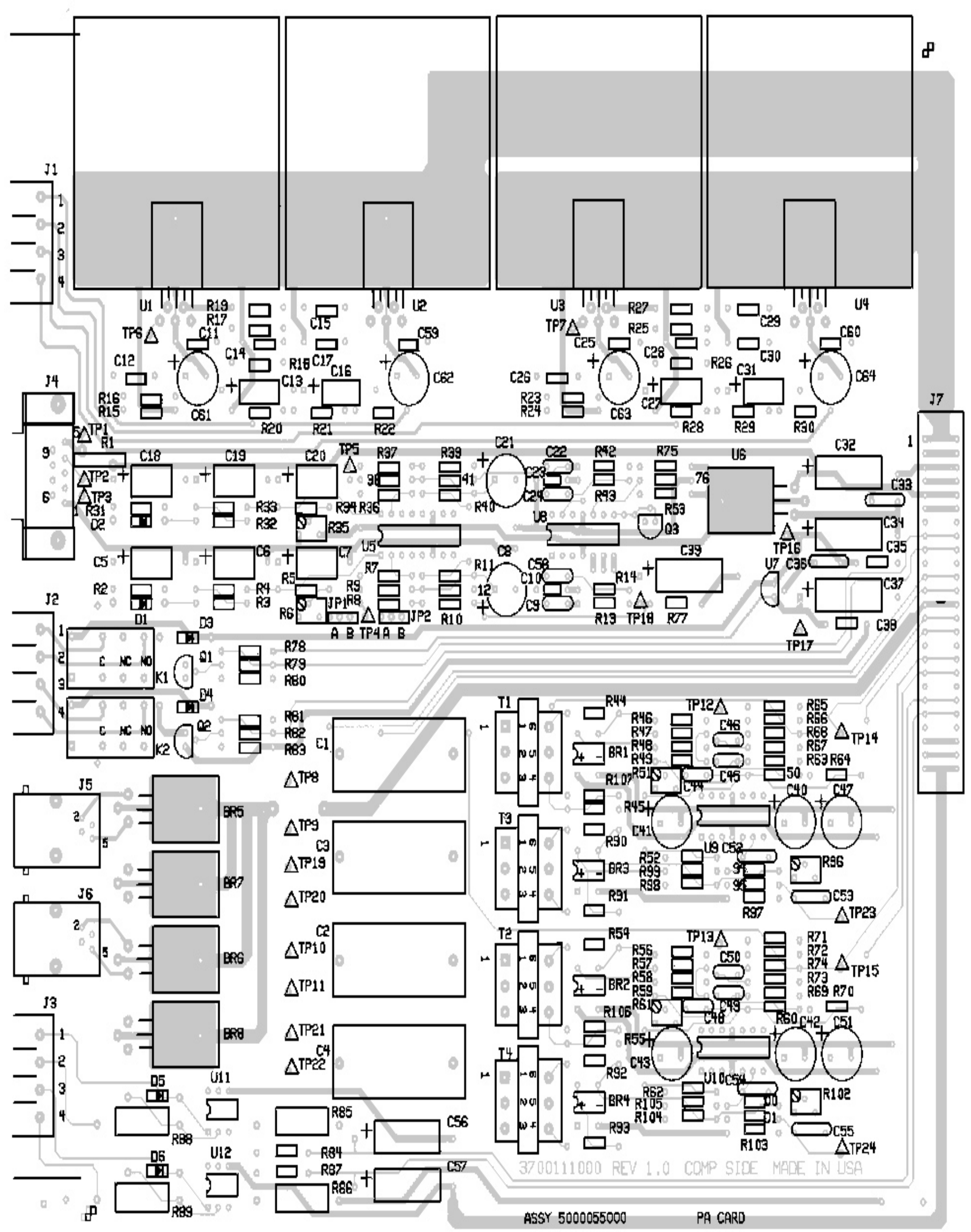
6. Line B Output

- Connect a 600-ohm resistor to TP21 and TP22.
- Remove the 600-ohm resistor from across the scope leads.
- Apply a 2.2-volt (±0.1) peak-to-peak 1 kHz sine wave to TP24.
- Connect the scope lead to U10, pin 6, and verify the presence of signal.
- Verify signal at U10, TP25 and TP26. This signal will be the input to the output transformer and should be a c1ean and undistorted sine wave.
- Likely problem areas are R102, U10, or BR4. Remember that this circuit expects to see a 600-ohm load when properly functioning, and levels observed without that load will be much higher at the output.

