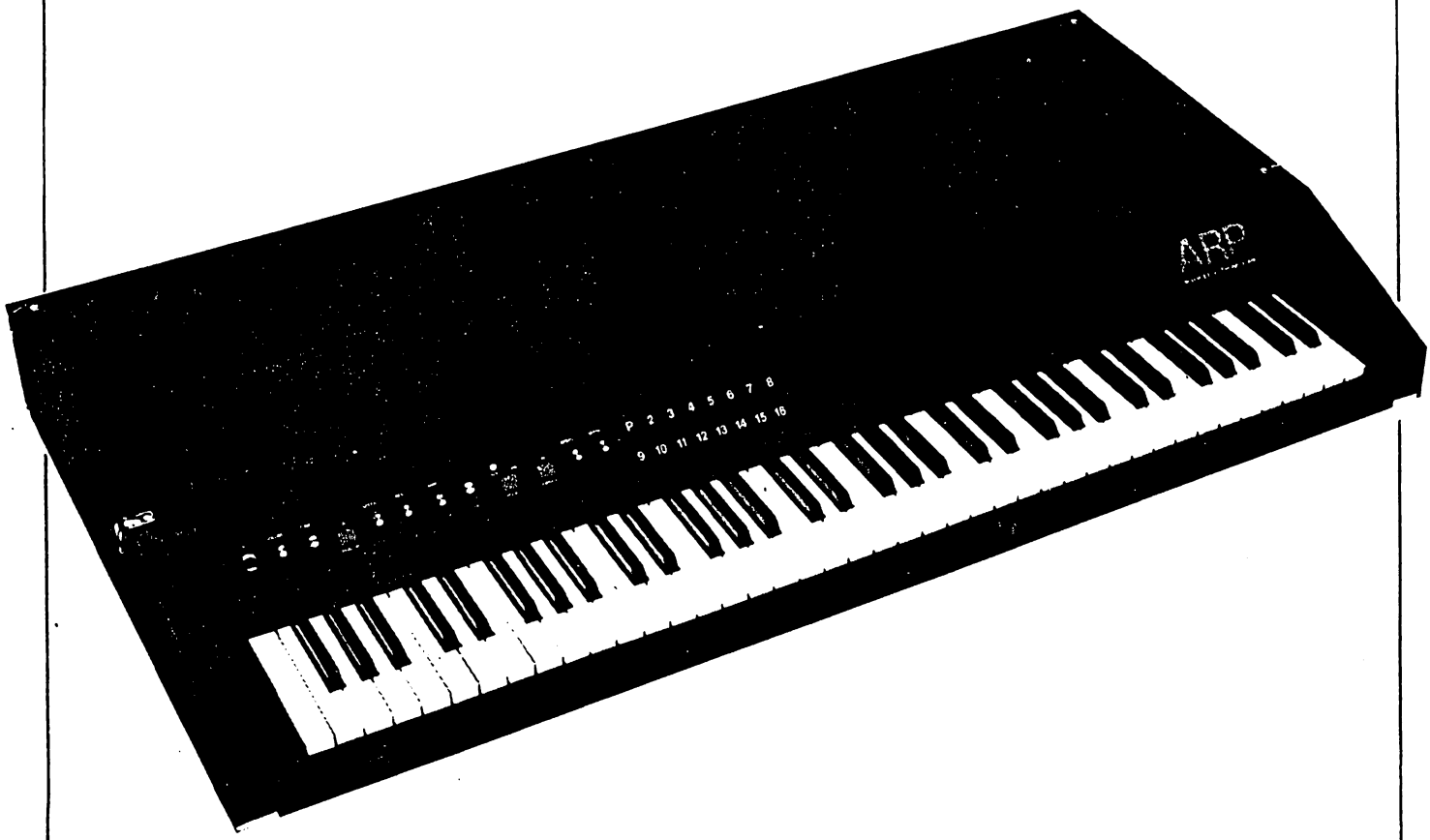
ARPPIANO

16 VOICE ELECTRONIC PIANO



SERVICE MANUAL

Models 3301, 3302, & 3303

MUSIC DEALER SERVICE
A Div. of T.E.A.M.S. Inc.
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SECTION 1 GENERAL DESCRIPTION

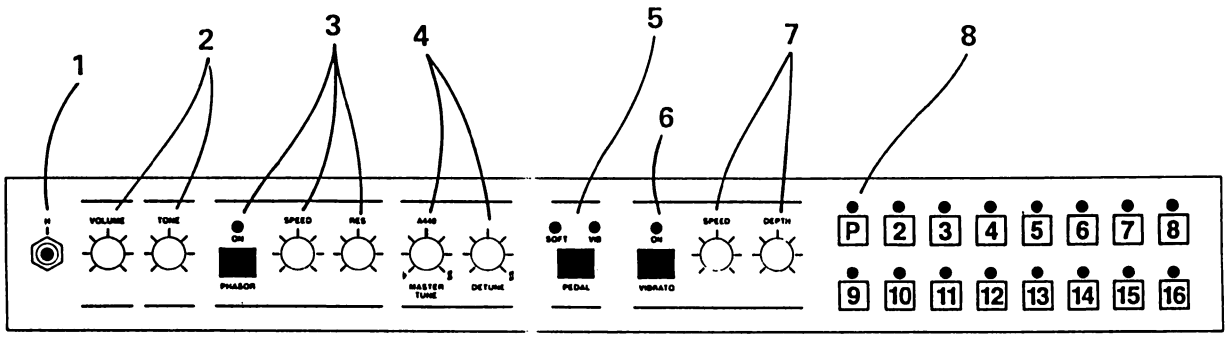
The ARP 16-voice Electronic piano is the first piano to offer a wide variety of touch responsive percussive sounds in one instrument. Among the sixteen sounds are acoustic piano, vibes, bells, harpsichord, harp, tunings, envelope follower effects and other voices which are ideal for both solo and group performance applications.

The instrument has a 73-note keyboard with standard wood piano keys and a specially designed and weighted maple action which faithfully reproduces the feel and response of traditional grand pianos.

In addition, a pedal assembly is included with two pedals, one for sustain and the other may be used as a soft pedal or may be reassigned to become a vibrato on/off pedal. Also a stereo phase shifter is included which can be switched on or off with any of the voices. Other features include vibrato, master tune controls and detune controls for effects such as honky-tonk piano or to "warm-up" the sound. A stereo headphone jack is provided on the control panel along with the volume and tone controls.

The instrument comes with four detachable legs, a keyboard cover and the pedal assembly.

SECTION 2 SPECIFICATIONS & CONTROLS



CONTROLS

1. STEREO HEADPHONE JACK: Accepts 8 ohm stereo headphones.

2. VOLUME & TONE: Affects all 16 Voices.

3. PHASOR: Stereo phasor may be used on all 16 voices. Speed & Resonance controls adjust the effect to taste.

4. MASTER TUNE & DETUNE: Master Tune control is used to tune the entire instrument, and the Detune control is used to produce a "slightly out of tune" character or flavor.

5. LEFT PEDAL SELECT SWITCH: Determines whether the left pedal is to be used for the "soft" effect, or for vibrato.

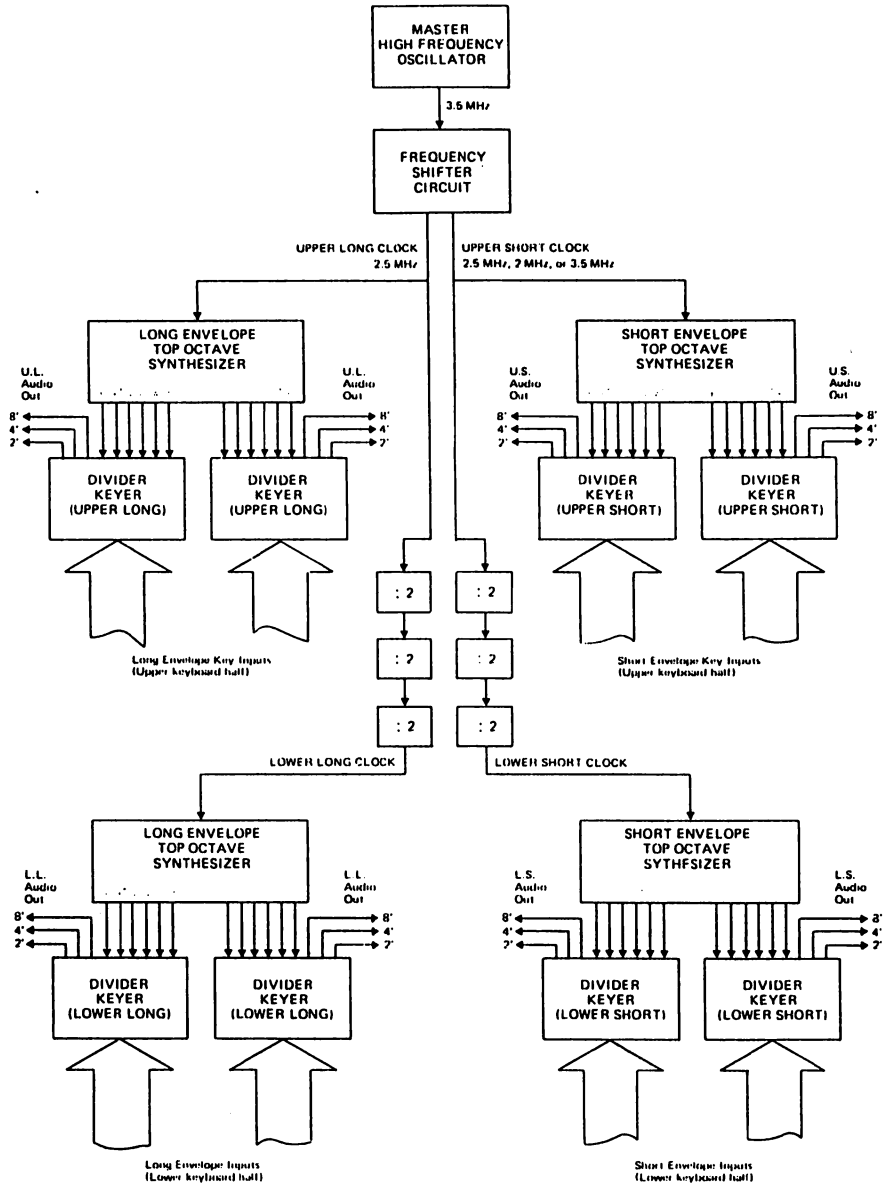
6. VIBRATO SWITCH: Used to provide continuous vibrato on all 16 voices.

7. VIBRATO SPEED & DEPTH: Sets vibrato speed & depth, and the Speed control is also used to set the trill rate for voice 5.

8. VOICE SELECT SWITCHES: Used to select any one of the 16 voices provided.

AUDIO OUTPUTS

LEFT: 8V PP, low impedance
RIGHT: 8V PP, low impedance
MONO: High, 8V PP; Low, 0.8V PP; low impedance



3.1 Tone Generation

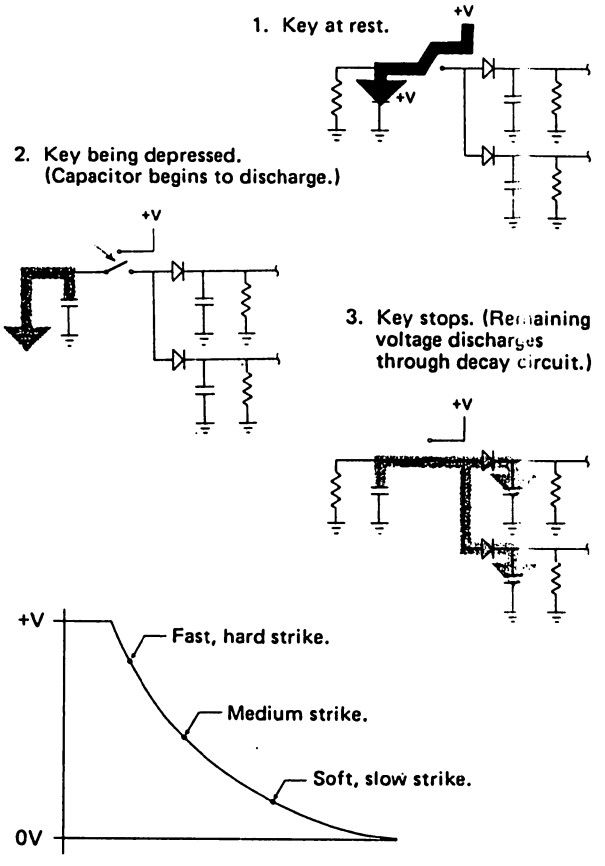
The tone generation system in the ARP 16-voice Electronic piano consists of a master high frequency oscillator, a clock frequency shifter circuit, top octave generator chips and 8 divider/keyer ICs. In order to produce pitches for each key on the keyboard, there are two divider chains in parallel. This dual tone generation system is used for two main reasons; 1) it permits the two pitches generated for each key to be detuned relative to each other and, 2) a dual keying system permits a more complex envelope decay characteristic.

To permit accurate detuning, a high frequency clock which is derived from the high-frequency oscillator drives one of the divider chains. The other divider chain is driven from the same clock signal after it has been processed, by a unique pulse chopping circuit which effectively increases its frequency. This scheme, which is described in more detail in the power supply circuit description, permits accurate detuning of the two divider chains and therefore establishes accurate detuning of the pitches on each key.

The final divisions in the divider chain are made in special purpose MOS integrated circuits. These devices contain all of the frequency dividers for each note and the keying circuits. There are three audio outputs on each chip (8', 4' and 2') which are buffered and then sent to the voicing circuits.

3.2 Keying Circuit

Since the ARP Electronic Piano is touch-responsive, envelopes must be generated which are proportional to the speed of keys which are depressed. This is accomplished by an RC Time-of-Flight measurement scheme. When a key is depressed, a capacitor begins to discharge until the key reaches its final position, then the remaining charge on the capacitor is used to charge two other capacitors (one for each of the two tones per key) which decay at a much slower rate. These two capacitors are directly connected to the divider/keyer chips, to gate out the audio signals. Thus the harder (faster) a key is depressed, the larger the initial envelope voltage on the two decay capacitors.



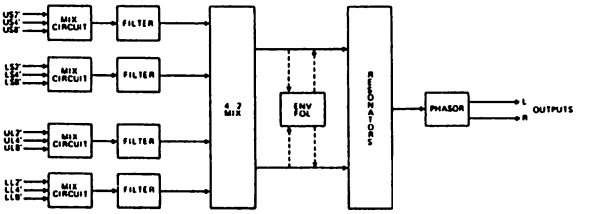
The decay characteristics of the struck and plucked string share a common form. The initial decay is more rapid (and frequently brighter) than the final decay rate. It is for this reason there are two different decay rates on each key, one rapid and one relatively long. These two decays are referred to as the "Short" envelope (or signal) and the "Long" envelope. The Short envelope decay rate can be altered by a PMD (pulse modulated decay) line to shorten its decay rate even further for plucked sounds. These two audio signals keyed on each note are combined in the voicing circuit, producing composite envelope on the output.

3.3 Voicing

The architecture of the voicing circuit is defined by the audio signals which are sent over from the divider/keyer circuitry. In total, there are four groups of three audio signals (all square waves) arranged as follows:

8', 4', 2'	Upper keyboard half, Short
8', 4', 2'	Upper keyboard half, Long
8', 4', 2'	Lower half keyboard, Short
8', 4', 2'	Lower half keyboard, Long

VOICE BOARD SIGNAL FLOW

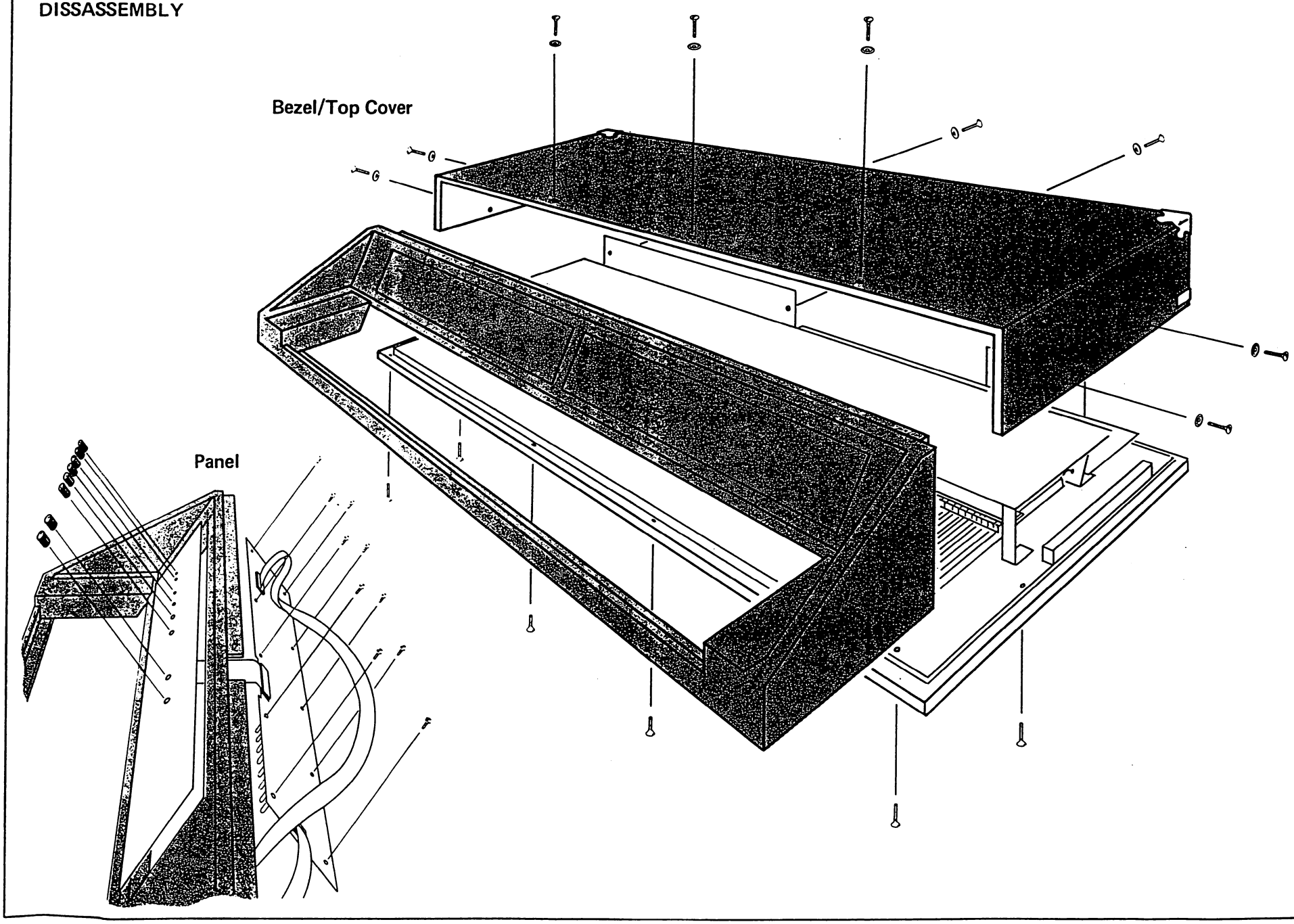


The first voicing step is to mix and prefilter the three footages in each voice, according to the voice selected. Some voices use all three footages, others may use only one or two. The outputs of the first mix stages yield four pre-mixed signals: Upper Short, Upper Long, Lower Short and Lower Long. These signals are then processed through select fixed filters which can be low-pass, band-pass, or high-pass, depending upon the voice which is selected. The outputs of the fixed filters are then combined from four signals (US, UL, LS, LL) to two signals in a 4-to-2 mix circuit. Depending again on the voice which is selected, two mixdown outputs are either Upper Keyboard/Lower Keyboard or Short Signal/Long Signal.

In the final voicing step, the two signals from the 4-to-2 mix circuit are sent to a six-band resonator bank which is similar to a graphic equalizer. Each voice has its own frequency response established by a resistor matrix before the resonator bank. The resonator bank has one output which is sent to the phase shifter circuit which harmonically derives a left and right output signal.

All of the signal paths and many of the circuit values are different for each voice. When a voice is selected, the control panel circuitry sends out a digital code which addresses a ROM (read only memory) which in turn sets up the voicing circuit for the appropriate signal paths and filter values.

DISSASSEMBLY



SECTION 4 CIRCUIT DESCRIPTIONS

4.1 Power Supply

The power supply is in a central location from an interconnection standpoint therefore all of the support circuitry for the keyer boards is on this circuit board. The support circuits are the High Frequency VCO, the Interval Logic and Frequency Shifter which determines the tuning or interval, Beat Frequency VCO which sets the amount of de-tuning, Pulse Generator Circuit which is used to modulate the decay rate of the Short envelopes on the keyer boards, Line Drivers which drive the top octave synthesizer on the keyer boards, and the Keyer Bias Supply Circuit, which supplies the keyer/divider chips on the keyer boards with the correct reference voltages.

