ARP AVATAR

MODELS 2221, 2222, 2223, & 2225

SERVICE MANUAL

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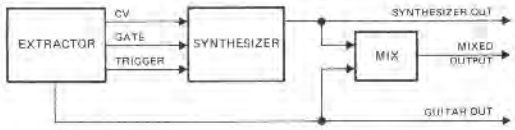
SECTION 1 GENERAL INFORMATION

1.1 Introduction

The AVATAR is divided into two sections: The Synthesizer and Pitch Extractor/CV Generator.

The Synthesizer section is like the ARP Odyssey (in fact, the AVATAR and Odyssey use several of the same printed circuit boards). It consists of two voltage controlled oscillators, a voltage controlled filter, a voltage controlled amplifier, two envelope generators (ADSR and AR), a low frequency oscillator, and a sample and hold circuit. As with standard keyboard synthesizers, the synthesizer requires a 1 V/Octave control voltage, gate and trigger to be played.

The Pitch Extractor/CV Generator translates the guitar string signals into the language of synthesizers: 1 V/Octave control voltage, gate and trigger. Using the ARP Six Channel (Hex) pickup, the string signals are multiplexed to one output (last note played) and then transformed to a control voltage. Since the synthesizer is monophonic (single note), only one string can be extracted and converted to a control voltage at a time.



A byproduct of the extraction process is a hexaphonic straight or fuzz guitar output which features no intermodulation distortion since each string signal is amplified and clipped independently.

1.2 Specifications

Noise Generator
Type 1: Digital
Noise Spectrum Types: White and pink

Trigger Sensitivity
Trigger Threshold: Soft to hard pluck, manually adjustable

Pitch Acquisition
Typically within 2 cycles

Portamento
Maximum Speed: About .01 msec./oct.
Minimum Speed: About 1.5 seconds/oct.

Voltage Controlled Oscillators
Waveforms: Sawtooth, Square, Pulse, Dynamic Pulse
Frequency Range: VCO 1 in low frequency mode .2 Hz to 20 Hz.; VCO 1 and VCO 2 (audio range), 20 Hz to 20 KHz
Warm-up Drift: 1/30 semitone from turn-on max.
Pulse Width: 50% to 5%
Pulse Width Modulation: ADSR, + 45%; LFO, + 15%
Voltage Controlled Response: 1 V/Octave
Maximum Freq. Shifts: LFO sine wave, + ½ oct.; LFO square wave, + 1.5 oct.; ADSR + 9 oct.; S/H + 2 oct.

Voltage Controlled Filter
Type: Low pass, 24dB/oct.
Frequency Range: 16 Hz to 16 KHz
Maximum Usable Q: 30
Resonance 1/2 to self oscillate
Voltage Controlled Response: 1 V/Octave

Voltage Controlled Amplifier
Dynamic Range: 80 dB

Ring Modulator
Type: Digital
Input Signals: VCO 1 and VCO 2 square waves

Sample and Hold
Command Sources: Guitar trigger or LFO trigger
Sampled Signals: VCO 1 square wave and sawtooth wave, VCO 2 square wave and pink noise

ADSR Envelope Generator
Attack Time: 5 msec. to 5 seconds
Decay Time: 10 msec. to 8 seconds
Sustain Level: 0 to 100% of peak
Release Time: 15 msec. to 10 seconds

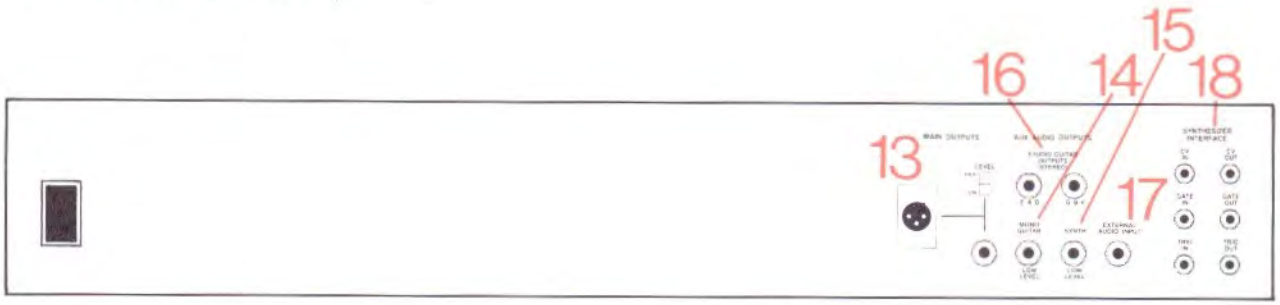
AR Envelope Generator
Attack Time: 5 msec. to 5 seconds
Release Time: 10 msec. to 8 seconds

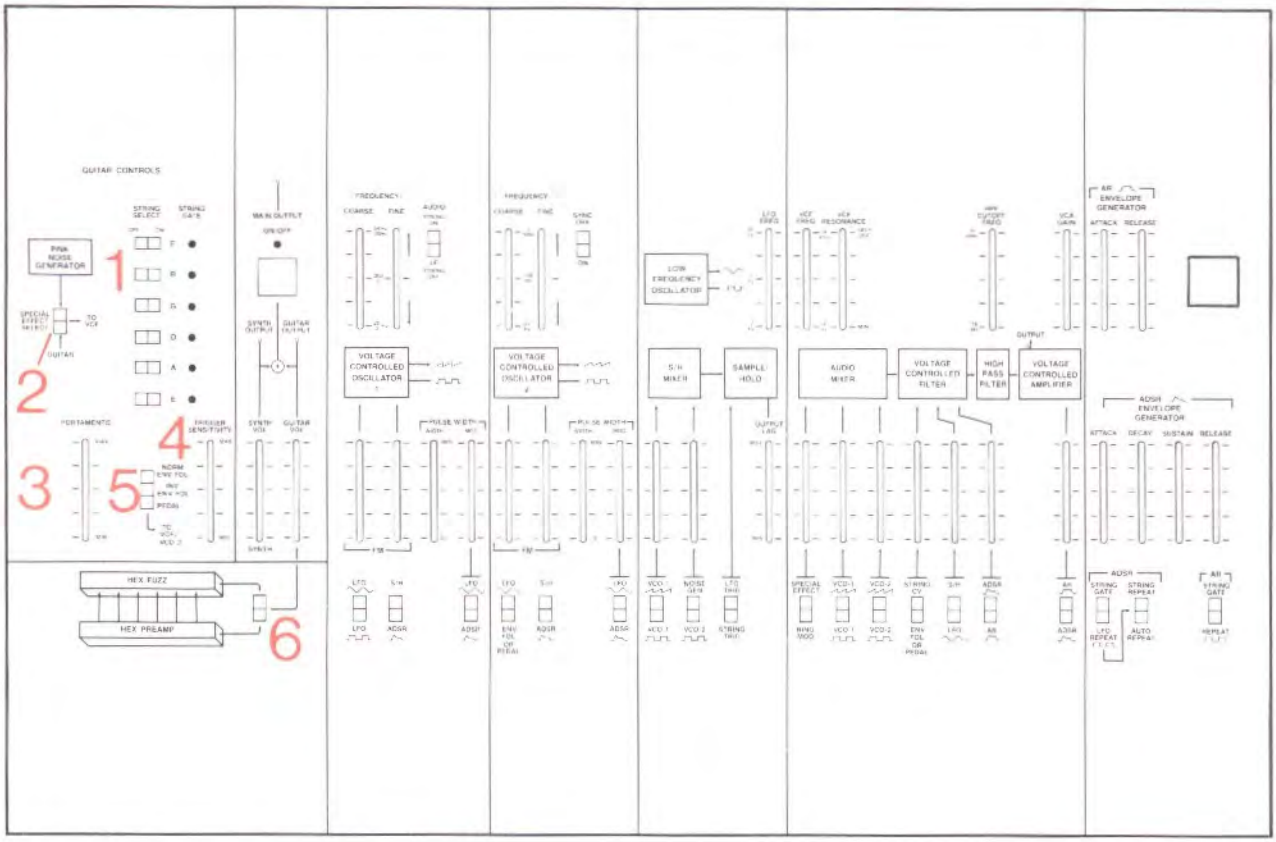
Interface Jacks
Strings CV IN/OUT: 1 V/Octave Tini 'D' jack Gate OUT: +10 volts, on; 0 volts, off. Tini 'D' jack
Gate IN: +8 volt minimum. Tini 'D' jack
Trigger OUT: +10 volt pulse, Tini 'D' jack, 10 microsec. duration
Trigger IN: +8 volt pulse min., 10 microsec. duration minimum, Tini 'D' jack
External Audio Input: ¼" phone jack, 500 millivolts maximum for full output

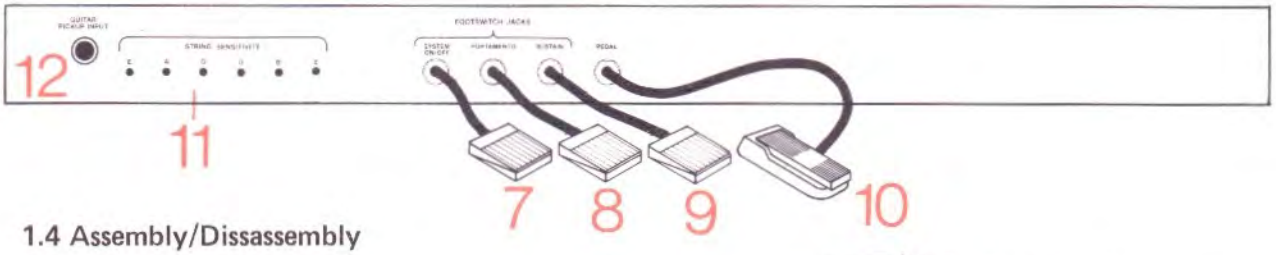
Pickup
ARP Hexaphonic (6 channel): Model 1241, Model 1244
Connector: 6 Pin Amphenol

Foot Switch Jacks
ARP Foot Switch: ¼" stereo jack, tip and ring normally closed
ARP Filter Foot Pedal: ¼" stereo jack to 100K and taper potentiometer in pedal

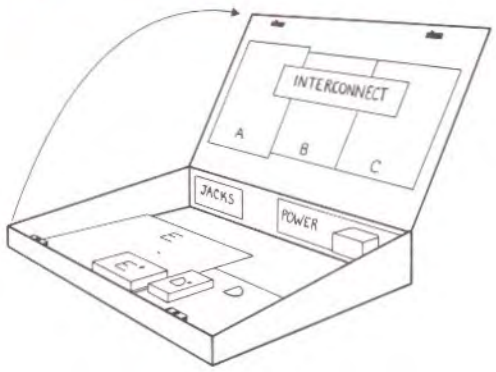
1.3 Function Descriptions



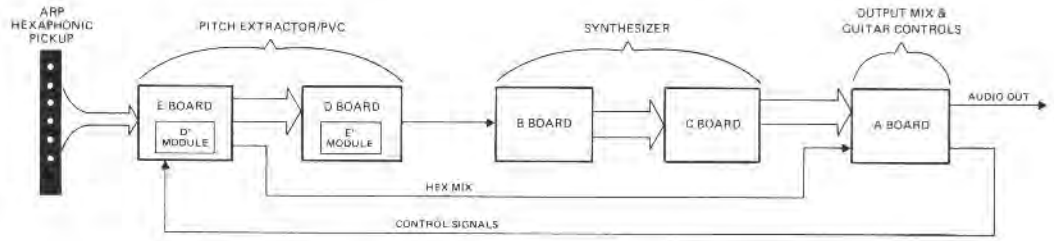




1.4 Assembly/Dissassembly



CONTROL/JACK		FUNCTION	USE
1	String Select Switches	Enables triggers from Trigger Generator Circuit to enter Trigger Select Circuit	Allows user to select which of the six strings can control the synthesizer.
2	Special Effect Select	Routes either pink noise or guitar signal to Board C.	Allows the guitar signal (straight or fuzz) to be processed through the VCF, in addition to the VCOs.
3	Portamento	Adds a lag or delay to the string control voltage.	Allows notes to slide from note to note.
4	Trigger Sensitivity	Sets the threshold of triggering when plucking strings	Allows user to adjust the triggering sensitivity to his playing style. Also permits synthesizer to be triggered on command (hard pluck only).
5	Envelope Follower Select Switch	Routes Pedal CV, Normal (positive going) envelope follower or inverted envelope follower (negative going) to VCF.	Allows expressive playing by controlling the VCF cutoff either by how hard the note is played or by foot pedal.
6	Hex Fuzz/Hex Preamp Switch	Selects either straight unmodified guitar or fuzz (clipped) guitar	Choice of fuzz or straight guitar signals at special effects select and guitar output.
7	System On/Off Switch	Toggles On/Off audio switch on foot switch depression	Remote On/Off
8	Portamento Foot Switch	Shorts out portamento pot except when depressed	When depressed, assumes portamento speed set by portamento slidepot.
9	Sustain	Locks out new pitch information and holds last note played	Allows a synthesizer note to be held while playing the straight or fuzz guitar.
10	Pedal	Provides a voltage to vary the VCF or VCO 2	Expression
11	String Sensitivity Trimmer	Adjusts preamp gain	Adjusts AVATAR to guitar
12	Guitar Pickup Input Jack	Six-conductor (shield, ground) cable which connects the ARP Hex Pickup to the AVATAR.	Hex input
13	Main Outputs	Mix of guitar and synth (high or low level)	Remote On/Off
14	Mono Guitar	Low level guitar mix output	Hex fuzz or Hex straight guitar
15	Synthesizer Output	Output from VCA via Mix slider	Synthesizer output only
16	Stereo Guitar Output EAD/GBE	Mix of E, A, D or G, B, E strings only	Stereo output
17	External Audio Input	Unattenuated input connected directly to VCF	For external signals or synthesizers
18	Synthesizer Interface Jacks	External CV gate and trigger inputs and outputs (CV will disconnect internal CV)	Allows other synthesizers to control or be controlled by the AVATAR.



2.1 General

The Avatar's Extraction/CV circuitry is divided into two basic sections: E and E' Boards, and D and D' Boards.

The E/E' Boards contain the analog extraction portion of the instrument. Six audio signals from the ARP Hex Pickup are supplied to the E Board. The output is an extracted pulse wave at the frequency of the last string plucked. This signal is only gated out when the E/E' circuitry is sure the signal is valid.

The D/D' Boards accept the extracted pulse wave from the E/E' Boards and digitally measure the period of the signal. This period measurement is then stored in memory so that it can be held and read out of memory as required. On command from gating circuitry, the period count is transformed back into a pulse wave at four times the original frequency (for speed) which then feeds a pitch to voltage converter (D' Module). The D' Module produces a 1 V/Octave control voltage to drive the synthesizer portion of the instrument. (See page 5.)

2.2 E & E' Boards

Each of the signals from the guitar strings is independently amplified in the Hex Preamplifier Circuit on Board E. The six outputs of the Preamplifier Circuit are sent three places: The Fuzz Circuit, The Trigger Generator Circuit, and the Audio Multiplexer Circuit.

The Fuzz Circuit produces (if selected) clipped guitar signals to the guitar output. Since the Fuzz is created per string and then mixed, the effect is a 'clean' distortion with low intermodulation distortion. The Hex Guitar outputs (Fuzz and straight) are by-products of the extraction process and have no function in the conversion of guitar signals to a control voltage.

The Trigger Generator Circuit produces a trigger for each plucked string. The six trigger outputs are routed through the String Select Switches (which enable or disable each string) to the Trigger Select Circuit. From the triggers, the Trigger Select Circuit produces a three bit string code for the last note played. A trigger pulse is also generated for each pluck to reset the extraction circuitry on new notes.

The Audio Multiplex Circuit selects one of the six guitar signals and routes it to the Extractor Module (E' Board) according to the three bit string code (last note played). The code is also sent to the Extractor Circuit to set up the approximate pitch range of the string signal it is to receive.

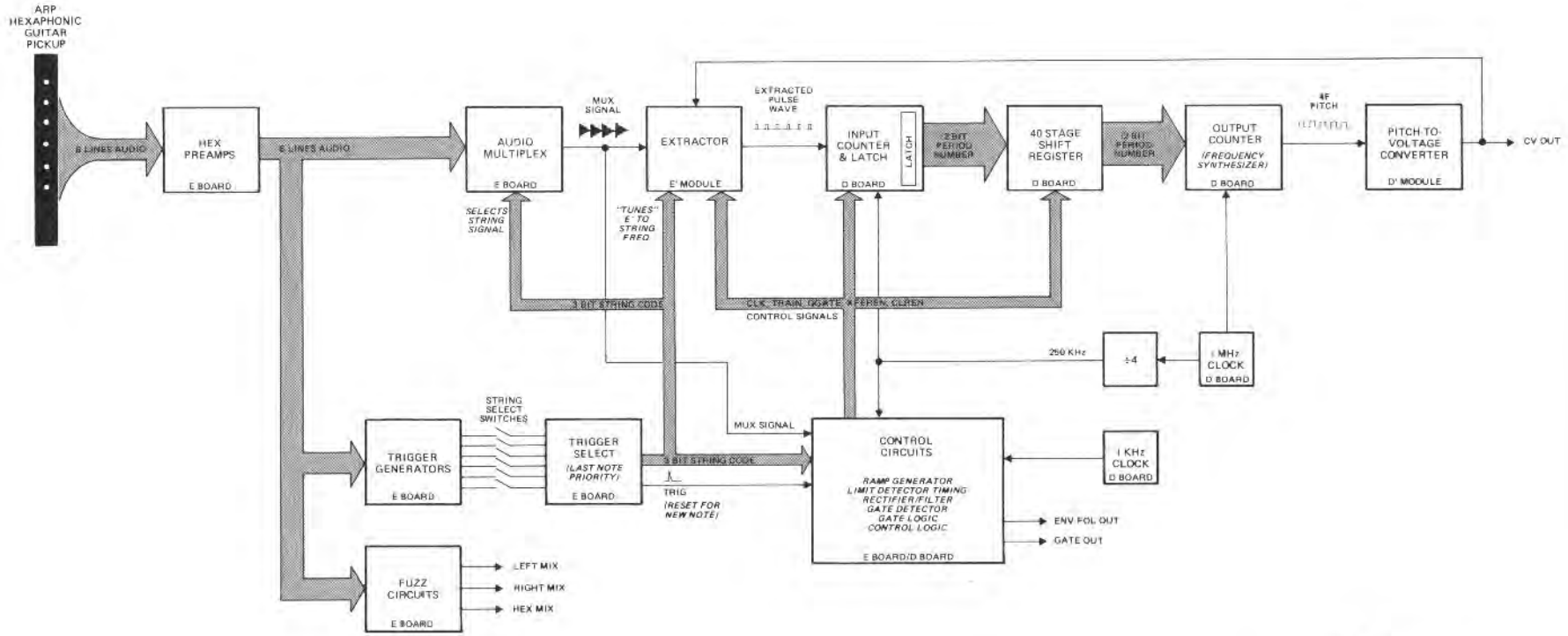
The Extractor transforms the guitar signal into a clean pulse wave which is only gated out when the signal is considered valid (stable and of usable amplitude).

Control circuitry on the E and E' Boards insures that the extraction begins only on a valid string pluck (Gate Detector Circuit), insures the signal is valid (Limit Detector and Ramp Detector Circuits), and gates the signal out only while the signal is clean (Gate Logic). The E Board also contains the Envelope Follower Circuit which is supplied to the Synthesizer VCF.

2.3 D & D' Boards

Boards D and D' accept a clean pulse wave from the E' Board, store it in memory, and then produce a control voltage to drive the synthesizer portion of the instrument. The memory feature of the circuit is used to produce continuously a valid control voltage even in the absence of a pulse on the input. The memory feature is also useful for masking the flatting effect caused by the release of a fretted string and other pitch inconsistencies typical of guitar signals which would otherwise cause instability. Infinite control voltage sustain is accomplished by locking out new information from entering the D Board and the memory.

The Input Counter Circuit on the D Board digitally measures the period of the pulse wave from the Extractor Module (E'). The Input Counter is a 12 bit counter clocked at 250 KHz which resets to zero for each new pulse wave period. The 12 bit period number is then latched and held until the next period count. This number is loaded into the 40 Stage Shift Register Circuit. On an initial string



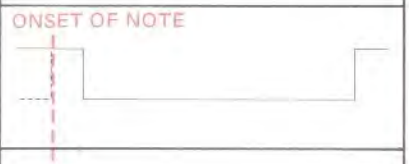
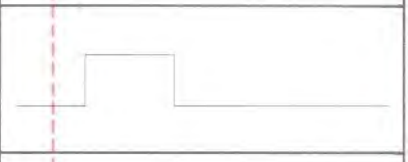
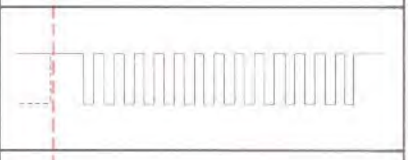
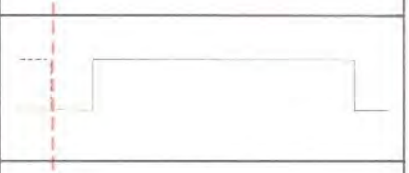
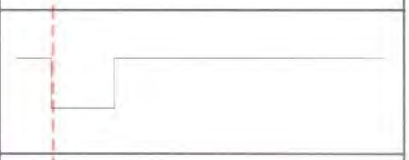
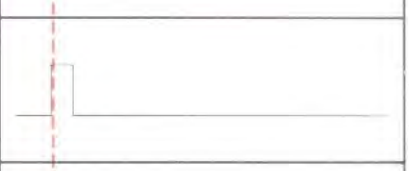
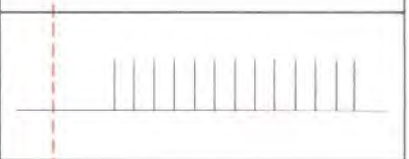
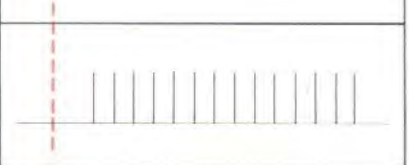
ARP

AVATAR
Model 2220
Block Diagram
Pitch Extraction/CV Generator
(Boards E, E', D, D')

pluck, the shift register is clocked fast (250 KHz) to process the first few period counts quickly. The shift register is then clocked at a slower rate of 1 KHz so that subsequent interruptions or glitches can be blocked before being sent to Board D. If the shift register receives no new period numbers from the E and E' Board (either due to glitches or because no note is being played), the shift register continuously outputs the last number it processed. Thus the circuit always outputs a usable period number. The binary period number on the output of the shift register is loaded in the Output Counter Circuit which converts the number back into a pulse wave. The Counter Circuit is clocked at four times the rate of the input counter (1 MHz) and therefore produces a pulse wave two octaves higher than the input signal. This insures fast pitch to voltage conversion.

The Pitch to Voltage Converter (D' Board) converts the pulse wave from the Output Counter to a 1 V/ Octave control voltage which is sent to the synthesizer section of the instrument and to the Extractor Module as a correction voltage.

