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MAINTENANCE MANUAL AUDIO MATRIX BOARD P29/5000056000

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DESCRIPTION

The Matrix Board's main function is to switch the CCS's audio from circuit to circuit as needed. The board contains the interface circuits for:

- the headsets
- the microphones
- the call director
- the paging input/outputs
- external recorders

The Matrix Board includes 2 relay closure circuits and 2 digital input circuits, as well as a matrix of crosspoint switches to route the audio signals correctly.

The Matrix Board contains only static logic circuitry and analog circuits and is controlled entirely by the external PC system through the DB37 connector.

CIRCUIT ANALYSIS

The backplane provides the power for the Matrix Board. Fifteen volts DC is sent to the 12-volt regulator VR1. Output from VRI serves as input to VR2 and the VBIAS circuit. VR2 is the 5-volt regulator that provides logic-level power for the Matrix Board.

Inputs and outputs can come from either the board's DB9 and DB37 connectors or from the backplane. The digital input lines from the DB37 cable are connected through an RC network to provide signal conditioning. Diode networks provide protection. The input signals then go to schmitt-trigger inverters to be conditioned for correct levels and values.

The digital inputs consist of the address, data, and strobe lines which control the switching of circuits on the Matrix Board. The single analog input is an audio tone used for signaling purposes. The tone is AC-coupled via C110 and level-adjusted via R187 to provide the system standard signal level of 2.2 volts (± 0.1) peak-to-peak from U12 to the switch matrix.



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The Logic Board provides a current-limited 12 volts DC (± 0.1) from the PC power supply to the Matrix Board to power the PTT circuits. This design effectively isolates the PTT circuits from any connection to the Matrix Board circuitry except for switch closures, which happen to be physically connected to the Matrix Board. As a result, the Audio Tower can be powered down without activating all of the PTT circuits.

The output lines from the Matrix Board to the Logic Board, via the DB37, carry DC voltages. One of these lines, the VU OUT, is a DC voltage proportional to the selected audio level. POWER IND is a voltage indicating that the Audio Tower is powered up and ready for communication with the Logic Board. The other lines are either PTT voltages, jack sense voltages, or digital inputs. The digital inputs are current-limited and diode polarity-protected. The inputs are optoisolator-coupled to the DB37 cable. PTT and jack sense circuits are powered by a pullup resistor, with the grounding of the circuit indicating an active condition. All of the outputs are filtered except the VU METER circuit and the POWER IND circuit.

On initial power-up, U27 grounds the reset line on U1-U8, which provides a reset to clear all previously set cross-point switches. This reset line ground is also input to U30, which provides a signal back to the Logic Board to indicate that the Audio Tower is powered up and ready to receive commands from the Logic Board.

Digital inputs SEL 0 thru SEL 3 serve as the chip select lines and are input into U21, a decoder. U21 then selects the correct chip for a switching operation. Digital inputs ADDR 0 thru ADDR 5 serve as the X and Y coordinates for cross-point switch positions in the matrix. ADDR3, ADDR 4 and ADDR 5 are the Y coordinate. STROBE is the strobe and DATA is the data.

In a switching operation, the Logic Board selects the X and Y coordinate of the switch to be changed and activates those lines in the DB37 cable. The data bit is set to 1 to turn on the switch or to 0 to turn off the switch. SEL 0 thru SEL 3 are used to select the chip to be involved in this operation (U1-U8). STROBE is then toggled to change the desired switch. This sequence is required for all switch operations in the cross-point switch matrix.

The Logic Board can also direct the Matrix Board to turn on or off either its own relays or the relays on the PA Board that the Matrix Board controls. The Logic Board can also select the digital pots (U37 and U38) in each headset circuit and control the audio level coming from the microphone or going to the earphone.

On initial power-up the Logic Board usually sends a "turn off" signal to every circuit on the Matrix Board to ensure that the initial matrix has no circuits turned "on." Since each of the cross-point switch chips is an 8 x 8 array of switches, several hundred "turn off" commands are sent. If the "POWER IND" line is lost for even an instant, the Logic Board resets and reloads all of the cross-point switches.

Because of the variety of inputs and outputs connected to the switch matrix, many combinations of audio routing are possible. The connections that are potentially valid on each cross-point chip are indicated on the schematic by a dot over that particular XY coordinate. Refer to the schematics for the Matrix Board for information on which connections are valid.

Audio inputs to the Matrix Board come from the backplane or from the Matrix Board's front panel edge connectors.

The "B/G MIC HI" is an input from the DB9 connected to the Boom/Gooseneck Microphone. The input is a low-level signal since the microphone is a magnetic cartridge type. The signal is AC-coupled through C136 and diode-protected from static problems. The output is sent to transformer T2, which is run-reversed and provides a gain of approximately 6 dB. The signal (and the 6 volts DC (\pm 0.1) bias) is then sent to U14 as a buffer amp with some frequency roll-off to limit response to about 3 kHz. The output is AC-coupled through C62 to pot R107 which enables the user to adjust the level input to the AGC circuit U29A. U29A provides limited AGC, with its main purpose being to limit the signal to a safe level for the matrix. The signal goes to a buffer amp U14B before it reaches the matrix. U14B adjusts the signal for approximately 2.2 volts (\pm 0.1) peak-to-peak with a DC bias of 6 volts.