TROUBLE SHOOTING HINTS

The Interval Logic and Frequency Shifter Circuit is running at a high frequency and it is difficult to determine whether the circuit is functioning properly or not.

To quickly check out the circuit, connect the trigger input of an oscilloscope to the D output of Z8B (Pin 14, TP1). This will permit a complete cycle to be displayed exactly like the timing diagram on page 7 (except that the waveforms are somewhat rounded). Then simply probe each gate output illustrated on the timing diagram.

4.1.1 POWER

Almost all of the instrument is run +12 volts, which is provided by two 3-terminal regulators (Z1 and Z2). Z3, Q1 and Q2 provide +15 volts for the keyer/divider ICs on the upper and lower keyer boards. A power sense line is sent through P9-6 to the voice board to activate a mute circuit when the instrument is turned on or off.

4.1.2 HIGH FREQUENCY VCO

The High Frequency Oscillator (Z6 and Q5) oscillates at about 3.4MHz. The 'M' tune line comes from the Master Tune control on the control panel and also has the vibrato signal from the control panel when it is selected.

4.1.3 INTERVAL LOGIC AND FREQUENCY SHIFTER

In total, there are three different pitch relationships used in the instrument: Unison tuning (voices P, 3, 4, and 7 through 16), musical fifth tunings (voices 2, 5 and 6), and a high-pitched eleven to eight ratio which is used to create a metallic "ting" (voices 7 and 8). (In the case of the fifth tuning relationship, the clock signal for the short chain is actually lowered by a musical fourth and the 8' signal is unused.) In all cases, the clock which drives the Short channel is the one which is altered. The Long divider chain is not alterable (except, of course, by the master tune). The different tuning relationships, including the unison detuning, are created by chopping pulses to create a derived signal.

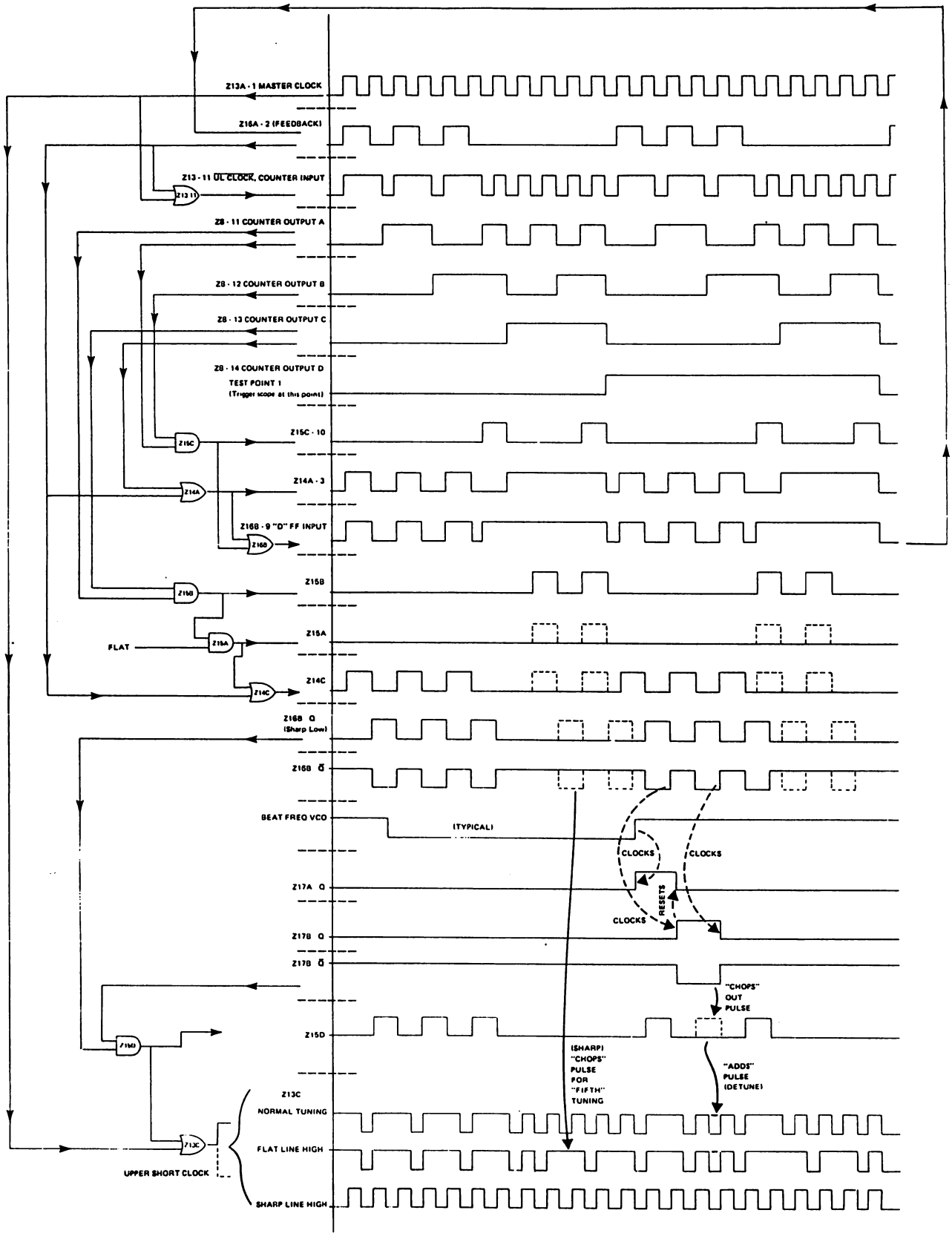
The High Frequency VCO oscillates at approximately 3.4 MHz, which is the frequency required to produce the metallic "ting" (voices 7 and 8). The remaining pitch relationships are derived from this clock signal in the Interval Logic Frequency Shifter Circuit. Long Clock: Z13B, Z14A and B, Z15B and C, and Z16A chop three pulses for every eleven of the High Frequency VCO (see timing diagram, TP Z13-11), which then becomes the clock signal for the Long divider chain (called the Upper Long clock or UL clock). Short Clock: When the Flat control line is high (Z15A, pin 1) then another two pulses are added to the same derived clock signal via Z14C. This lowers the pitch of the short clock signal, which will be supplied to the Short chain by a musical fourth. Since the 8' audio will not be used, it will come out sounding like a musical fifth above the Long chain.

The Beat Frequency VCO periodically sends a pulse over to Z16B and Z17, to add in pulses occasionally which slightly raises the frequency of the clock signal which is supplied to the Short divider chain. If the frequency of the Beat Frequency VCO is increased, the rate of pulse adding also increases, which in turn raises the effective frequency of the clock. The Beat Frequency VCO ranges from about 450Hz to 60KHz. At maximum frequency the Beat Frequency VCO raises the Sharp clock approximately ¼ of a semitone. Z13, Pin 10 is the "Upper Short Clock." The "Lower Long Clock" is picked off of counter Z8B, Pin 14 and is three octaves lower than the "Upper Long Clock." This clock is for the Lower Keyer boards. The "Lower Short" is provided by Z8A, which also divides the Upper Short clock in half, three times, for the Lower keyer boards.

4.1.4 BEAT FREQUENCY VCO

The Beat Frequency VCO determines the exact amount of detuning between the Short and Long clock signals by supplying a pulse of constant width

TIMING DIAGRAM



(4.5 microseconds) to the Interval Logic and Frequency Shifter Circuit. Its frequency ranges between 450Hz (minimum detune) and 60KHz (maximum detune), depending upon the setting of the Detune control on the front panel. The more often pulses are supplied to the Frequency Shifter Circuit, the more often are pulses added to the clock signal which raises the frequency of the Short Clock. However, these pulses are ignored on voices 7 and 8.

4.1.5 PULSE GENERATOR

The Pulse Generator derives from available clock signals, one of four signals which are supplied to the keyer board to set the decay rate of the Short envelopes on the PMD (Pulse Modulated Decay) line. A two-bit code supplied from the voice board determines which decay rate is set by this circuit (P9, pins 5 and 12). The four signals are as follows:

D1	D0	SIGNAL	DECAY SETTING
0	0	0 (0 Volts)	Maximum Decay Rate, Short Envelope
1	0	25% (39KHz) ↕ Duty Cycle	Medium Decay Rate, Short Envelope
0	1	75% (39KHz)	Medium Decay Rate, Short Envelope
1	1	1 (+10 Volts)	Minimum (shortest) Decay Rate, Short Envelope

Notice that Z10B, which drives the PMD line, is powered from a voltage which is derived (and is always less than) the keying bias voltage. This is to insure that the modulating signal does not affect the envelope voltage levels when the Short envelopes decay near the keying bias voltage level.

4.1.6 KEYER BIAS SUPPLY

This circuit supplies the Keyer board with the following reference voltages: Pedal Control ($\overline{PED}$), Keyer Bias (KB), Timing Bias (TB), +7 Volts for the Keyer/Divider chips, and the decay chopping power line (PMD line).

Z4A sets the Keyer Bias level to approximately +10.5 volts. This voltage is set to coincide exactly with the pinch-off voltage of the keyers in the Keyer/Divider chip. This voltage is typically two diode drops (about 1.6 volts) below the Keyer/Divider chip's supply voltage (+12 volts). In practice, the best envelope decay characteristic is achieved by setting the Keyer Bias such that the Keyer/Divider chip does not quite pinch-off. This prevents the the decaying sound from abruptly stopping when the envelope reaches the pinch-off value. To prevent this truncation, a trimmer (R37) is set to allow a very small signal through when the envelope has fully decayed. The damper circuit on each key supplies a voltage to pinch-off the signal when keys are not being depressed, thus preventing unwanted bleed-through.

Q4 supplies the damper buffers on the Keyer board with a supply voltage of +12 volts when the pedal is not depressed. When the Sustain Pedal is depressed, the $\overline{PED}$ line goes low, which removes the damping function from all of the keys. When this happens, the Keyer Bias voltage level is shifted up slightly via R9 and R10 so that the keyers in the Keyer/Divider chips pinch-off during the time the dampers are removed.

Z4B and Q3 generate the Timing Bias reference for the Keyer boards. The capacitors which establish the time of flight are discharged to this reference level. It is set to be about a half-volt lower than the Keyer Bias level. Z5A supplies about 9.8 volts to the pulse modulated decay drive (Z10). It is also derived from the Keyer Bias voltage so that the decay rate of the Short envelope only affects the first part of the decay.

4.2 Upper and Lower Keyer Boards (Refer to the Upper Keyer Board schematic.)

The Upper and Lower Keyer Boards are almost identical in design. They both use the same printed circuit layout but are assembled with slightly different component values. The Upper Keyer Board is assembled to key only 36 notes and the envelope decay resistors are scaled to produce short decay times for the higher pitches. The Lower Keyer Board is wired for 37 notes and has a longer decay time for the bass notes. In all other respects, the two boards are the same.

TROUBLE SHOOTING HINTS

Envelope Generators: Often problems assumed to be associated with the keyswitches are actually on the Keyer Board in the Envelope Generator Circuits. These circuits cannot be probed easily since they are very high impedance circuits. Just touching a probe to most of the envelope circuit nodes is usually enough to key the pitch on.

When a problem occurs, use a small scribe or screwdriver as a probe. Touch the damper bar (ground) with one hand and probe with the other (Stay away from the Power Supply!).

(CONTINUED)

Just touching the various nodes in the envelope circuit will be enough to key on the note and, by comparing to adjacent keys, problems can be quickly traced.

CAUTION: Avoid touching the board with your fingers as this will leave salts which can contaminate the surface. Then, in high humidity, notes may bleed through.

NOTE: The 73 keys are numbered 8 through 80 to correspond with the key numbers found on a standard 88-note piano keyboard. Since the keys on the keyboard are numbered this way, the schematic references are to the key numbers on the key. Note that "L" denotes Long, and "S" denotes Short. Therefore, the symbol L37 denotes Long envelope, key number 37 as stamped on the key, not the number from the lowest key.

4.2.1 ENVELOPE GENERATORS

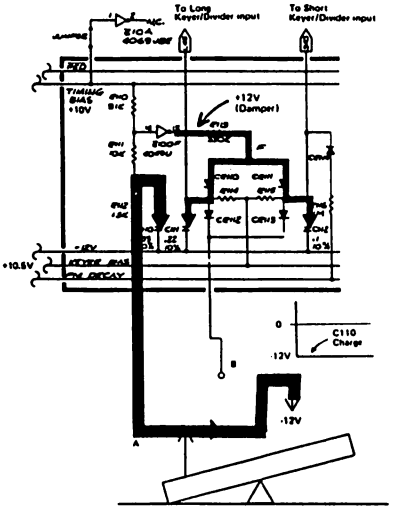
For each key there is an Envelope Generator Circuit which produces two envelopes. All of the Envelope Generators are identical except for the value of the decay resistors. The envelopes are all negative going; that is, they are initially at a high voltage (about +11 volts) and they drop to a negative voltage when a key is struck and then they decay back up to the Keyer Bias voltage of approximately +10.5 volts.

4.2.2 TIME OF FLIGHT MEASUREMENT

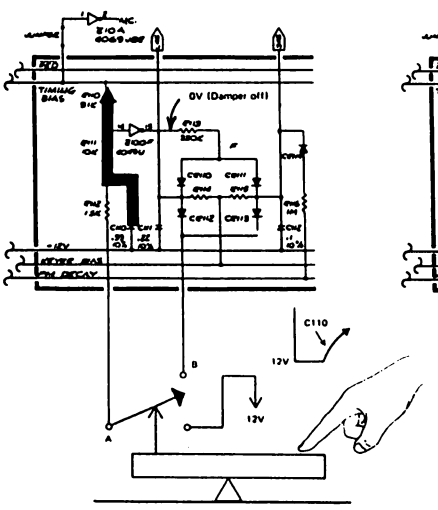
1) When the key is at rest, the key switch holds the timing capacitor T110 at -12 volts through R112. 2) When a key is pressed down, the keyswitch breaks contact with the -12 volts, and the timing capacitor quickly begins to discharge through R111 and R110 to the timiag bias bus (about +10 volts). 3) When the key nears the end of its travel, the key switch makes contact with the B contact and the rest of the charge on the timing capacitor, which is proportional to the time elapsed since it left the -12 volt contact, is then deposited on the envelope capacitors C111 and C112, through diodes CR112 and CR113. Rapidly struck keys will deposit a more negative peak voltage on the two envelope capacitors and thus produce louder notes. Softly played keys will produce a small negative peak voltage on the envelope capacitors.

The envelopes which are generated by C111 and C112 are directly connected to the envelope inputs of the Keyer/Divider chips (Z1, 2, 3 and 4). These inputs are very high impedance and have no effect upon the discharge rate of the envelope capacitors. The more negative the voltage on these inputs, the larger the audio signal on the output of the Keyer/Divider chips.

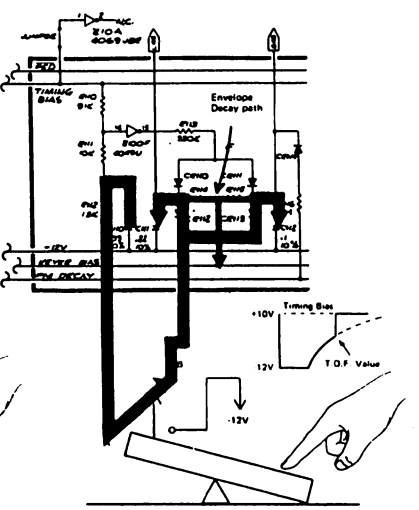
C111 is the Long envelope generator capacitor and its decay path is through R114. In the bass region of the Lower Keyer Board where very long decay times are required, the value of this resistor is 33 megohms. On the treble end of the Upper Keyer Board the value is 3.9 megohms. C112 is the Short envelope capacitor and its decay path is through R115. The pulse modulated decay line (PMD) provides an additional discharge path for C112 through diode CR114 and R46. This line provides a high frequency pulse to discharge the Short envelope capacitor more quickly for some of the voices. The PMD line has one of four values; 0 volts, 25% duty cycle pulse, 75% duty cycle pulse or +10 volts. These signals are generated on the Power Supply PC Board.



1. KEY AT REST



2. KEY IN MOTION



3. KEY DOWN ("STRIKE")

Z100F and R113 provide the damping function for the envelopes. The input of Z100 is connected to the timing capacitor via R111 to monitor its voltage level. R111 and R110 are scaled so that when the timing capacitor is at -12V (indicating the key is at rest), the output of Z100F is a logic 1 (about +12V). When the output is high, the envelope generators are "damped" or held to this voltage through CR110 and CR111, however, as soon as the key is pressed down and the timing capacitor begins to charge towards +10 volts, the output of Z100F goes low, thus having no effect on the decay rate of the envelope generators. When the Sustain Pedal is depressed, the power supplied to all of the damper buffers (Z100, etc.) is removed to allow all of the notes to decay without any damping action.

4.2.3 KEYER/DIVIDER CIRCUIT

On each Keyer Board there are two pairs of Keyer/Divider chips. Z1 and Z2 are for the Long divider chain and Z3 and Z4 are for the Short divider chain. Each of the Keyer/Divider chips have six audio inputs for six of the twelve pitches in an octave. These pitches are supplied by a top octave synthesizer chip (either Z1 or Z11) which derives the 12 master frequencies in an octave from the upper Short clock (USCLK) and the upper Long clock (ULCLK). Inside the chip, these six pitches are divided down and connected to internal keyers. When a negative voltage is supplied to the envelope inputs of the Keyer/Divider chips, square waves are gated out on the 8', 4' and 2' audio outputs.

The three audio outputs from the Keyer/Divider chip are supplied to very low input impedance buffers to limit intermodulation distortion between keys. The outputs of the buffers (Z4, 5, and 14) are sent over to the Voice Board.

4.3 Voice Board

TROUBLE SHOOTING HINTS

All of the audio signals on the Voice Board are percussive, and most are polyphonic. Therefore, it is very difficult to probe the audio paths and be sure that what is displayed is in fact what it seems to be.

A more effective technique for trouble shooting problems associated with the audio paths on the Voice Board is to construct an audio probe. (See Audio Probe diagram)

Connect the probe to a power amp (one with a fair amount of gain), and hold the mute switch while you connect the probe to the circuit. Remember that all of the audio on the Voice Board is referenced to +6 volts and will cause a loud "POP" if you forget to use the mute switch.

(CONTINUED)

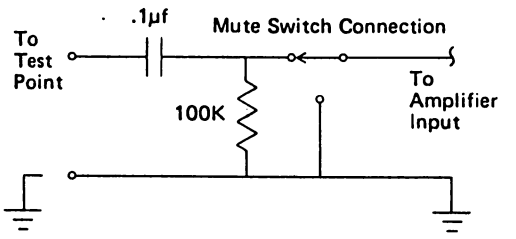
To trouble shoot, start at the 8', 4' and 2' signals from the Keyer Boards and work your way through the test points. Refer to the voice flow charts on page 21 - 36.

NOTE: THE FOLLOWING TEST POINTS ARE SUMMING JUNCTIONS AND ARE ONLY USED AT THE FACTORY. THESE TEST POINTS SHOULD BE DISREGARDED.

TP1, TP3, TP4, TP5, TP10, TP11, TP12

Usually, the presence of a signal on a test point means the circuit is working properly. Compare upper and lower keyboard test points if in doubt (e.g., compare TP7, upper keyboard, and TP6, lower keyboard, to see if they are similar).