2.4 Table of Control Signals Used in the Extraction Process

SIGNAL	GENERATED BY	PURPOSE	CHARACTERISTICS
$\overline{\text{A GATE}}$	ON NEW NOTE, Z27	STARTS GATING SEQUENCE (HELD LOW BY LEVEL)	
TRAIN	$\overline{\text{A GATE}}$ Z30A	CONTROLS E' EXTRACTION; STARTS E' FIRST MODE EXTRACTION	
Q GATE	FROM $\overline{\text{A GATE}}$ VIA TRAIN	ENABLES OR STARTS E' EXTRACTION. DENOTES "START EXTRACTION"	
CLK (CLOCK)	E' MODULE	EXTRACTED GUITAR SIGNAL (SQUARE WAVE SENT TO BOARD D).	
LEVEL	E' MODULE	HOLDS $\overline{\text{A GATE}}$ LOW FOR DURATION OF EXTRACTION; DENOTES: "EXTRACTION OCCURRING"	
PITCH GATE	FROM CLK VIA Z33A AND Z34B	CONFIRMS E' HAS OUTPUT; DENOTES "E' HAS OUTPUT"	
TRIG	STRING SELECT LOGIC	RESETS GATE LOGIC ON NEW NOTE	
XFEREN	LIMIT DETECTOR TIMING	TRANSFERS DATA TO SHIFT REGISTERS ON D BOARD	
CLREN	FROM CLK VIA TIMING DETECTORS	RESETS D BOARD PERIOD COUNTERS	

3.1 Board A

3.1.1 NOISE GENERATOR

Shift registers Z5 and Z6 are used to digitally generate a random noise source which is filtered and buffered by Z7 to produce a pink noise signal. The Special Effect Select switch, switches either pink noise or the mixed guitar signals to Board C.

3.1.2 CONTROL VOLTAGE BUFFER

The Control Voltage Buffer is a high input impedance FET input op amp. It is used to add portamento (a voltage lag) through the use of R1 and C14. The control voltage output is supplied to Boards B and C via the CV INPUT and OUTPUT jacks on the rear of the unit.

3.1.3 SYSTEM ON/OFF

Z11B clocks Z11A when the System ON/OFF button or footswitch is depressed which toggles the Q output (pin 1) of Z11A alternately high or low. Z10 then either grounds the audio output from Z8A (guitar signal) and Z9A (synthesizer signal) or allows the the signals to pass to Z8B out to the main output.

3.1.4 TRIGGER SENSITIVITY

Z3B supplies a DC voltage to the Trigger Detector Circuit on Board E to set the trigger threshold for all of the strings.

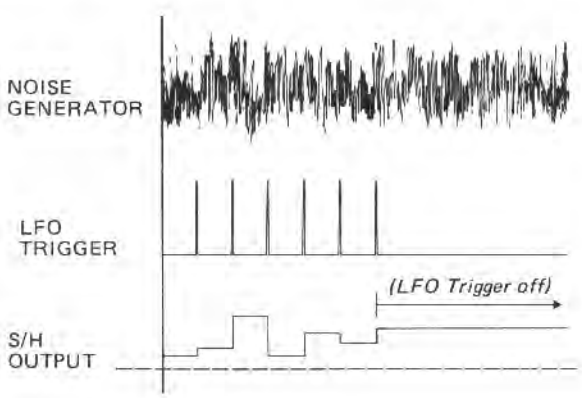
3.1.5 LAMP DRIVER/STRING SELECT SWITCH

The three bit string code (D0, D1, D2) from Board E is gated by comparators Z3B, -C, -D to decoder Z2. Z2 then lights the LED which corresponds to the String Code. The String Select switches are routed to the Trigger Detector Circuit on the E board to either enable or disable each string.

3.2 Board B

3.2.1 SAMPLE & HOLD (S/H)

The sample and hold circuit provides a DC voltage output by sampling and storing the instantaneous voltage level of signals on its input each time a trigger pulse is provided. This stored voltage is held until the next trigger pulse occurs. Signals which are to be sampled and applied to pin 3 of Z1A. Z1A amplifies and buffers the signal and supplies it to Q1. When a trigger from either the LFO or the guitar string is received through C3, Q1 conducts just long enough for the memory capacitor (C1) to assume the new voltage level, then Q1 turns off until another trigger is supplied. Q2 and Z2A are a FET op amp follower which buffers the voltage on C1 and provides it to the lag circuit (R15 and C2) and the output buffer (Z2B).



3.2.2 LOW FREQUENCY OSCILLATOR (LFO)

The LFO produces a triangle and a square wave output in a frequency range from about .1Hz to 25Hz. Z5A and C7 are an integrator which charges from current passing through R33. Z5B is a hysteretic switch whose output switches from -15 volts to +15 volts when the output of Z5A reaches +5 volts. This change in output polarity then reverses the direction of current through R33 and the rate control (R34) and thus the direction of integration at the output of Z5A. When the output of Z5A reaches -5 volts, the output of Z5B switches back to -15 volts and the cycle repeats. An LFO reset pulse is supplied from Q4 every time a key is depressed. Q5 is turned on momentarily by the LFO reset pulse and discharges the integrating capacitor (C7) thus reinitializing the LFO output to zero.

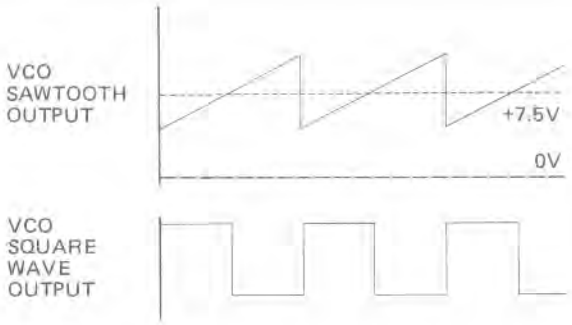
3.2.3 VOLTAGE CONTROLLED OSCILLATORS (VCOs)

Control voltages from the guitar string, Initial Frequency and Fine Tune sliders, the Sample and Hold circuit, LFO square wave and sine wave, and the ADSR are summed on the base of Q6. Q6 and Q7 are a linear voltage to exponential current generator; for every volt applied to the control input of the VCO, Q6 will conduct twice as much current. C11 is the integrating capacitor; it is initially charged to 15 volts and discharges through R61 and Q7 towards

ground. Q7 determines the discharge current of the capacitor and, therefore, the period of oscillation. Q9 buffers the voltage on C11 and supplies it to a comparator, Z3B and Z3A. Pin 2 of Z3A is fixed at about +7.5 volts. When the voltage on pin 4 of Z3B decreases to below +7.5 volts, Z3A turns on Q11 which supplies +15 volts to the gate of Q8. Q8 then charges capacitor C11 back to +15 volts to start the cycle over again.

R63, C10 and R59 supply current to Q7 as the frequency of the oscillator is increased to prevent the oscillator from going flat due to the recovery time of the circuit. Q12 is a phase splitter which takes the sawtooth from pin 3 of Z3 and supplies it to the oscillator output and the pulse converter. The waveform on the emitter of Q12 is 7.5 volts peak to peak negative going (+7.5 volts offset), and the collector is about 5 volts peak to peak positive going (zero referenced).

Sawtooth To Pulse Converter: Z3C and Z3D is a comparator with R86 and R87 setting the switch point as +7.5 volts. The sawtooth wave from the oscillator is supplied to the comparator through R75 and C12. Z3E supplies an offset current to raise or lower the DC level of the sawtooth wave to change



the point at which the comparator switches. When the pulse width sliders on the front panel are at minimum, the comparator will switch exactly in the middle of the sawtooth slope, producing a square wave (50% duty cycle). The output of the comparator (Z3, pin 8) is processed through Z4A which inverts and shapes the pulse output.

3.2.4 RING MODULATOR

The ring modulator utilizes two CMOS nand gates (Z4B and Z4C) and Q20 in an 'exclusive or' function. Square waves from VCO 1 and VCO 2 are supplied to pin 5 and pin 8 of Z4 and the output is taken from the emitter of Q20.

3.3 Board C

3.3.1 VOLTAGE CONTROLLED FILTER (VCF)

Audio signals from the VCF are processed by the high pass filter (C3, R13 and R74) and connected to the noninverting input of Z2. Z2 is an operational transconductance amplifier (OTA) whose gain is a function of the current signal supplied to pin 5. Control voltages from the two envelope generators and the VCA gain slider are connected to Q1 which supplies current to the OTA. R70, the control reject trimmer, balances the inputs of the OTA to minimize the effect of control voltages on the audio output of the VCA.

3.3.2 VOLTAGE CONTROLLED AMPLIFIER (VCA)

Audio signals from both VCOs, the ring modulator, and the noise generator are applied to the audio input of the voltage controlled filter (pin 1, M1) through C1 and C13. Control voltages from the S/H, LFO, STRING CV, and the envelope generators (ADSR and AR) are summed and inverted by Z1. The control input of the VCF accepts negative going control voltages; as the voltage on TP-1 is decreased, the filter cutoff increases. Signals on the output of the VCF (pin 10) are fed back to the resonance input (pin 2) via the resonance slider (R73).

3.3.3 AR ENVELOPE GENERATOR

The Attack-Release envelope generator produces a control voltage with variable rise and fall times. It is used to control the VCF or the VCA. When a string gate voltage is supplied or the LFO through S-10, Q4 turns on which charges capacitor C7 through R76, R32 and CR5. The position of R76 (Attack slider) determines the time C7 takes to charge up. When the gate voltage is removed, Q4 turns off which allows Q5 to turn on. The voltage on C7 then discharges through CR6, R77, R31, and Q5. R77 (release slider) sets the release time. Q6 and Q7 buffer the voltage on C7 and supply it to the VCA and VCF.

3.3.4 ADSR ENVELOPE GENERATOR

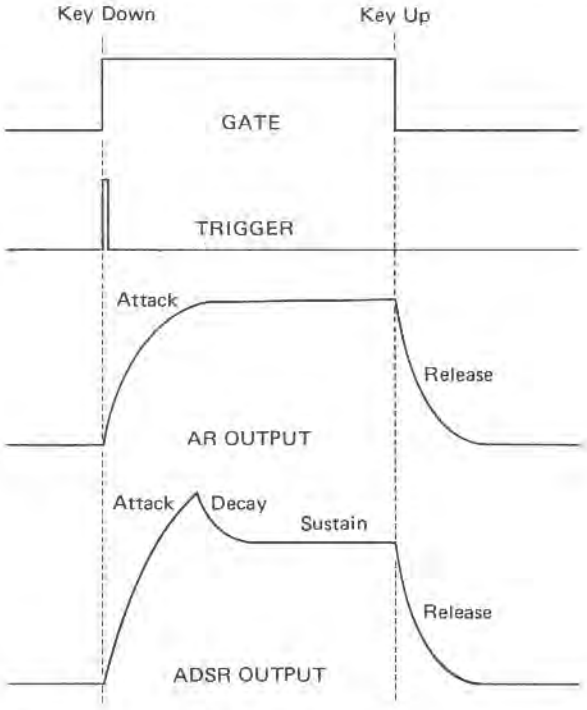
The Attack-Decay-Sustain-Release envelope generator produces a control voltage with variable rise and fall times. It is used to control the VCF or the VCA. A string gate and trigger signal must be supplied or LFO to start the ADSR voltage rising.

Attack: When a gate signal (+10 volts) is supplied through S8, Q8, Q9 and Q10 turn on which then allows Q16 to turn off. With Q16 off, a trigger

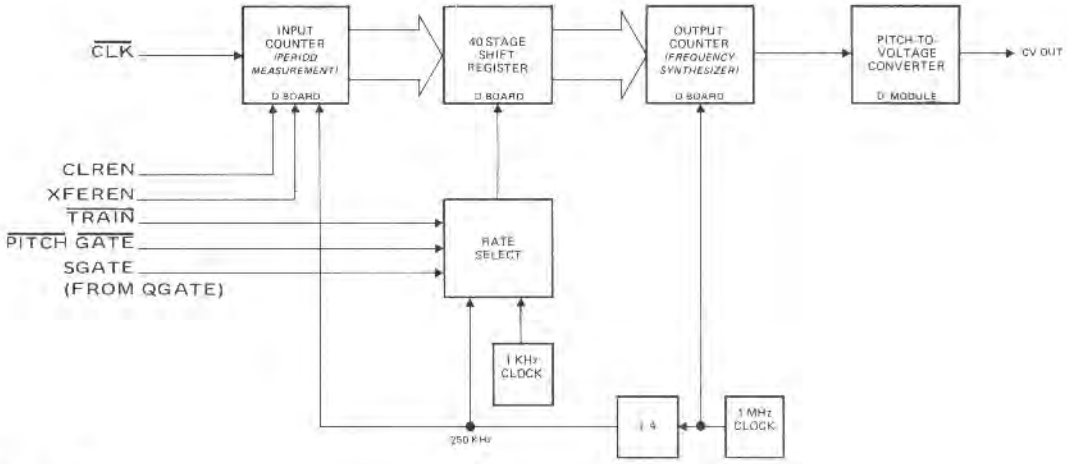
applied through C9 and R55 will momentarily turn on Q18 and Q17. Q17 then supplies +15 volts through CR18, CR19, CR17 and R57 to hold Q18 on. Q18 and Q17 (the attack latch) now supplies +15 volts through the attack slider (R85), R43, and CR9 and charges up the integrating capacitor, C8.

Q12, Q13, and Q14 buffer the voltage on C8 and provide it to the VCA and VCF. Q15 is the peak detector which monitors the output of the ADSR. When the ADSR voltage reaches its maximum, (about +10 volts), Q15 will turn on and provide this voltage to the base of Q16 through CR15. Q16 then grounds out the voltage on the base of Q18 to unlatch Q18 and Q17 and end the attack portion of the ADSR cycle.

Decay & Sustain: When the attack portion of the ADSR cycle has completed, the voltage on C8 is allowed to discharge through CR11, R47, and the decay slider (R86) to the emitter of Q11. The sustain slider (R87) sets the voltage level on the base of Q11. When the voltage level on th emitter of Q11 falls below the level on the base, Q11 turns off and prevents the voltage on Q8 from discharging further.



Release: When the gate is removed, the remaining voltage on C8 is discharged to ground through CR10, R44 and the release slider (R88).



3.4 Board D

3.4.1 HIGH FREQUENCY CLOCK

Z6, R3, R4 and C7 are the 1 MHz oscillator. Z5A and Z5B divide this frequency by four to produce a 250 KHz clock signal. The 1MHz signal is used primarily to clock the Output Counter/Frequency Synthesizer Circuit. The 250 KHz signal is used to clock the input counters and the shift registers on initial string plucks.

3.4.2 LOW FREQUENCY CLOCK

Z2, R1, R2 and C4 are the 1 KHz oscillator. Z7A and Z7B are used to synchronize 1 KHz clock with the high frequency clock. This synchronization also insures that the 1 KHz will not occur at the same time the Transfer (XFER) signal occurs. The 1 KHz signal is used to clock the shift register after initial string pluck to create a delayed pitch output.

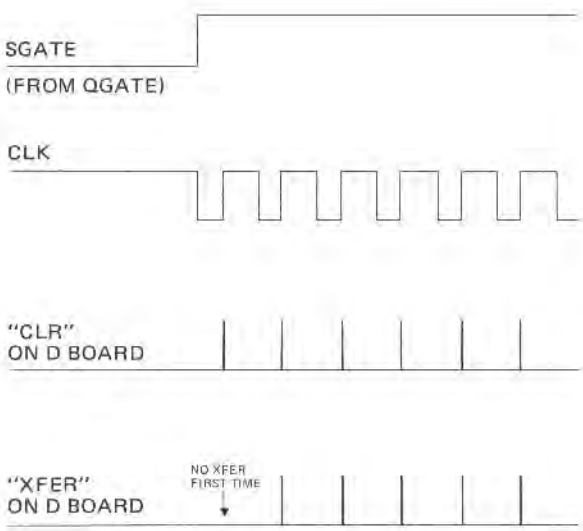
3.4.3 CONTROL LOGIC/RATE SELECT

The Rate Select Circuit controls when and at what speed the Shift Register Circuit is clocked. When both $\overline{\text{TRAIN}}$ and $\overline{\text{PITCH GATE}}$ signals are low, the 250 KHz clock signal is supplied to Z9C (on

initial string pluck). Once Q GATE goes high, Z9C passes the 250 KHz clock signal to the shift register which processes the initial string period number quickly (about 0.15 milliseconds). When either $\overline{\text{PITCH GATE}}$ or $\overline{\text{TRAIN}}$ is high, Z9C outputs a 1 KHz clock signal which slows the processing of the string period numbers to 40 milliseconds.

3.4.4 CONTROL LOGIC

Z10A and Z10B are used to synchronize the $\overline{\text{CLK}}$ signal (extracted guitar signal) with the 250 KHz clock signal. Z11 generates from the synchronized $\overline{\text{CLK}}$ signal a 1 microsecond Transfer pulse (XFER) followed by a 1 microsecond Clear pulse (CLR). These timing circuits insure that the transfer pulse always occurs within 1 microsecond (one cycle of the 1 MHz clock) after the $\overline{\text{CLK}}$ signal goes low. The Clear pulse always occurs within 2 microseconds (2 cycles of the 1 MHz clock) after the $\overline{\text{CLK}}$ signal goes low.



3.4.5 TIME INTERVAL COUNTER/ INPUT COUNTER

Z25, -26, -27 are a 12 bit binary counter. When reset to zero by the CLR pulse, the counter counts until it is transferred to the Latch Circuit and cleared for the next count. The resulting number represents the period of the $\overline{\text{CLK}}$ signal. For example, the counter is clocked at 250 KHz; therefore, a 100 Hz guitar signal would produce a binary count of 2500, or in binary, 100111000100.

3.4.6 LATCHES

Z22, -23, and -24 are the Latch. When a TRANSFER (XFER) pulse is received, the 12 bit period number is latched and held. After the transfer occurs, the counter is reset to zero by the clear pulse. The Q outputs of the latch are used to produce the binary complement of the pitch number so that the output counter will count up from it and produce the same period length. For example, for a guitar frequency of 100 Hz, the Input counter will produce the binary equivalent of 2500 (100111000100). The Latch circuit outputs the number 1595 (011000111011). The output counter counts up from this number to the maximum count of 4095 (111111111110). There are 2500 counts between 1595 and 4095, thus the output counter processes the same period count as the input counter.

3.4.7 STORAGE REGISTERS/SHIFT REGISTERS

The binary number from the Latch Circuit is clocked into the 40 stage shift register (Z19 and Z20) at a rate determined by the Rate Select Circuit. Initially, the Shift Register is clocked at 250 KHz resulting in a 0.16 millisecond delay (Q GATE high, $\overline{\text{TRAIN}}$ low, $\overline{\text{PITCH GATE}}$ low). After the initial pluck, the rate select switches to a 1 KHz clock speed which creates a 40 millisecond delay (Q GATE high, either $\overline{\text{TRAIN}}$ or $\overline{\text{PITCH GATE}}$ high). If the Q GATE is low, the shift register stops, maintaining the last output it has received when Q GATE was high.

3.4.8 OUTPUT COUNTER/ FREQUENCY SYNTHESIZER

The binary period number is loaded into the output counter (Z12, -13, -14) which then counts up from this number to the maximum binary number (111111111110) at a rate of 1 MHz. When the maximum count is reached Z16A, pin 6 goes low and the counter loads a new number from the shift registers on the next clock (111111111111).

Since the Output Counter is clocked at four times the frequency of the Input Counter (1 MHz), the pulse on the output of Z16A will be two octaves above the frequency of the extracted pulse wave (CLK). This is to insure fast frequency to voltage conversion.

3.4.9 D' MODULE

The D' Module is a Pitch to Voltage Converter. It accepts the pulse from the Output Counter/ Frequency Synthesizer Circuit via Z16BR5, the Span Trimmer, adjusts the control voltage output to exactly 1 Volt/Octave, and the Zero Trimmer (R6) adjusts the lowest pitch (open low E string) to exactly zero volts.

3.5 Board E

3.5.1 PREAMPLIFIERS

Z1B through Z6B are the string preamplifiers. The trimmers on the output of the amplifiers adjust the gain from 22 to 220. Coupling capacitors C1 through C6 rolloff frequencies below the lowest note of each string for hum reduction.

3.5.2 FUZZ CIRCUITS & FUZZ PREAMP SELECT SWITCH CIRCUIT

Z1A through Z6A are the Fuzz Circuits. They have a gain of about 20, a rolloff above approximately 2 KHz, and are soft clipped at +0.7 volts by the feedback diodes. Z7 and Z8 select either the preamplifier signals or fuzz signals which are routed to the Hex Mixer, Left Output Mixer, and the Right Output Mixer Circuits.

3.5.3 STRING SELECT LOGIC

Z15 is a priority encoder which produces a three bit binary code for the last pulse it has received from the Trigger Detector Circuit. When a pulse appears on any of the inputs of Z15, pin 14 fires Z17A which generates a TRIG pulse. R123 creates a small delay to make sure the outputs of Z15 have settled. The TRIG pulse then latches the latest three bit string code into Z16B, Z17A and Z17B. This code is supplied to the Audio Multiplex Circuit so that it will pass the appropriate guitar string signal from the preamplifier to the pitch extractor module (E'). The code is also sent to the E' module and to the Ramp Generator Circuit.

3.5.4 AUDIO MULTIPLEX CIRCUIT

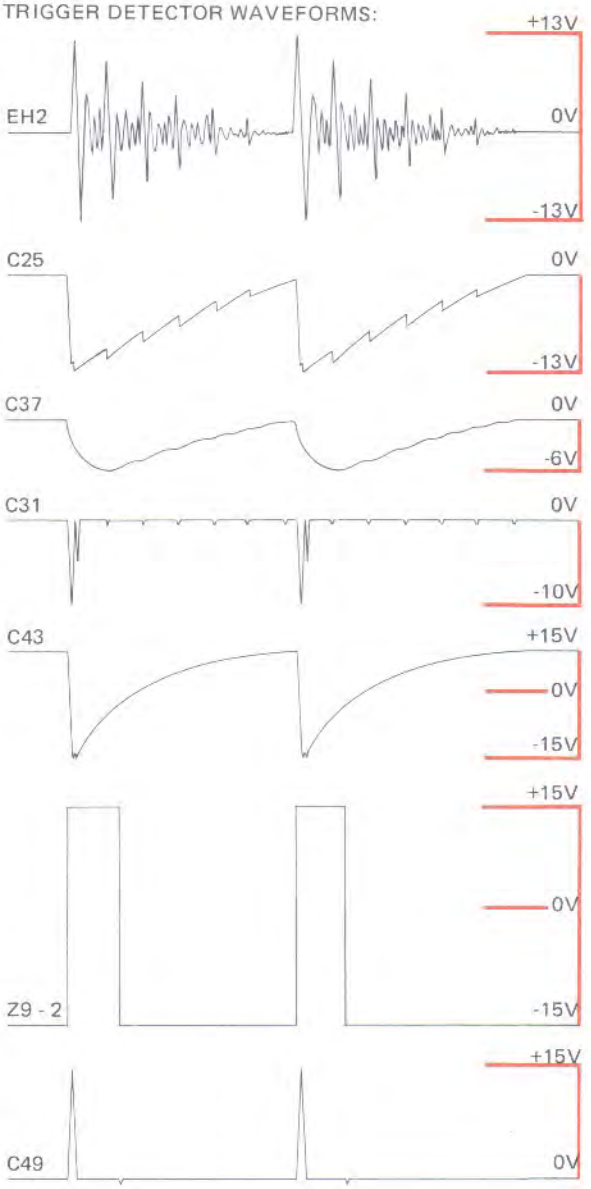
Z18 is an eight channel audio multiplexer. The audio inputs (pins 5, 1, 12, 15, 14 and 13) are switched to the output (pin 3) according to the three bit string code on pins 9, 10, and 11:

D2	D1	D0	
0	0	0	LOW E STRING
0	0	1	A STRING
0	1	0	D STRING
0	1	1	G STRING
1	0	0	B STRING
1	0	1	HIGH E STRING

3.5.5 TRIGGER DETECTOR CIRCUITS

Z9 through Z14 are the trigger sensors. Looking at the high E channel, Z9C and Z9D form a peak follower. The negative going output is stored by C25. Z9D is a noninverting peak follower and Z9C is an inverting peak follower. Their outputs are 'wired-ored' together for full wave operation. R67, R79, and C37 form a low pass filter, with an attenuation of 2. R73 and C31 form a high pass filter, with DC offset (from TRIG SENSE) added. When the high pass output falls below the low pass output, Z9B will fire, discharging C43. C43 will recharge through R85. Z9A converts this voltage to a wide pulse and C49 passes the rising edge of the pulse to the String Select Logic Circuit. CR13 grounds the pulse when the enable line from the String Select Switch on the front panel is low.