The "DESK MIC HI" is an input from the DB9 connected to the Desk Microphone. The input is a high-level signal ranging from 100 mV to 800 mV peak-to-peak. The R88, R89, R90, and R91 network provides the bias to power the desk microphone. The signal is AC-coupled via C47 into the diode protection network. The signal is then input to buffer amp U14D, which also provides frequency roll-off above 3 kHz. The output is then AC-coupled via C54 to pot R97, which allows adjustment of the level input to AGC circuit U29B. AGC U29B provides limited AGC, with its main purpose being to limit the signal to a safe level for the matrix. The signal then goes to buffer amp U14C before it reaches the matrix. R97 adjusts the signal for about 2.2 volts (±0.1) peak-to-peak with a DC bias level of 6 volts.

The "OPR MIC HI" is a moderate-level input from the DB9 connected to the operator headset. R85 provides the bias to power the headset. Input is sent through a diode protection network to C17, which AC-couples to buffer amp U11A. U11A provides frequency roll-off of signals above 3 kHz. The output is directly coupled through pot R249 to AGC circuit U28B. AGC U28B provides limited AGC, with its main purpose being to limit the signal to a safe level for the matrix. The signal then goes to buffer amp U30A before it reaches the matrix. R249 adjusts the signal for about 2.2 volts (±0.1) peak-to-peak with a DC bias level of 6 volts.

The "SUPR MIC HI" is a moderate-level input from the DB9 connected to the supervisor headset. R39 provides the bias to power the headset. Input is sent through a diode protection network to C18, which AC-couples to buffer amp U9A. U9A provides frequency roll-off of signals above 3 kHz. The output is directly coupled through pot R240 to AGC circuit U28A. AGC U28A provides limited AGC, with its main purpose being to limit the signal to a safe level for the other stages of this headset circuit. The signal is further limited by circuit U9D. The output is then scaled by divider network R43, R44 and input to a high pass filter circuit U9C, which reduces such problems as 60 Hz hum. U9C output is then sent to low pass filter U9B, which reduces high frequency hiss. The output is AC-coupled to digital pot U9A, which allows the Logic Board to set the volume level from this input. Upon power-up the pot defaults to its midpoint setting. The Logic Board can then select this chip and by the process of turning STROBE and DATA on and off, toggle the correct setting into the chip. The chip supports 256 settings and 2 circuits, which means 17 toggle operations are required to serially load the desired setting. Output from the digital pot is AC-coupled through C133 to buffer amp U13C and to the matrix. A divider network on this output provides an attenuated output for sidetone. which is also sent to the matrix. The digital pot circuit is selected just as a matrix switch would be selected -- by chip select address.

During normal operation the Logic Board selects one of the inputs ("B/G MIC HI", "DESK MIC HI", or "OPR MIC HI") and connects it to "OPR MIC". The input is limited by limiter circuit U11D. The output is then scaled by divider network R65 and R66 and input to high pass filter U11C. which reduces such problems as 60 Hz hum. U11C output is then sent to low pass filter U11B, which reduces high frequency hiss. The output is AC-coupled to digital pot U9B, which allows the Logic Board to set the volume level from this input. Upon power-up the pot defaults to its midpoint setting. The Logic Board can then select this chip and by the process of turning STROBE and DATA on and off, toggle the correct setting into the chip. The chip supports 256 settings and 2 circuits, which means 17 toggle operations are required to serially load the desired setting. Output from the digital pot is AC-coupled through C41 to buffer amp U13B and to the matrix. A divider network on this output provides an attenuated output for sidetone, which is also sent to the matrix.

The Logic Board selects the correct audio to send to "OPR RCVR HI" and activates the appropriate switches in the matrix. The audio is limited in the matrix by circuit U13A and scaled by divider R218 and R219. The signal is then AC-coupled to digital pot circuit U10B, which allows the Logic Board to set the volume level from this input. Upon power-up the pot defaults to its midpoint setting. The Logic Board can then select this chip and by the process of turning STROBE and DATA on and off, toggle the correct setting into the chip. The chip supports 256 settings and 2 circuits, which means 17

The Logic Board selects the desired audio for a VU meter reading and activates the correct switches. The signal is ACcoupled through C14 to rectifier amp U18A. R36 controls the circuit's gain. The circuit's output is a half-wave picture of the input, which C15 and R220 filter to provide a DC voltage proportional to the AC input. As part of testing, R36 is adjusted for an output at "VU OUT" of 1.25 volts DC (±0.1) with an input of 2.2 volts (±0.1) peak-to-peak 1 kHz at U6, pin 6. The output to the backplane (and then to the I/O Board) of "UNSEL RCDR HI" is the sum of several matrix signals. A resistor pack sums the signals and inputs them to buffer amp

C1 I/C na "S

toggle operations are required to serially load the desired setting. Output from the digital pot is AC-coupled through C140 to low pass filter U12A, which reduces hiss in the earphone. Output from the low pass filter is AC-coupled to U29, which boosts the level and drives the earphone through AC coupler C88.