AUDIO TEST PROBE



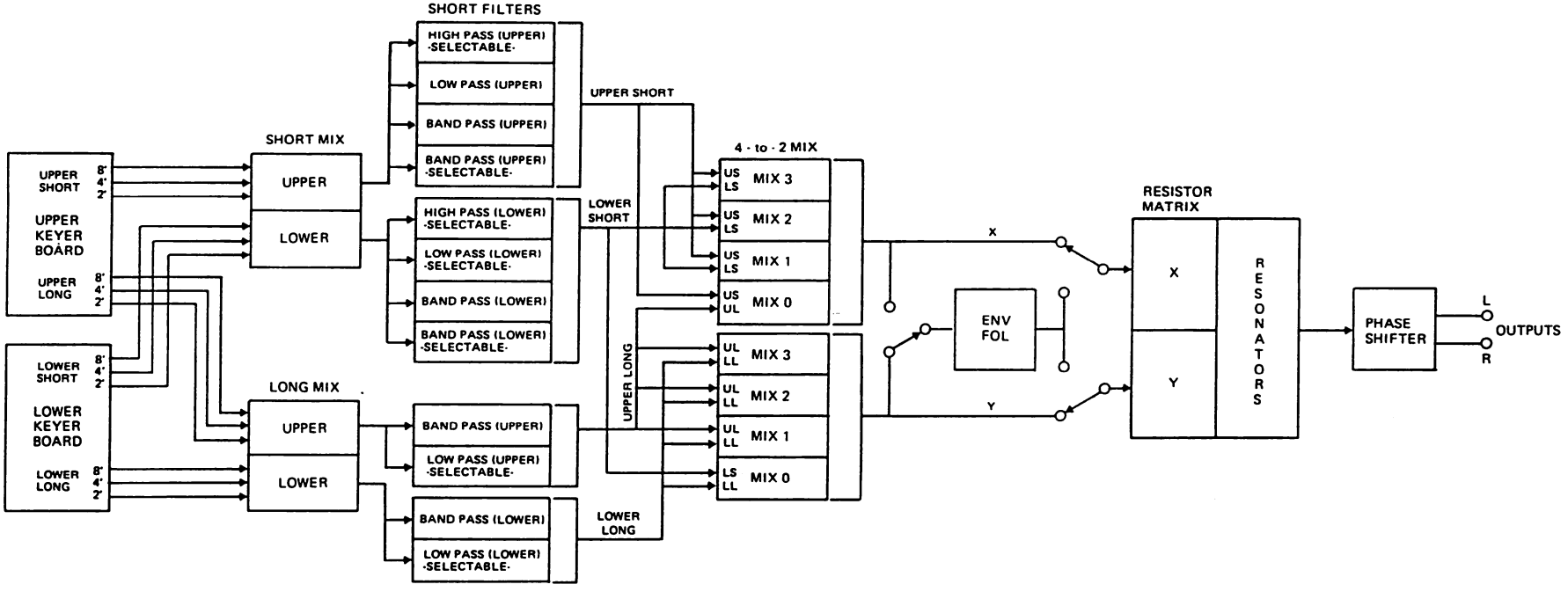
4.3.1 SIGNAL FLOW

Although the mixtures, signals and filter settings are different for each voice in the instrument, all voices share a similar signal flow. Each of the four groups of three signals coming from the Keyer Board are mixed together and prefilterd, resulting in four signals: Upper Short, Upper Long, Lower Short, and Lower Long (US, UL, LS, LL). Each of these four signals is filtered once again and then sent to a 4-to-2 mix circuit. The two outputs from this circuit are then set into the resonator bank which has one audio output. This output is processed through the phaser circuit which has stereo output.

4.3.2 SHORT MIX CIRCUIT

The Short Mix Circuit combines the three footages (8', 4' and 2') from the Upper and Lower Keyer Boards in one of four different weightings and com-

VOICE BOARD SIGNAL FLOW



binations. For some of the voices, these signals are mixed and sent directly to the Short Filter Circuit. For others,the signals are individually filtered before they are mixed by C3, 5, 7, 9 and 11. The following chart lists the different possible combinations.

Z1 Address Code (14) A	(15) B	Z1 Mix Selected	Footage Combination	
0	0	0	2', 4', 8'	Prefiltered
0	1	1	2', 4'	Prefiltered
1	0	2	2'	Prefiltered
1	1	3	2', 4'	Unfiltered

Z2 is the mixing Op amp for the Short Mix Circuit. Z3A and Z3B attenuate the outputs of Z2 when the soft pedal is depressed which lowers the amount of Short signal in the final mix.

4.3.3 SHORT FILTERS

In all, there are 8 different filters in the Short Filter Circuit. Four are used for the upper half of the keyboard and four for the lower half. Z7 is the high-pass filter with a switchable cutoff frequency. Z8 and Z9 are fixed band-pass filters and Z11 is a low-pass filter, also with a switchable cutoff frequency. The outputs from the Short Mix are sent to all four of these filters but only one is selected at a time by Z12. The following chart lists filters and their approximate frequencies:

Z12A Address Code (03) A	(04) B	Filters Selected	Filter OPAMP Ref. No.		
0	0	0	Z11A	Low Pass	2.7KHz or 1.87KHz (02)
0	1	1	Z8A	Band Pass	715Hz
1	0	2	Z9A	Band Pass	2.2KHz
1	1	3	Z7A	High Pass	1KHz or 4.3KHz (02)

Z12B (03) A	(04) B				
0	0	0	Z11B	Low Pass	2.75KHz or 889Hz (02)
0	1	1	Z8B	Band Pass	889Hz
1	0	2	Z9B	Band Pass	2.23KHz
1	1	3	Z7B	High Pass	1KHz or 4.3KHz (02)

Two outputs from the Short Filter Circuit are sent to the 4-to-2 Mix Circuit (see the voice flow charts for the signal flow for each voice).

4.3.4 LONG MIX AND LONG FILTERS

The Long Mix Circuit combines the Long 8', 4', and 2' signals from the Upper and Lower Keyer Boards. Unlike the Short Mix, the signals are always pre-filtered. Z5A sums the Upper Long signals and Z5B sums the Lower Long signals. The following chart lists various selections available.

Code Line (16)	(17)	Footage Selected (Long)	
0	0	8'	Prefiltered
0	1	8', 4'	Prefiltered
1	0	8', 2'	Prefiltered
1	1	8', 4' 2'	Prefiltered

In the Long Filter Circuit there are only four filters; two for the upper keyboard and two for the lower keyboard. Z13A and B are band-pass filters and Z16A and B are low-pass filters with selectable cut-off frequencies. The following chart lists their approximate frequencies.

UPPER LONG FILTERS

Code 05	06	07	OPAMP	FILTER TYPE
X	X	1	Z13A	Band Pass, 496Hz
0	0	0	Z16A	Low Pass, 329Hz
0	1	0	Z16A	Low Pass, 703Hz
1	0	0	Z16A	Low Pass, 723Hz
1	1	0	Z16A	Low Pass, 1.5KHz

LOWER LONG FILTERS

X	X	1	Z13B	Band Pass, 492Hz
0	0	0	Z16B	Low Pass, 277Hz
0	1	0	Z16B	Low Pass, 283Hz
1	0	0	Z16B	Low Pass, 604Hz
1	1	0	Z16B	Low Pass, 1.29KHz

Z7A selects either the low-pass filters or the band-pass filters and routes the signal to the 4-to-2 Mix Circuit.

4.3.5 THE 4-TO-2 MIX CIRCUIT

The outputs of the Short and Long Filter Circuit are mixed together in the 4-to-2 Mix Circuit. For some of the voices, the Upper and Lower Short signals are combined. For others, the Long and Short signals for each half of the keyboard are combined. One of the signal paths inserts a special equalizer circuit (Z18B) which is used on voices P, 2 and 9 after the Short and Long signals have been combined. The following chart illustrates the combinations:

Z19A "X" Mixdown

Address (00) A	(01) B	Mix Output	Signals Combined
0	0	0	Upper Short, Upper Long
0	1	1	Upper Short, Lower Short
1	0	2	Upper Short, Lower Short
1	1	3	Upper Short, Lower Short

Z19B "Y" Mixdown

0	0	0	Lower Short, Lower Long
0	1	1	Upper Long, Lower Long
1	0	2	Upper Long, Lower Long
1	1	3	Upper Long, Lower Long

Z20 sums the two signals and sends them to the resonator circuit via the envelope follower circuit.

4.3.6 ENVELOPE FOLLOWER CIRCUIT

For voices P through 13, the Envelope Follower is not used and the two signals (X and Y) are routed around the circuit via Z35 and Z36 (See the voice flow charts for the signal paths). CR5, 6, and 7 decode the voice code so that there is a logic 0 on Z36, pin 9, only for voices 14, 15 and 16, thus routing the outputs of the Envelope Follower directly to the resonator bank. The Envelope Follower can process either the X or the Y signal from the 4-to-2 Mix Circuit (selected by Z35A) but not both.

The Envelope Follower is a two pole, band-pass filter whose resonant frequency is determined by two LDRs (Light Dependent Resistors) which are inside of photo module PM1. Z36C decreases the resonance of the filter on voice 14 (only).

4.3.7 ENVELOPE FOLLOWER CONTROL CIRCUIT

Two 2' Short audio signals are taken directly from the Keyer Boards and filtered by CR1 and C1 in the Short Mix Circuit and are used to generate an envelope to sweep the filter. This envelope is sent to Z32B and the Envelope Follower Control Circuit which powers the LED and PM1. This LED, in turn, "sweeps" the envelope filter at the decay rate of the 2' audio. R169 sets the sensitivity of the Envelope Follower.

4.3.8 RESISTOR MATRIX AND RESONATOR BANK CIRCUITS

The Resonator Bank consists of 6 band-pass filters, tuned to 125Hz, 250Hz, 500Hz, 1KHz, 2KHz and 4KHz. A "straight" unfiltered signal path is also available. The voice code generated by the control panel addresses four demultiplexers (Z1 through Z4) on the Resistor Matrix Board which routes the X and Y signals from the 4-to-2 Mix Circuit to resistors which set the amount of signal going to each band-pass filter in the Resonator Bank (see the voice flow charts for signal paths). Z49B sums the outputs of the resonators and sends it to the phasor circuit via the volume and tone controls on the control panel (tone feed J11-1).

4.3.9 PHASE SHIFTER

The Phase Shifter operates in two modes. 1) When the phasor is turned on the control panel, it provides traditional phasor effects (deep notches and high resonance peaks), 2) when the phasor is off, it provides a subtle stereo animation by slowly sweeping with shallow notches and no resonance. The phasor always processes the audio signals, whether it is turned on or off by the control panel.

The output of the Resonator Bank is sent to Z30B which drives 6 phase shift stages. The amount of phase shift is varied by 5 LDRs (Light Dependent Resistors) inside a photo module PM2. The resistance of these LDRs is determined by the control LED in PM2, which is driven by the Phasor Control Circuit. When the phasor is turned off on the control panel, the output of the phase shift stages are routed through Z54C to the left audio output. The right channel receives a straight unphased signal through R228 and R54A. The mono output is a combination of straight phased outputs. Also the resonance feedback path is broken by Z36A. When the phasor is turned on, the left output has both straight and phased signals summed along with the resonance feedback. The right and mono outputs are the straight and phased signals averaged together in different amounts. The resonance feedback path is through Z55B, the resonance control on the control panel, Z36A and Z30A (which inverts the signal).

4.3.10 PHASOR CONTROL

A low frequency triangle wave is supplied to the Phasor Control Circuit from the control panel. C72 filters the triangle wave (and causes it to decrease in amplitude at higher speeds). Z32A drives CR8 through 12 to simulate an exponential response. This response is desirable to create an even sweep effect to the ear as the LFO oscillates. The LED and Photo module PM2 are driven by Z33B. It establishes the resistance of the 6 LDRs in the Photo module. One of the LDRs (PM2B) is on the input of Z33A, providing an effective feedback path from the output of Z33B to the input of Z33A. In this configuration, the resistance of PM2B will be automatically adjusted to be inversely proportional to the current supplied by Z32A, thus establishing the phasor tuning. As the LFO from the control panel oscillates, the LED and PM2 increase and decrease the resistance of all 6 LDRs in the Photo module, thus varying the amount of phase shift.

4.3.11 +6 VOLT POWER SUPPLY

All of the audio circuits on the Voice Board, with the exception of the Output Amplifiers and Headphone Circuit are referenced to +6 volts instead of ground. The +6 volts is supplied by Q11, 12 and 13. This voltage reference is used to keep the audio signals between the power supply voltages supplied to all of the CMOS switches (Ground and +12V).

4.3.12 OUTPUT AMPLIFIERS

The three audio outputs from the Phasor Circuit are supplied to the output buffers (Z56 and Z57A) through N channel FETs (Z55). These FETs turn off the audio when a voice is selected and during power up and power down to mute the outputs. The external audio inputs are supplied to the left and right output amplifiers. The three output buffers are referenced to ground, as is the headphone amplifier. Note that the ground path for the headphones is not from the Voice Board; ground is supplied to the voice panel via the green ground cable from the power supply panel.

4.3.13 MUTE CIRCUIT

The Mute Circuit controls the FETs which interrupt the audio output of the instrument when the voices are changed or when the instrument is turned on or off. During a voice change, a strobe pulse is generated by the control panel which momentarily turns on Q5, which turns off the 3 FETs. When the instrument is first turned on, the voltage supplied from the power supply on P9-6 (power sense) begins to rise. R146 and C70 slow down the rise of the voltage, thus preventing the output from turning on immediately. CR4 is a quick discharge path to turn off the 3 FETs fast, when the power is turned off.

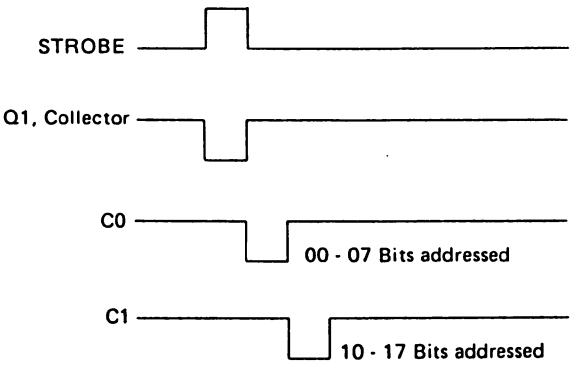
4.3.14 ROM LATCHES AND ROM LATCH CONTROL CIRCUITS

The signal paths and the filter settings for each of the 16 voices in the instrument are stored by a Read Only Memory (ROM, Z22). A total of 16 lines is used to set the different parameters of the instrument. Since 16 lines are necessary to program the instrument and there are only 8 outputs on the ROM (Z22), 8 output states are read out of the ROM at a time, then they are stored by a latch (Z27). The ROM is immediately addressed again and the second 8 output states are stored in latch Z9, thus storing the total of 16 lines. Once the 16 lines are stored, the ROM is no longer needed and the power to it is turned off, since the device draws a lot of current.

Controlling the access of information stored in the ROM is a strobe pulse and a 4 bit (4 line) address code provided by the control panel. These signals are generated each time a new voice is selected or when the instrument is first turned on. The voice code from the control panel is actually the complement of the code which is used by the ROM. The code is inverted by Z21. The following chart lists the codes for each voice.

VOICE	CODE	CODE COMPLEMENT (From Panel)
P	0000	1111
2	0001	1110
3	0010	1101
4	0011	1100
5	0100	1011
6	0101	1010
7	0110	1001
8	0111	1000
9	1001	0111
10	1001	0110
11	1010	0101
12	1011	0100
13	1100	0011
14	1101	0010
15	1110	0001
16	1111	0000

When the strobe from the control panel is generated, it momentarily turns on Q2 in the ROM Latch Control Circuit to clock Z31A. Z31A and Z31B are 1-shot pulse generators and have a pulse duration of about 3 microseconds. The output of Z11A in turn clocks Z11B, thus producing two pulses (C0 and C1, sequentially). The first pulse (C0) is used to clock Z27 in the ROM Latch Circuit, which latches the first 8 data lines. The second signal (Z1) is used to clock the second latch (Z28) which stores the second 8 data lines. The C1 pulse is also used as th MSB (Most Significant Bit) in the 5-bit code necessary to address the ROM. The other 4 bits are supplied by the control panel. (See the ROM truth table in the schematic section of this manual.) Z24 and Z25 are used as inverter buffers to drive the latches.



Q3 and Q4 in the ROM Latch Control Circuit are used to supply power to the ROM (+5V) only during the pulses from the 1-shots (Z51A and B).

4.4 Control Panel Board

4.4.1 AUDIO CONTROLS

The output of the Resonator Bank on the Voice Board is sent via the Tone Send line to the Control Panel. There, the tone control (R2) boosts or cuts

the treble and the volume control attenuates the signal. The Tone Return line sends the signal back to the phasor input on the Voice Board.

4.4.2 TUNING CONTROLS

The Master Tune Control supplies a voltage between +12 and -12 to the CV input of the high frequency VCO on the supply via the tune line (P10-15). If selected, the vibrato triangle wave is supplied to the tune line also.

4.4.3 VIBRATO LFO, SWITCH

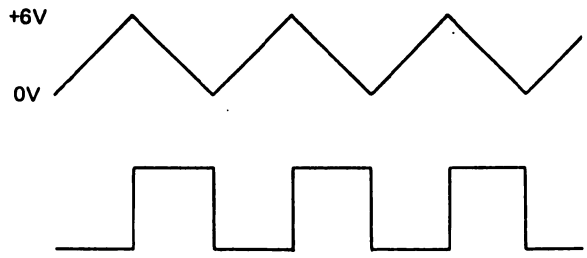
Z3A and Z3B are a low frequency oscillator which produces a square wave and a triangle wave. Its frequency varies between 3 and 7Hz , depending on the setting of the speed control. R7, the vibrato speed control, varies the current supplied to integrator Z3A and thus sets the frequency. The square wave output is supplied through R33 to the Trill line. It is used only for voice 5, to create the trill effect. The triangle output of the vibrato LFO is supplied from Z3A, Pin 1, through the vibrato depth control (R8) to the input of the vibrato VCA (Z5A, B and Z9B). This VCA is used to slowly turn on the vibrato when the left foot pedal is depressed, thus insuring that the vibrato does not abruptly snap on when it is selected.

When the vibrato on/off line from Z13F and 12 goes low, Q6 turns off and C6 begins to discharge through R43 toward -12 volts. As the voltage on C6 goes more negative, more current is drawn through the vibrato VCA via R42 and the vibrato triangle wave is gated out to the Tune line. Z5E is turned off, which allows the vibrato LED (CR20) to light when the vibrato on/off line is low (0V).

4.4.4 PHASOR LFO

The Phasor LFO operates in two modes. When the phasor is turned off, it oscillates at about .2Hz and its speed is not controllable. When the phasor is turned on, speed is increased to between .1 and 6.3Hz, depending on the speed control setting.

The Phasor LFO is not unlike the vibrato LFO. Z1A is an integrator which supplies a rising or falling voltage (a triangle waveform) to a hysteretic switch composed of Z1B and Z6A. Z6A is used to provide accurate output voltage of either 0 or +12 volts which is necessary for precision control of the LFO output swing. The hysteretic switch is set to switch at +5.9 volts when the voltage on Z1A, Pin 1, is rising and 0 volts when it is falling.

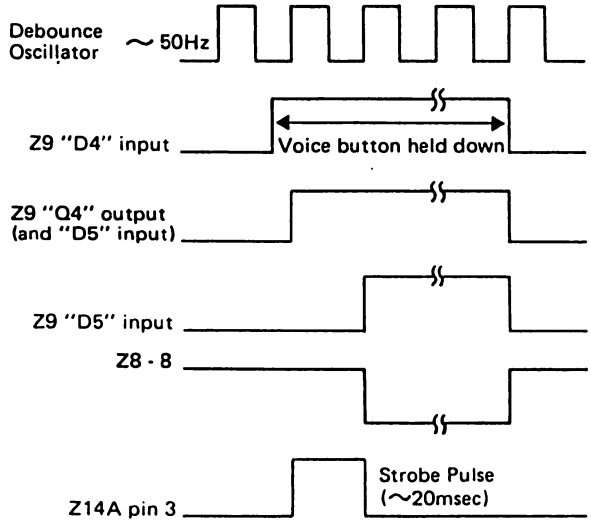


When the phasor is turned on, the P signal from the Switch Latch Circuit is high (+12V) and the P signal is low. This turns on the N and P channel FETs connecting the phasor speed control to the input of integrater Z1A. Z5D is also turned off enabling CR7 to light. When the phasor is turned off, R10 is connected to the input of Z1A, setting a fixed speed. Z4A generated +6 volts as a reference voltage so that the circuit is compatible with the Voice Board circuitry.

4.4.5 VOICE SELECT LOGIC AND DEBOUNCE LOGIC

This circuit debounces and latches the state of the 19 switches on the control panel, lights the indicator LEDs, generates a strobe pulse for the Voice Board ROM Circuit, and processes the left foot pedal control signal. The 16 voice switches are arranged in a 2 by 8 matrix (voices P through 8 and 9 through 16). Q1 senses whether the voice being pressed is in the upper or lower bank; the collector Q1 is low when voices P through 8 are pressed and high (+12V) when voices 9 through 16 are pressed. The 8 switch lines from the control touch panel are connected to an encoder (7 through Z7) which reduces the 8 lines to a 3-bit code. This 3-bit code and the bank code from Q1 make up the voice code. This code is supplied to latch Z8. (See the voice code chart on Page 20.)

NEW VOICE STROBE PULSE GENERATION



To be sure that signals from the control panel are valid, a free running debounce oscillator (Z13A, B and C), oscillating at approximately 50Hz, clocks latch Z9. One of the lines on the input of this latch is from the encoder (Z7, Pin 14, GS line). This line goes high whenever there is a signal present on any of the inputs from the switches (thus indicating a voice button is being pressed). When a button is pressed and when the debounce oscillator clocks a high into the 'D4' input of Q9 (Pin 13), the next clock signal from the debounce oscillator produces a high on the 'Q5' output, then clocks the voice code latch Z9. The voice code is thus stored.

Z10A and Z10B decode the voice code to a 4 by 4 matrix of LEDs to indicate the voice which has been selected. The complement of the voice code (Q0, Q1, Q2 and Q3) is sent to the Voice Board.