7. Line A Output

- Connect a 600-ohm resistor to TP19 and TP20.
- Remove the 600-ohm resistor from across the scope leads.
- Apply a 2.2-volt peak-to-peak 1 kHz sine wave to TP23.
- Verify signal at U9, TP27 and TP28. This signal will be the input to the output transformer and should be a clean and undistorted sine wave.
- Likely problem areas are R96, U9, or BR3. Remember that this circuit expects to see a 600-ohm load when properly functioning, and levels observed without that load will be much higher at the output.

COMPONENT SIDE



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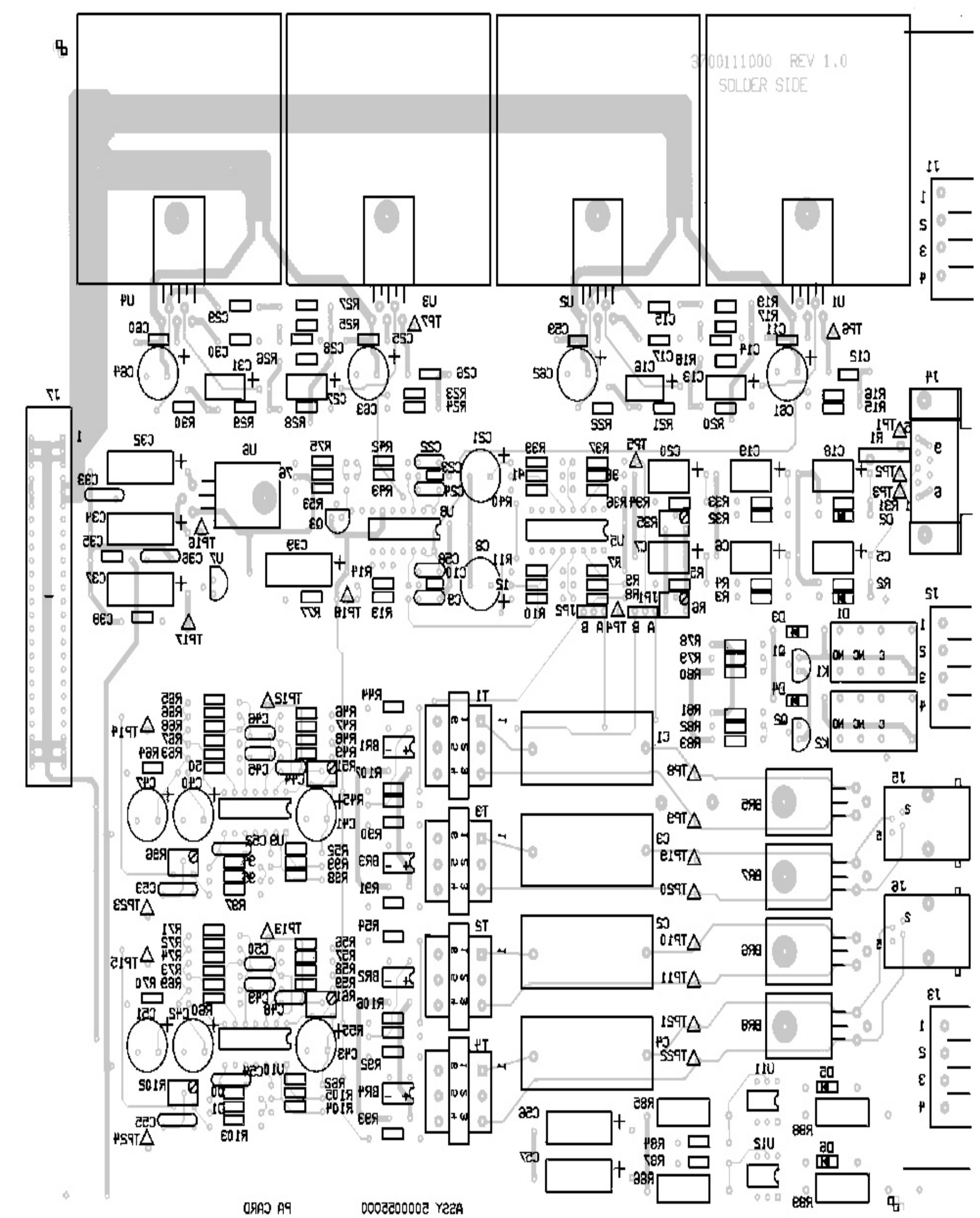