The Logic Board selects the correct audio to send to "SUPR RCVR HI" and activates the appropriate switches in the matrix. The audio is limited in the matrix by circuit U13D and scaled by divider R115 and R116. The signal is then AC-coupled to digital pot and, by the process of turning STROBE and DATA on and off, toggle the correct setting into the chip. The chip supports 256 settings and 2 circuits, which means 17 toggle operations are required to serially load the desired setting. Output from the digital pot is AC-coupled through C145 to low pass filter U12D, which reduces hiss in the earphone. Output from the low pass filter is AC-coupled to U28, which boosts the level and drives the earphone through AC coupler C72.

The output to the backplane (and then to the I/O Board) of "UNSEL RCDR HI" is the sum of several matrix signals. A resistor pack sums the signals and inputs them to buffer amp U17D. U17D performs a frequency roll-off of signals above 3 kHz. The output is adjusted by R11 and AC-coupled through C12 to the backplane and then to the edge connector on the I/O Board. The signal terminates as a removable screw terminal set on the I/O Board.

The output to the backplane (and then to the I/O Board) of "SEL RCDR HI" is the sum of several matrix signals. Various resistors sum the selected outputs of several circuits and input them to buffer amp U17C. U17C performs a frequency roll-off of signals above 3 kHz. U17C's output is adjusted by R16 and AC-coupled through C13 to the backplane and then to the edge connector on the I/O Board. The signal terminates as a removable screw terminal set on the I/O Board.

The output to the backplane (and then to I/O Board) of "CD RCVR HI" is selected and sent to buffer amp U18C. U18C performs a frequency roll-off of signals above 3 kHz. The output is sent to buffer amp U18B through pot R22. R22 allows adjustment of the output to the desired level. U18B performs a frequency roll-off of signals above 3 kHz. U18B's output is AC-coupled through C132, through a 600 ohm transformer, to the backplane and then to the edge connector

on the I/O Board. The signal is terminated in a DB9 connector. Generally, outputs from the matrix area are sent to buffer amps with filters to attenuate frequencies above 3 kHz.

The matrix operates with a DC bias of 6 volts and an AC signal of approximately 2.2 volts (±0.1) peakto-peak. Signals greater than 2.2 volts can cause crosstalk from one circuit in a switch to another.

The "CD MIC HI" is an input from the DB9 on the I/O Board to the backplane. On the Matrix Board, "CD MIC HI" is AC-coupled through C73, through a 600 ohm transformer, through a diode protection network to pot R125. At pot R125 the level is adjusted for input to buffer amp U15D. U15D performs a frequency roll-off of signals above 3 kHz. R125 is used to adjust the output of the buffer amp to about 2.2 volts (± 0.1) peak-to-peak for input to the matrix. The output is also sent to the VOX circuit through coupling capacitor C79 to half-wave rectifier U10B. The sensitivity of the VOX is adjusted by R130. The output of half-wave rectifier U10B is sent to two places: 1) to an RC network which slowly charges when signal is applied; and 2) to a carefully biased op amp U10C (from the RC network). The network's output is adjusted by feedback and input divider network R141, R142 and R143 so that its output is 1.2 volts DC (± 0.1) with no input. The input divider network's output is sent to comparator U10D on the non-inverting input. The inverting input of comparator U10D is taken directly from the output of the half-wave rectifier. With R144 the comparator has a hysteresis of 0.2 volts. The RC network feeding U10C gives it a 4-second time constant. U10B's output feeds the comparator and a background noise circuit with a 4-second time constant, which means that generally constant background noise adjusts the threshold needed to trip the VOX at comparator U10D. Once the VOX is tripped. the output of the comparator U10D is sent through the attackand-delay network D31-R145, D32-R146.

This network determines how long the circuit waits after the presence of signal before activating and how long it waits after cessation of signal before deactivating. The output then goes into inverter U10A and through divider network R147-R148. The output then either turns on Q1, causing it to conduct and activate PTT, or leaves it off, leaving 12 volts DC (±0.1) present on the circuit (a non-PTT condition). The Logic Board provides the power for the transistor Q1 through the DB37 cable. "CD MIC HI" comes from the same DB9 connector on I/O Board as "CD RCVR HI." A jack sense line and PTT line are available from the Call Director DB9. The jack sense line indicates insertion of a jack, and the PTT line indicates PTT.

The "PAGE INPUT HI" is an input from the I/O Board to the screw terminals on the I/O Board and to the backplane. On the Matrix Board, the signal is AC-coupled through C76 to a diode protection network and through pot R152 to buffer amp U15C. R152 is used to adjust the output level of the buffer amp to the standard 2.2 volts (± 0.1) peak-to-peak. The buffer amp performs frequency roll-off of signals above 3 kHz.

Two addressable latches, U22 and U23, are provided on the Matrix Board. The outputs from these chips either drive the relays on the Matrix Board, or drive the lines to the relays on the PA Board. The chips' outputs normally sink enough current to turn off Q3 and Q4. When on, the pullups turn on Q3, Q4 and the desired relays. The Matrix Board relays terminate in removable screw terminals on the I/O Board.