4.4.6 PHASOR ON/OFF

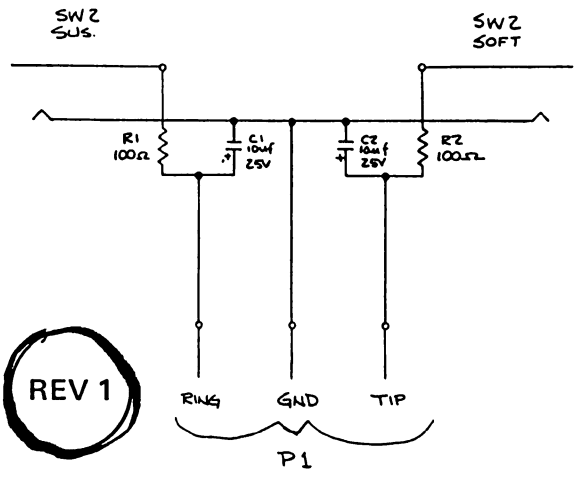
When the phasor button is pressed, a high is sent to the 'D' input of latch Z12A. This latch is also clocked by the debounce oscillator. The output of the latch is sent to flip/flop Z12B, which toggles up alternately high or low (Phasor on or off). The P and $\overline{P}$ outputs are sent to the Phasor LFO Circuit and the P signal is sent to the Voice Board on P10, pin 10.

4.4.7 VIBRATO ON/OFF

When the Vibrato button is pressed, +12 volts is supplied from J12, Pin 3, to the 'D2' input of latch Z9. When the debounce oscillator clocks Z9, a high is sent out on 'Q2' (Z9, Pin 7) to toggle flip/flop Z16B alternately high or low. The output of Z16B drives Z13F through Z15D to turn on the vibrato.

4.4.8 PEDAL AND VIBRATO LOGIC

The left foot pedal can be assigned by the control panel to either turn on the vibrato or to act as a 'soft' pedal. When the Pedal Select button is pressed, +12 volts is supplied to 'D3' (Pin 11) of the Z9. The debounce oscillator then clocks a logic 1 to 'Q3' (Pin 10) output which toggles Z16A. This signal is also sent via Z15C to reset the vibrato on/off flip/flop Z16B to the "off" state. If the output (Pin 1) of Z16A toggles high, then the red LED (CR19) lights to indicate the vibrato pedal function is selected. Pin 12 of Z14B is high, and when the left pedal is depressed so that +12 volts from P10, Pin 9, is also high, the output of Z14B also goes high, thus turning on the vibrato through Z15B and Z13F. When Z16A, Pin 1 is low (soft mode), Pin 2 of Z13F is high, which lights the green LED. This enables Z14C to gate the pedal signal to the Voice Board. Z16A is reset to the 'soft' state whenever the vibrato flip/flop Z16B is toggled via Z15B.



SCHEMATIC, PEDAL ASSEMBLY

4.4.9 STROBE (DEBOUNCE LOGIC)

A strobe signal is generated for the Voice Board when the instrument is first turned on and whenever a voice is selected. When the power is first turned on, C10 and R66 causes the 'D1' input (Pin 4) of Z9 to briefly rise to a logic 1 state. Once it has reached a high state (above +6V) and the debounce oscillator clocks high to 'Q1' (Pin 5), the output is sent to reset and initialize the phasor flip/flop (C12B) to the off state and the soft/vibrato select slip/flop Z16A to the 'soft' state and the vibrato on/off to the 'off' state. The high on the 'Q1' output of Z9 is clocked on the next debounce oscillator cycle to the 'Q0' output. When this happens, the 'D1' input is low once again and the 'Q1' output is clocked low. This provides a high on the input of Z14B through Z13E so that Z14B's output goes high, creating a strobe pulse. Similarly, a strobe pulse is generated from the outputs of 'Q5' and 'Q4' of Z9 when a voice is selected.

SECTION 5 MAINTENANCE

General

The ARP 16-Voice Electronic Piano is all-electronic so no regular maintenance is required. The following procedures should be followed if a problem occurs.

5.1 Key Actuator Adjustment

ADJUST KEY ACTUATOR WHEN A KEY CONTINUES TO SUSTAIN (AS THOUGH THE "DAMPER" WERE STUCK) WHEN THE KEYS AND THE PEDAL ARE RELEASED.

1. Remove the top cover and top three nuts (only) of the Keyer Board. Gently lift the Keyer Board to gain access to the keyboard action.

2. Identify the faulty key and slightly loosen the actuator screw on the rear of the hammer arm. Gently push the actuator spring in the hammer arm slot toward the rear of the instrument to apply more pressure to the switch. *THE ACTUATOR SHOULD REQUIRE NO MORE THAN 1/16" ADJUSTMENT.*

3. If the problem persists, note the location of the actuator wheel. It should be within the top switch square (see illustration, page 18). If it is above or below this square, remove the key and adjust the capstan screw on the end of the key.

5.2 Switch Replacement Procedure

MOST PROBLEMS WHICH APPEAR TO BE RELATED TO THE KEY SWITCHES ARE ACTUALLY ON THE KEYER BOARDS. REPLACE THE KEY SWITCH ONLY AFTER TESTING THE CONTINUITY OF THE SWITCH WITH AN OHMMETER. (NOTE: CONTACT RESISTANCE IS TYPICALLY BELOW 40 OHMS.)

There are three 18 key switch assemblies and one 19 key switch assembly. The 19 key switch assembly is for the bottom 19 keys. *BE SURE THAT YOU HAVE THE CORRECT KEY SWITCH ASSEMBLY BEFORE STARTING THE REPLACEMENT PROCEDURE.*

1. Remove the top cover, Voice Board and Power Supply printed circuit boards.

2. Remove the six nuts on the front and rear of both Keyer Boards and disconnect the six tail connectors on each Keyer Board.

3. Remove the three switch plate mounting screws, the two retaining bolts, and remove the entire switch assembly.

4. Peel off the defective switch assembly and clean the metal surface with denatured alcohol. BE SURE THE SURFACE IS CLEAN AND FREE OF ANY BUMPS.

5. Peel the backing from the keyswitch and align it with the other keyswitches.

6. Put the switch plate in place on the key bed and insert but do not tighten the three key switch mounting screws.

7. Be sure the rollers are in a line of sight with a deviation of no more than +1/32" vertically and +1/16" horizontally. Adjust as needed.

8. Gently move the switch plate toward the keys until the plate just touches all of the rollers on the keyboard action, then move the plate exactly 3/32" towards the action and tighten the mounting screws. This will put a load of approximately 45grms. on each keyswitch. Replace the two bolts through the switch plate and keybed.

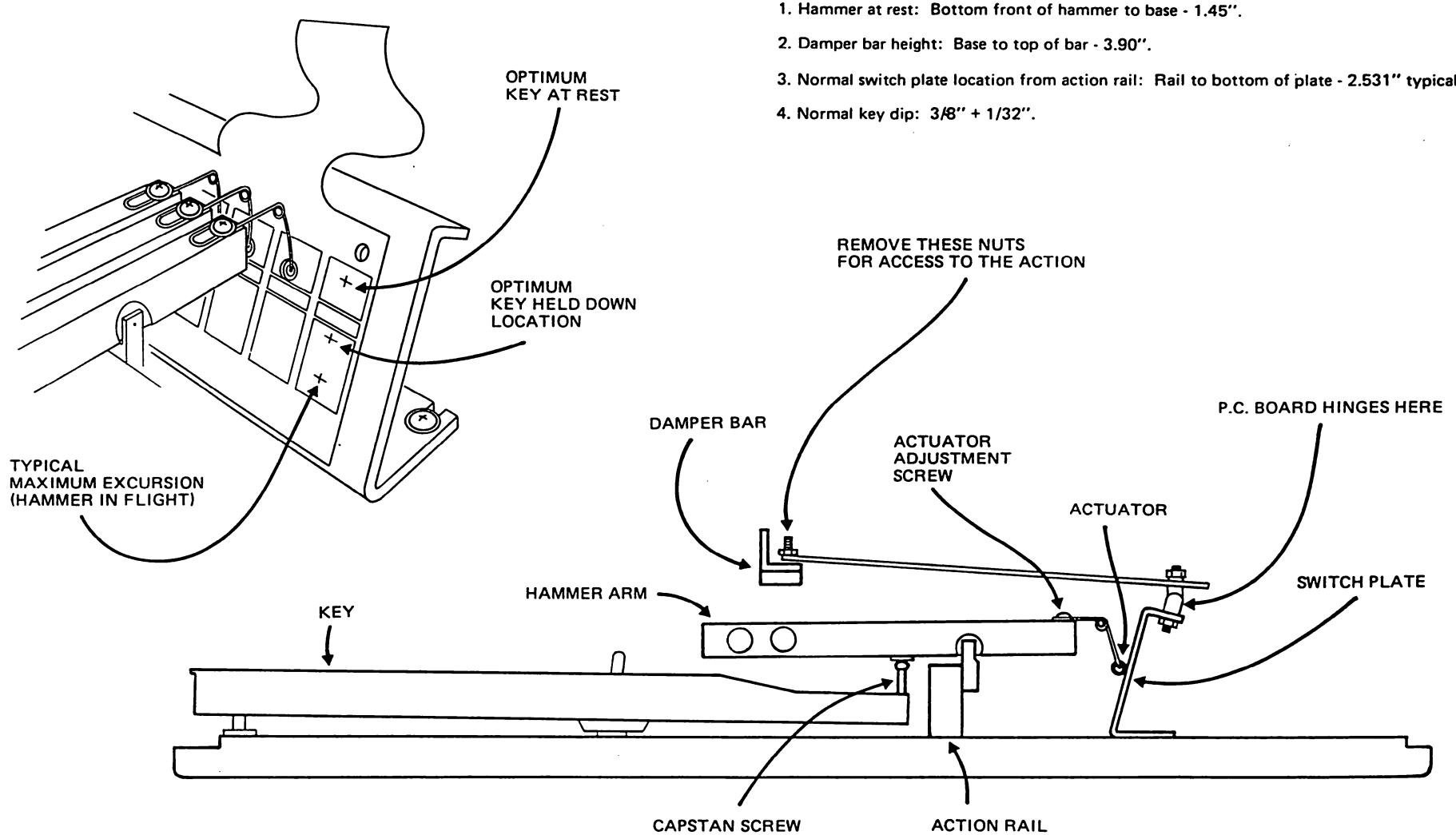
9. Remount the Keyer Boards, carefully insert the 12 switch tails and remount the Power Supply and Voice Boards.

10. Turn on the instrument and test each key. Adjust individual key switch actuators if necessary. See diagram, page 18.

KEY ACTION & SET-UP DIAGRAM

SET-UP SPECIFICATIONS

1. Hammer at rest: Bottom front of hammer to base - 1.45".
2. Damper bar height: Base to top of bar - 3.90".
3. Normal switch plate location from action rail: Rail to bottom of plate - 2.531" typical.
4. Normal key dip: 3/8" + 1/32".



SECTION 6 CALIBRATIONS

6.1 Power Supply Trim Procedures

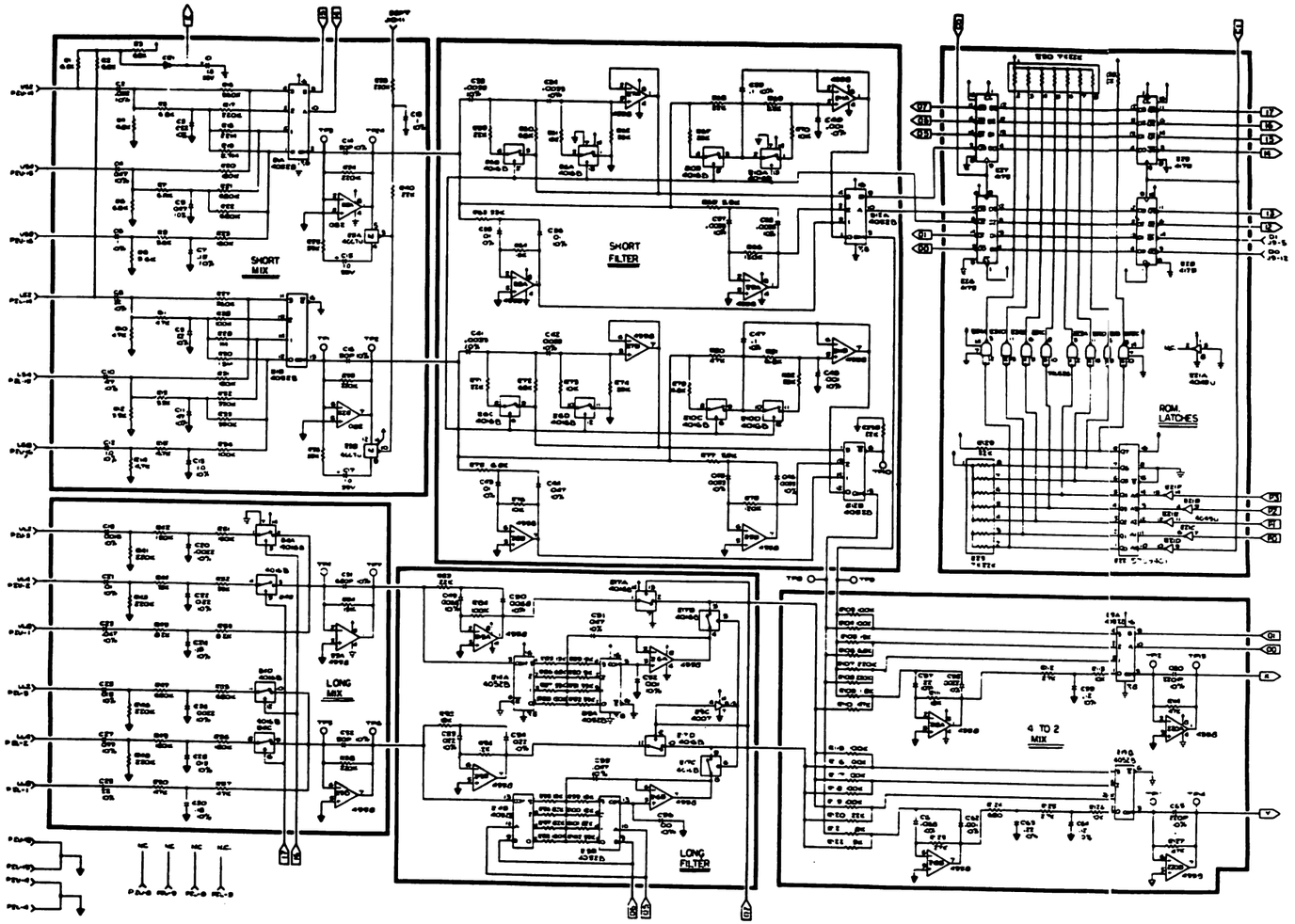
REF.	TRIMMER	TRIM PROCEDURE
R21	Master Tune Calibrate	1. Set the master tune control on the control panel to the 12:00 position. 2. Set the detune control to minimum. 3. Adjust R21 so that middle A is 440 Hz.
R37	Keyer Bias	1. Select voice P and turn the volume up relatively high. 2. Very slowly press several keys and hold them. (DO NOT Press the sustain pedal). 3. Adjust trimmer R37 so that no pitches are heard, then adjust the trimmer so that the notes are just audible. If the trimmer is set so the notes are not heard, it will adversely affect the envelope decay.
R9	Pedal Bias	1. Adjust the keyer bias first. (See above). 2. Do not press any keys. Hold the sustain pedal (Left Pedal) and adjust R9 until all pitches begin to bleed through. Re-adjust the trimmer so the bleed through just stops. (If the trimmer is set too far from the bleed through threshold, it will adversely affect the decay envelope.

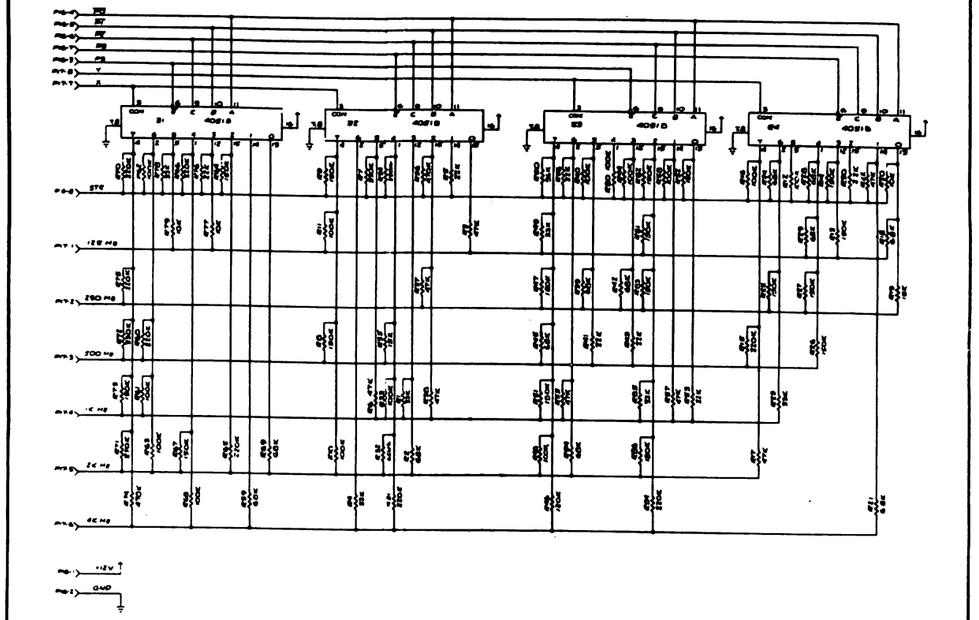
6.2 Voice Board Trim Procedures

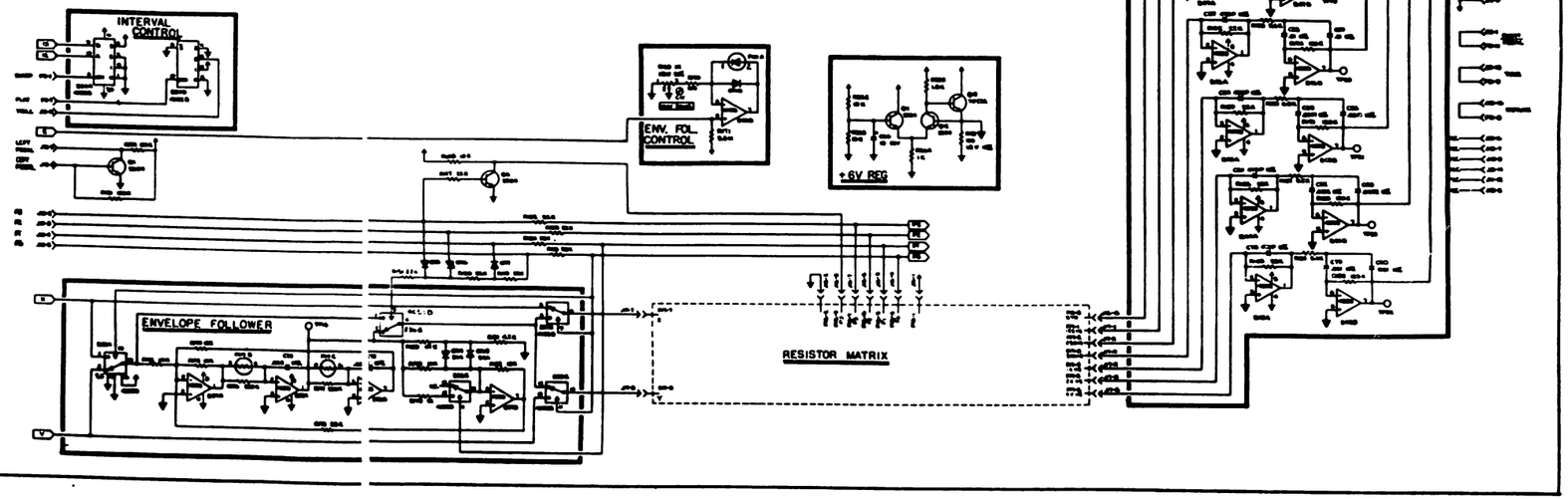
R169	Envelope Sensitivity	1. Select voice 16. 2. Adjust R169 so that envelope effect sweeps fully when a four note chord is played hard. (NOTE: THIS TRIMMER MAY BE ADJUSTED TO SUIT THE USER'S TASTE.)
R205	Phasor Resonance Limit	1. Lower the master volume control to protect the speakers and your ears. 2. Turn on the phasor and turn the resonance fully clockwise. 3. Adjust R205 so that the phasor oscillates and then re-adjust the trimmer to where it just stops oscillating. (This trimmer may also be adjusted to the user's taste, however, this procedure provides maximum resonance range.)