TRIGGER DETECTOR WAVEFORMS:



3.5.6 E'MODULE

The E' Module accepts the guitar signal from the Audio Multiplex Circuit (MUX, pin 17) and extracts from it a pulse wave (CLK and CLK). This clock output (at the frequency of the guitar string) is sent to the D board for processing. The three bit string code from the String Select Circuit is supplied to pin 13, 14 and 15 so that the circuit can 'set up' for the open string frequency of the guitar signal it is to receive. The clock output (CLK, pin 23) is also sent to the Limit Detector Circuit to generate Transfer (XFER) and Clear (CLR) signals. The level signal from the E' Module goes high to confirm that an extracted signal is appearing on the clock output.

The CV input (pin 6) comes from the output of the D' Module and is used to adjust the E' circuit to the pitch which is being extracted. After an initial pluck, the TRAIN signal (pins 10, 12) causes the E' Module to ignore temporarily the CV input until a new pitch has been extracted and processed through the D board.

The Q GATE inputs (pins 20 and 19) instruct the E' Module to begin extraction.

3.5.7 RECTIFIER/FILTER

The signal from the Audio Multiplex Circuit (MUX) is sent to the Rectifier/Filter Circuit which is a precision full wave rectifier. C76 partially averages the output and Q3 discharges upon each TRIG pulse so that the rectified average starts from zerio on a new string pluck.

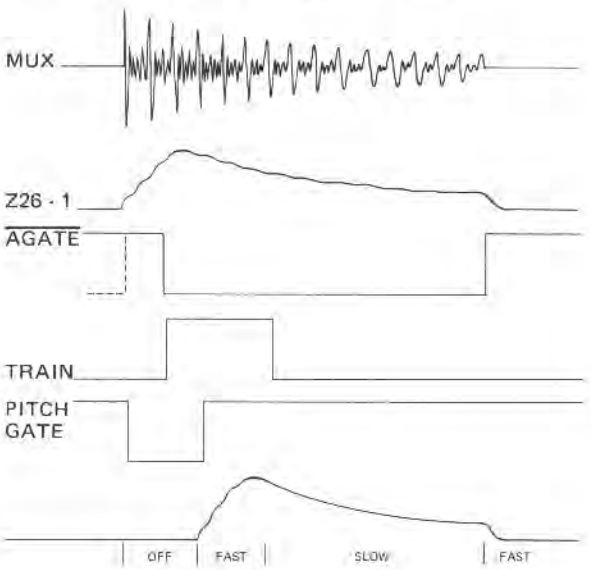
3.5.8 GATE DETECTOR CIRCUIT

The purpose of the Gate Detector Circuit is to make the gating sequence dependent upon a signal with good energy; hence, making the gating insensitive to accidental striking of the guitar string with a pick.

When the output of the Rectifier/Filter Circuit exceeds the threshold established by R205 (about .5 volts on Z27 pin 9, when $\overline{\text{A GATE}}$ is high), Z27C will go low ($\overline{\text{A GATE}}$ output). This starts the gating sequence. The threshold is set by R205 so the $\overline{\text{A GATE}}$ goes low after the second cycle of a moderate level input. Final adjustment should be done with a guitar since this adjustment is to a degree a matter of preference.

3.5.9 ENVELOPE FOLLOWER

Z24 and Z25 take the rectified signal from the Rectifier/Filter Circuit and smooth it out to yield an envelope suitable for VCO or VCF modulation. Z24 controls the time constant for a fast attack and smooth decay. On initial pluck, C73 charges quickly since the TRAIN signal switches in R182 via Z24B. After a pluck, C73 follows the signal more slowly through R183. When the note dies out, A GATE turns on Z24B to discharge C73 quickly.



3.5.10 GATE LOGIC

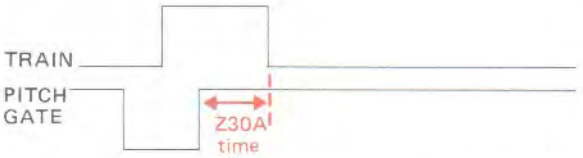
The Gate Detector Circuit starts the gating sequence. When new notes are plucked, the Gate Logic circuitry is reset by the TRIG signal.

First, $\overline{\text{A GATE}}$ clocks Z30A to produce a TRAIN and $\overline{\text{TRAIN}}$ signal which is used to set up E' Module for initial new note extraction. It is also used in the Envelope Follower Circuit to create a fast rise time envelope.

Next, the TRAIN signal clocks Z37A to generate a Q GATE and $\overline{\text{Q GATE}}$ signal which is used to start the E' extraction. Once the E' has begun extraction, it sends out a LEVEL signal to the Gate Generator Circuit to hold $\overline{\text{A GATE}}$ low for the duration of pitch extraction.

Pitch Gate is generated by Z34B which confirms E' pitch Extraction. The extracted pulse wave (CLK) output from E' clocks Z33A in the Limit Detector Circuit which is in turn supplied (in pulse form) to the 'set' input of Z34B to produce the PITCH GATE and $\overline{\text{PITCH GATE}}$ signals.

As soon as the PITCH GATE signal goes high, one shot Z30A (TRAIN) is allowed to time out. Thus the time constant of the TRAIN one shot (and therefore the duration of TRAIN) is dependent upon the presence of a clock signal on the E' output (via Z33A and Z34B). The PITCH GATE is also used to enable the Envelope Follower.



Sustain Latch: The purpose of the SUSL and $\overline{\text{SUSL}}$ signals is to 'freeze' the extraction process while the sustain footswitch is held. Z30B is used as a debouncer for the footswitch: when the footswitch is depressed, Z30 pin 9 goes high which clocks Z32B (the sustain latch). Providing the D gate is high, (when TRIG and $\overline{\text{A GATE}}$ are both low) SUSL goes high and stops the following signals from changing: TRAIN (via Z30A pin 3), D GATE (via Z31 pin 5), Q GATE (via D GATE to CR24 and Z29D), and TRIG (via Z17A pin 5 in the String Select Circuit). During the time the footswitch is held, no pitch extraction takes place and new string plucks are ignored.

3.5.11 RAMP GENERATOR CIRCUIT

The purpose of the Ramp Generator Circuit is to generate a window to determine if the extracted pitch from the E' Module is within acceptable frequency limits. The extracted signal (CLK) is compared with the ramp generator signal in the Limit Detector Circuit and determines the validity of the pitch. Anything the E' Module produces which exceeds these limits is ignored by the D board.

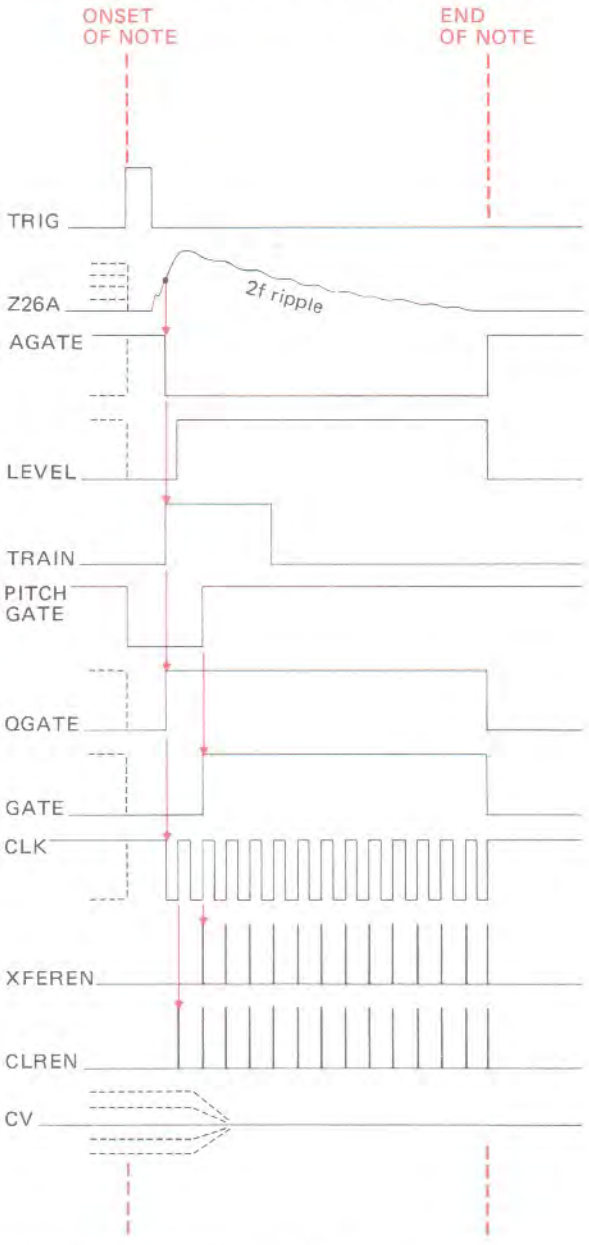
Upon an initial string pluck, the three bit string code is sent to an Audio Multiplexer (Z22) in the Ramp Generator Circuit which selects one of the resistors on pin 5, 1, 12, 15, 14, or 13. These resistor values are selected to produce a specific current (for each string) which charges C72. The Clear pulse (CLR), which is generated by Z33B, resets the Ramp Generator.

3.5.12 LIMIT DETECTOR

The Transfer Enable (XFEREN) and Clear Enable (CLREN) signals are generated by the Limit Detector Circuit. Transfer Enable transfers data from the input counters on the D board for a new number.

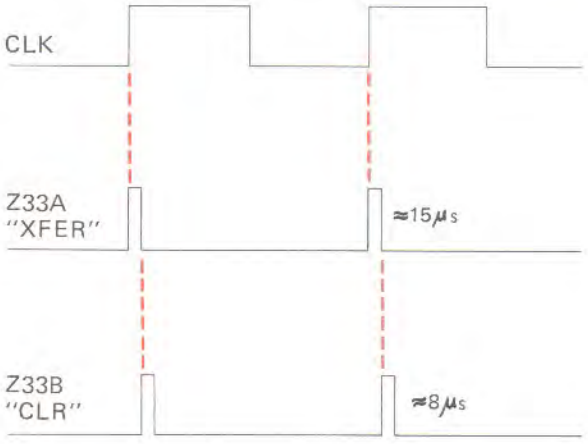
To generate these signals the ramp voltage from the Ramp Generator Circuit is compared to fixed thresholds in the Limit Detector Timing Circuit by Z27A and Z27B. Pin 1 of Z27B will be high when C27 is discharged and will go low after enough time has passed to account for one cycle of the highest note of the string being played. Until it goes high, both CLREN and XFEREN will be low, causing the D board to ignore transitions of the CLK signal. Z27A pin 2 will initially high also, and will go low after a time equal to the period of the lowest note of the string. Once it goes low, it will set XFEREN low, causing the D board to ignore the period measurement of the current CLK cycle, yet still allowing the D board to clear its counter when the next cycle starts. The thresholds of Z21A and Z21B are set so that pitch information will be passed only if it is between four semitones below the bottom of the string and two octaves and two semitones above the bottom of the string (2½ octave range). Any frequency that the E' produces outside of these limits is considered 'out-to-lunch' and accordingly is ignored.

CONTROL SIGNALS TIMING CHART



3.5.13 LIMIT DETECTOR TIMING

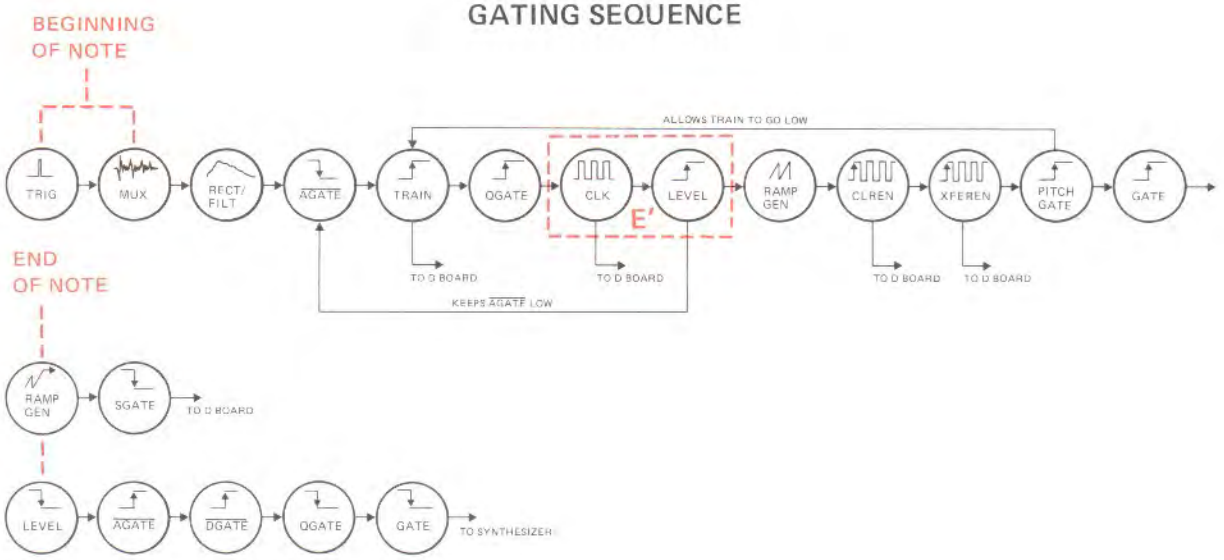
The Limit Detector Timing Circuit generates a CLR signal and a 1st XFER INHIBIT signal.



Z33A is clocked by the extracted pulse from the E' Module (CLK) and produces a pulse on the Q (pin 1) output. The $\overline{Q}$ output of Z33A clocks Z33B to produce a clear (CLR) pulse to reset the Ramp Generator.

The $\overline{CLR}$ signal from Z33B (pin 12) sets Z34A (first transfer inhibit). Until it is set, XFEREN will be low, hence disabling the first transfer of the D board since it is necessary to wait for the second clock cycle before any valid period measurement can be made. R221 and CR25 gate the 'transfer' pulse from Z33A and XFER ENABLE together causing Z34B (PITCH GATE) to be set on the second pulse.

GATING SEQUENCE



3.6 Power Supply

3.6.1 +15 VOLT SUPPLY

Z1 contains a voltage reference which supplies approximately +7 volts to pin 6 of Z1. This voltage is connected through pin 5 to the noninverting input of an op amp. The output of the op amp is connected to an emitter follower, also located in Z1, which controls the pass transistor (Q1). Should the output of the power supply change, the voltage at the junction of R11 and R12 will supply the inverting input of the op amp in Z1 with the voltage difference. The emitter follower and pass transistor (Q1) and bring the power supply's voltage to normal.

3.6.2 -15 VOLT SUPPLY

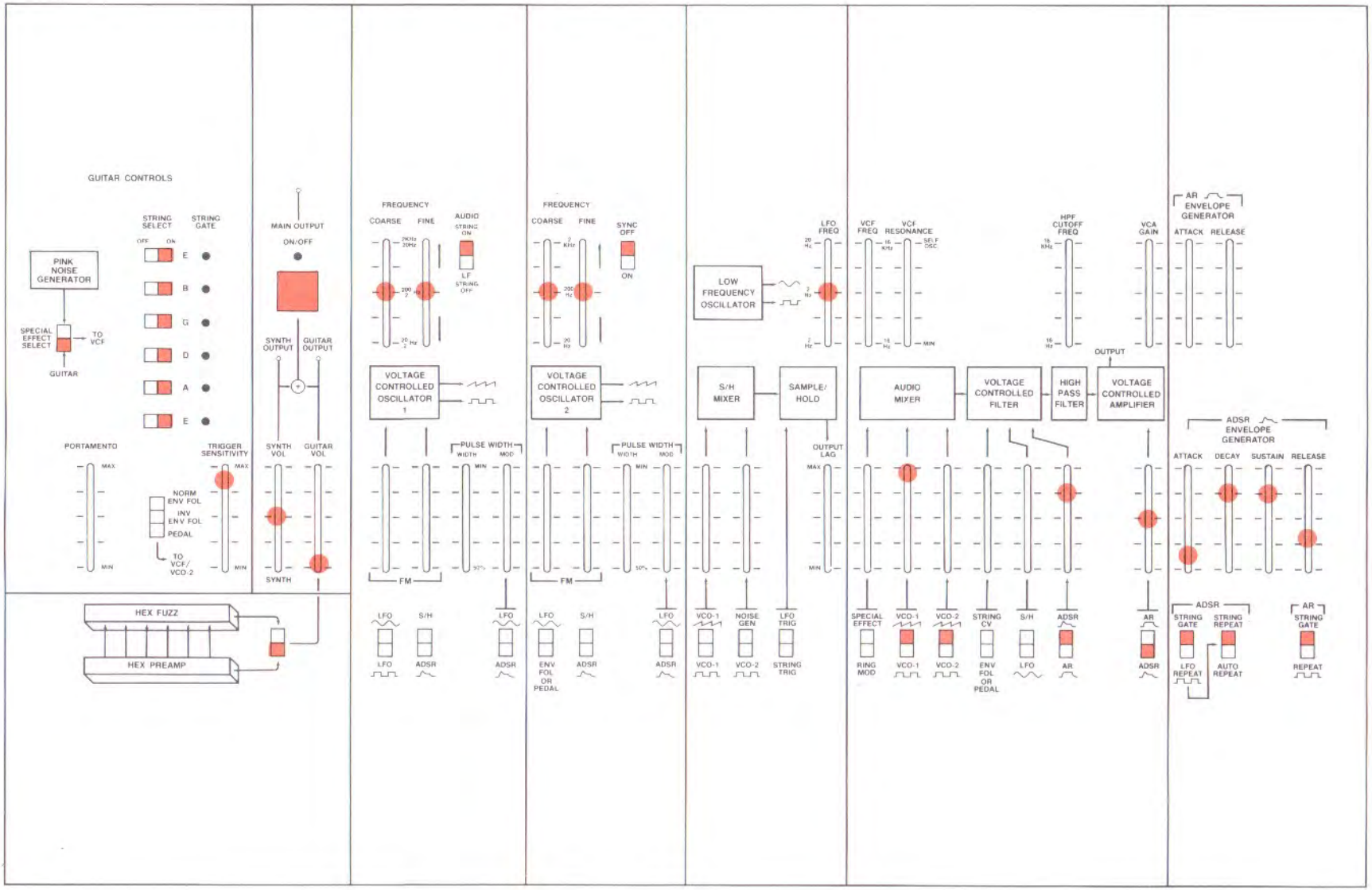
The −15 volt supply derives its regulation from the +15 volt supply through R14. When the output of the −15 volt supply is at the correct voltage, the junction of R14 and R15 is 0 volts. Z2 is referenced to 0 volts through R2. Should the output of the minus supply increase, the voltage on pin 2 of Z2 also increases. Z2 then forces Q2 to supply more current, thereby lowering the output to −15 volts.

3.6.3 SHORT CIRCUIT PROTECTION

R7 and the transistor in Z1 connected to pins 2 and 3 limit the +15 supply's current to a maximum of 800 milliamps. Q3 and R5 limit the −15 supply's current to a maximum of 1000 milliamps.

3.6.4 SPACE CONSIDERATIONS

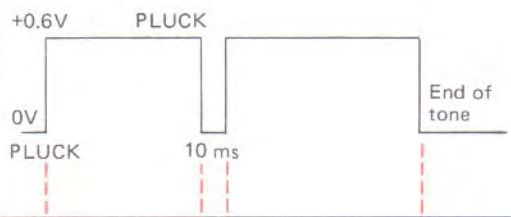
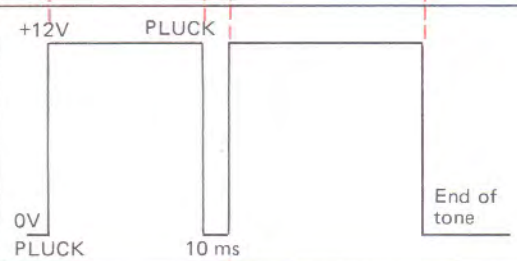
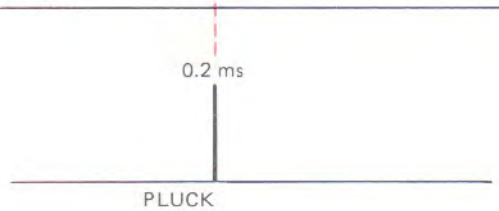
This section is not totally relevant to the Power Supply, but is inserted here for the purpose of increasing the length of the Power Supply Circuit Description, which was too short without it.



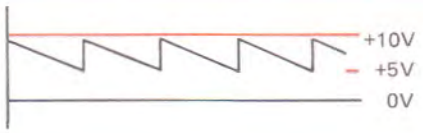
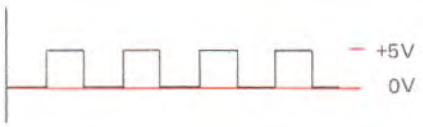
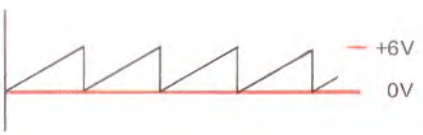
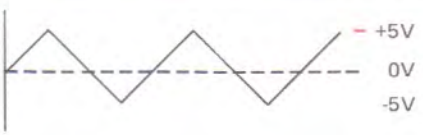
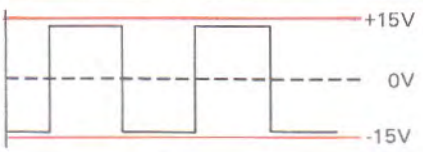
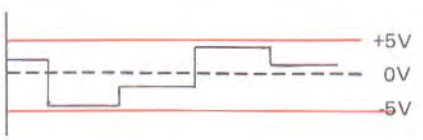
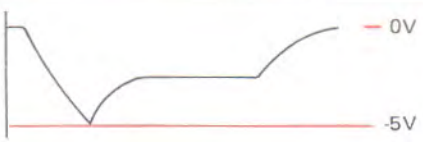
TEST PATCH SET - UP

Sliders and switches not illustrated should be all the way down.