Two digital inputs are provided on the Matrix Board. The digital inputs require the user to supply 5 to 16 volts DC (± 0.1) to the appropriate removable screw terminals on the I/O Board. The inputs are current-limited by R229 and R230 and polarity-protected by a diode. The resulting signal is opto-isolated and sent through the DB37 cable to the Logic Board.

For future expansion of more than two PA Boards, summing circuits U15B and U15A are provided to sum several of the future inputs and present them to the matrix.

TESTING THE MATRIX BOARD

Listed below are test procedures for the CCS Matrix Board (not using a Logic Board). In the event of a problem, refer to the same item number in the "Problem Resolution" section.

Required tools:Oscilloscope, 15 volts DC (±0.1) power
supply, audio signal source, 0. 1 μF ca-
pacitor, test leads.

Setup procedure:

- Position the board so that the voltage regulators are in the upper right corner.
- Input signals are amplified up to 2.2 volts (±0.1) peak-to-peak for internal use in the matrix. Output signals to either the audio amplifiers or line driver circuits are at this level. Inputs to headset circuits are 2.2 volts peak-to-peak with amplifiers/attenuators to adjust the signals to correct levels.

Test procedures:

- 1. Power
- Connect the ground lead of the scope, DVM, and signal source to TP GND, which is the ground of the board (the left lead of either VR1 or VR2).

- Apply 15 volts DC (±0.1) to input regulator VR1 (the connections are, left to right: ground, output, and input).
- Verify 12 volts DC (±0.1) output at TP46 (regulator VR1).
- Verify 5 volts DC (±0.1) output at TP47 (regulator VR2).
- Verify 6 volts DC (±0.1) output at TP48 (use any VBIAS point on the board; U15, pin 5, for example).

2. B/G MIC

- Connect the audio signal source through a 0.1 μF capacitor to TP20 (pin 5 of the B/G microphone jack).
- Connect the ground lead of the signal source to TP GND (pin 9 of the B/G Microphone jack).
- Adjust the signal source to a signal of 0.04 volts (±0.01) peak-to-peak and a frequency of 1 kHz.
- Connect the scope lead to TP24 (U6, pin 23).
- Adjust R107 so that the wave form is 2.2 volts peak-to-peak on the scope. The waveform should be symmetrical. Verify that the signal is at that level and on top of a 6-volt DC bias level.

3. DESK MIC

- Connect the audio signal source through a $0.1 \ \mu\text{F}$ capacitor to TP15 (pin 9 of the desk microphone jack).
- Connect the ground lead of the signal source to TP GND (pin 5 of the desk microphone jack).
- Adjust the signal source to a signal of 0.75 volts (±0.1) peak-to-peak and a frequency of 1 kHz.
- Connect scope lead to TP19 (U6, pin 7).
- Adjust R97 so that the wave form is 2.2 volts peak-to-peak on the scope. The waveform should be symmetrical. Verify that the signal is at that level and on top of a 6-volt DC bias level.

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4. OPERATOR HEADSET

- Connect the audio signal source through a 0.1 μF capacitor to TP 11 (pin 9 of the operator headset jack).
- Connect the ground lead of the signal source to TP GND (pin 5 of the operator headset jack).
- Adjust the signal source to a signal of 0.2 volt (±0.05) peak-to-peak and a frequency of 1 kHz.
- Connect the scope lead to TP14 (U6, pin 22).
- Verify that the signal has a symmetric waveform. Verify that the signal is at least 0.8 volts (±0.1) peak-to-peak on the scope and that it is atop a 6-volt DC bias level.

5. SUPERVISOR HEADSET

- Connect the audio signal source through a 0.1 µFcapacitor to TP3 (pin 9 of the supervisor headset jack).
- Connect the ground lead of the signal source to TP GND (pin 5 of the supervisor headset jack).
- Adjust the signal source to a signal of 0.2 volts (0.05) peak-to-peak and a frequency of 1 kHz.
- Connect the scope lead to TP10 (U7, pin 23).
- Verify that the signal has a symmetric waveform. Verify that the signal is at least 0.8 volts (±0.1) peak-to-peak on the scope and that it is atop a 6-volt DC bias level.

6. CD MIC HI

- Connect the audio signal source through a 0.1 μF capacitor to TP41.
- Connect the ground lead of the signal source to TP GND (pin 5 of the supervisor headset jack).
- Set the signal source for a 1 kHz sine wave.

- Connect the scope lead to the same point and adjust the level on the signal source for 2.2 volts (±0.1) peak- to-peak.
- Connect the scope lead to TP42 (U15, pin 14).
- Adjust R125 for 2.2 volts (± 0.1) peakto-peak.
- Verify that the signal is a clean, undistorted sine wave and is atop a 6-volt DC bias level.

7. Call director VOX

- Connect the scope lead to TP43 (U10, pin 1).
- Remove the signal source from TP41 for 10 seconds.
- Reconnect the signal source to TP41, observing the scope as it is connected. There should be a jump in the DC level on the scope as the signal is applied. There should be another jump in less than 10 seconds, which is caused by the VOX circuit functioning.
- 8. PAGER INPUT HI
 - Connect the audio signal source through a $0.1 \ \mu F$ capacitor to TP44.
 - Set the signal source for a 1 kHz sine wave.
 - Connect the scope lead to the same point and adjust the level on the signal source for 2.2 volts (±0.1) peak-to-peak.
 - Connect the scope lead to TP45 (U15, pin 8).
 - Adjust R152 for 2.2 volts (±0.1) peakto-peak.
 - Verify that the signal is a clean, undistorted sine wave and is atop a 6-volt DC bias level.