SECTION 7 ROM TRUTH TABLES

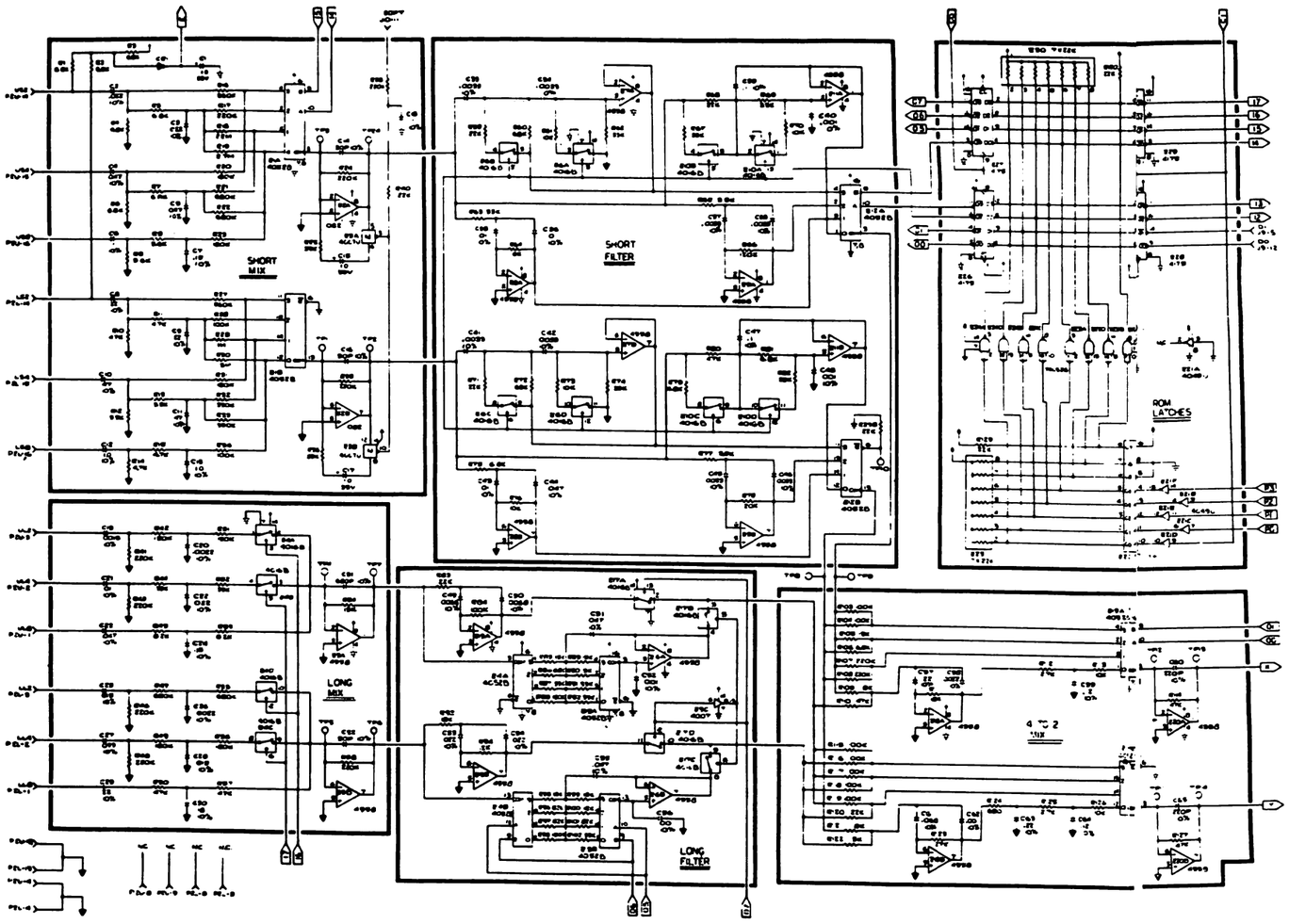
VOICE	BINARY ADDRESS					BINARY DATA														
	VOICE CODE				C0/C1	LONG FILTER SELECT	LONG FILTER FREQUENCY		SHORT FILTER SELECT	SHORT FILTER FREQUENCY	4 - 2 MIX SELECT		LONG MIX SELECT		SHORT MIX SELECT		INTERVAL CONTROL		DECAY SELECT	
	A4	A3	A2	A1	A0	7	A 6	B 5	B 4	A 3	2	B 1	A 0	17	16	B 15	A 14	B 13	A 12	D1 11	D0 10
P	0	0	0	0	0	1	0	0	0	1	0	0	0								
	0	0	0	0	1									1	1	0	0	0	0	0	1
2	0	0	0	1	0	1	0	0	0	1	0	0	0								
	0	0	0	1	1									1	1	0	1	0	1	0	1
3	0	0	1	0	0	0	0	0	0	1	0	1	1								
	0	0	1	0	1									0	0	1	0	0	0	1	1
4	0	0	1	1	0	0	0	1	1	1	0	1	1								
	0	0	1	1	1									0	1	1	0	0	0	0	1
5	0	1	0	0	0	0	0	0	0	1	0	1	1								
	0	1	0	0	1									0	0	1	0	1	0	0	0
6	0	1	0	1	0	0	0	1	0	0	0	1	1								
	0	1	0	1	1									1	0	1	0	0	1	1	1
7	0	1	1	0	0	0	1	1	1	1	1	1	1								
	0	1	1	0	1									1	1	1	0	1	1	0	0
8	0	1	1	1	0	0	1	0	1	1	1	1	1								
	0	1	1	1	1									1	0	1	0	1	1	1	1
9	1	0	0	0	0	0	1	0	0	1	0	0	0								
	1	0	0	0	1									1	0	0	0	0	0	1	1
10	1	0	0	1	0	0	0	0	1	1	1	1	0								
	1	0	0	1	1									1	1	0	0	0	0	1	1
11	1	0	1	0	0	0	1	1	1	1	0	1	1								
	1	0	1	0	1									1	1	1	1	0	0	1	0
12	1	0	1	1	0	0	1	1	1	1	1	1	1								
	1	0	1	1	1									0	1	1	1	0	0	0	1
13	1	1	0	0	0	0	1	1	1	0	0	1	1								
	1	1	0	0	1									1	0	0	0	0	0	0	1
14	1	1	0	1	0	1	0	0	0	0	1	0	1								
	1	1	0	1	1									1	1	0	0	0	0	0	0
15	1	1	1	0	0	0	1	0	1	1	0	1	0								
	1	1	1	0	1									1	1	0	0	0	0	0	0
16	1	1	1	1	0	0	1	1	0	0	1	1	1								
	1	1	1	1	1									1	1	0	0	0	0	0	0