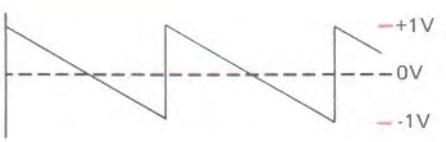
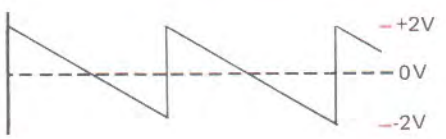
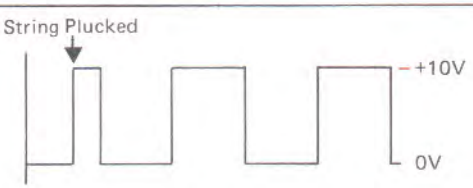
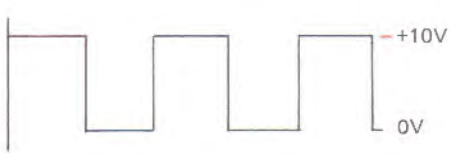
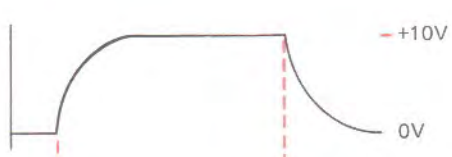
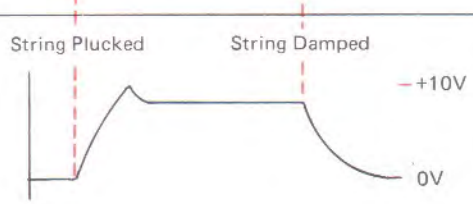
4.1 Board A

REF.	FUNCTION	SET - UP	SPECIFICATION
J5A-5	NOISE GENERATOR OUTPUT		12V - 20V p-p (typical)
J4A-2	GATE INPUT	1. Pluck a string.	
J5A-3	GATE OUTPUT	1. Pluck a string.	
J5A-4	TRIGGER OUTPUT	1. Pluck a string.	
J1A-2	TRIGGER SENSITIVITY OUT	1. Trigger sensitivity maximum. → 10mV (typical) 2. Trigger sensitivity minimum. → 14V (typical)	
J3A-6	FILTER CONTROL VOLTAGE	1. Plug filter pedal in. 2. Put Envelope Follower Select Switch in PEDAL position. 3. Fully depress pedal. → 11.5V (typical) 4. Put pedal at minimum. → 0V (typical)	
Z11A pin 1 (Q output)	SYSTEM ON/OFF VOLTAGE	1. Depress the system ON/OFF Button.	+15V = ON 0V = OFF

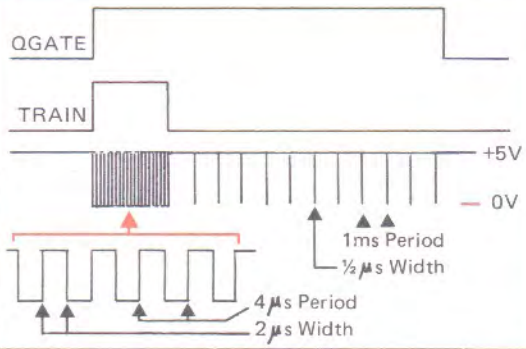
4.2 Board B

REF.	FUNCTION	SET - UP	SPECIFICATION
TP-1	SAWTOOTH (VCO 1 & 2)	1. Initial Frequency sliders midposition. 2. All other sliders down.	
TP-2	SAWTOOTH (VCO 1 & 2)	1. Initial Frequency sliders midposition. 2. All other sliders down.	
TP-3	RESET PULSE (VCO 1 & 2)	1. Initial Frequency sliders midposition.	
TP-4	SAWTOOTH TO PULSE (VCO 1 & 2)	1. Initial Frequency sliders midposition. 2. All other sliders down.	
TP-5	SQUARE WAVE OUTPUT (VCO 1 & 2)	1. Initial Frequncy sliders midposition.	
TP-6	SAWTOOTH OUTPUT (VCO 1 & 2)	1. Initial Frequency sliders midposition. 2. All other sliders down.	
TP -7	LFO TRIANGLE OUTPUT	1. LFO Frequency slider up.	
TP -8	LFO SQUARE WAVE OUTPUT	1. LFO Frequency slider up.	
TP-9	S/H OUTPUT	1. S/H 'Noise' slider up. 2. LFO/KYBD slider switch:up (LFO) 3. LFO Frequency slider up.	
TP-10	ADSR INVERTER	1. Put all ADSR sliders at ½. 2. Pluck any string. (repeat switches all up).	
TP-11	TRIGGER PROCESSOR	1. Pluck any string.	

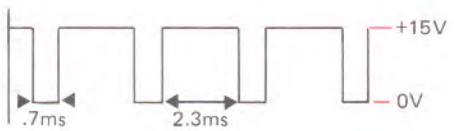
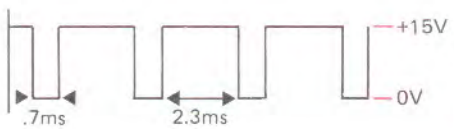
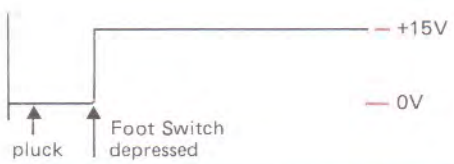
4.3 Board C

REF.	FUNCTION	SET - UP	SPECIFICATION
TP-1	CV INVERTER	1. VCF 'CV' slider: up. 2. All other sliders down. 3. Pluck the Low E string.	0 V
		4. Pin high 'C' on the keyboard	-3V
TP3	VCF OUTPUT	1. Raise the VCF 'VCO 1 sawtooth' slider. 2. Raise the Initial Filter Frequency slider. 3. Put all other sliders down.	
TP-3a	VCA OUTPUT	1. Raise the VCF 'VCO 1 sawtooth' slider. 2. Raise the Initial Filter frequency slider. 3. Raise the VCA gain slider. 4. Put all other sliders down.	
TP-4	GATE BUFFER	1. All repeat slide switches under the ADSR should be UP. 2. Depress and release a key.	
		3. Repeat switch: AUTO position (down).	
TP-5	AR OUTPUT	1. AR Attack slider: ½ 2. AR Release slider: ½ 3. Depress and release a key (all repeat switches up).	
TP-6	ADSR OUTPUT	1. ADSR Attack slider: ½ 2. ADSR Decay slider: ½ 3. ADSR Sustain slider: ½ 4. ADSR Release slider: ½ 5. Depress and release a key (all repeat switches up).	

4.4 Board D

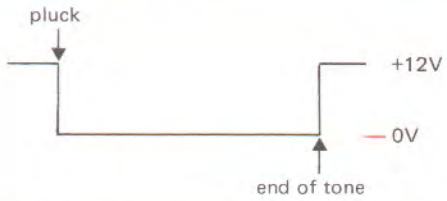
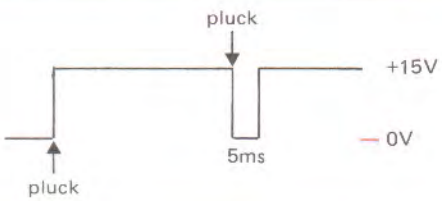
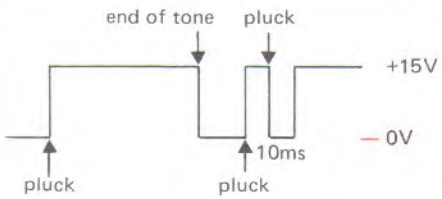
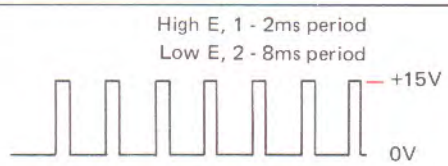
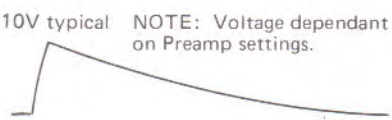
REF.	FUNCTION	SET - UP	SPECIFICATION
Z9C-8	SHIFT REGISTER CLOCK	1. Pluck a string.	
Z12A-3	XREN	1. Pluck a string.	 T low E = 12ms T high E = 3ms Pulse Width = 1µs
Z12B-6	CLR	1. Pluck a string.	 T low E = 12ms T high E = 3ms Pulse Width = 1µs
Z16B-8	OUTPUT	1. Pluck a string.	 T low E = 3ms T high E = .75ms Pulse Width = 1µs
D' Module J30-7	CV OUT	1. Pluck each string. 2. Measure voltage.	Voltage change on new string pluck. E high = 2V B = 1.6V G = 1.3V D = 0.9V A = 0.5V E low = 0V

4.5 Board E

REF.	FUNCTION	SET - UP	SPECIFICATION
J2E-1 High E J2E-2 B J2E-3 G J2E-4 D J2E-5 A J2E-6 Low E	PICKUP OUTPUTS	1. Pluck each string and monitor the corresponding test point location.	300mV, P - P typical
EH2 High E B2 B G2 G D2 D A2 A LE2 Low E	PREAMP OUTPUTS	1. Pluck each string and monitor the corresponding test point location.	500mV, P - P typical (after Preamps have been adjusted)
J1E-13	FUZZ/PREAMP SELECT	1. Turn Fuzz/Preamp Select On and Off.	Preamp selected = 0V Fuzz selected = +15V
Guitar Output Jack, Left Output Jack, Right Output Jack	HEX MIX OUTPUT, LEFT & RIGHT OUTPUT	1. Strum all 6 strings.	1.5V, P - P typical (after Preamps have been adjusted)
J4-5	CLREN	1. Pluck high E string open.	
J4-4	XFEREN	1. Pluck high E string open.	
Z17A-1	TRIGGER	1. Pluck a string.	
Z32B-13	SUSL	1. Plug foot switch into Sustain. 2. Pluck string and depress foot switch.	
E' module pin 13 E' module pin 14 E' module pin 15	D0 D1 D2	1. Pluck each string. 2. Check against truth table.	

	E high	B	G	D	A	E low
D0	+15	0	+15	0	+15	0
D1	0	0	+15	+15	0	0
D2	+15	+15	0	0	0	0

4.5 Board E (continued)

REF.	FUNCTION	SET - UP	SPECIFICATION
Z27C-14	$\overline{\text{A GATE}}$	1. Pluck a string.	
E' module pin 17	MUX	1. Pluck each string.	3V 3V, P - P typical
E' module pin 19	Q GATE	1. Pluck a string. 2. Pluck a second string.	
Z34B-13	$\overline{\text{PITCH GATE}}$	1. Pluck a string.	
E' module pin 22	LEVEL	1. Pluck a string.	
E' module pin 10	TRAIN	1. Pluck a string.	
E' module pin 23	CLK	1. Pluck a string.	
J1E-14	ENVELOPE FOLLOWER	1. Pluck each string.	

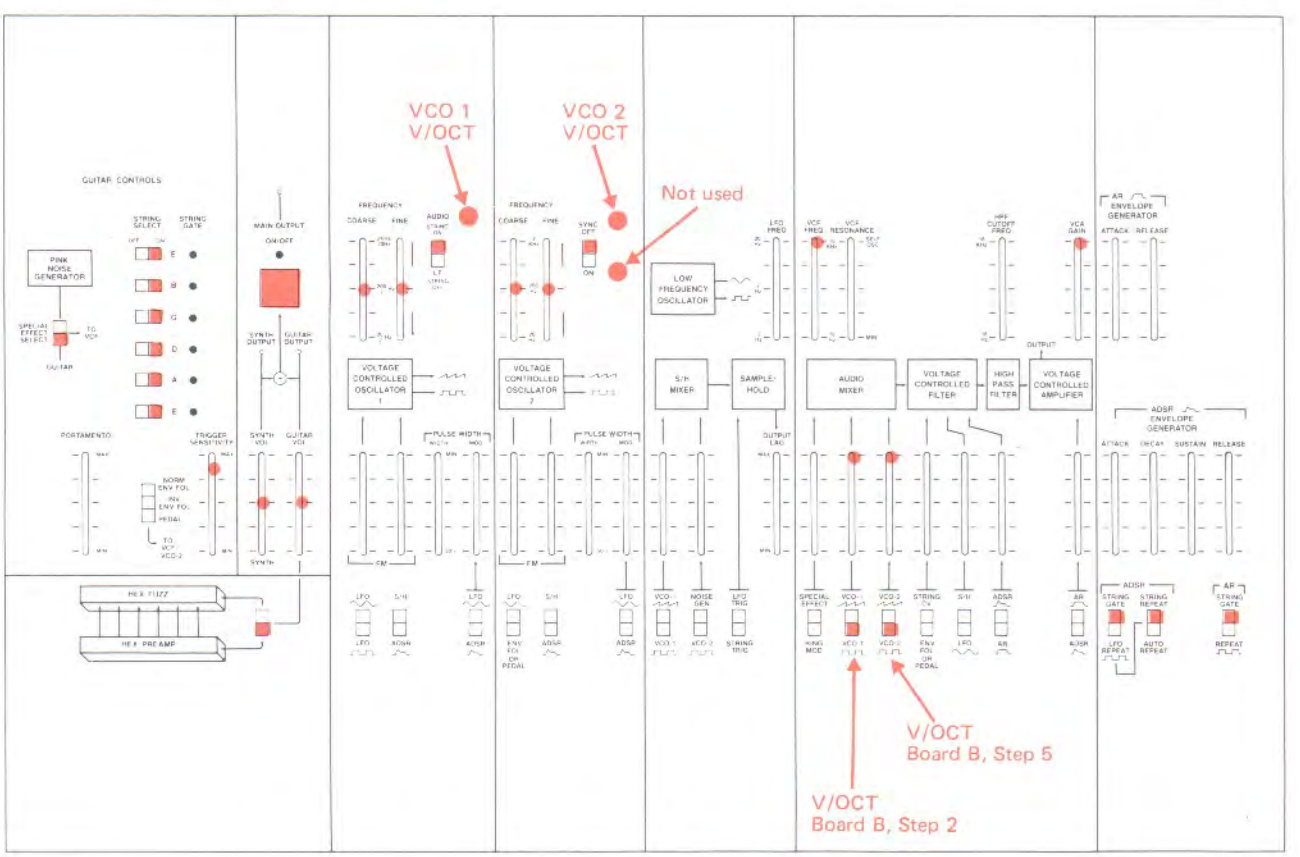
SECTION 5 TRIM PROCEDURES

5.1 Power Supply (NOTE: These trims should always be executed first.)

REF.	TRIMMER	TRIM PROCEDURE
R19	+15 VOLT SET	1. Monitor the Power Supply's +15 volt output with a digital voltmeter. 2. Adjust R19 for exactly +15.00 volts.
R20	-15 VOLT SET	1. Set R5 (+15 volts) first. 2. Put the digital voltmeter's ground lead on the Power Supply's -15 volt output and put the meter's plus lead on the Power Supply's ground output. 3. Adjust R20 exactly +15.00 volts (reversed polarity).

5.2 Board B

R141, R80	VCO 1 & 2 50% PULSE WIDTH	1. Pluck the low E string. 2. Monitor TP-5 (square wave output) with an oscilloscope. 3. Adjust the VCO 1 (or VCO 2) Coarse Frequency Slider to display exactly 1 complete cycle. 4. Adjust the 50% PULSE WIDTH trimmer until waveform duty cycle is exactly square (50%).
R118, R42	VCO 1 & 2 CALIBRATE	1. Monitor TP-5 in VCO 1 (or VCO 2) with an oscilloscope or a frequency counter. 2. Put the VCO 1 (or VCO 2) Coarse Frequency Slider DOWN fully. 3. Put the VCO 1 (or VCO 2) Fine Tune Slider exactly in the MIDDLE. 4. Pluck the low E string. 5. Adjust the VCO CAL trimmer for a 50 msec. period, or 20 Hz.
R44, R104	VCO 1 & 2 V/OCT	1. Set all panel controls as illustrated below. 2. Raise VCO 1 (square wave) to audio mixer. 3. Pluck the low E string and adjust the VCO 1 Coarse and Fine Tune Sliders until VCO 1 and the guitar signal are tuned together exactly. 4. Fret the high E string about halfway up the neck and pluck it. Using the VCO 1 V/OCT trimmer, (see below) tune the VCO 1 exactly to the guitar signal. 5. Lower the VCO 1 Slider & raise the VCO 2 Slider. Repeat steps 3 & 4 with VCO 2.



5.3 Board C

REF	TRIMMER	TRIM PROCEDURE
R67	VCF BAL	1. Put the following sliders at MAXIMUM: VCA Gain, and LFO Frequency. 2. Put the ADSR 'Decay' Slider at ONE FOURTH. 3. Put all other sliders on the front panel DOWN. 4. Put the three slide switches under the ADSR Sliders DOWN. 5. Monitor the HIGH OUTPUT of the AVATAR with an oscilloscope (set to about .5 volts per division). 6. Adjust the VCF BAL trimmer on Board C for the minimum amplitude signal on the output of the AVATAR.
R71	VCF CUTOFF	1. Put the VCF Resonance Slider at MAXIMUM. 2. Put all other sliders on the front panel DOWN. 3. Monitor pin 10 of M1 with an oscilloscope or frequency counter. 4. Adjust the VCF CUTOFF trimmer for a 62.5 msec. period, or 16 Hz.
R68	VCF V/OCT	1. Put the following sliders at MAXIMUM: VCF Resonance, VCA Gain, and VCF String CV. 2. Put all other sliders on the front panel DOWN. 3. Pluck low E on the guitar. 4. Monitor the HIGH OUTPUT of the AVATAR with a frequency counter. 5. Adjust the VCF Frequency Slider for 100 Hz. 6. Pluck high E on the guitar. 7. Adjust the VCF V/OCT trimmer on Board C for 400 Hz. 8. Repeat Steps 3 and 7 until the frequency of the VCF is correct on low E and high E.
R69	VCA GAIN	1. Put the following sliders at MAXIMUM: VCO 1 'Square Wave' to the Audio Mixer, VCF Frequency, and VCA Gain. 2. Put all other sliders on the front panel DOWN. 3. Monitor the HIGH OUTPUT of the AVATAR with an oscilloscope. 4. Adjust the VCA GAIN trimmer on Board C so that the amplitude of the waveform on the main output of the AVATAR is 2 volts peak to peak (high level).
R70	VCA CVR	1. Put the following sliders at MAXIMUM: VCA, ADSR, and LFO Frequency. 2. Put the ADSR 'Decay' Slider at ONE FOURTH. 3. Put all other sliders on the front panel DOWN. 4. Put the three slide switches under the ADSR Sliders DOWN. 5. Monitor the HIGH OUTPUT of the AVATAR with an oscilloscope (set to about .5 volts per division). 6. Adjust the VCA CVR trimmer on Board C for the minimum amplitude signal on the main output of the AVATAR (high level).

5.4 Board D

R6	ZERO SET	1. Pluck the low E string on the guitar. 2. Monitor the CV Output Jack of the AVATAR. 3. Adjust R6 for 0.0 volts + .01 volt.
R5	SPAN TRIM (V/OCT)	1. Pluck the low E string of the AVATAR. 2. With a DVM, monitor and record the voltage on the CV Output of the AVATAR. 3. Tune high and low E strings exactly together. Using R5, adjust the CV Ouput for exactly 2.0 volts higher than the voltage measured in Step 2.

5.5 Board E

REF	TRIMMER	TRIM PROCEDURE
R176	'T' TRIMMER	1. Tune the guitar to a standard (A440) pitch reference. 2. Using the chart on Page 15, set up the instrument panel for the test patch. 3. Detune the high string two semitones (from 330 Hz to 293 Hz). 4. Adjust the 'T' TRIMMER so that the pitch from the synthesizer begins to breakup when the high E string is plucked. 5. Turn the trimmer back so that the pitch just ceases to break up and so that the pitch just acquires reliably. Note: If this trimmer is set too low, high fretted notes on the guitar may not acquire as well. This trimmer adjusts the pitch range for the strings.
R105	GS TRIMMER	1. Using the chart on Page 15, set up the instrument panel for the test patch. 2. Pluck a string lightly; adjust the GS TRIMMER so that notes trigger only on deliberate plucks. Note: This trimmer is similar to the trigger sensitivity pot and is, therefore, somewhat a matter of taste. The GS TRIMMER should be adjusted so that accidental string plucks do not trigger the synthesizer, but should not be set so that it requires a hard pluck to trigger (typical setting: 75 to 80%).

5.6 String Sensitivity Trimmers

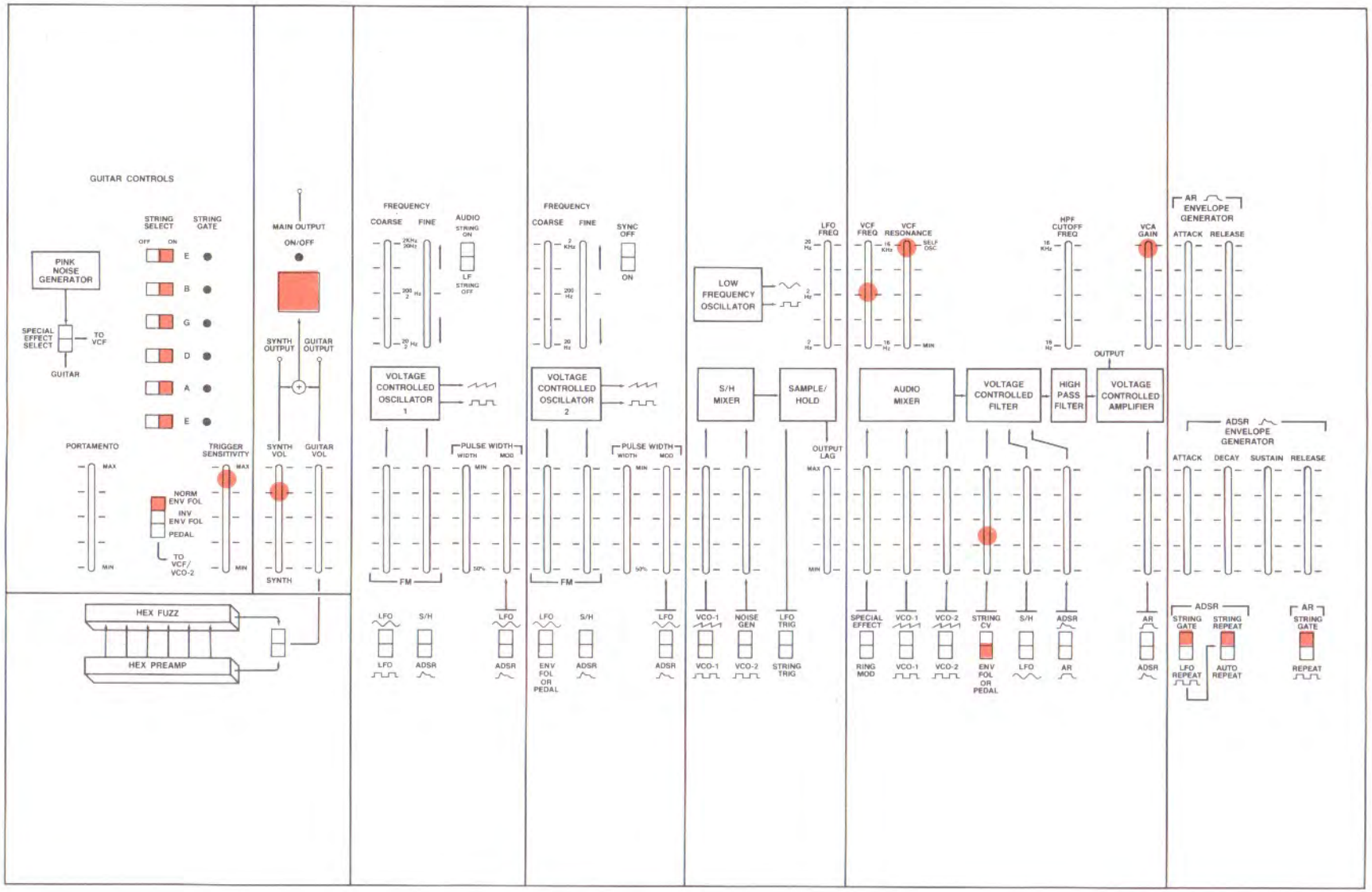
The purpose of the AVATAR STRING SENSITIVITY trimmers is to compensate for differences in pickup outputs from guitar to guitar. The output voltage of the pickup coils is dependent to some extent upon the guitar itself and the type of strings used, yet it is primarily dependent upon the distance and alignment between the pole pieces and the strings themselves. Therefore, the pickup should be mounted with great care given to pole piece alignment and the preamps must be set accordingly.