9. TONE

- Connect the audio signal source through a 0.1 μF capacitor to TP1.
- Set the signal source for a 1 kHz sine wave.

- Connect the scope lead to the same point and adjust the level on the signal source for 2.2 volts (±0.1) peak-to-peak.
- Connect the scope lead to TP2 (U12, pin 8).
- Adjust R187 for 2.2 volts (± 0.1) peakto-peak.
- Verify that the signal is a clean, undistorted sine wave and is atop a 6-volt DC bias level.

10. VU Meter

- Connect the audio signal source through a 0.1 µF capacitor to TP64 (U6, pin 6).
- Set the signal source for a 1 kHz sine wave.
- Connect the scope lead to the same point and adjust the level on the signal source for 2.2 volts (±0.1) peak-to-peak.
- Connect the scope lead to TP65 (the end of the resistor nearest J4).
- Adjust R36 for 1.25 volts (±0.1) DC.

11. OPR MIC

- Connect the audio signal source through a 0.1 µF capacitor to TP35 (U6, pin 15).
- Set the signal source for a 1 kHz sine wave.
- Connect the scope lead to the signal source side of the capacitor and adjust the level on the signal source for 2.2 volts (±0.1) peak-to-peak.
- Connect the scope lead to TP40 (U8, pin 21).
- Verify that the signal is a clean, undistorted sine wave and is about 0.8 volts (±0.05) peak-to-peak.

12. OPR RCVR HI

- Connect the audio signal source through a 0.1 µF capacitor to TP25 (U7, pin 15).
- Set the signal source for a 1 kHz sine wave.

- Connect the scope lead to the signal source side of the capacitor and adjust the level on the signal source for 2.2 volts (±0.1) peak-to-peak.
- Connect the scope lead to TP29 (U12, pin 1).
- Verify that the signal is a clean, undistorted sine wave and is about 0.25 volts (± 0.05) peak-to-peak.
- Plug the headset into the operator headset jack. You should hear a loud but undistorted tone.

13. SUPR RCVR HI

- Connect the audio signal source through a 0.1 μF capacitor to TP30 (U8, pin 11).
- Set the signal source for a l kHz sine wave.
- Connect the scope lead to the signal source side of the capacitor and adjust the level on the signal source for 2.2 volts (±0.1) peak-to-peak.
- Connect the scope lead to TP34 (U12, pin 14).
- Verify that the signal is a clean, undistorted sine wave and is about 0.25 volts (±0.05) peak-to-peak.
- Plug the headset into the supervisor headset jack. You should hear a loud but undistorted tone.
- This completes the testing of the Matrix Board that can be done without a PC and Logic Board to set switches on the Matrix Board. At this point all audio circuits have been tested. The only item that has not been tested at this point is the functioning or switching of the matrix. That requires a tester or a PC-Logic Board-DB37 Cable combination to activate the switches.

PROBLEM RESOLUTION

Use the following procedures to resolve problems:

1. Power

The 12-volt regulator VR1 powers the 5-volt regulator and the bias circuit. If the 12-volt regulator fails, neither of the other circuits will function. Check VR1 for cracks or any other visible signs of damage to the package; such damage will cause the package to fail.

If the bias circuit is the problem, check for shorts in the transistor (Q2) socket or incorrect resistor values in its circuit.

Verify polarity on all power supply capacitors.

B/G MIC

2.

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With the scope ground connected as in the testing procedure, trace the audio signal through the circuit from beginning to end until the failure is located.

Verify that T2 is installed correctly; the input should be to the secondary and the output should be from the primary.

Trace the audio signal, starting with the input to TP 20 (U14, pin 3). Check the input and output to each stage. Observe the signal at TP 21, TP 23, and TP 24.

Verify the bias voltage on U14, pin 3; U39, pins 3 and 4; and U14, pin 5. Verify that the AGC jumper is in either the AGC (C - A) or non-AGC (C - B) position.

To test the AGC circuit, enable it and then disable it to verify its functioning.

DESK MIC

3.

With the scope ground connected as in the testing procedure, verify about 4 volts DC (± 0.1) bias on the desk microphone jack, pin 9, with the microphone connected.

Trace the audio signal, starting with the input to TP15 (U14, pin 12). Check the input and output to each stage. Observe the signal at TP16, TP18, and TP19.

Verify bias voltage on U14, pin 12; U39, pins 13 and 14; and U14, pin 10.

Verify that the AGC jumper is in either the AGC (C -A) or non-AGC (C - B) position.

To test the AGC circuit, enable it and then disable it to verify its functioning.