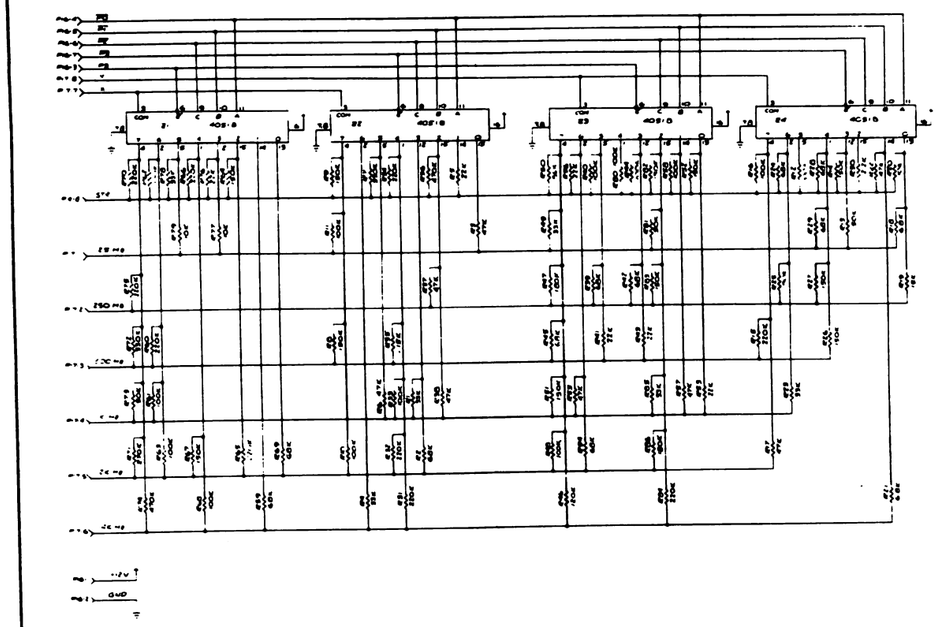


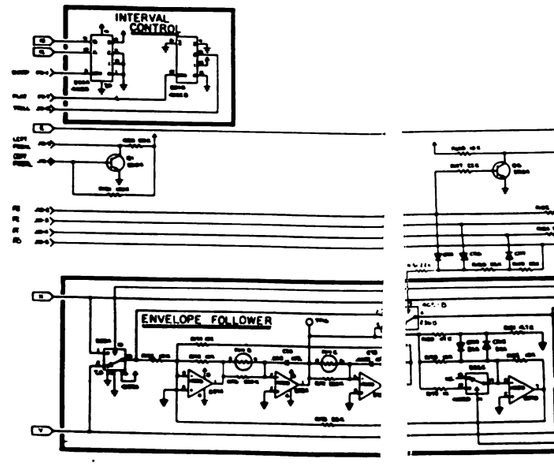


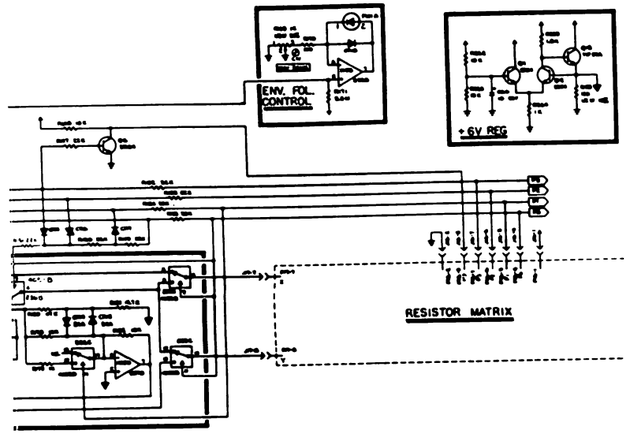


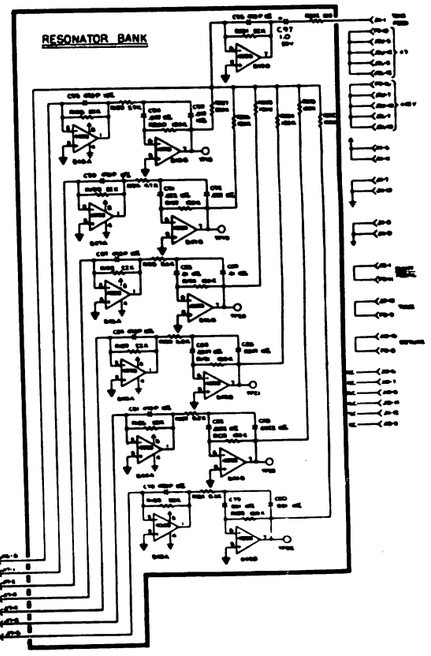
SECTION 8 VOICE FLOW CHARTS

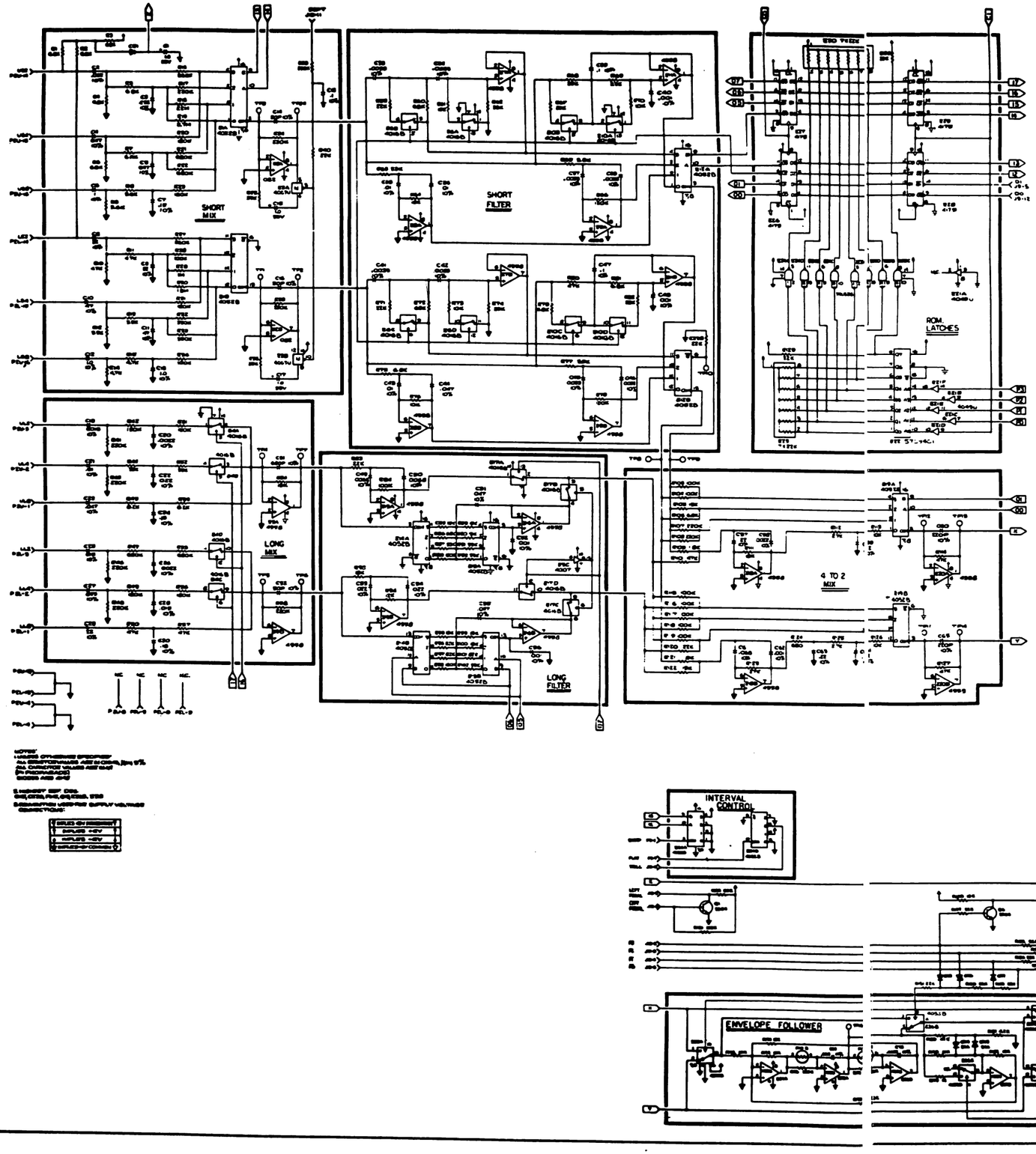












SHORT MIX

SHORT FILTER

ROM LATCHES

LONG MIX

LONG FILTER

4 TO 2 MIX

INTERVAL CONTROL

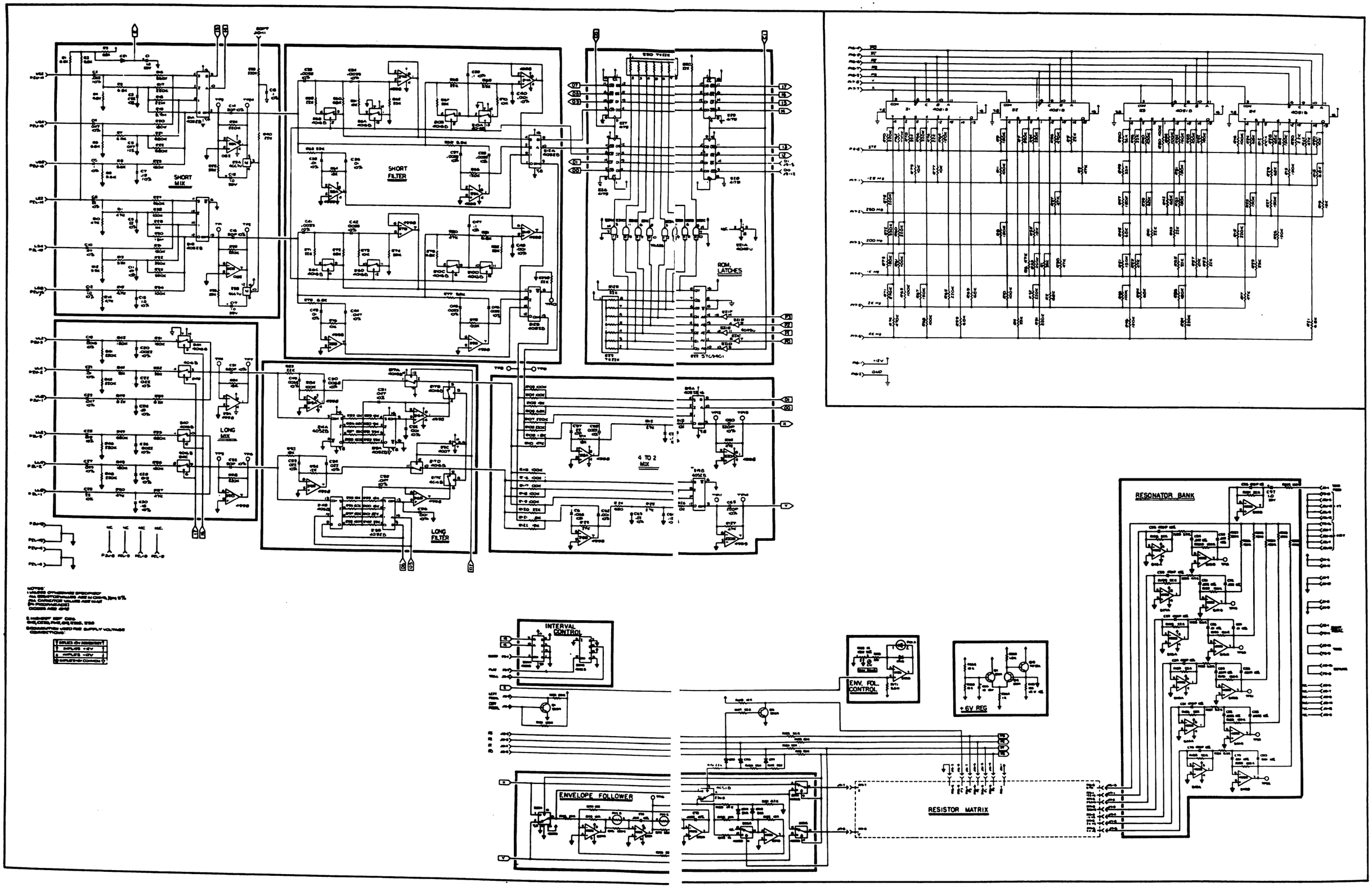
ENV. FOL CONTROL

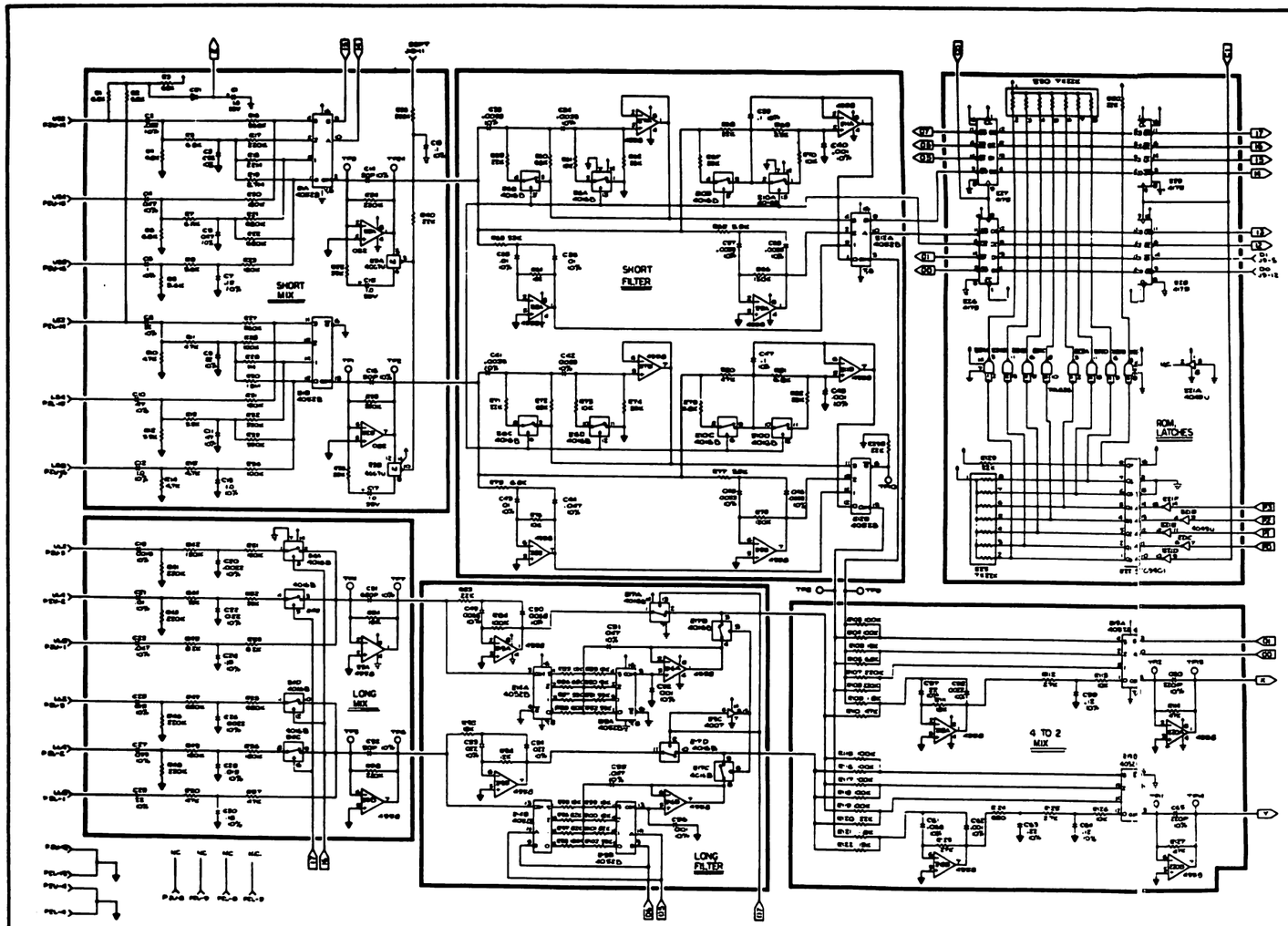
+6V REG

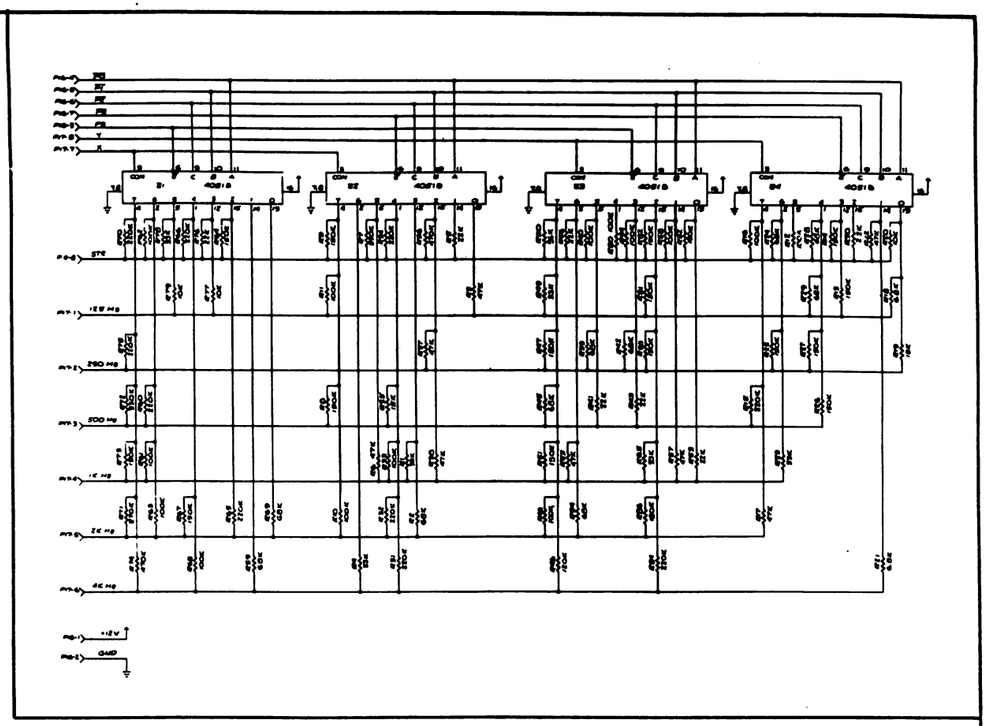
ENVELOPE FOLLOWER

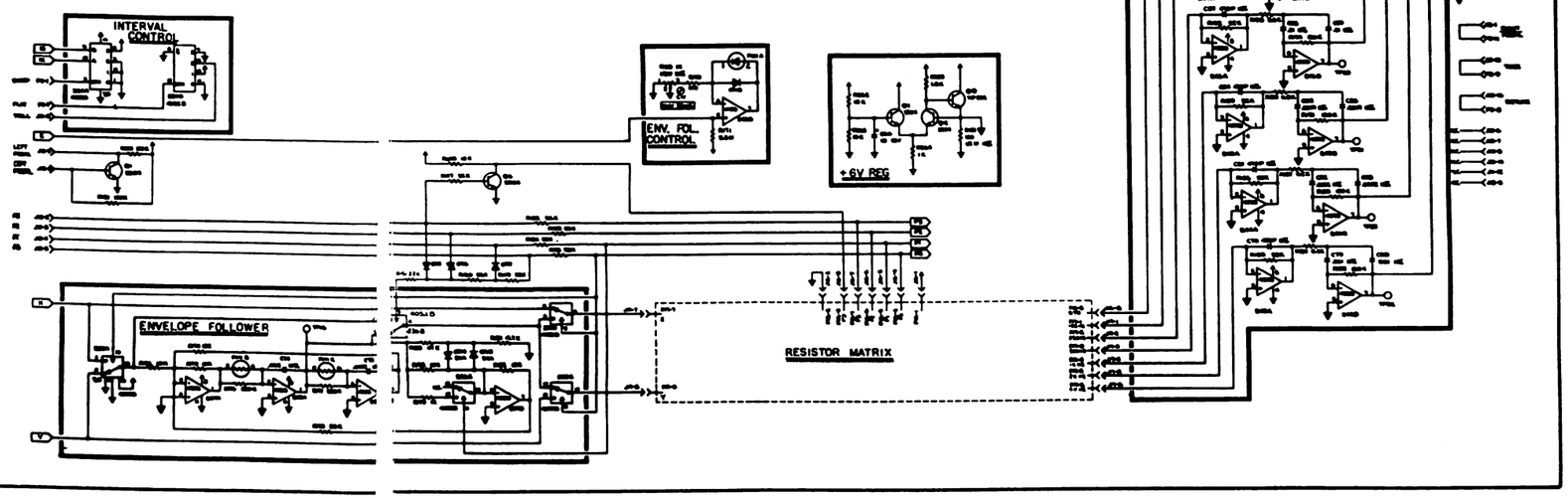
RESISTOR MATRIX