The STRING SENSITIVITY trimmer adjustments are not extremely critical. If a string's trimmer is adjusted too low, the string will feel less sensitive when played through the synthesizer, therefore, one should set the trimmer as high as possible. However, setting a trimmer too high can cause problems. First of all, the initial acquisition of each note will be unclean; that is, it will take the synthesizer longer to acquire the proper pitch. Second, the guitar output signal from the synthesizer will sound 'dirty' when a note is plucked. A better understanding of these difficulties can be attained by setting the trimmers at their extremes and attempting to play.

To find the proper settings for the trimmers, use the following procedure:

1. Plug the guitar into unit, and connect MAIN OUTPUT to a suitable amplifier.
2. Turn main power switch on.
3. Set all sliders and switches according to the front panel facsimile on the next page.
4. Using a pick, pluck the low E string on the guitar. Use a moderately firm, but not hard, pick stroke. The pitch should rise according to the force with which the string is plucked.
5. Turn the low E STRING SENSITIVITY trimmer CCW. Further plucking should cause only a slight pitch rise.
6. Turn the trimmer CW and pluck again. The pitch should rise suddenly and hold at a higher pitch for a time, before falling again. The time in which the output holds at its maximum pitch corresponds to the time in which the preamp is being overloaded.
7. On successive 'DOWN' plucks (using as consistent a stroke as possible), reduce the trimmer setting. Each reduction in sensitivity should reduce the time duration that the pitch holds at its maximum point. The proper setting will be achieved when the pitch rises to its maximum point and immediately starts to fall without holding at all.
8. Repeat the last four steps for the remaining five strings, adjusting the appropriate trimmer for each string.

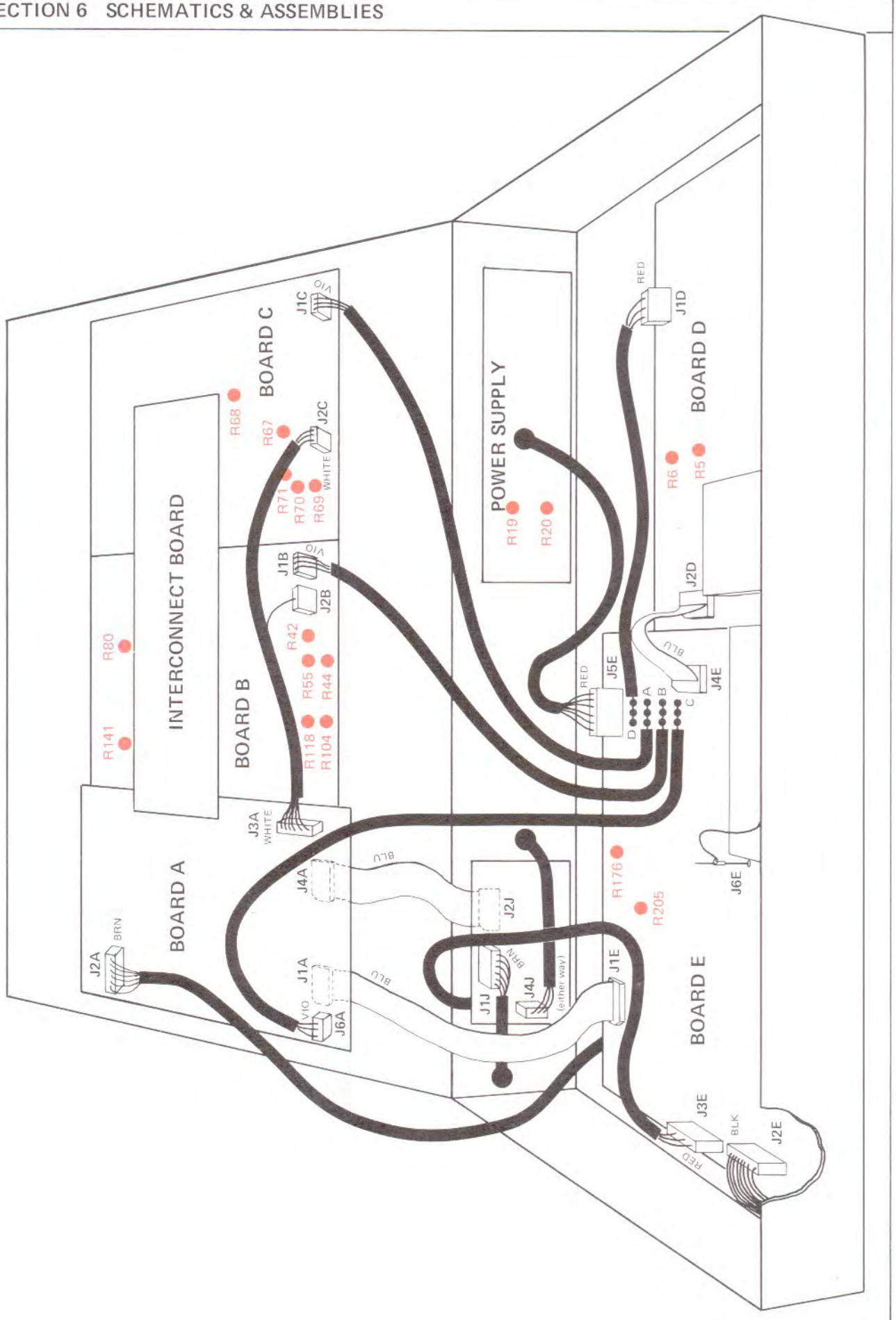
Upon completion of this procedure, the instrument should perform well. The user is encouraged to make minor adjustments as he develops a 'feel' for the instrument since the settings are somewhat a matter of taste. Some prefer the playing feel of a lower preamp setting, others will prefer the longer sustain resulting from a higher preamp setting. Experiment, and if a problem crops up, go through the preamp setup procedure again.

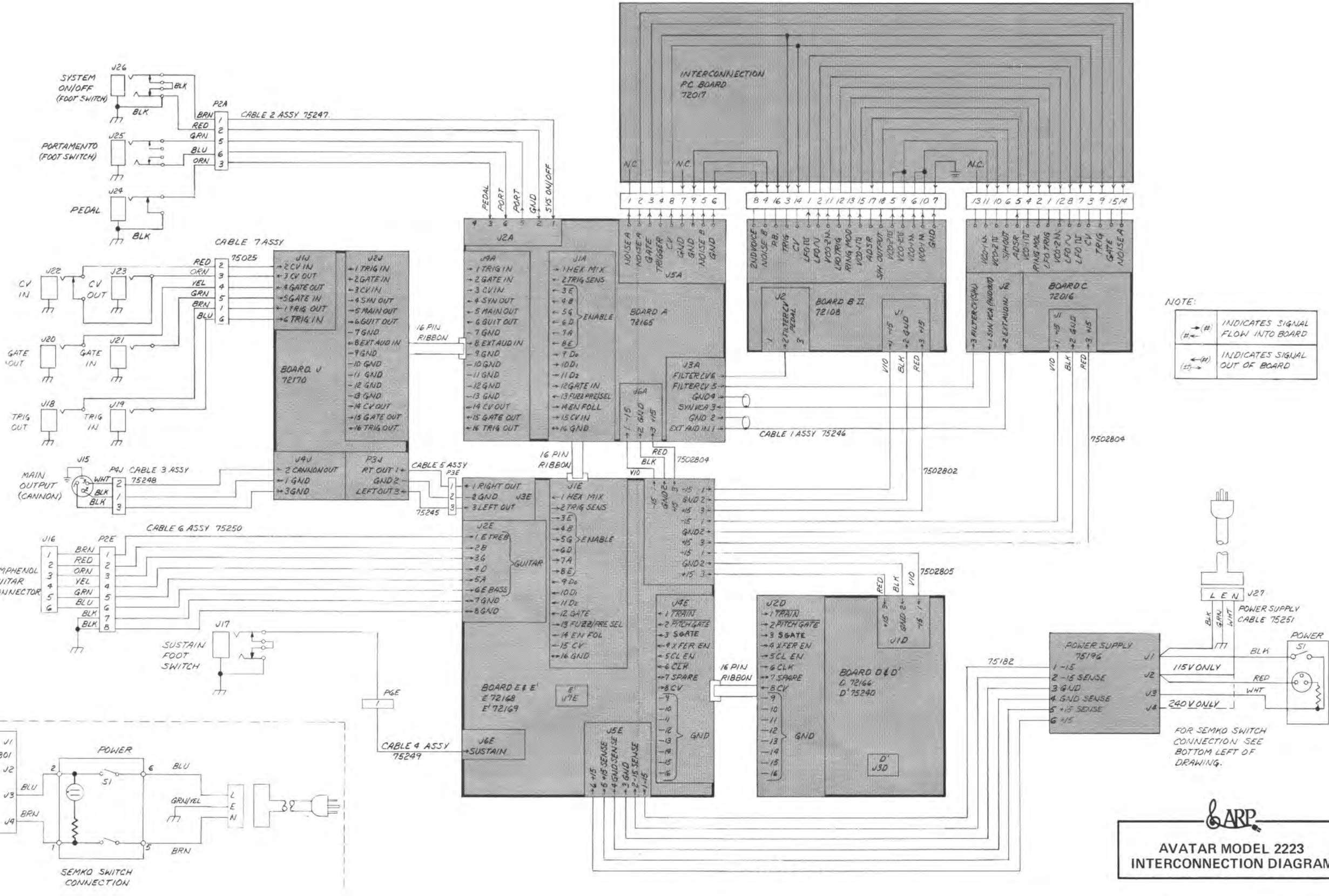


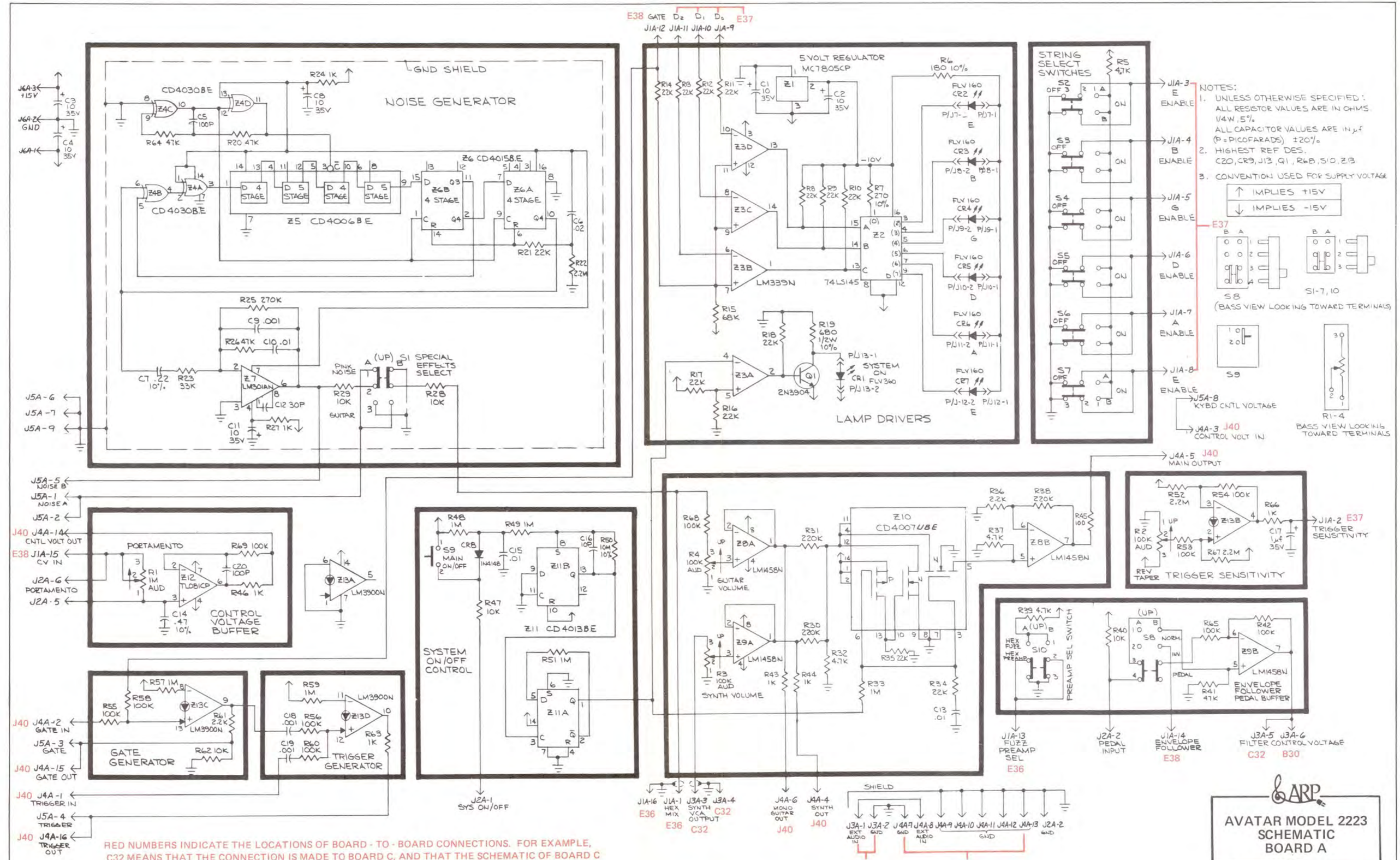
STRING SENSITIVITY TRIMMERS TEST SET - UP PATCH

ALL SLIDERS AND SWITCHES NOT ILLUSTRATED SHOULD BE ALL THE WAY DOWN.

INTERCONNECTION OVERVIEW AND TRIM POT LOCATIONS




INTERCONNECTION P.C. BOARD 72017
N.C.
N.C.
N.C.
J2A
J5A
BOARD A 72165
BOARD B II 72108
BOARD C 72016
BOARD D & D'
D 72166
D' 75240
BOARD E & E'
E 72168
E' 72169
BOARD U 72170
SYSTEM ON/OFF (FOOT SWITCH)
PORTAMENTO (FOOT SWITCH)
PEDAL
CABLE 2 ASSY 75247
PEDAL
PORT
PORT
GND
SYS ON/OFF
CABLE 7 ASSY 75025
CV IN
CV OUT
GATE OUT
GATE IN
TRIG OUT
TRIG IN
16 PIN RIBBON
CABLE 1 ASSY 75246
7502804
7502802
7502805
MAIN OUTPUT (CANNON)
P4J CABLE 3 ASSY 75248
CABLE 5 ASSY 75245
AMPHENOL GUITAR CONNECTOR
CABLE 6 ASSY 75250
SUSTAIN FOOT SWITCH
CABLE 4 ASSY 75249
POWER SUPPLY 75196
75182
POWER SUPPLY CABLE 75251
115V ONLY
240V ONLY
FOR SEMKO SWITCH CONNECTION SEE BOTTOM LEFT OF DRAWING.
SEMKO SWITCH CONNECTION
NOTE:
INDICATES SIGNAL FLOW INTO BOARD
INDICATES SIGNAL OUT OF BOARD
AVATAR MODEL 2223
INTERCONNECTION DIAGRAM

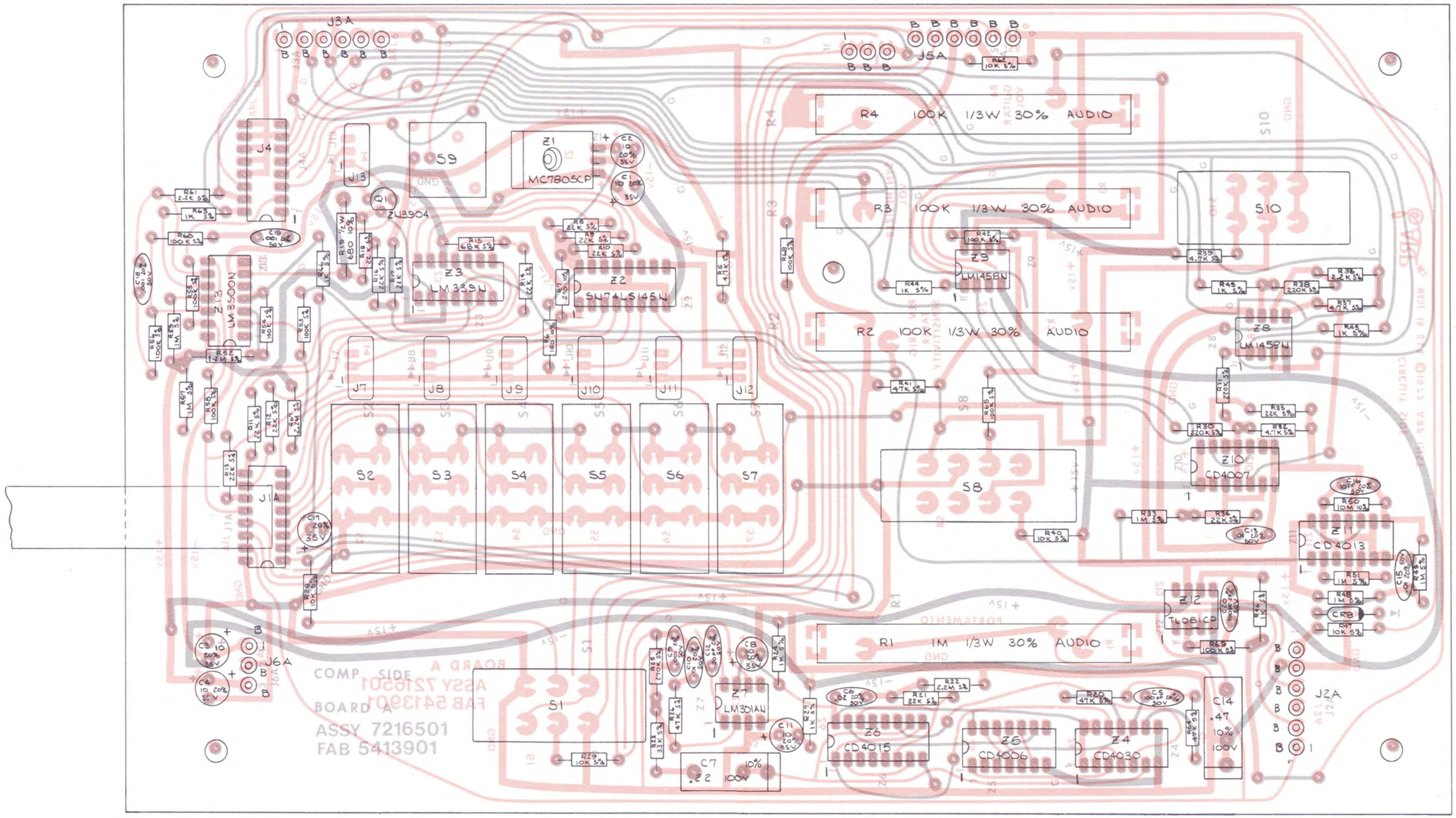


RED NUMBERS INDICATE THE LOCATIONS OF BOARD - TO - BOARD CONNECTIONS. FOR EXAMPLE, C32 MEANS THAT THE CONNECTION IS MADE TO BOARD C, AND THAT THE SCHEMATIC OF BOARD C IS FOUND ON PAGE 32.