OPERATOR HEADSET

- With the scope ground connected as in the testing procedure, verify about 4 volts DC (± 0.5) bias on the operator microphone jack, TP11 (pin 9), with the operator headset connected.
- Trace the audio signal through the circuit from beginning to end until the failure is located.
- Trace the audio signal, starting with the input to TP11 (U11, pin 2).
- Verify bias voltage on U11, pin 3: U40, pins 13 and 14: and U30, pin 3. Observe the signal at TP12, TP13, and TP14.
- Verify that the AGC jumper is in either the AGC (C A) or non-AGC (C - B) position.
- To test the AGC circuit, enable it and then disable it to verify its functioning.

SUPERVISOR HEADSET 5.

- With the scope ground connected to TP GND as in the testing procedure, verify about 4 volts DC (± 0.5) bias on the supervisor microphone jack, TP3 (pin 9), with the supervisor headset connected.
- Trace the audio signal through the circuit from beginning to end until the failure is located.
- Trace the audio signal, starting with the input to TP3 (U9, pin 2).
- Verify bias voltage on U9, pin 3; U40, pins 3 and 4; and U13, pin 10.
- As you track the signals through this circuit, you will find that the most likely problem is incorrect or faulty components in either the high pass or low pass filters. Observe the signal at TP3, TP4, TP5, TP6, TP7, TP8, TP9 and TP10.

To test the AGC circuit, enable it and then disable it to verify its functioning.

6. CD MIC HI

- With the scope ground connected as in the testing procedure and the audio signal still being input to TP41, check for signal from beginning to end.
- Trace the audio signal, starting with the input to TP41 (U15, pin 13). Observe the signal at TP41 and TP42.
- Verify bias voltage on U15, pin 12.

7. Call Director VOX

- With the scope ground connected as in the testing procedure and the audio signal still being input to TP41, check for signal from beginning to end.
- Trace the audio signal, starting with the input to TP42 (the input to the VOX, which is U10, pin 5). If audio signal is present, check U10, pin 13. It should have a DC voltage when an AC signal is present as input to TP41. Remove and reconnect the input signal to TP41 and observe the DC voltage drop and climb.
- Remove the signal input to TP41. Connect the scope lead to U10, pin 8. Wait for 30 seconds.
- Reconnect the input signal to TP41. You should see a DC voltage slowly climb up to about 1.5 volts DC (± 0.5). This is the background noise amp. Should the voltage fail to climb, check the resistor and capacitor values in that part of the circuit.
- Connect the scope lead to U10, pin 1. A voltage should be seen as the TP41 signal is applied. After a few seconds the background noise amp should turn the voltage off.
- Connect the scope lead to the collector of Q1. The inverse of the last operation should be observed. Q1 should normally have a DC voltage which should fall to near 0 volts DC as the signal is input to TP41 and should return to several volts a few seconds later.

8. PAGER INPUT HI

With the scope ground connected as in the testing procedure and the audio signal still being input to TP44, check for signal from beginning to end.

- Trace the audio signal, starting with TP44 and then proceeding to TP45.
- Verify bias voltage on U15, pin 10.

9. TONE

- With the scope ground connected as in the testing procedure and the audio signal still being input to TP1, check for signal from beginning to end.
- Trace the audio signal, starting with TP1 and then proceeding to TP2.
- Verify bias voltage on U12, pin 10.

10. VU Meter

With the scope ground connected as in the testing procedure and the audio signal still being input to TP64 (U6, pin 6), check for signal at U18, pin 3. A half wave signal should be present at U18, pin 1. The amplitude of that half wave signal should be adjustable by R36. The rectified signal should be present at TP65 (R38), the 220-ohm resistor located in the test procedures. There should be no bias voltages on this circuit as it is AC-coupled by C14.

11. OPR MIC

- With the scope ground connected to TP GND as in the testing procedure and the audio signal still being input to TP35 (U6, pin 15), check for signal from beginning to end.
- Start by checking the output at TP36 (limiter amp U11D, pin 14). A good clean sine wave of approximately 1 volt (± 0.1) peak-to-peak should be present on the scope.
- Check the output at TP37 (300-Hz high pass filter U11C, pin 8). If signal is present at TP 37, check the output at TP38 (low pass filter U11B, pin 7).
- The output of the digital pot is at TP39 (U9, pin 4).
- The output from the final buffer amp is at TP40 (U13B, pin 7). There should be bias on the signal except in the immediate vicinity of the digital pot.
- Verify bias on U11, pin 12; U11, pin 7; and U13, pins 5 and 7.

12. OPR RCVR HI

Start by checking the output from TP26 (limiter amp U13A, pin 1). A good, clean sine wave of about 1 volt (± 0.2) peak-to-peak should be present on the scope.

Check the output of TP27 (digital pot U10, pin 12). If signal is present at TP27, check the output of TP26 (low pass filter U12A, pin 1). The digital pot default resistance will reduce inputs by 3 dB.

13. SUPR RCVR HI

As you track the signals through this circuit, you will find that the most likely problem is incorrect or faulty components in either the high pass or low pass filters.

The digital pot is AC-coupled and bias is restored at U13B.

With the scope ground connected to TP GND as in the testing procedure and the audio signal still being input to TP25 (U7, pin 15), check for signal from beginning to end.

Check the bias voltage at U13, pin 3, and U12A, pin 1.