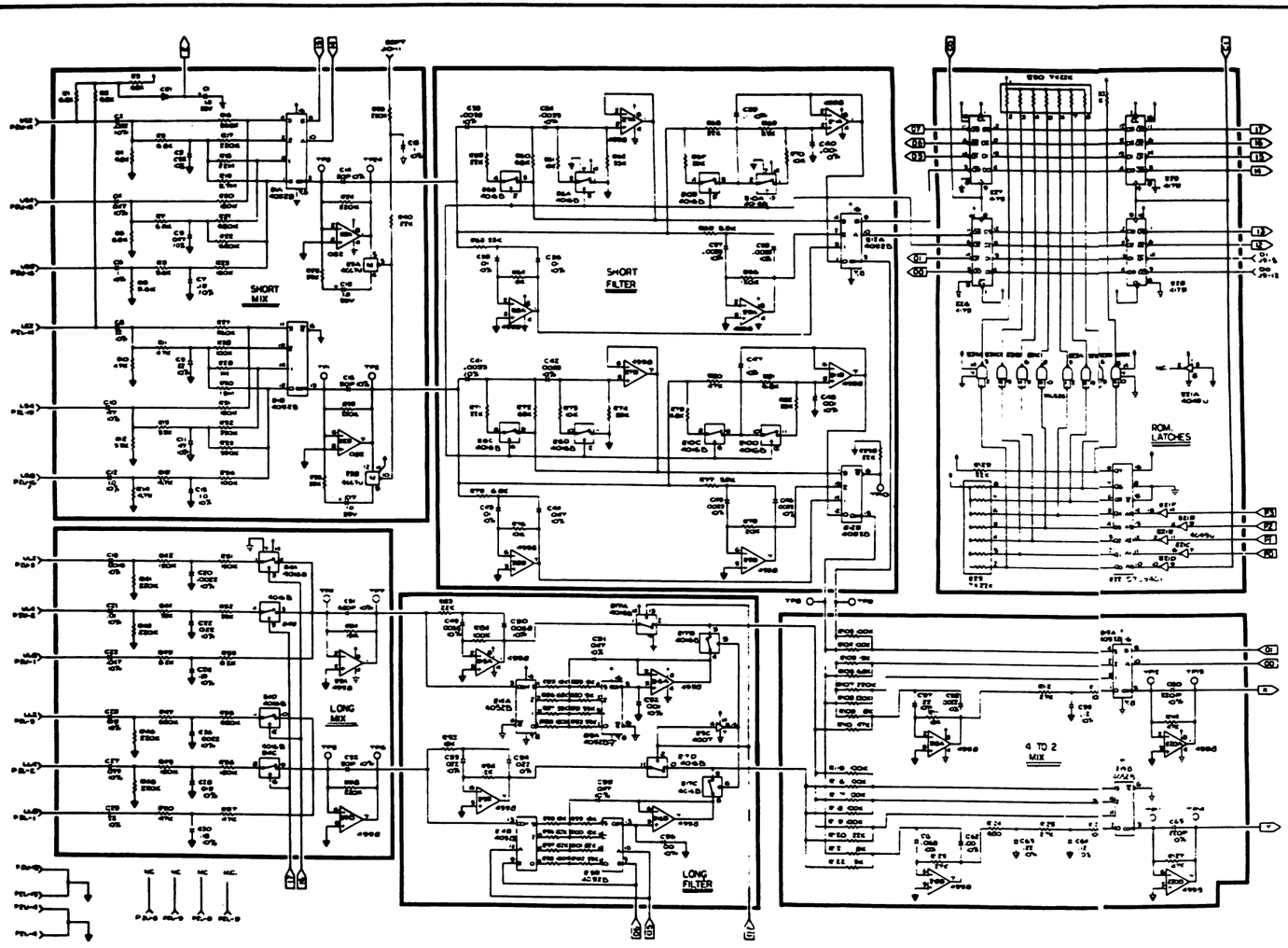
RESONATOR BANK

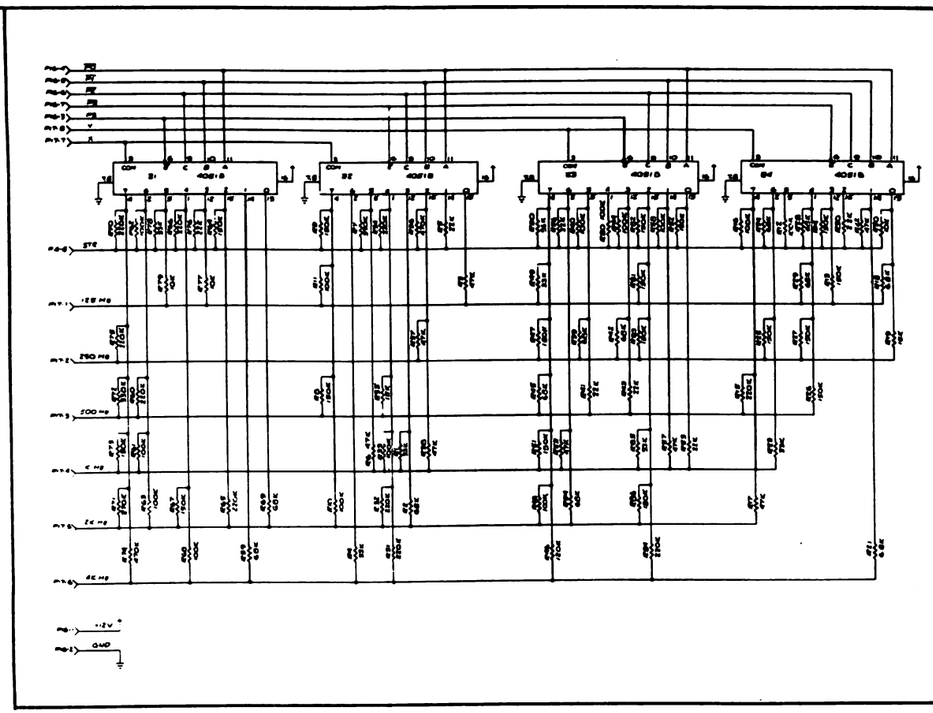


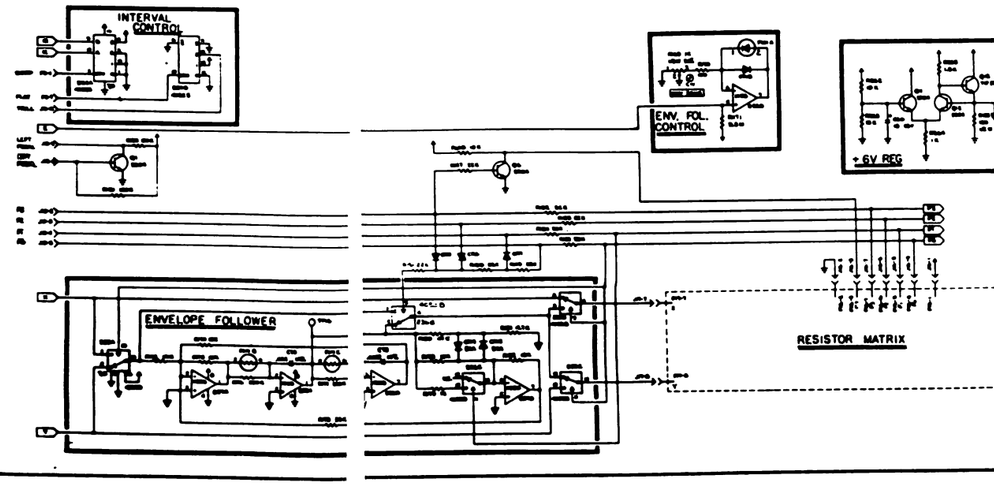


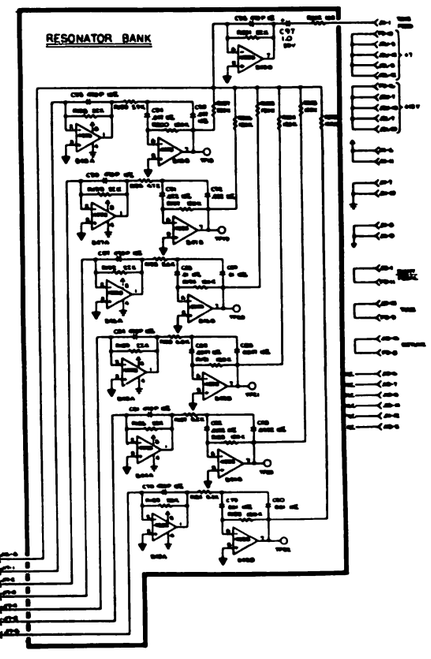


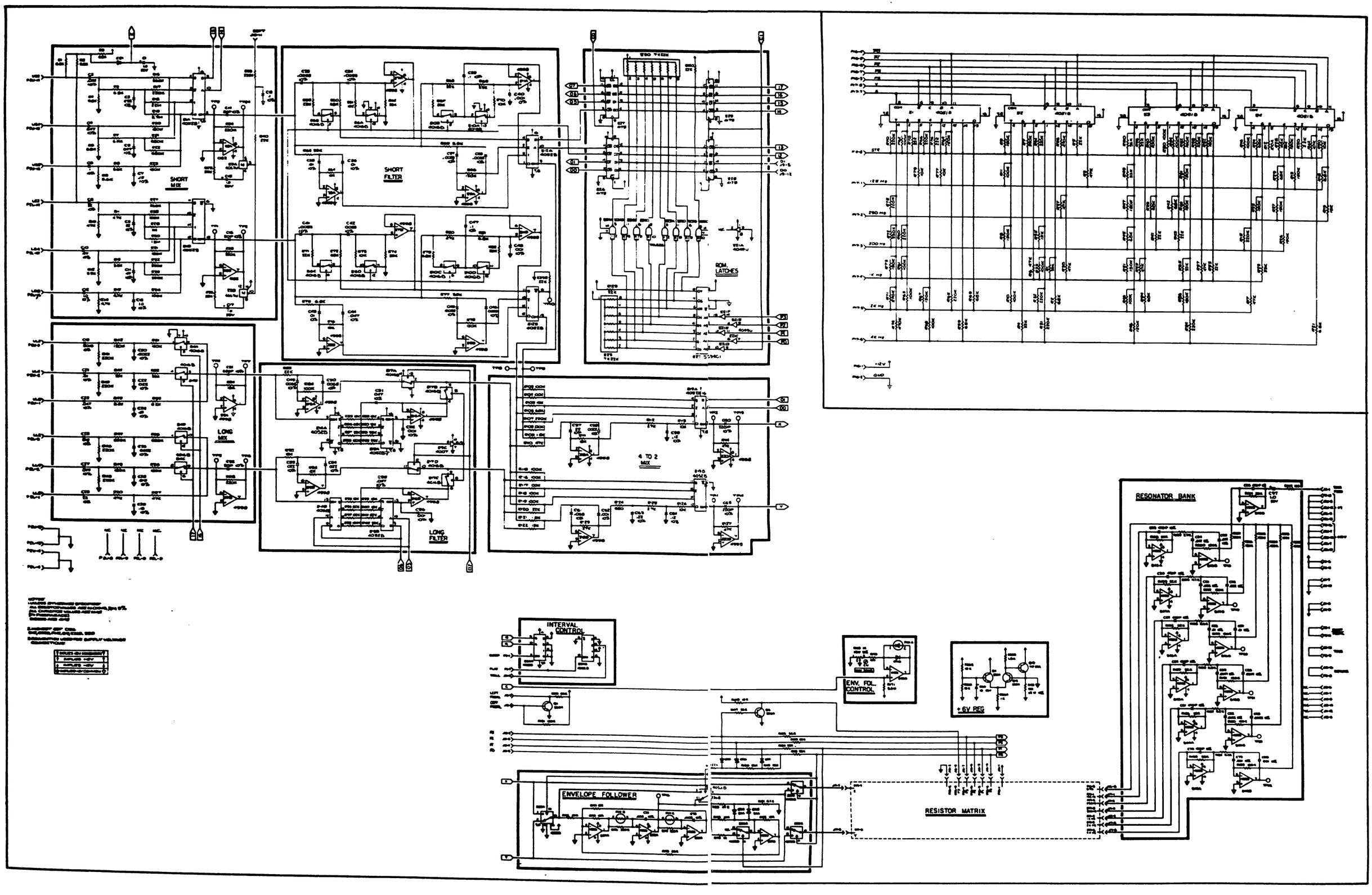












SHORT MIX

SHORT FILTER

ROM LATCHES

4 TO 2 MIX

LONG FILTER

INTERVAL CONTROL

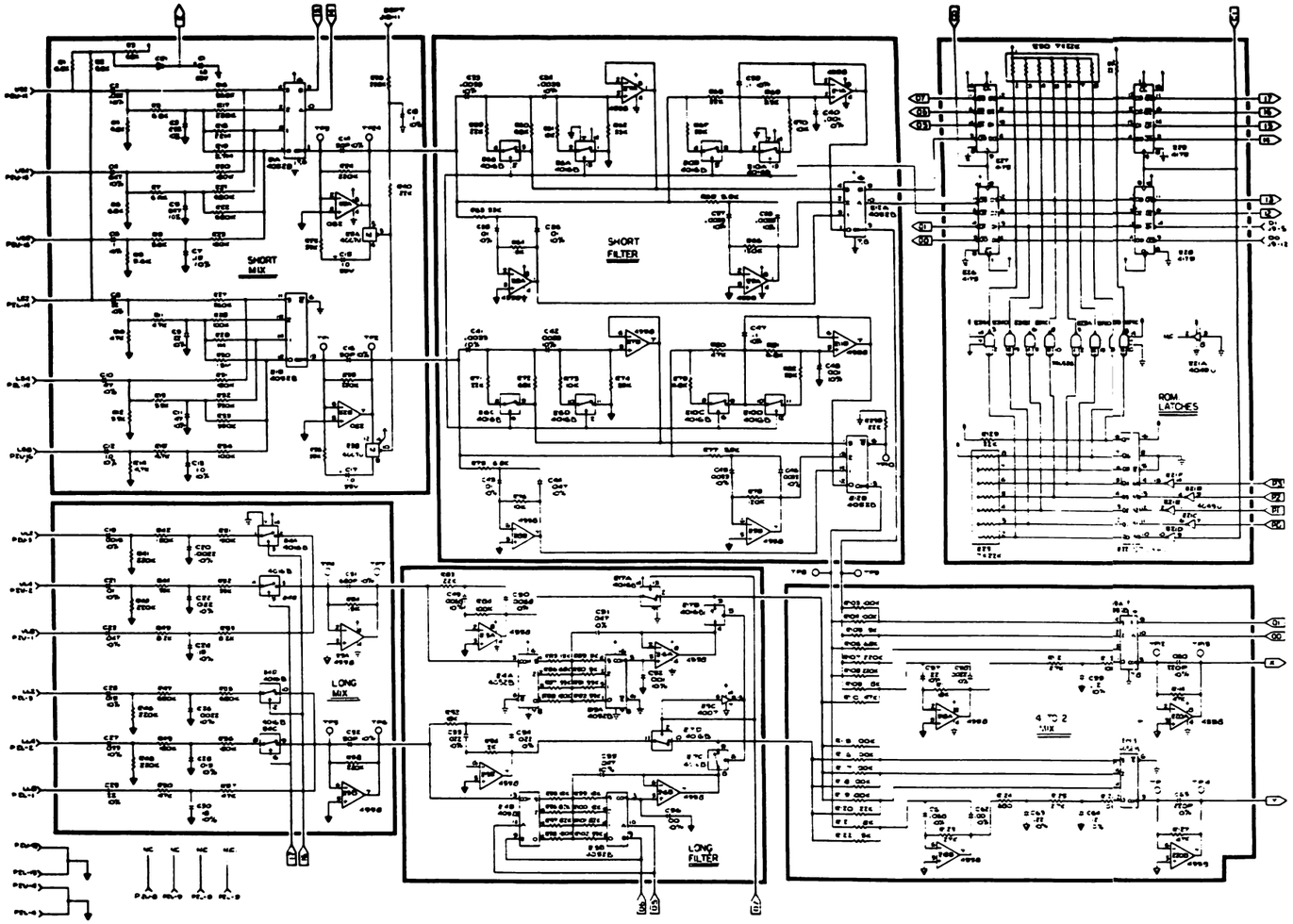
ENV. FOL CONTROL

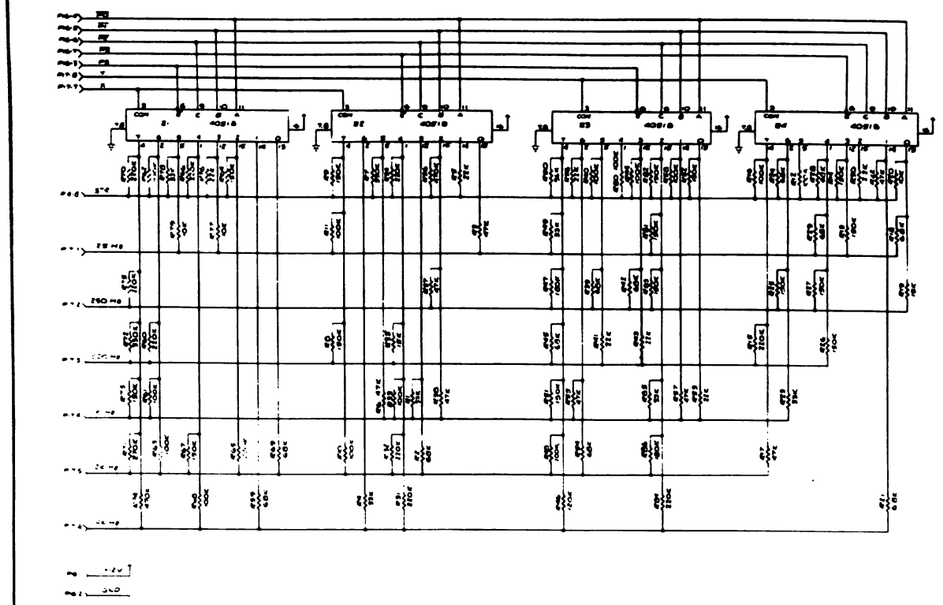
+6V REG

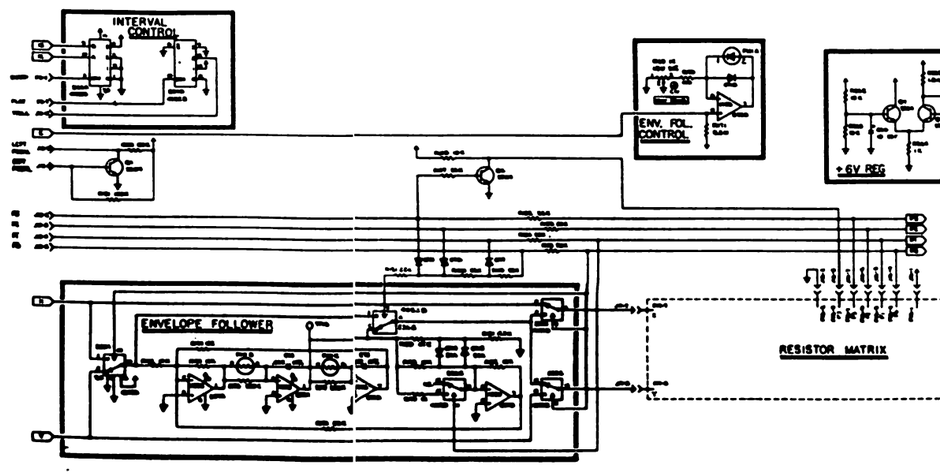
ENVELOPE FOLLOWER

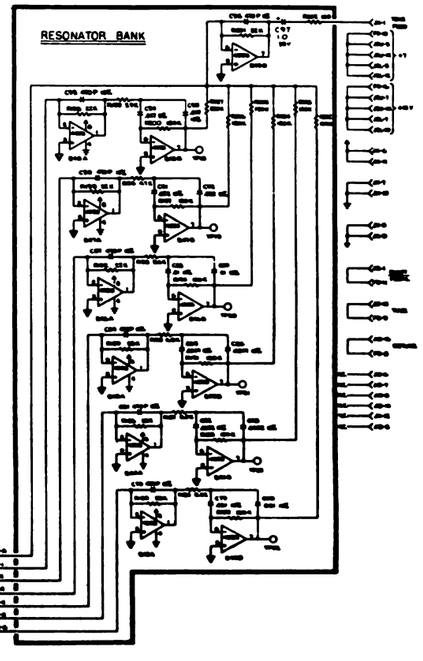
RESISTOR MATRIX

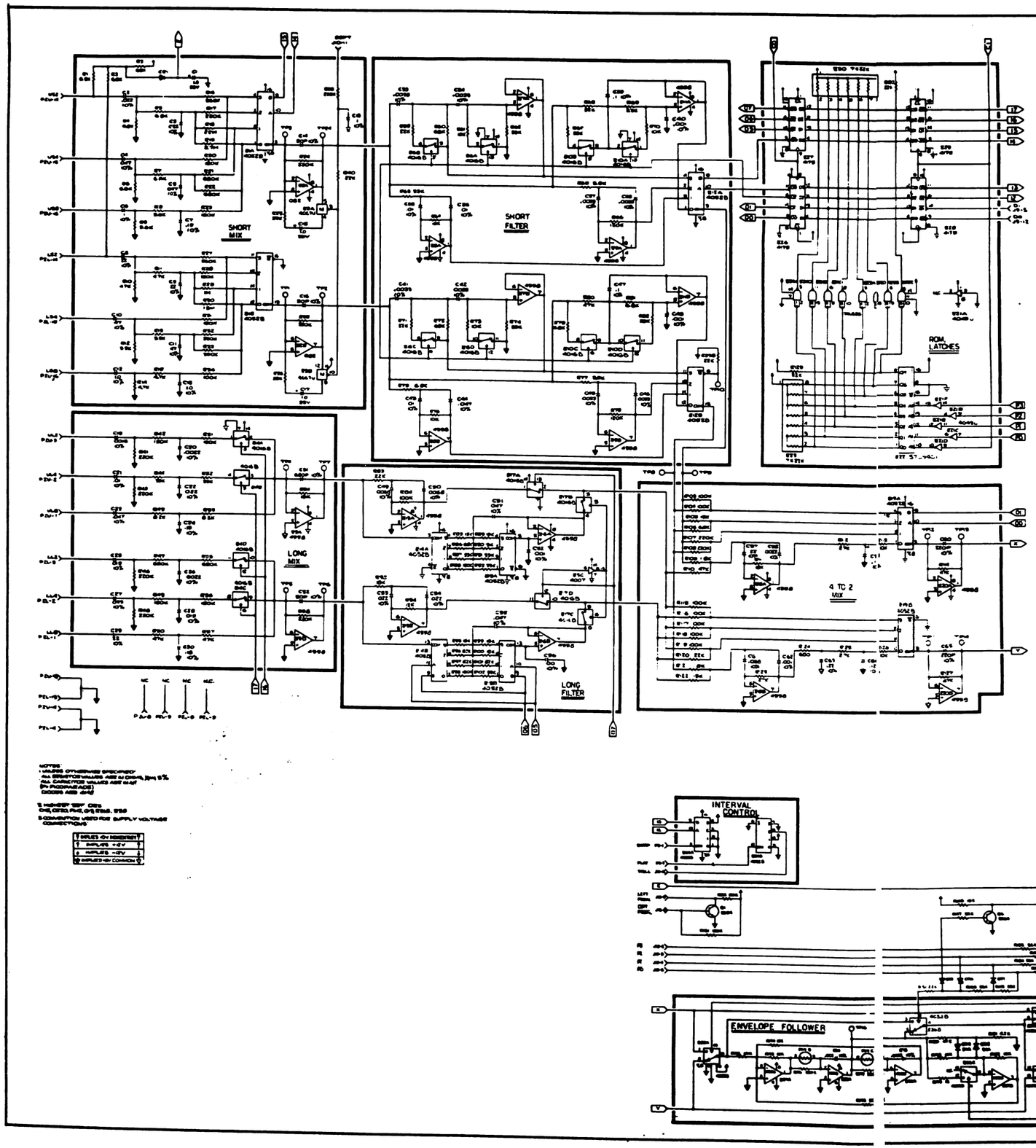