ARP

AVATAR MODEL 2223 SCHEMATIC BOARD A

Circuit Description on Page 7

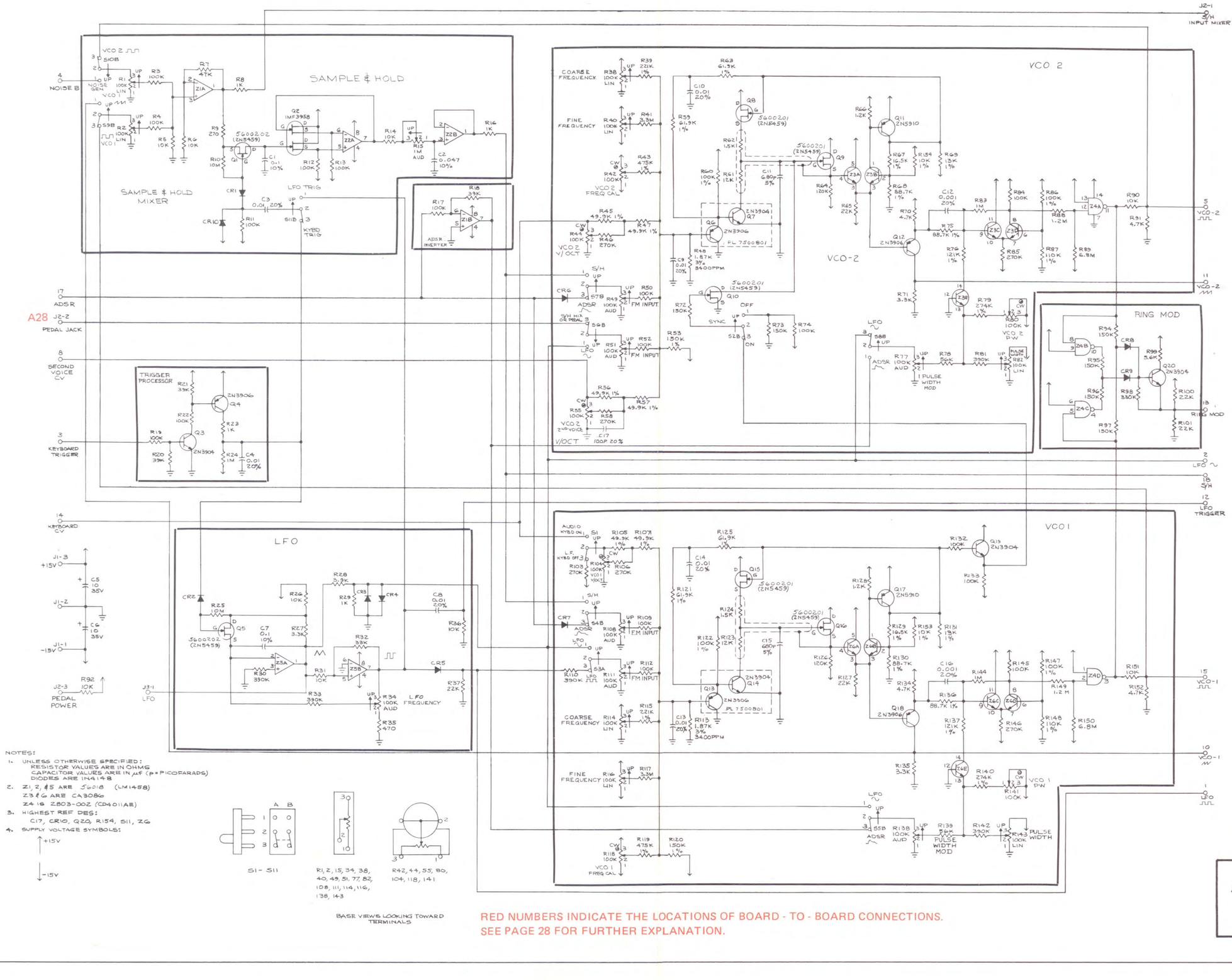


NOTES :

1. UNLESS OTHERWISE SPECIFIED,
   RESISTOR VALUES ARE IN OHMS, 1/4WATT
   CAPACITOR VALUES ARE IN µF,
   (P= PICOFARADS)

ARP

AVATAR MODEL 2223
ASSEMBLY
BOARD A



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   RESISTOR VALUES ARE IN OHMS
   CAPACITOR VALUES ARE IN µf (p = PICOFARADS)
   DIODES ARE IN4148
2. Z1, 2, 15 ARE 5601B (LM1458)
   Z3 & G ARE CA3086
   Z4 IS Z803-002 (CD4011AE)
3. HIGHEST REF DES:
   C17, CR10, Q20, R154, S11, ZG
4. SUPPLY VOLTAGE SYMBOLS:
   ↑ +15V
   ↓ -15V

S1 - S11

R1, 2, 15, 34, 38, 40, 49, 51, 77, 82, 108, 111, 114, 116, 138, 143

R42, 44, 55, 80, 104, 118, 141

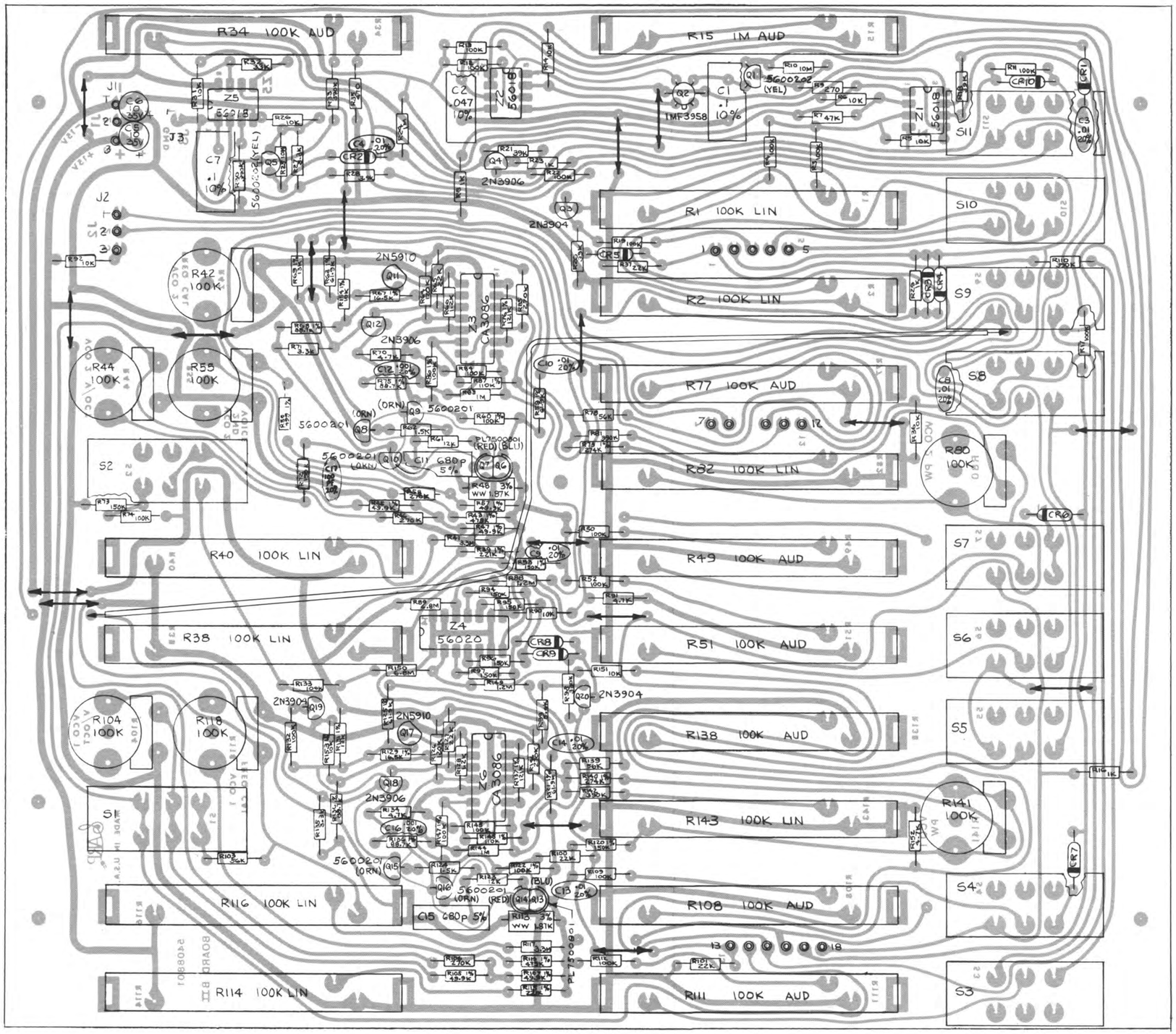
BASE VIEWS LOOKING TOWARD TERMINALS

RED NUMBERS INDICATE THE LOCATIONS OF BOARD - TO - BOARD CONNECTIONS.
SEE PAGE 28 FOR FURTHER EXPLANATION.

ARP

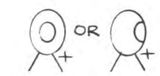
AVATAR MODEL 2223
SCHEMATIC
BOARD B

Circuit Description on Page 7



NOTES:

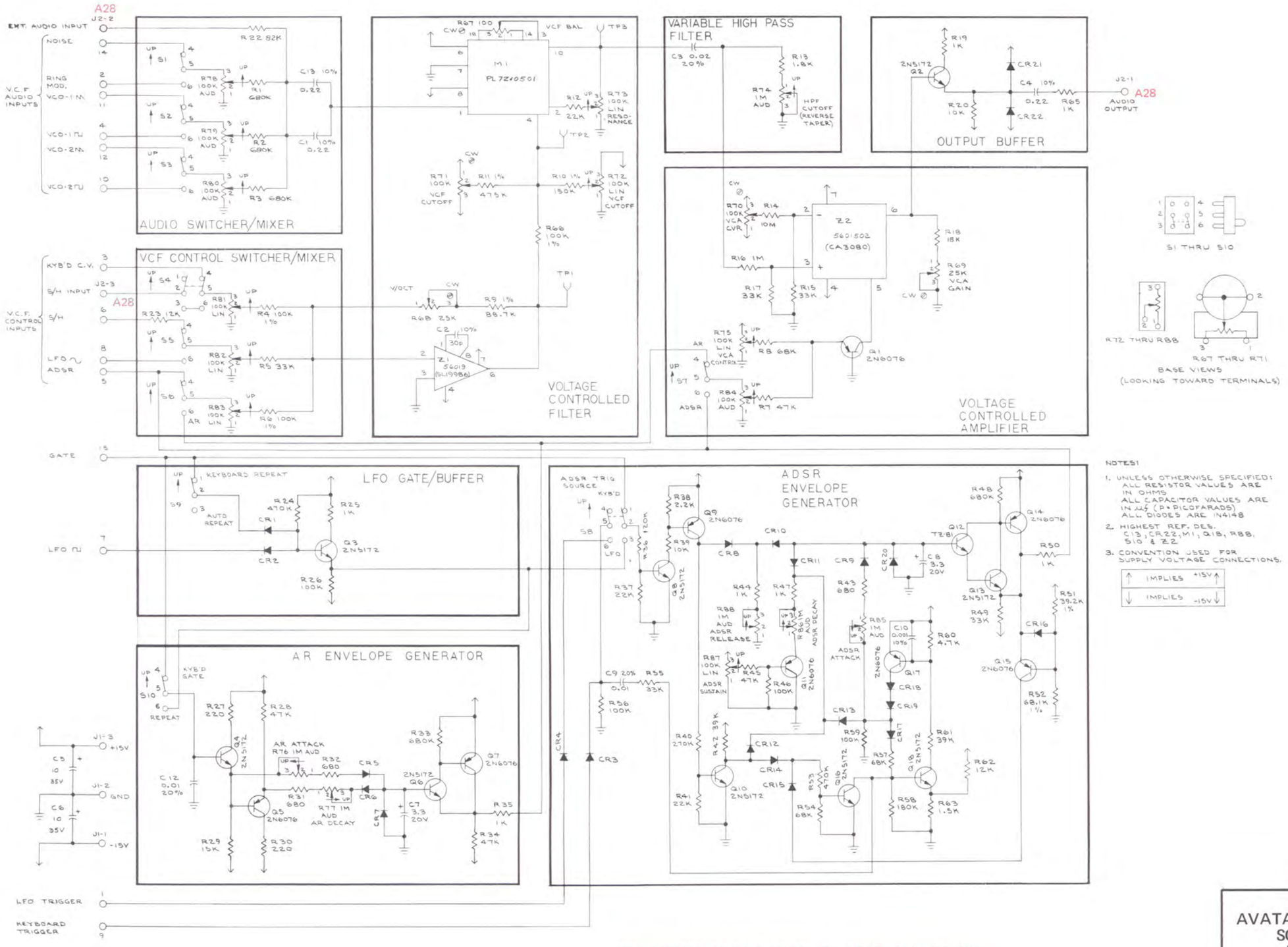
1. UNLESS OTHERWISE SPECIFIED:
   RESISTOR VALUES ARE IN OHMS
   CAPACITOR VALUES ARE IN μf (p = PICOFARADS)
   DIODES ARE IN4148



POLARITY OF C5, 6

ARP

AVATAR MODEL 2223
ASSEMBLY
BOARD B

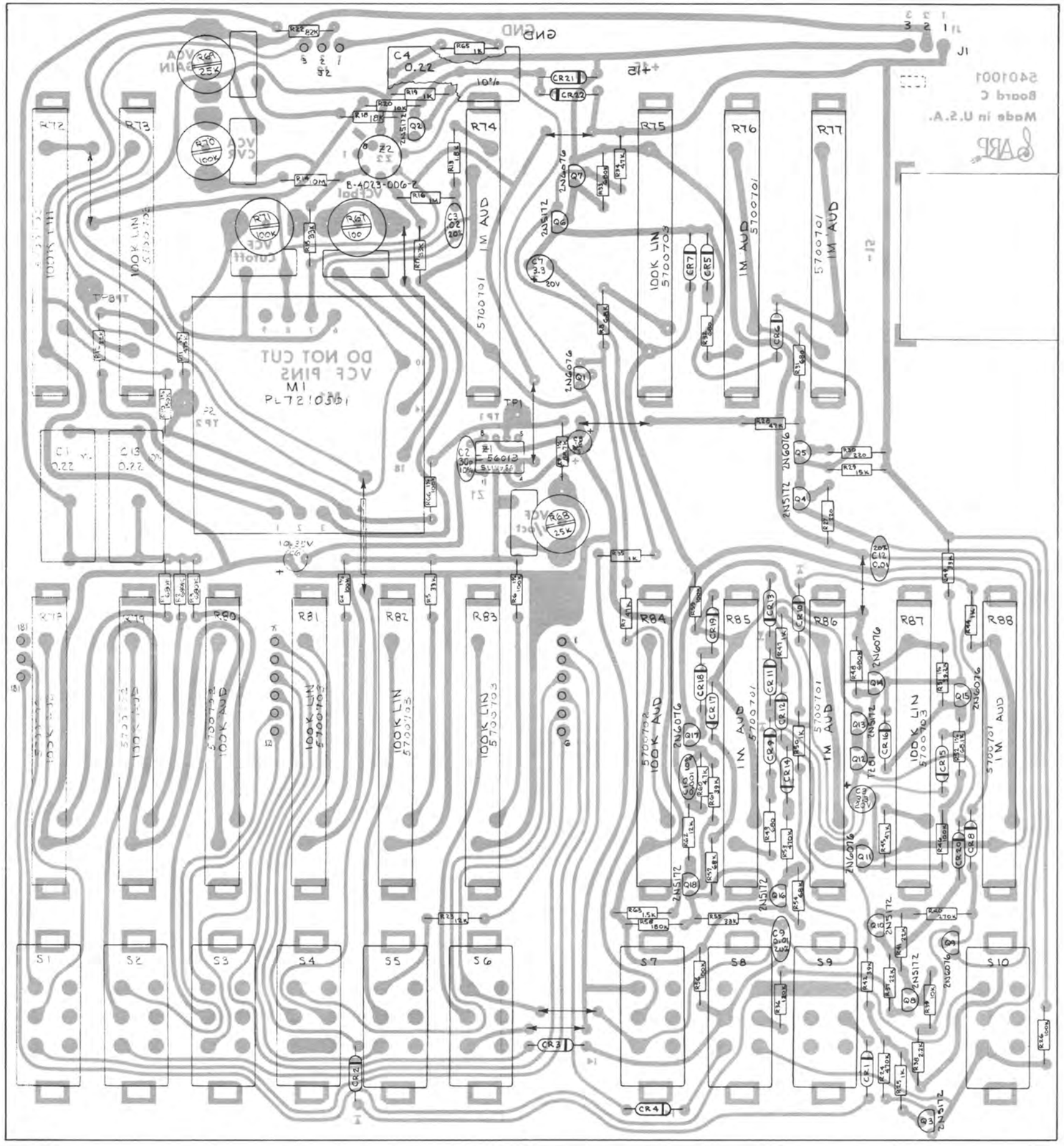


RED NUMBERS INDICATE BOARD - TO - BOARD CONNECTIONS.
SEE PAGE 28 FOR FURTHER EXPLANATION.

ARP

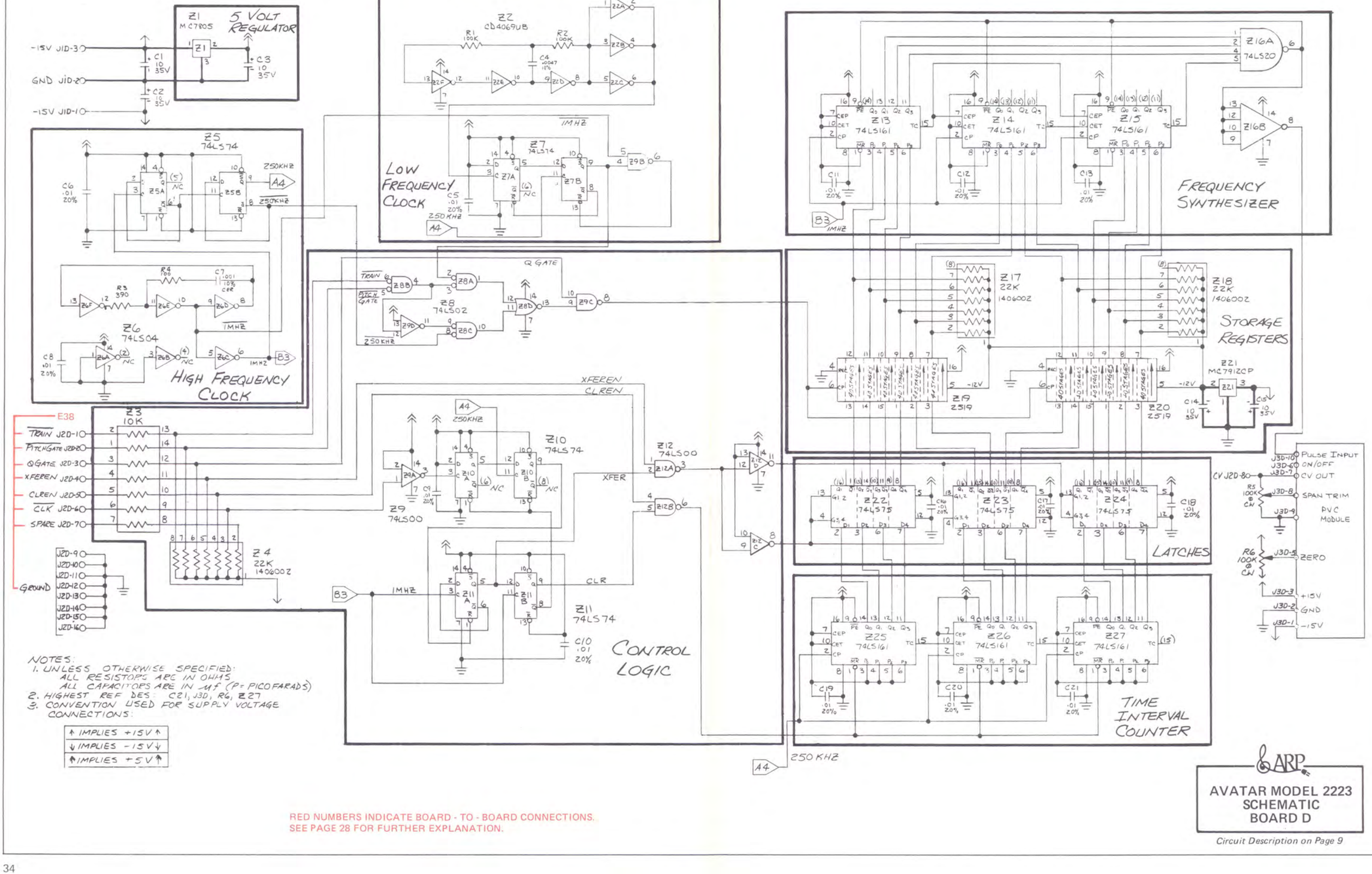
AVATAR MODEL 2223 SCHEMATIC BOARD C

Circuit Description on Page 8



ARP

AVATAR MODEL 2223
ASSEMBLY
BOARD C



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS
   ALL CAPACITORS ARE IN μf (P= PICOFARADS)
2. HIGHEST REF DES: C21, J3D, R6, Z27
3. CONVENTION USED FOR SUPPLY VOLTAGE CONNECTIONS:

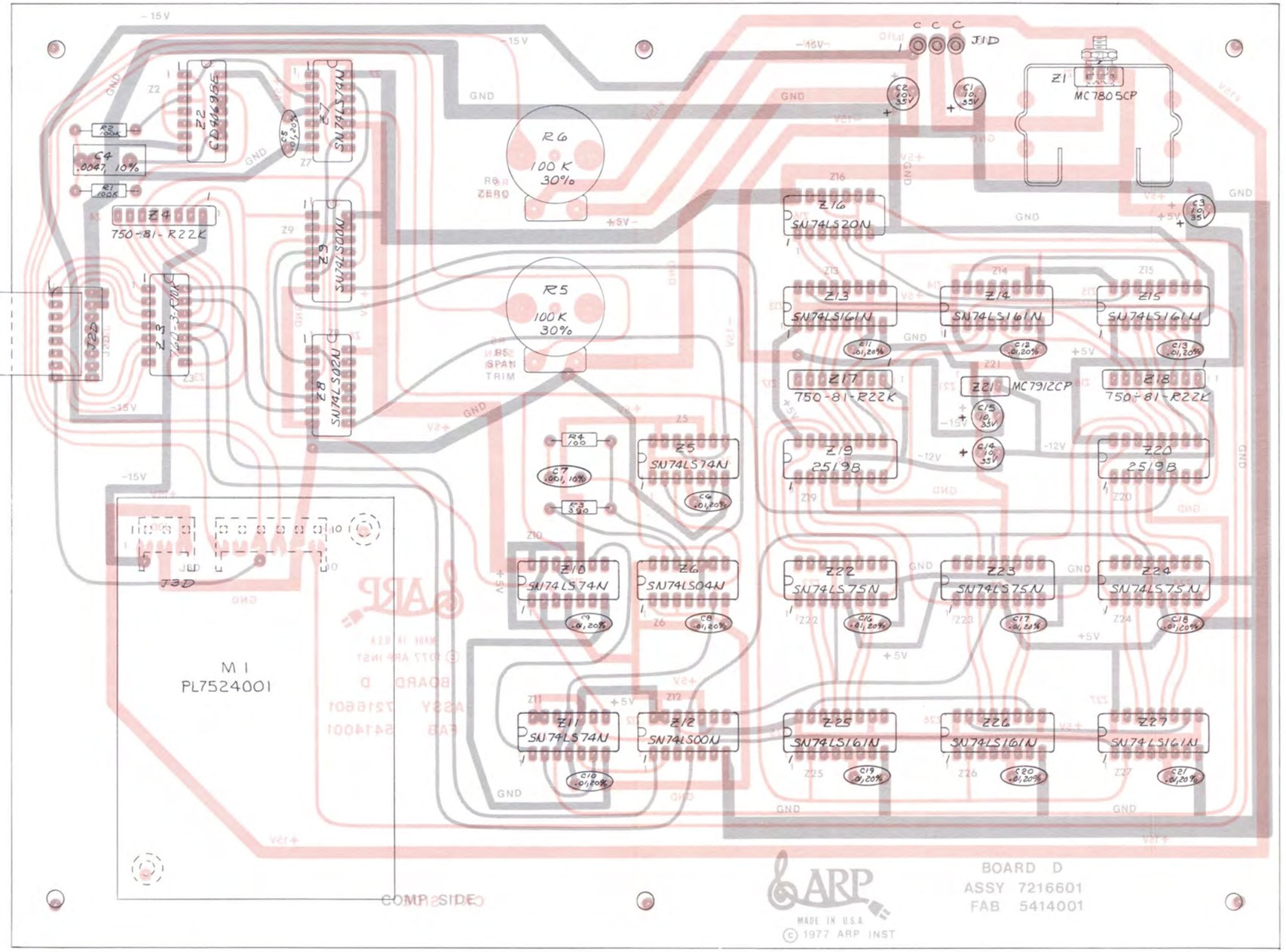
↑ IMPLIES +15V ↑
↓ IMPLIES -15V ↓
↑ IMPLIES +5V ↑

RED NUMBERS INDICATE BOARD - TO - BOARD CONNECTIONS.
SEE PAGE 28 FOR FURTHER EXPLANATION.