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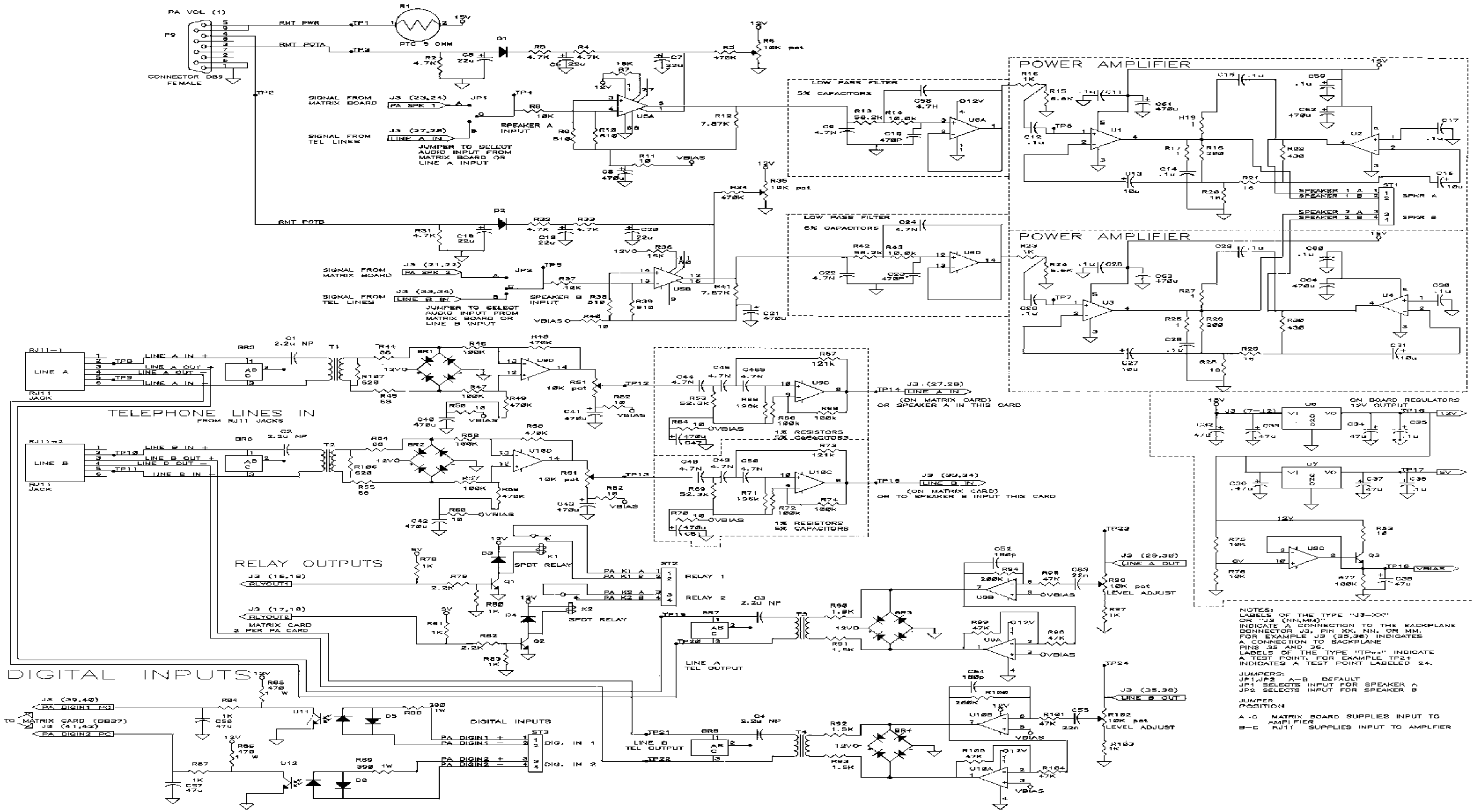
AUDIO PA BOARD
(P29/3700111000, Rev. 1.0)