As you track the signals through this circuit, you will find that the most likely problem is incorrect or faulty components in the low pass filter or digital pot.

With the scope ground connected to TP GND as in the testing procedure and the audio signal still being input to TP30 (U8, pin 11), check for signal from beginning to end.

Start by checking the output from TP31 (limiter amp U13D, pin 14. A good, clean sine wave of about 1 volt (± 0.2) peak-to-peak should be present on the scope.

Check the output of TP32 (digital pot U10A, pin 4). If signal is present at TP32, check the output of TP33 (low pass filter U12D, pin 14). The digital pot default resistance will reduce inputs by 3 dB.

Check the bias voltage at U13, pin 14, and U12, pin 14.

As you track the signals through this circuit, you will find that the most likely problem is incorrect or faulty components in the low pass filter or digital pot.

COMPONENT SIDE



OUTLINE DIAGRAM





(P29/3700112000, Silkscreen, Rev. 2) (P29/370012000, Rev. 0) (P29/3700112000, Gnd Plane, Rev. 0)

(P29/3700112000, Silkscreen, Rev. 2) (flipped) (P29/3700112000, Rev. 0) (P29/3700112000, Power Plane, Rev. 0)

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AUDIO MATRIX BOARD



(Sheet 1 of 4)



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MICS AND HEADSETS

(Sheet 2 of 4)



AUDIO MATRIX BOARD (Sheet 3 of 4)

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VOX (Sheet 4 of 4)

PARTS LIST

AUDIO MATRIX BOARD P29\5000056000

Revised: July 31, 1991 Revision: 1.0

ITEM	QUANTITY	REFERENCE	PART	
1	4	P5,P6,P7,P8	CONNECTOR DB9 FEMALE	
2	7	RP1,RP2,RP3,RP4,RP5,RP10,RP11	9x10 K SIP PACK	
3	1	J2	AMP 1-532956-0	
4	14	C2,C1,C3,C4,C5,C6,C7,C9C11,C30,C43,C94,C95,C160	2.2n	
5	50	$\begin{array}{l} R1, R2, R3, R4, R5, R6, R7, R9, R13, R14, R15, R18, R19, R20,\\ R21, R40, R58, R59, R80, R81, R86, R92, R112, R115, R119,\\ R120, R133, R134, R156, R157, R160, R161, R162, R163,\\ R164, R165, R166, R167, R168, R169, R189, R218, R222,\\ R223, R258, R276, R277, R278, R291, R292 \end{array}$	10K	
6	24	R24,R45,R55,R62,R68,R77,R84,R96,R98,R105,R108, R127,R143,R153,R155,R188,R232,R237,R241,R247, R250,R256,R265,R272		
7	18	R12,R17,R129,R150,R170,R171,R191,R192,R193, R194,R195,R196,R197,R198,R199,R200,R201,R202	١K	
8	1	C14	22 n	
9	12	R37,R43,R44,R60,R65,R66,R82,R100,R110, R227,R228,R285	2.2K	
10	2	R38,R103	220	
11	9	R34,R42,R63,R64,R113,R114,R215,R216,R217	20K	
12	15	R35,R41,R87,R116,R144,R159,R219,R245,R248, R254,R257,R263,R266,R270,R273	100K	
13	3	C15,C46,C85	22u 16V	
14	18	C131,C19,C26,C31,C38,C44,C48,C50,C57, C58,C75,C78,C81,C83,C111,C130,C142,C147	470u 35V	
15	1	C161	.01u	
16	3	C12,C13,C56	4.7u	
17	11	U16,U9,U10,U11,U12,U13,U14,U15,U17,U18,U30	MC3303 QUAD OP AMP	
18	1	U36	MAX690 RESET TIMER	
19	16	D1,D2,D3,D4,D9,D10,D17,D18,D19,D20,D29,D30, D59,D60,D61,D62	1N4001 DIODE	
20	8	U1,U2,U3,U4,U5,U6,U7,U8	MT8809-DIP CROSSPOINT SWITCH	
21	4	C132,C37,C73,C76	2.2u 50V NON POLAR	
22	2	T4,T3	STANCOR PCT-78	
23	6	R279,R141,R244,R253,R262,R269	12K	
24	7	C8,C27,C39,C77,C109,C144,C148	470p	
25	4	R8,R142,R154,R190	47K	
26	1	R25	510	
27	1	R23	5.1K	
28	1	R280	30.9K 1%	
29	8	R11,R16,R22,R125,R152,R187,R240,R249	10K pot	
30	4	R275,R97,R107,R274	50K pot	
31	1	R36	100K pot	