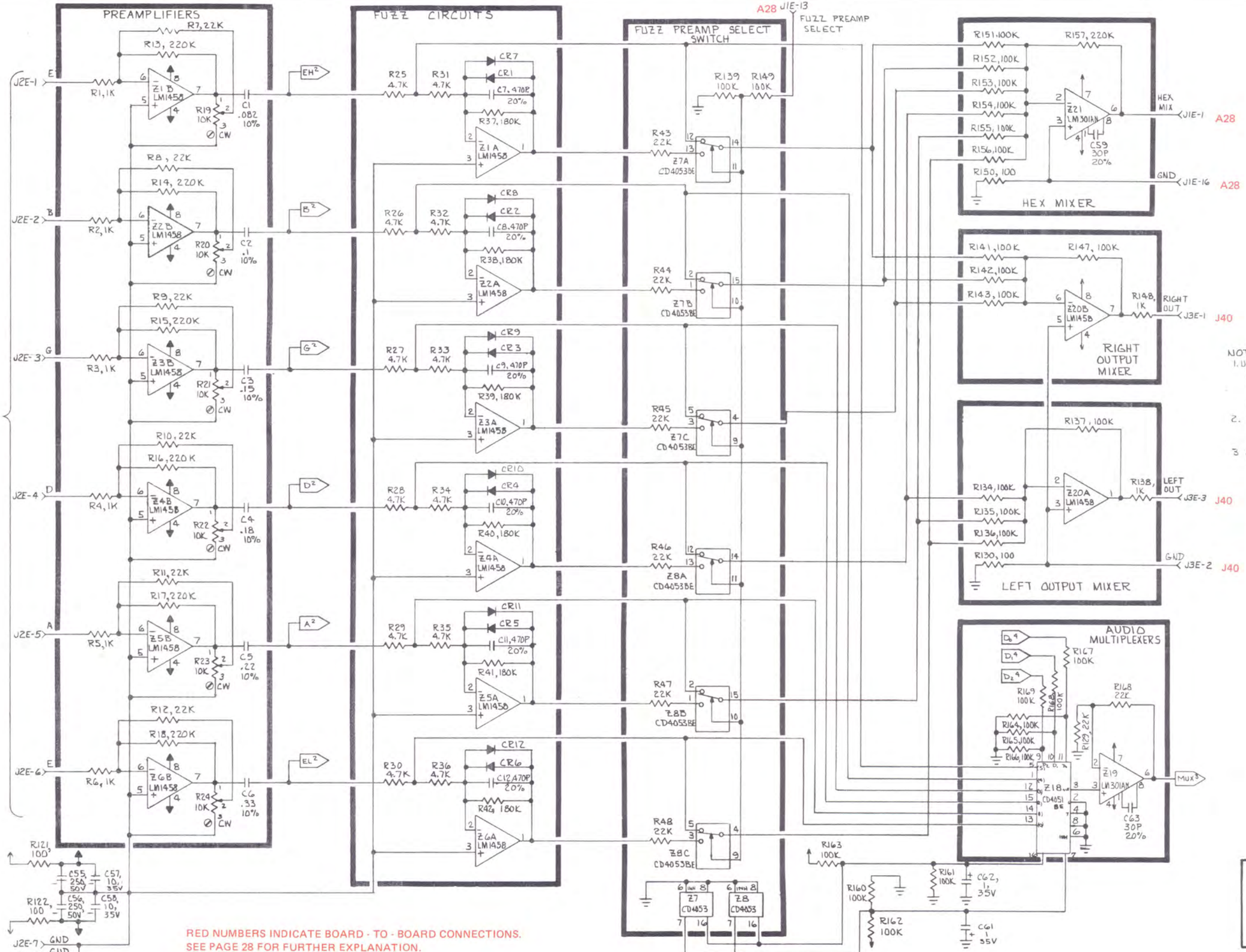
ARP

AVATAR MODEL 2223
SCHEMATIC
BOARD D

Circuit Description on Page 9



AVATAR MODEL 2223
ASSEMBLY
BOARD D



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTOR VALUES ARE IN OHMS.
   ALL CAPACITOR VALUES ARE IN μf
   (P= PICOFARADS)
   ALL DIODES ARE IN4148
2. HIGHEST REF DES: C78, CR25, J6E, M1, Q4, R225, Z34
3. CONVENTION USED FOR SUPPLY VOLTAGE CONNECTIONS

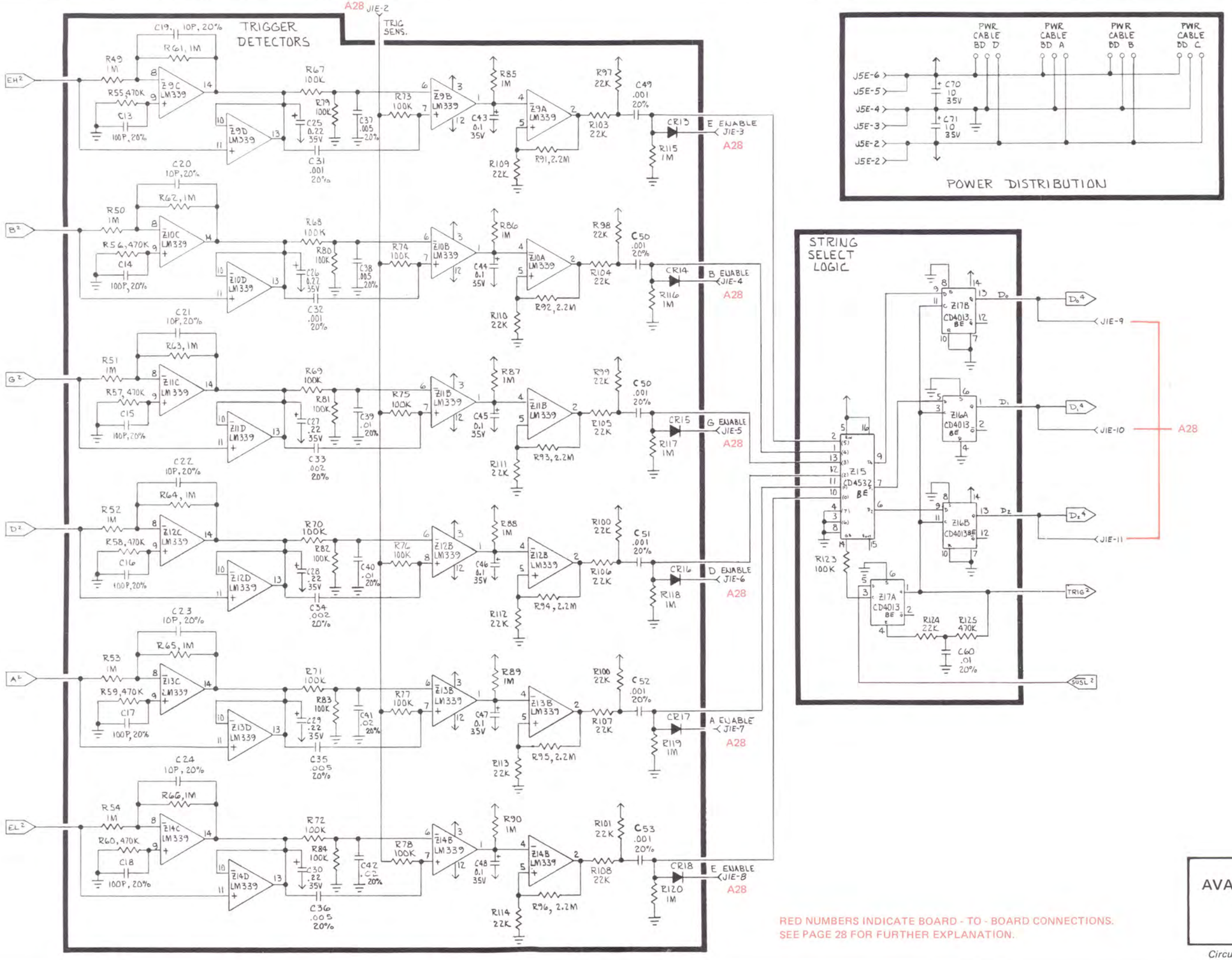
↑	IMPLIES +15V ↑
↓	IMPLIES -15V ↓
↑	IMPLIES DECOUPLED +15V ↑
↓	IMPLIES DECOUPLED -15V ↓

RED NUMBERS INDICATE BOARD - TO - BOARD CONNECTIONS.
SEE PAGE 28 FOR FURTHER EXPLANATION.

ARP

AVATAR MODEL 2223
SCHEMATIC
BOARD E
1 OF 3

Circuit Description on Page 11

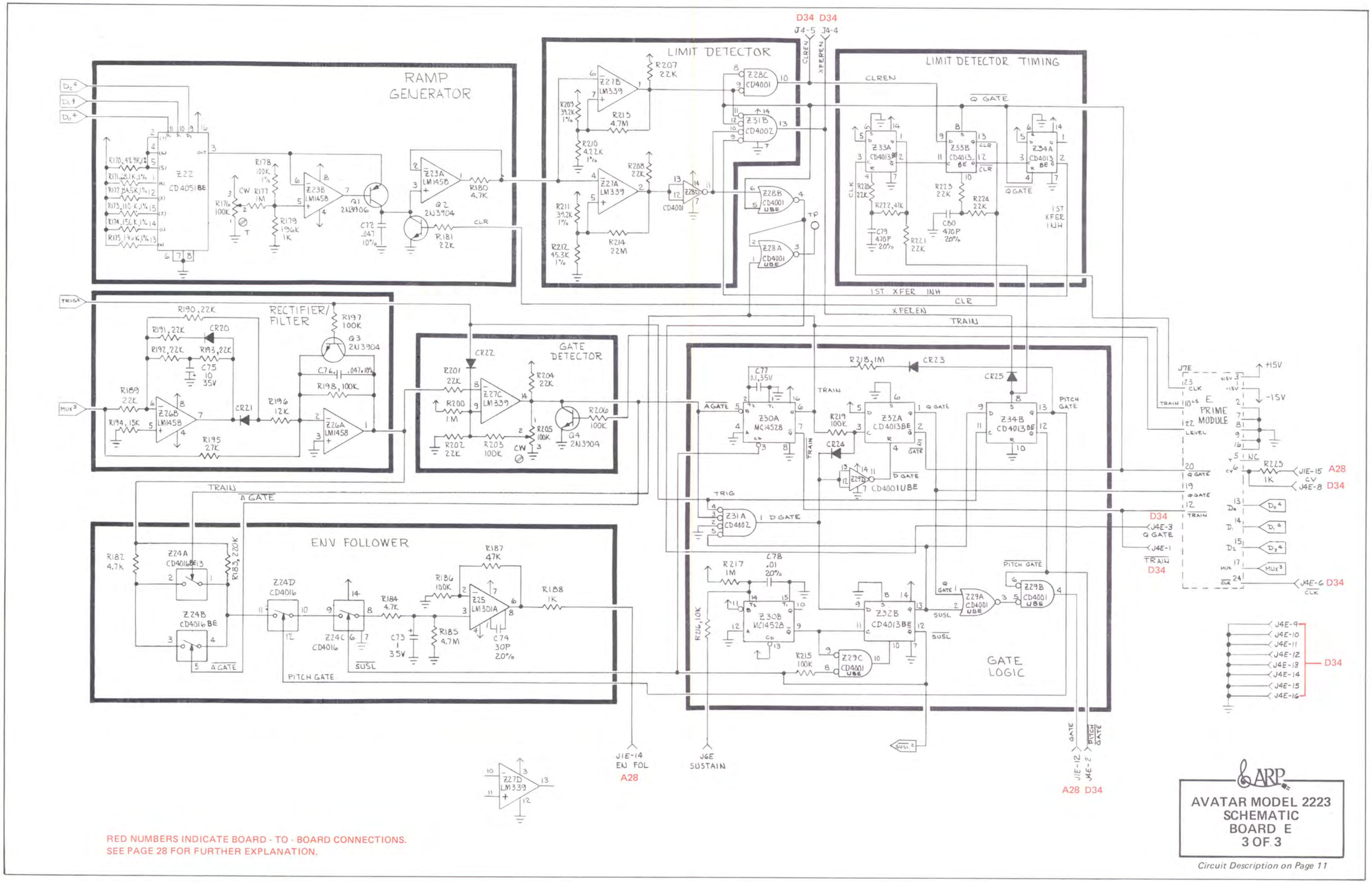


RED NUMBERS INDICATE BOARD - TO - BOARD CONNECTIONS.
SEE PAGE 28 FOR FURTHER EXPLANATION.

ARP

AVATAR MODEL 2223
SCHEMATIC
BOARD E
2 OF 3

Circuit Description on Page 11

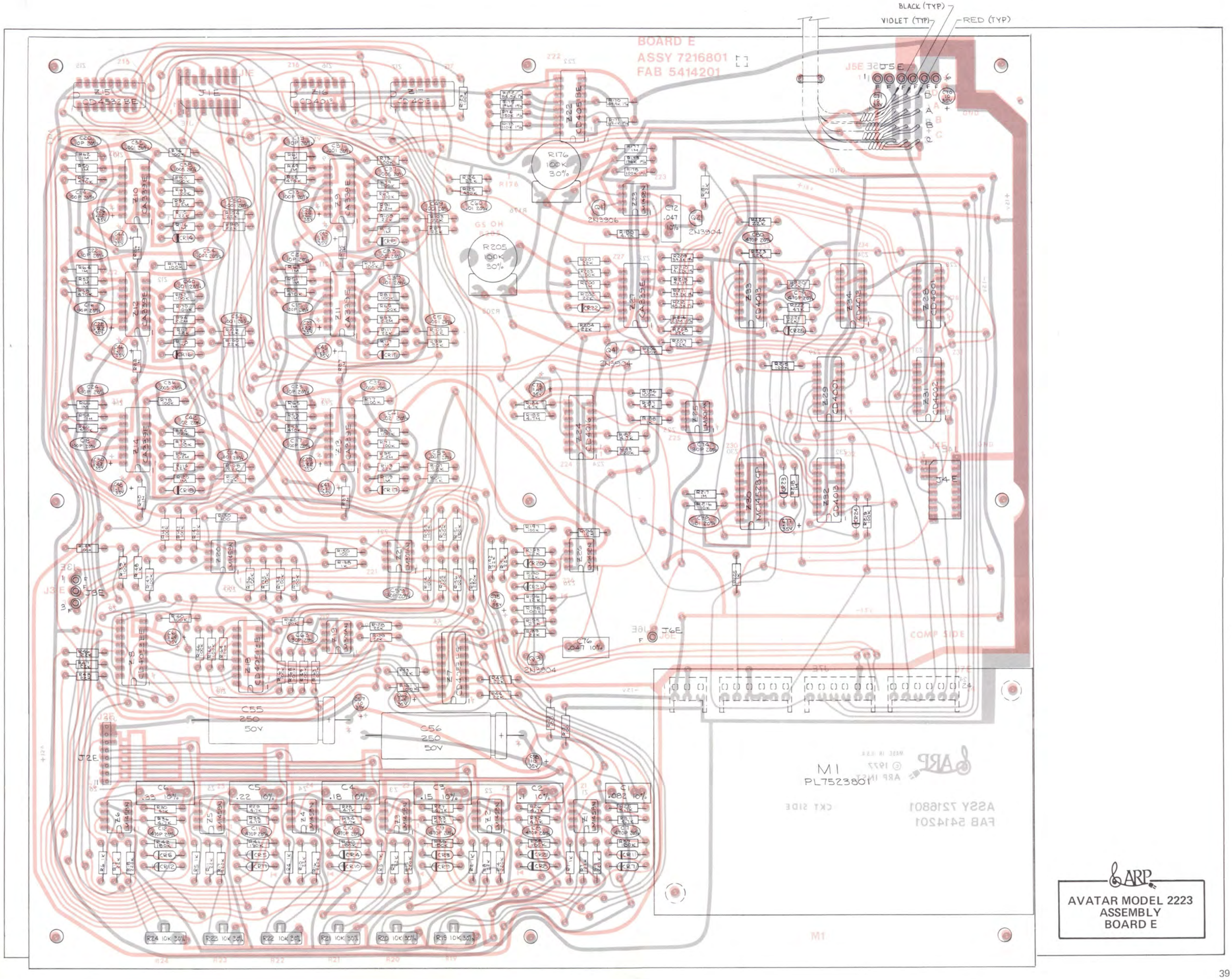


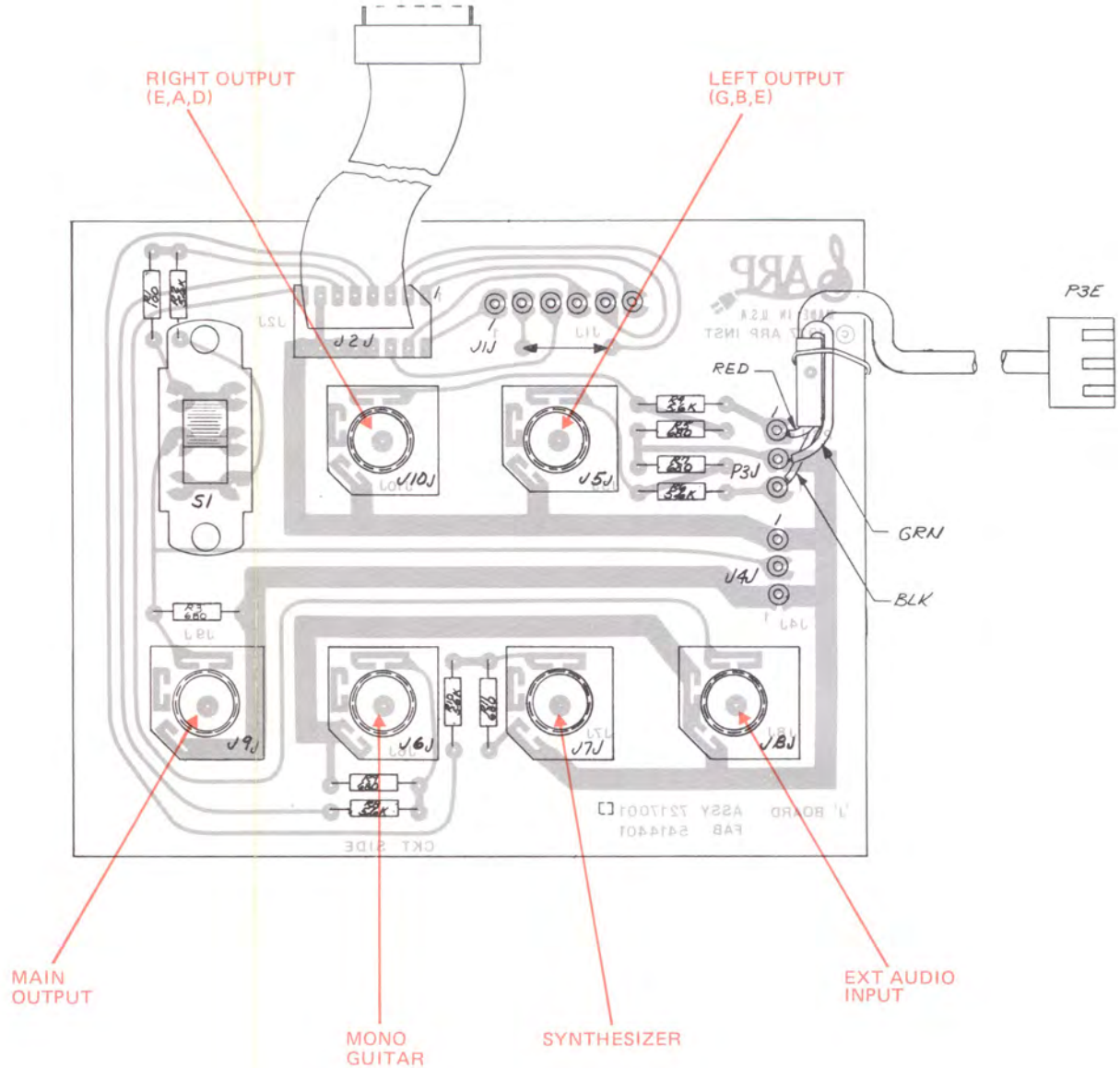
RED NUMBERS INDICATE BOARD - TO - BOARD CONNECTIONS.
SEE PAGE 28 FOR FURTHER EXPLANATION.

ARP

AVATAR MODEL 2223
SCHEMATIC
BOARD E
3 OF 3

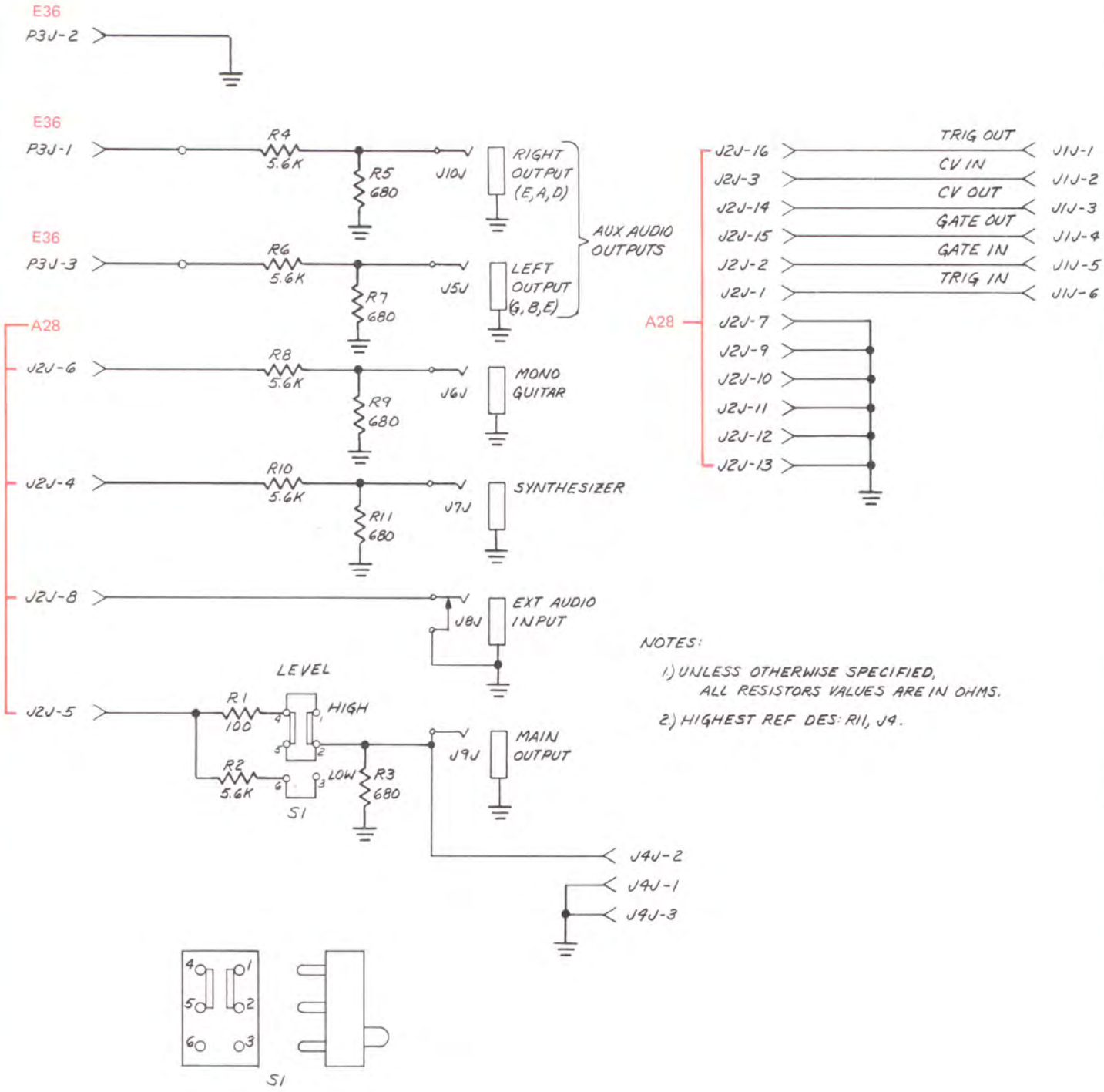
Circuit Description on Page 11


BLACK (TYP)
VIOLET (TYP)
RED (TYP)
BOARD E
ASSY 7216801
FAB 5414201
M1
PL7523801
ARP
AVATAR MODEL 2223
ASSEMBLY
BOARD E



ARP

AVATAR MODEL 2223
ASSEMBLY
JACK BOARD



NOTES:

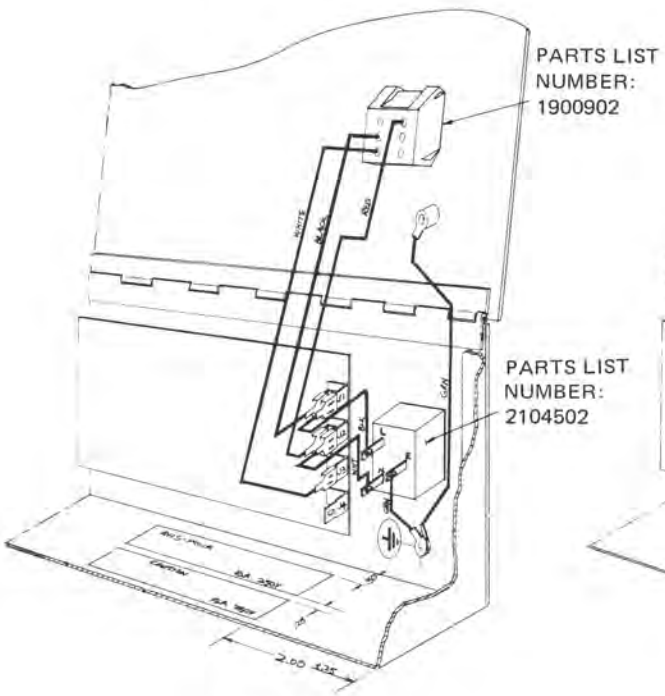
1.) UNLESS OTHERWISE SPECIFIED, ALL RESISTORS VALUES ARE IN OHMS.