AUDIO PA BOARD

PA BOARD
P29/5000055000

Revised: September 30, 1991

ITEM	QUANTITY	REFERENCE	PART
1	6	R2,R3,R4,R31,R32,R33	4.7K
2	6	C5,C6,C7,C18,C19,C20	22u 25v
3	6	R5,R34,R48,R49,R58,R59	470K
4	2	R7,R36	15K
5	4	R8,R37,R75,R76	10K
6	4	R9,R10,R38,R39	510
7	9	R11,R40,R50,R52,R53,R60,R62,R64,R70	10
8	14	C11,C12,C14,C15,C17,C25, C26,C28,C29,C30,C35,C38,C59,C60	.1u 25v
9	4	C13,C16,C27,C31	10u 25v
10	2	R18,R26 200	
11	2	R22,R30 430	
12	4	R21,R20,R28,R29	16
13	12	C64,C8,C21,C40,C41,C42,C43,C47,C51,C61,C62,C63	470u 16v
14	4	R44,R45,R54,R55	68
15	5	R46,R47,R56,R57,R77	100K
16	10	R78,R16,R23,R80,R81,R83,R84,R87,R97,R103	1K
17	2	R79,R82	2.2K
18	6	C56,C32,C34,C37,C39,C57	47u 35v
19	2	R89,R88	390 1w
20	4	R90,R91,R92,R93	1.5K
21	6	R101,R95,R98,R99,R104,R105	47K
22	4	R25,R17,R19,R27	1
23	2	C36,C33	.47u
24	2	R94,R100	200K
25	2	R85,R86	470 1w
26	2	K2,K1	RELAY OMRON Z768-ND
27	1	R1	PTC KEYSTONE KC005R-ND
28	2	RJ11-1,RJ11-2	RJ11
29	1	P9	CONNECTOR DB9 FEMALE
30	3	ST1,ST2,ST3	WEIDMULLER 12593.6 BL4
31	3	Q3,Q1,Q2	2N3904 TRANSISTOR
32	4	T4,T1,T2,T3	MICROTRAN T2106
33	4	BR4,BR1,BR2,BR3	DIODE BRIDGE DF005M
34	4	BR8,BR5,BR6,BR7	TISP2180 SURGE PROTECTOR
35	1	U5	LM13700 TRANSCONDUCTANCE AMPLIFIER
36	3	U9,U8,U10	MC3303 QUAD OP AMP
37	4	C3,C1,C2,C4	2.2u NP 250v
38	6	D4,D1,D2,D3,D5,D6	1N4001 DIODE
39	2	U11,U12	TIL127 OPTO ISOL
40	1	U7	LM78L05 VOLTAGE REG
41	4	U1,U2,U3,U4	TDA2003 AMPLIFIER
42	1	U6	LT1086-12CT VOLTAGE REG
43	2	R12,R41	7.87K 1%
44	2	R15,R24	5.6K

Continued

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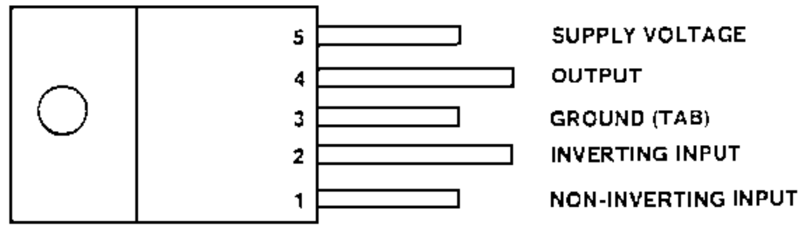
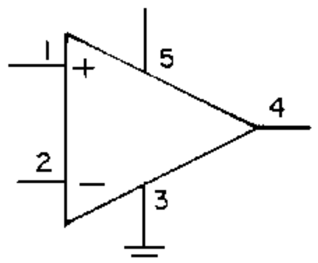
ITEM	QUANTITY	REFERENCE	PART
45	2	R107,R106	620
46	6	R35,R6,R51,R61,R96,R102	10K pot BOURNS 3266W-1
47	2	R71,R65	196k 1%
48	4	R72,R66,R68,R74	100k 1%
49	2	R73,R67	121k 1%
50	2	R63,R69	52.3k 1%
51	2	R42,R13	56.2k 1%
52	2	R43,R14	10.0k 1%
53	2	C10,C23	470P 100V
54	10	C9,C22,C24,C44,C45,C48,C49,C50,C58,C465	4.7N 50V
55	2	C52,C54	180p 100V
56	2	C55,C53	22n 50V
57	1	2 FT CABLED	B9 TO DB9
58	1	J3	AMP 532955-8
59	1	PCB	
40	36	TEST POINTS	TP1 THROUGH TP35
41	2	JP1,JP2	3 POSITION HEADERS
42	2	JUMPERS	FOR JP1,JP2

ALL RESISTORS 1/4 WATT 5% CARBON UNLESS OTHERWISE NOTED.