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ITEM	QUANTITY	REFERENCE PART		
32	15	C162,C16,C17,C25,C28,C40,C47,C64,C67, C69,C71,C87,C90,C140,C145	.47u 25V	
33	13	R149,R203,R204,R205,R206,R207,R208,R209,R210, R211,R212,R213,R214	470 1W	
34	2	C45,C18	220p	
35	1	R89	3.9K	
36	7	R93,R94,R104,R106,R126,R147,R148	4.7K	
37	4	R246,R255,R264,R271	50	
38	1	R88	1200	
39	25	C29,C42,C66,C70,C86,C88,C91,C93,C112,C113,C120, C121,C122,C123,C124,C125,C126,C127,C128,C129, C136,C151,C154,C156,C158	47u 16V	
40	2	G68,C72	100u 16V	
41	4	BR1,BR2,BR3,BR4	DIODE BRIDGE DF005M	
42	34	D5,D6,D7,D8,D11,D12,D21,D22,D31,D32,D33,D34, D35,D36,D37,D38,D39,D40,D41,D42,D43,D44,D45,D46, D47,D48,D49,D50,D51,D52,D53,D54,D55,D56	1N4148 DIODE	
43	2	U37,U38	DS1267-10 DIGITAL POT	
44	2	U39,U40	LM13700 TRANSCONDUCTANCE AMPLFILER	
45	2	R39,R85	150 IW	
46	1	R90	560	
47	1	R91	201W	
48	2	U29,U28	LM386 AMPLIFIER	
49	2	C41,C133	.22u	
50	2	C54,C62	47n	
51	14	C55,C63,C96,C97,C98,C99,C100,C101C102,C103,C104, C105,,C106,C107	6.8n	
52	1	T2	STANCOR PCT-15	
53	4	R242,R251,R260,R267	240K	
54	2	R83,R61	2K pot	
55	4	R75,R53,R234,R239	10.0k 1%	
56	4	R74,R52,R233,R238	56.2k 1%	
57	4	R73,R51,R230,R235	7.87k 1%	
58	2	R69,R47	196k 1%	
59	4	R70,R48,R50,R71	100k 1%	
60	2	R72,R49	121k 1%	
61	2	R67,R46	52.3k 1%	
62	4	R76,R54,R231,R236	4.75k 1%	

Continued

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ITEM	QUANTITY	REFERENCE	PART	
63	14	C20,C21,C22,C23,C24,C32,C33,C34,C35,C36,C141, C143,C146,C149	4.7N 5%	
64	4	R243,R252,R261,R268	12.7k 1%	
65	6	C152,C150,C153,C155,C157,C159	150u 16V	
66	6	R131,R135,R136,R137,R138,R140	220K	
67	1	R139	6.8K	
68	1	R145	3.3K	
69	37	C89,BC1,BC2,BC3,BC4,BC5,BC6,BC7,BC8,BC9,BC10, BC11,BC12,BC13,BC14,BC15,BC16,BC17,BC18,BC19, BC20,BC21,BC22,BC23,BC24,BC25,BC26,BC27,BC28, BC29,BC30,BC31,BC32,BC33,C79,C82,C92	.1u 50V	
70	1	R146	68K	
71	2	K2,K1	RELAY OMRON Z768-ND	
72	4	Q1,Q2,Q3,Q42	N3904 TRANSISTOR	
73	1	U34	1086CT-12 VOLTAGE REG	
74	3	U27,U25,U26	74HC14 HEX INVERTING SCHMITT TRIGGER	
75	1	U21	74HC154 DUAL 4-INPUT MULTIPLEXER	
76	2	U22,U2	374HC259 3-TO-8 LINE DECODER	
77	1	U24	74HC32 QUAD 2-INPUT OR GATE	
78	2	R124,R151	620	
79	1	R132	150K	
80	1	C80	820p	
81	1	C74	47p	
82	1	R128	470K	
83	1	R130	20K pot	
84	1	U35	1086CT-5 VOLTAGE REG	
85	2	C84,C110	1Ou	
86	12	R172,R173,R174,R175,R176,R177,R178,R179,R180, R181,R182,R183	5.6K	
87	1	P4	CONNECTOR DB37 FEMALE	
88	2	U31,U32	TIL127 OPTO ISOLATOR	
89	2	R229,R286	390	
90	2	RP8,RP9	9x1 K SIP PACK	
91	2	RP6,RP7	9x4.7 K SIP PACK	
92	8	R57,R56,R78,R79,R117,R118,R220,R221	470	
93	66	TP1 THROUGH TP66	TEST POINTS	
94	4	JP1, JP2, JP3, JP4	3-POINT HEADERS	
95	4	JP1 JP2 JP3 JP4	JUMPERS	

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IC DATA

8-BIT ADDRESSABLE LATCH/3-TO-8 LINE DECODER U22 AND U23 (74HC259)









HEX INVERTING SCHMITT TRIGGER U25, U26 AND U27 (74HC14)



8X8 ANALOG SWITCH ARRAY U1 THRU U8 MT8809-DIP



QUAD OPERATIONAL AMPLIFIERS U9 THRU U18 AND U30 MC3303





4-T0-16 LONE DECODER U21 (74HC154)



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TRUTH TABLE

r	G	Outputs of Addressed Latch	Each Other Output	Function
	L	D	Q _{iO}	Addressable Latch
	H	Q _{iO}	Q _{iO}	Memory
	L	D	L	8-Line Decoder
	H	L	L	Clear







WIDEBAND RMS-DC CONVERTER U35

(GROUND)*



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PRECISION VOLTAGE MONITOR U36 (MAX690)



DUAL DIGITAL POTENTIOMETER CHIP U37 AND U38 (DC1267-10)



DUAL OPERATIONAL AMPLIFIERS U39 AND U40 (LM13700)