2.) HIGHEST REF DES: R11, J4.

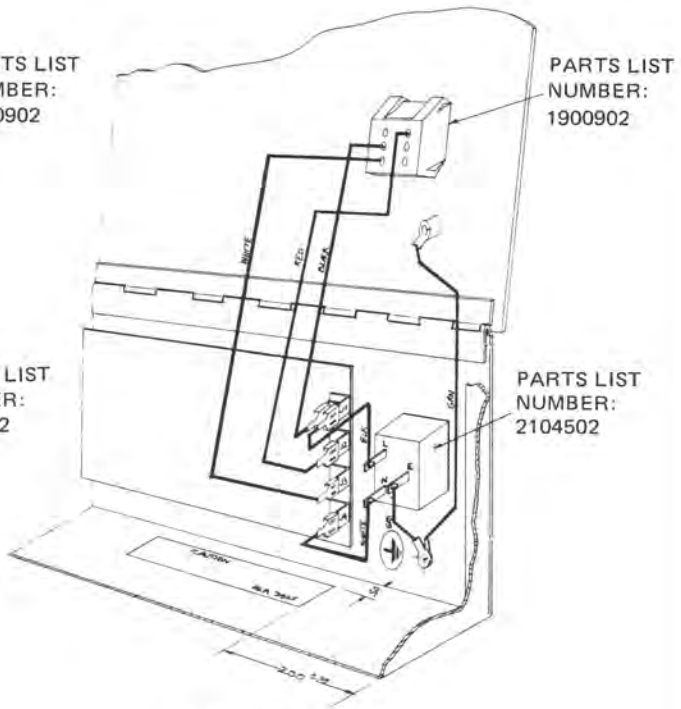
RED NUMBERS INDICATE BOARD - TO - BOARD CONNECTIONS.
SEE PAGE 28 FOR FURTHER EXPLANATION.

ARP

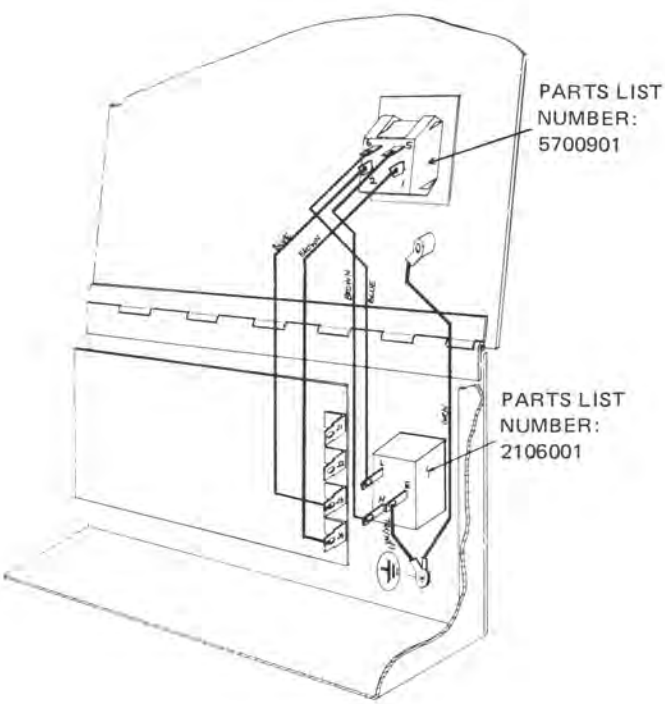
AVATAR MODEL 2223
SCHEMATIC
JACK BOARD



120V CSA, LA



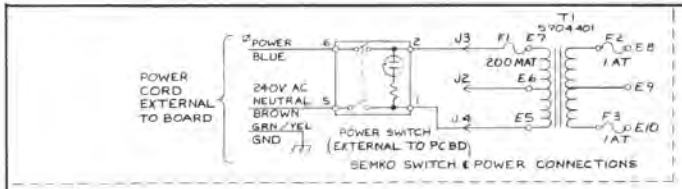
240V STANDARD

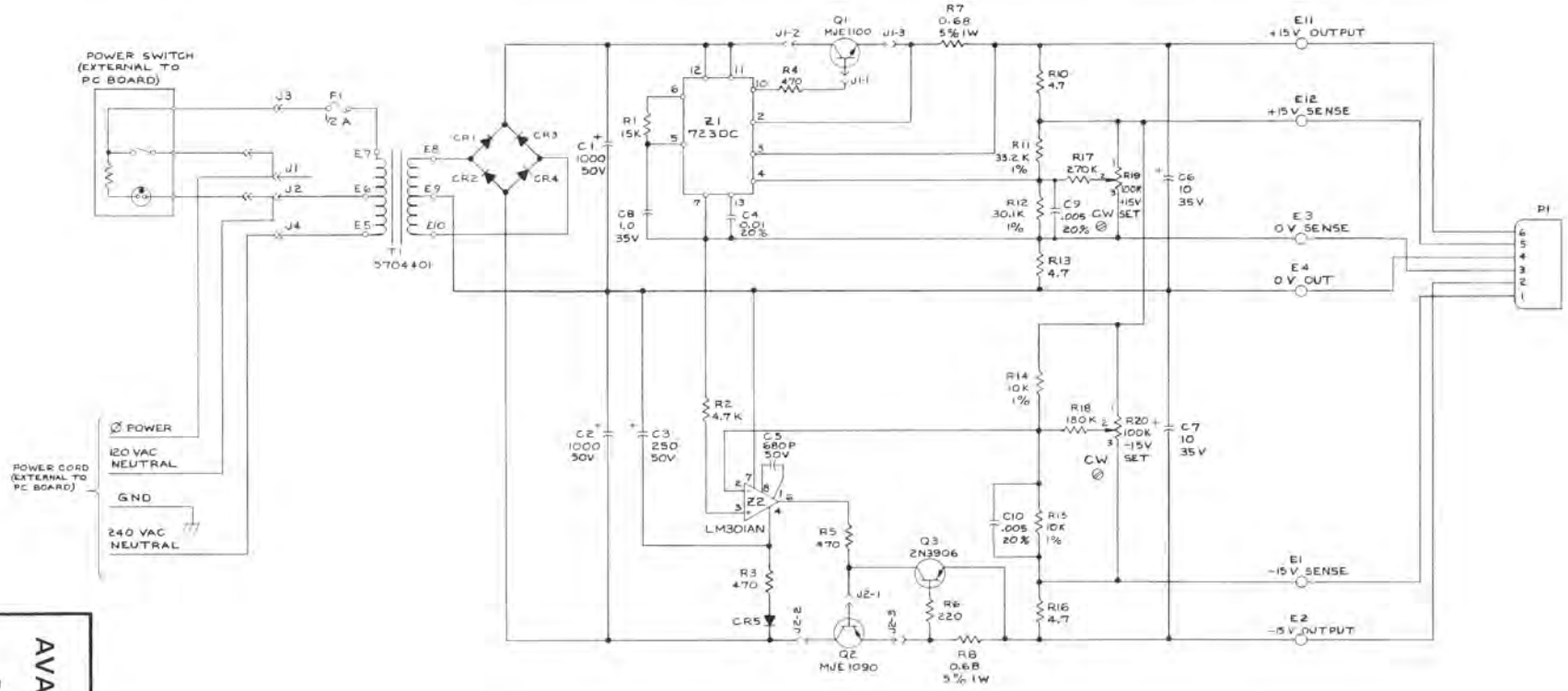


240V SEMKO

ARP

AVATAR MODEL 2223
WIRING DIAGRAM
POWER SUPPLY

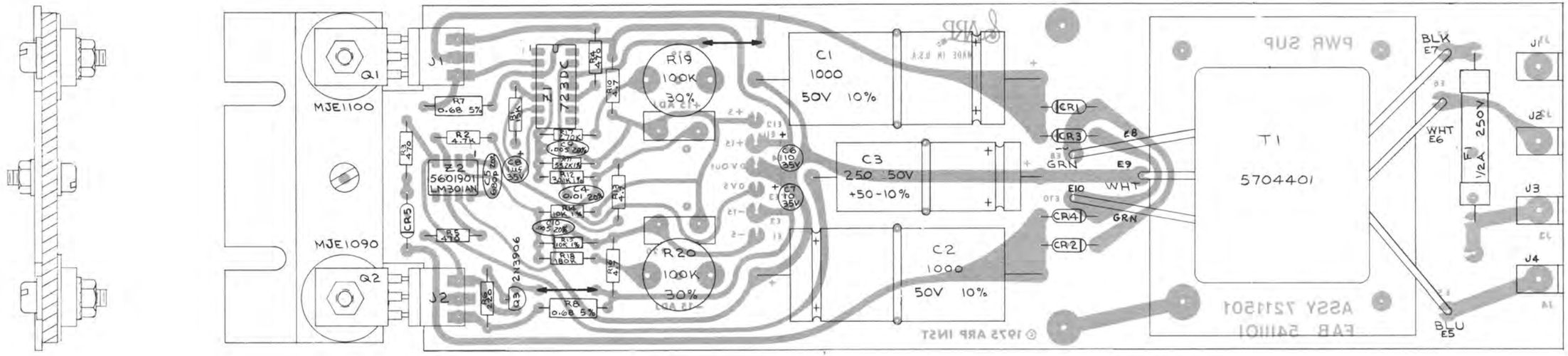




AVATAR MODEL 2223
SCHEMATIC
POWER SUPPLY

ARP

NOTES:
UNLESS OTHERWISE SPECIFIED:
ALL RESISTOR VALUES ARE IN OHMS.
ALL CAPACITOR VALUES ARE IN μF
(P= PICOFARADS).
ALL DIODES ARE IN4001.



AVATAR MODEL 2223
ASSEMBLY
POWER SUPPLY

7.1 Board A

REFERENCE	ARP PART NUMBER	ARP/MFG NUMBER	DESCRIPTION
CR8	1200301	1N4148	DIODE SIGNAL
Q1	1302901	2N3904	TSTR NPN GP
Z1	1400803	LM301AN	IC OP AMP
Z8, 9	1401101	LM1458	IC OP AMP DUAL
Z13	1401001	LM3900N	IC OP AMP QUAD NORTON
Z4	1405401	CA339E	IC QUAD COMPARATOR
Z12	1407601	TL081CP	IC OP AMP FET
Z1	1407401	MC7805CP	IC +5V REGULATOR
Z5	1407701	CD4006	IC 18-STAGE STATIC SHIFT REG
Z10	1404201	CD4007	IC CMOS PAIR PLUS INVERTER
Z11	1404401	CD4013	IC DUAL 'D' FLIP FLOP SET/RESET
Z6	1407801	CD4015	IC DUAL 4-STAGE STATIC SH REG
Z2	1407901	CD4030	IC GATE QUAD EXCLUSIVE-OR
Z7	1408101	SN74LS145N	IC BCD-TO-DEC. DECODE/DRIVER
R1	5700701	2801-006-1	POT SLIDE AUDIO 1M,
R2,3,4	5700702	2801-006-2	POT SLIDE 100K AUDIO
C17	1100609	G-0-001-G-20-0	CAP TANT 1UF 35V 20%
C1,2,3,4,8,11	1100612	G-0-010-G-20-0	CAP TANT 10UF 35V 20%
S1,2,3,4,5,6,7,10	1903401	01-481-0006	SWITCH SLIDE DPDT
S8	1900601	01-481-0004	SWITCH SLIDE DPST
S9	1903001	DC-51-01	SW MOMENTARY CONTACT PB
J2,5,9,10,11,12,13	2102801	10-18-2031	3-PIN CONNECTOR RECP
IA6	2101202	16-511-10	SOCKET DUAL IN LINE 16-PIN
J1A	2200806	5142-015	CABLE 16-PIN

7.2 Board B

REFERENCE	ARP PART NUMBER	ARP/MFG NUMBER	DESCRIPTION
CR1-10	1200301	1N4148	DIODE SIGNAL
Q3,18,20	1302901	2N3904	TSTR NPN GP
Q4,12,19	1303001	2N3906	TSTR PNP GP
Q11,17	1302701	2N5910	TSTR PNP SW HS
Q6,7,13,14	7500801	2N3904/2N3906	TSTR ASSY NPN/PNP
Q8,9,15,16,10	5600201	2N5458	TSTR N CHAN SEL
Q1,5	5800202	2N5459	TSTR N CHAN SEL
Q2	1303901	IMF3958	TSTR N CHAN
Z3,6	1400501	CA3086	IC TSTR ARRAY
Z1,2,5	1401101	LM1458	IC OP AMP DUAL
Z4	1400601	CD4011	IC GATE 4 X 2I NAND
R40,44,58,80,104,116,141	1000915	———	RES WW TC
R1,2,38,40,82, 114,116,149	5700703	2801-006-3	POT SLIDE LIN 100K
R34,49,51,77,106,111,138,	5700702	2801-006-2	POT SLIDE AUD 100K
R18	5700701	2801-006-1	POT SLIDE AUD 1M
C5,6	1100612	G-0-010-G-20-0	CAP TANT 10UF 35V 20%
C11,15	1101205	ADM-19-681J	CAP MICA 680PF 500V 5%
S1-11	1903401	01-481-0006	SWITCH SLIDE DPDT

7.3 Board C

REFERENCE	ARP PART NUMBER	ARP/MFG NUMBER	DESCRIPTION
	7210501	4075	VCF
CR1-22	1240301	1N4148	DIODE SIGNAL
Q3,4,5,6,8,10,13,16,18	1301701	2N5172	TSTR NPN GP
Q1,2,7,9,11,14,15,17	1302501	2N6076	TSTR PNP GP
Q12	1304601	TZ81	TSTR NPN LOW LEV
Z1	1400801	LM301AN	IC OP AMP
Z2	5601502	4023-006-2	IC DTA SEL
R67	1060901	U201R101B	POT ROT TRIM 100OHM ¼W
R68,69	1060911	U201R253B	POT ROT TRIM 25K ¼W
R70,71	1060915	U201R104B	POT ROT TRIM 100K ¼W
R74,76,77,89,86,88	5700701	2801-006-1	POT SLIDE AUDIO 1M
R78,79,80,84	5700702	2801-006-2	POT SLIDE AUDIO 100K
R72,73,75,81,82,83,87	5700703	2801-006-3	POT SLIDE LINEAR 100K
C7,8	1100602	G-0-3X3-E-16-0	CAP TANT 3.3UF 35V 10%
J1-10	1902401	01-481-0000	SWITCH SLIDE DPDT

7.4 Board D

REFERENCE	ARP PART NUMBER	ARP/MFG NUMBER	DESCRIPTION
M1	7524001		D* MODULE ASSY
Z1	1407401	MC7805CP	IC +5V REGULATOR
Z21	1403401	MC7912CP	IC -12V REGULATOR
Z2	1405801	CD4069BE	IC HEX INVERTER
Z9,12	1401702	SN74LS00N	IC GATE QUAD 2-INPUT NAND
Z8	1401802	SN74LS02N	IC GATE QUAD 2-INPUT NOR
Z6	1406601	SN74LS04N	IC HEX INVERTER
Z16	1402302	SN74LS20N	IC GATE DUAL 4-INPUT NAND
Z5,7,10,11	1406701	SN74LS74N	IC DUAL D FLIP FLOP PRESET/CL
Z22,23,24	1406801	SN74LS75N	IC 4-BIT BI-STABLE LATCH
Z13,14,15,25,26,27	1406901	SN74LS161	IC SYNC 4-BIT BIN COUNTER
Z19,20	1407501	2519B	IC HEX 40-BIT STATIC SH. REG
Z3	1406104	760-3-R10K	IC RES NETWORK 14-PIN 10K
Z4,17,18	1406002	750-81-22K	IC RES NETWORK 8-PIN 22K
R5,6	1060915	U201R104B	POT ROT TRIM 200K ¼W
C7	1101202	CD7EA102J03	CAP MICA .001 100V 5%
C1,2,3,14,15	1100612	G-0-010-G-20-0	CAP TANT 10UF 35V 20%
	2101801	09-52-3033	CONN PC BOARD 3-PIN TOP ENTRY
	2101802	09-52-3063	CON PC BOARD 6-PIN TOP ENTRY
J20	2200806	5142-0804	CABLE RIBBON 26 AWG, 16-PIN 4"
	2602001	295-2	HEAT SINK PC MOUNT

7.5 Board E

REFERENCE	ARP PART NUMBER	ARP/MFG NUMBER	DESCRIPTION
M1	7523801		E' MODULE ASSY
CR1-18, 20-25	1200301	1N4148	DIODE SIGNAL
Q2,3,4	1302901	2N3904	TSTR NPN GP
Q1	1303001	2N3906	TSTR PNP GP
Z19,21,25	1400801	LM301AN	IC OP AMP
Z1-6,20,23,26	1401101	LM1458	IC OP AMP DUAL
Z28,29	1404301	CD4001	IC GATE QUAD 2 INPUT NOR
Z16,17,32,33,34	1404401	CD4013	IC DUAL D FLIP FLOP SET/RESET
Z24	1404501	CD4016	IC QUAD BILATERAL SWITCH
Z18,22	1404901	CD4051	IC SINGLE 8-CHAN MULTIPLEXER
Z30	1405301	MC14528CP	IC DUAL MONO MULTI
Z9-14,27	1405401	CA339E	IC QUAD COMPARATOR
Z7,8	1406201	CD4053BE	IC TRIPLE 2-CHAN MULTIPLEXER
Z31	1406301	CD4002BE	IC DUAL 4-INPUT NOR
Z15	1408301	CD4532BE	IC ENCODER 8 BIT PRIORITY
R19-24	1000910	X201R103B	POT ROT TRIM 10K ¼W 30%
R176,205	1000915	U201R104B	POT ROT TRIM 100K ¼W 30%
C43-48,77	1100614	G-0-0X1-G-20-0	CAP TANT .1UF 35V 20%
C25-30	1100615	T390A224M035AS	CAP TANT .22UF 35V 20%
C61,62,73	1100609	G-0-001-G-20-0	CAP TANT 1UF 35V 20%
C57,58,70,71,75	1100612	G-0-010-G-20-0	CAP TANT 10UF 35V 20%
C55,56	1101702	TAD250TQ50	CAP ELECT 250UF 50V +50-10%
J1E,J4E	2101302	16-511-10	SOCKET DUAL IN LINE 16-PIN
J2E	2104403	22-33-2081	CONN WAFER 8-PIN
	2101801	09-52-3033	CONN PC BOARD 3-PIN TOP ENTRY
	2101802	09-52-3063	CONN PC BOARD 6-PIN TOP ENTRY

7.6 Power Supply

REFERENCE	ARP PART NUMBER	ARP/MFG NUMBER	DESCRIPTION
Q1	1304501	MJE1100	TSTR NPN PWR DARL
Q2	1304301	MJE1090	TSTR PNP PWR DARL
T1	5704401		XFMR POWER
F1	1700404	MDV-½	FUSE PIGTAIL SLO-BLO ½A
CR1-5	1200201	1N4001	RECT 50V 1A
Q3	1303001	2N3906	TSTR PNP GP
Z1	1401301	723DC	IC VR
Z2	1400801	LM301AN	IC OP AMP
R7,8	1000111	BW-20	RES WW TC ,68OHM 1W 5%
R19,20	1000915	U201R104B	POT ROT TRIM 100K ¼W 30%
C8	1100609	G-0-001-G-20-0	CAP TANT 1UF 35V 20%
C6,7	1100612	G-0-010-G-20-0	CAP TANT 10UF 35V 20%
C3	1101702	TAD250TQ50	CAP ELECT 250UF 50V 50-10
C1,2	1101301	TCW102V050N1R3P	CAP ELECT 1000UF 50V 75-10

7.7 Board J

REFERENCE	ARP PART NUMBER	ARP/MFG NUMBER	DESCRIPTION
J2J	2101302	16-511-10	SOCKET DUAL IN LINE 16-PIN
J5J,J6J,J7J,J8J,J9J,J10J	2104001	112A	JACK HI-D 2 COND
S1	1902401	01-481-0006	SWITCH SLIDE DPDT

7.8 General

REFERENCE	ARP PART NUMBER	ARP/MFG NUMBER	DESCRIPTION
	5704702	————	DIODE LED GREEN .912
	5704502	————	DIODE LED RED .912
	5204101	————	KNOB BLACK
	5204102	————	KNOB RED
	5204103	————	KNOB YELLOW
	5204104	————	KNOB GREEN
	5204105	————	KNOB BLUE
	5204106	————	KNOB PINK
	5204107	————	KNOB WHITE
	7500301	8000-010	SWITCH ASSY 11 IN.
	5203801	————	END BLOCK LEFT
	5203802	————	END BLOCK RIGHT
	2103401	91-T-3403-9	CONN 6-PIN FEMALE
	2101001	11	JACK PHONO MONO
	2101101	14B	JACK PHONO STEREO
	2104502	————	CONNECTOR, RECP., 120V
	2106001	————	CONNECTOR, RECP., 240V SEMKO
	1900902	————	SWITCH, 120V
	5700901	————	SWITCH, 240V SEMKO

PARTS ORDERING

Telephone: 617/861-6000, Service Department

Replacement parts can be ordered in writing or by phone. Contact the ARP Service Department and use the ARP part number when ordering. *A five dollar minimum is required unless the order is received with cash in advance. No collect calls will be accepted.*