AMPLIFIER
U1, U2, U3, U4
(TDA2003)

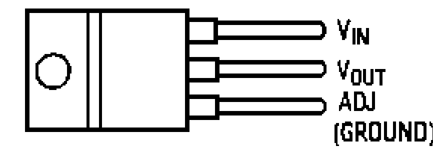


PIN INDENTIFICATION

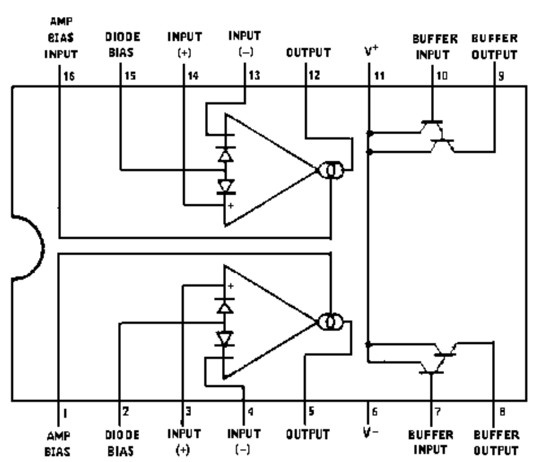


VOLTAGE REGULATOR
U6
(LT1086-12CT)

FRONT VIEW

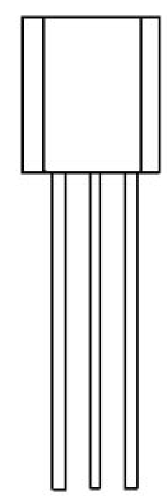


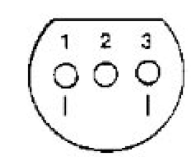
DUAL OPERATIONAL AMPLIFIERS U5
(LM13700)



Top View

3-TERMINAL POSITIVE REGULATOR U7
(LM78105)



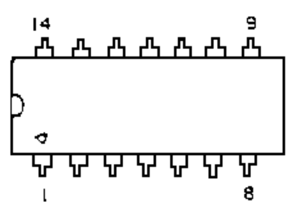


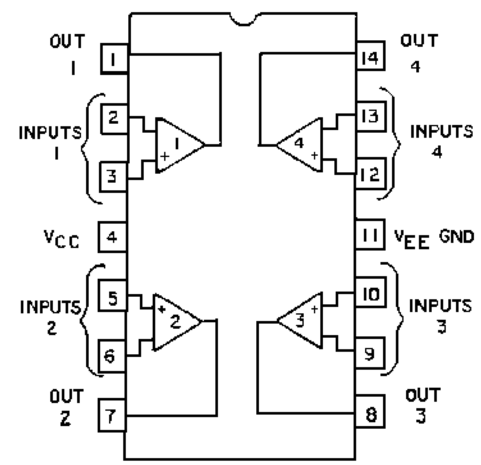
BOTTOM VIEW

PIN INDENTIFICATION

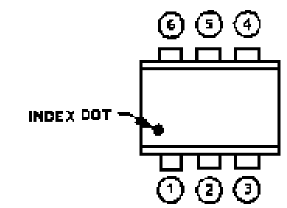
PIN 1. OUTPUT
PIN 2. GROUND
PIN 3. INPUT

QUAD LOW POWER OPERATIONAL AMPLIFIER U8, U9, U10 (MC3303)





OPTO-COUPLER U11, U12 (TIL127)



Pin 1 identified by index dot.
Terminal connections:

1. Anode
2. Cathode
3. No internal connection

(1, 2: Infrared-emitt diode)

4. Emitter
5. Collector
6. TIL127: Base

(4, 5, 6: Photo-transistor)