RESONATOR BANK

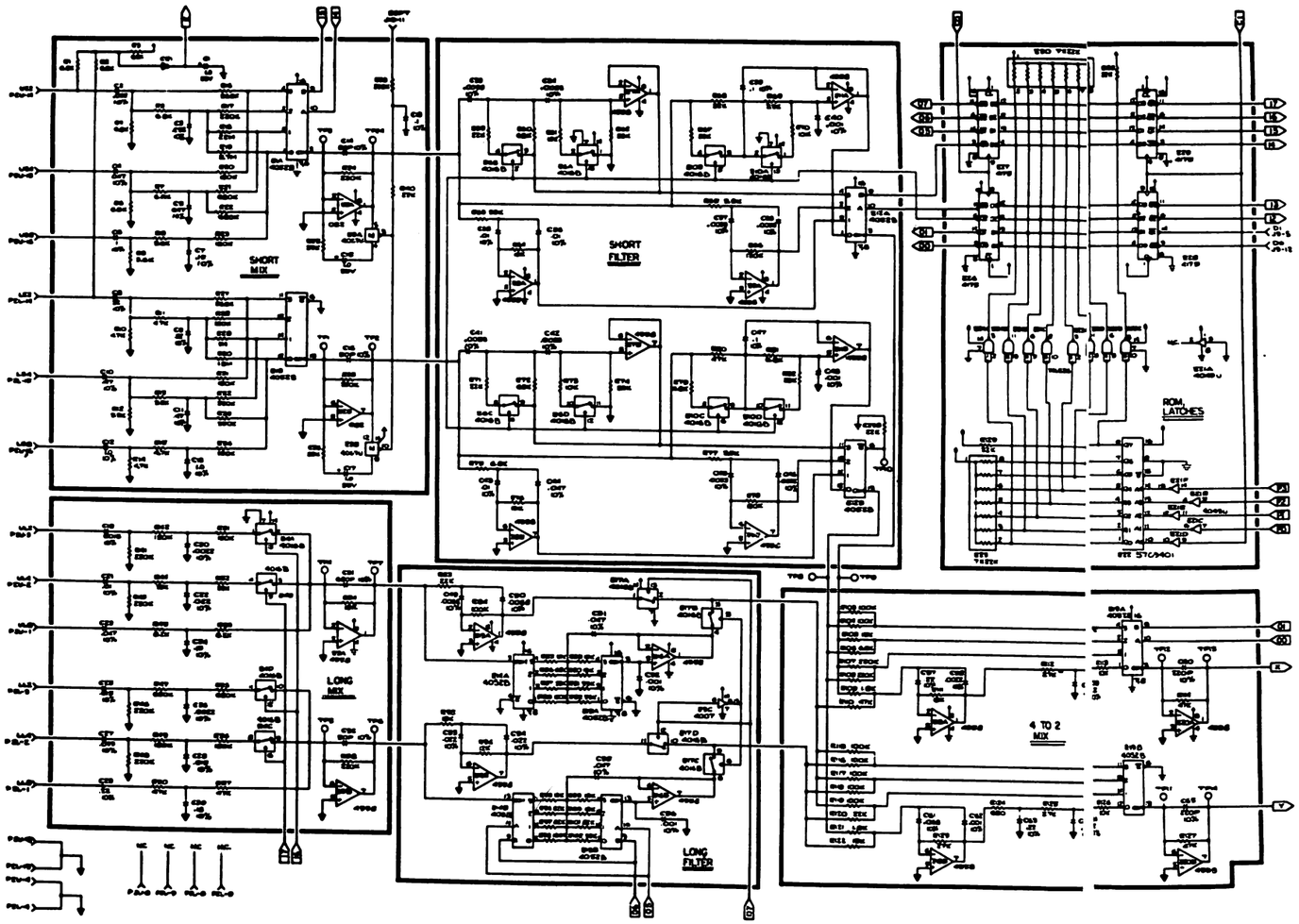


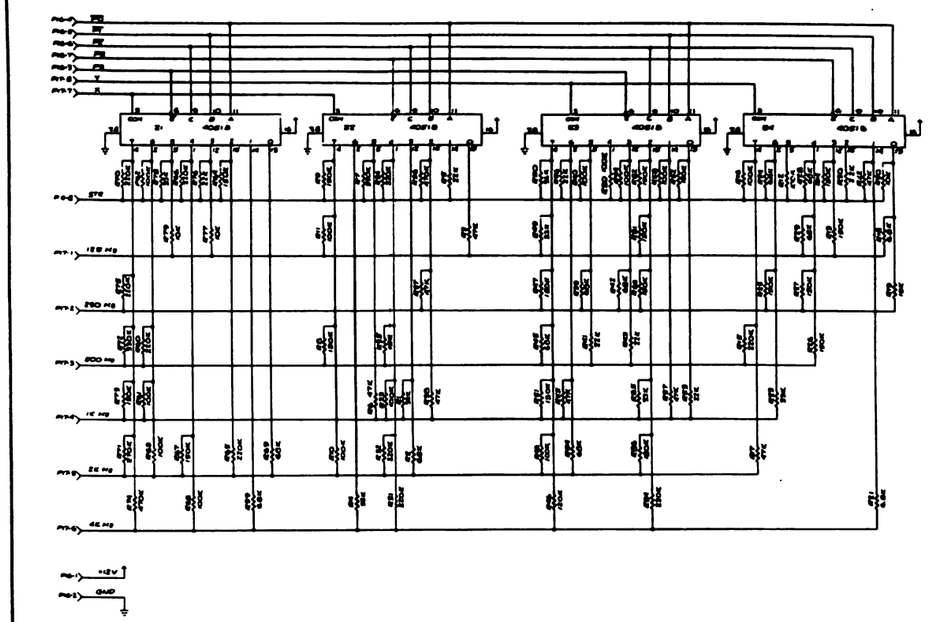


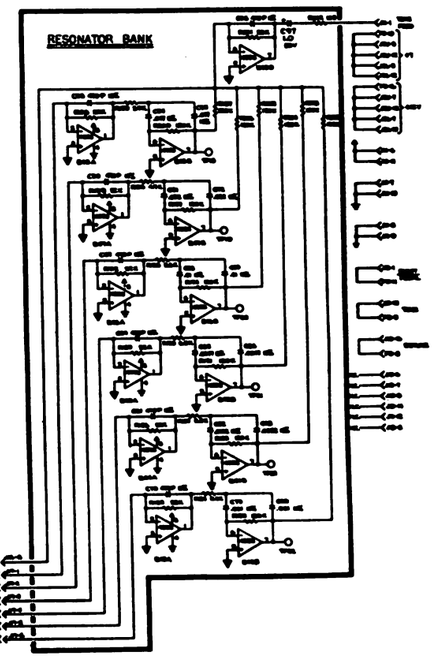


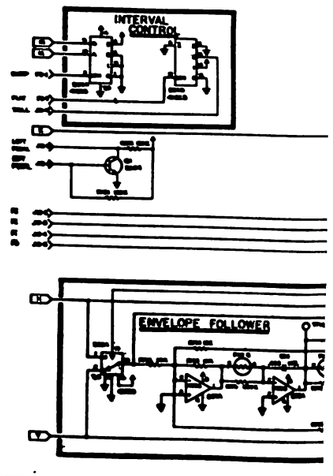


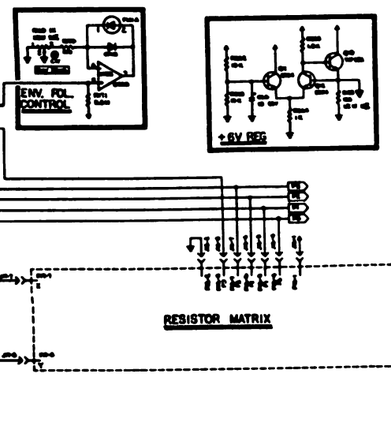


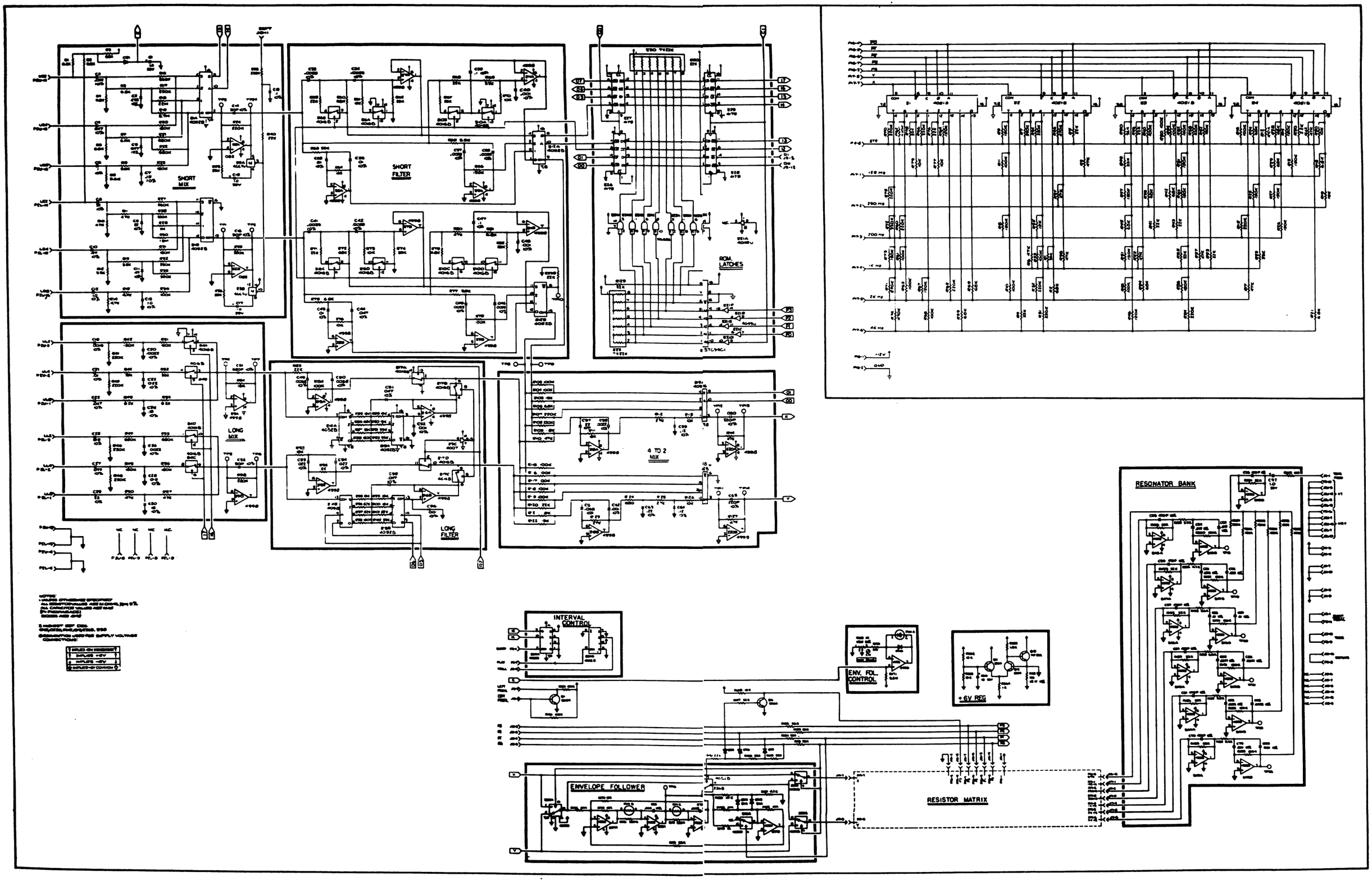


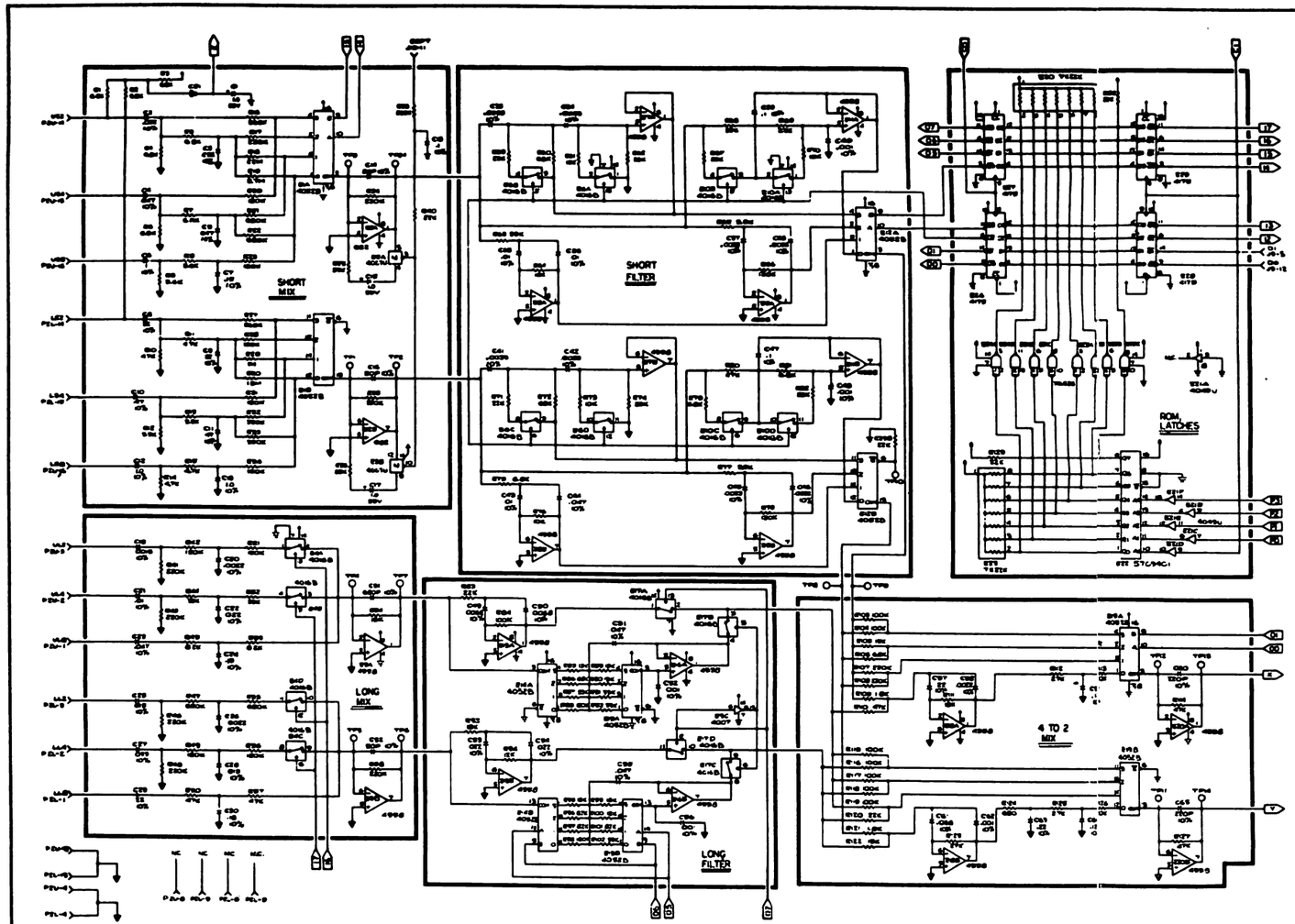


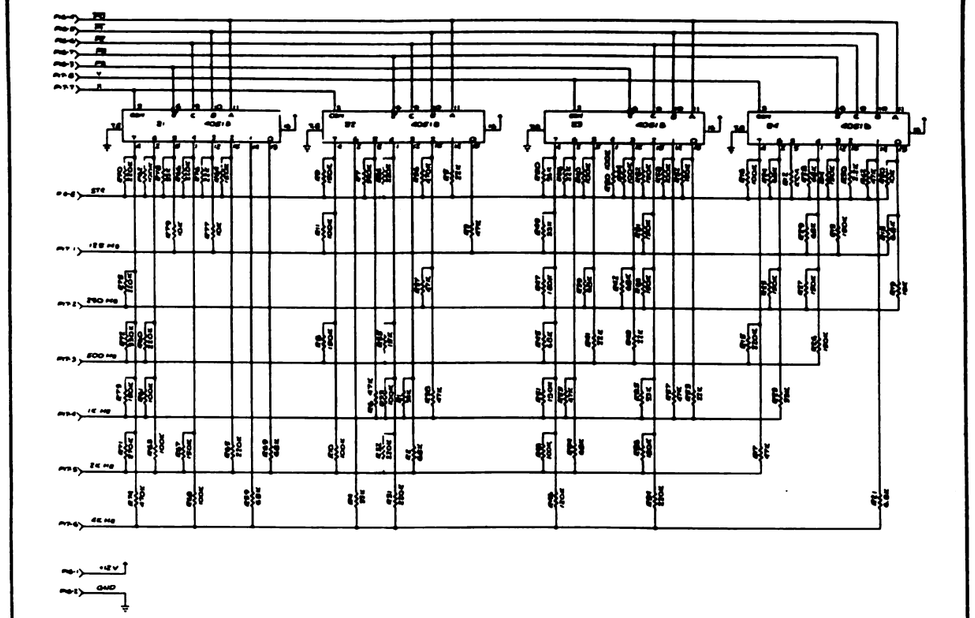


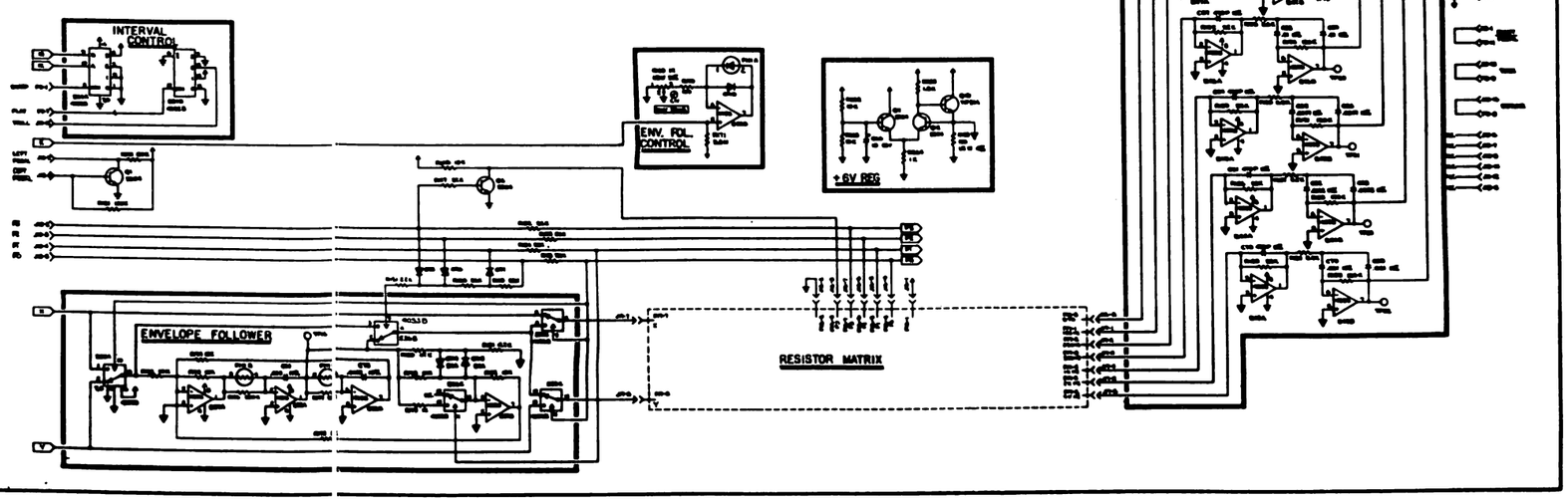


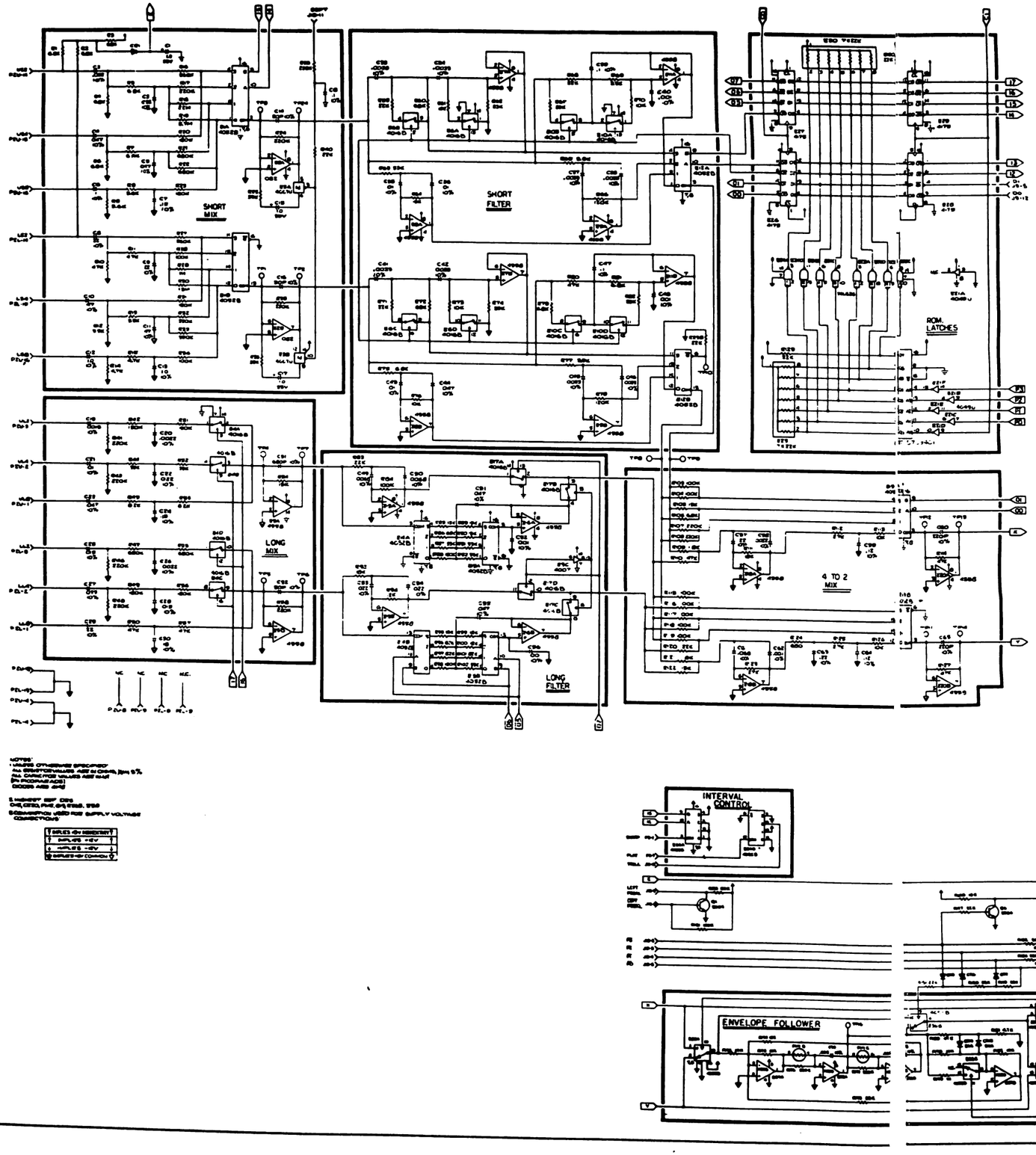


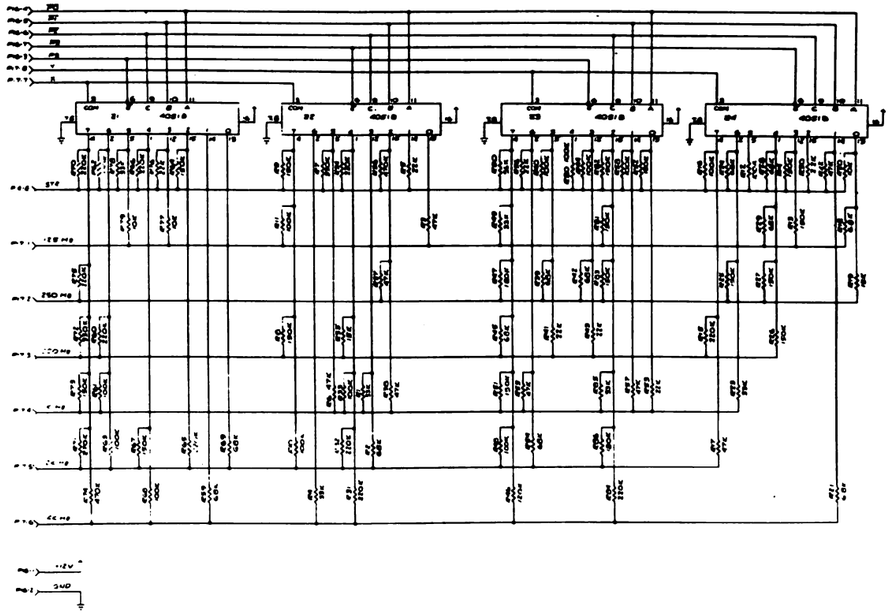


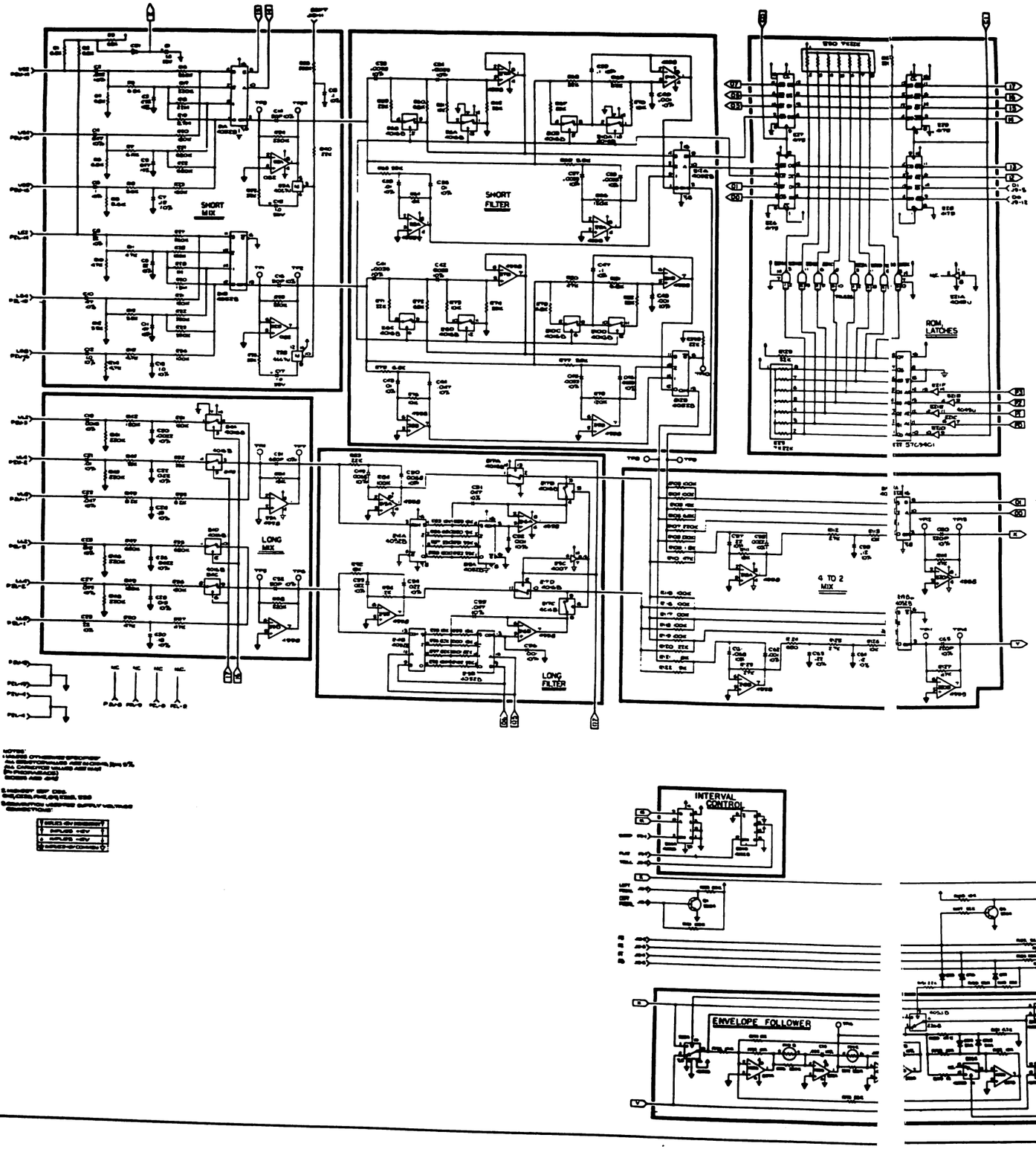


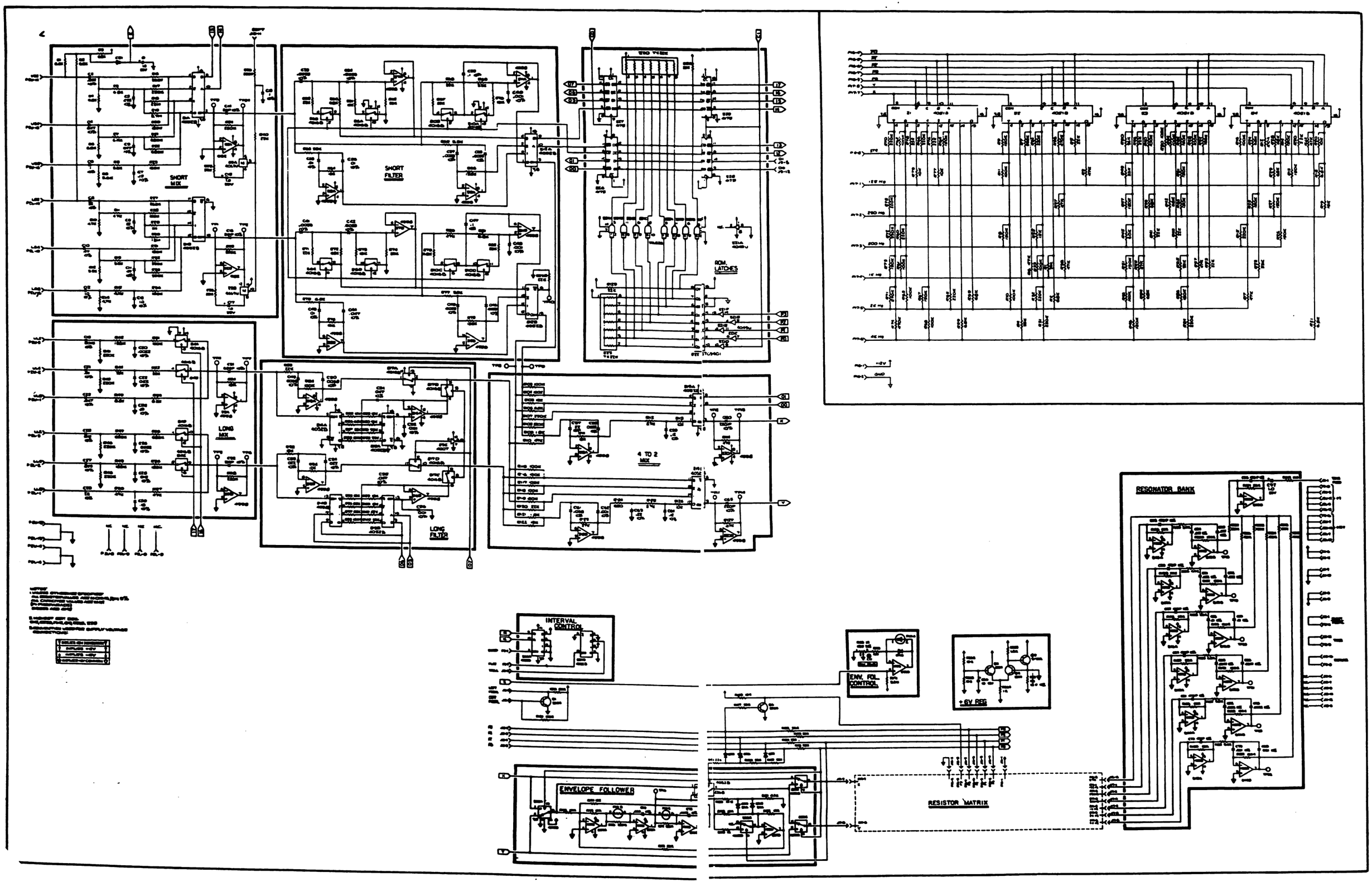




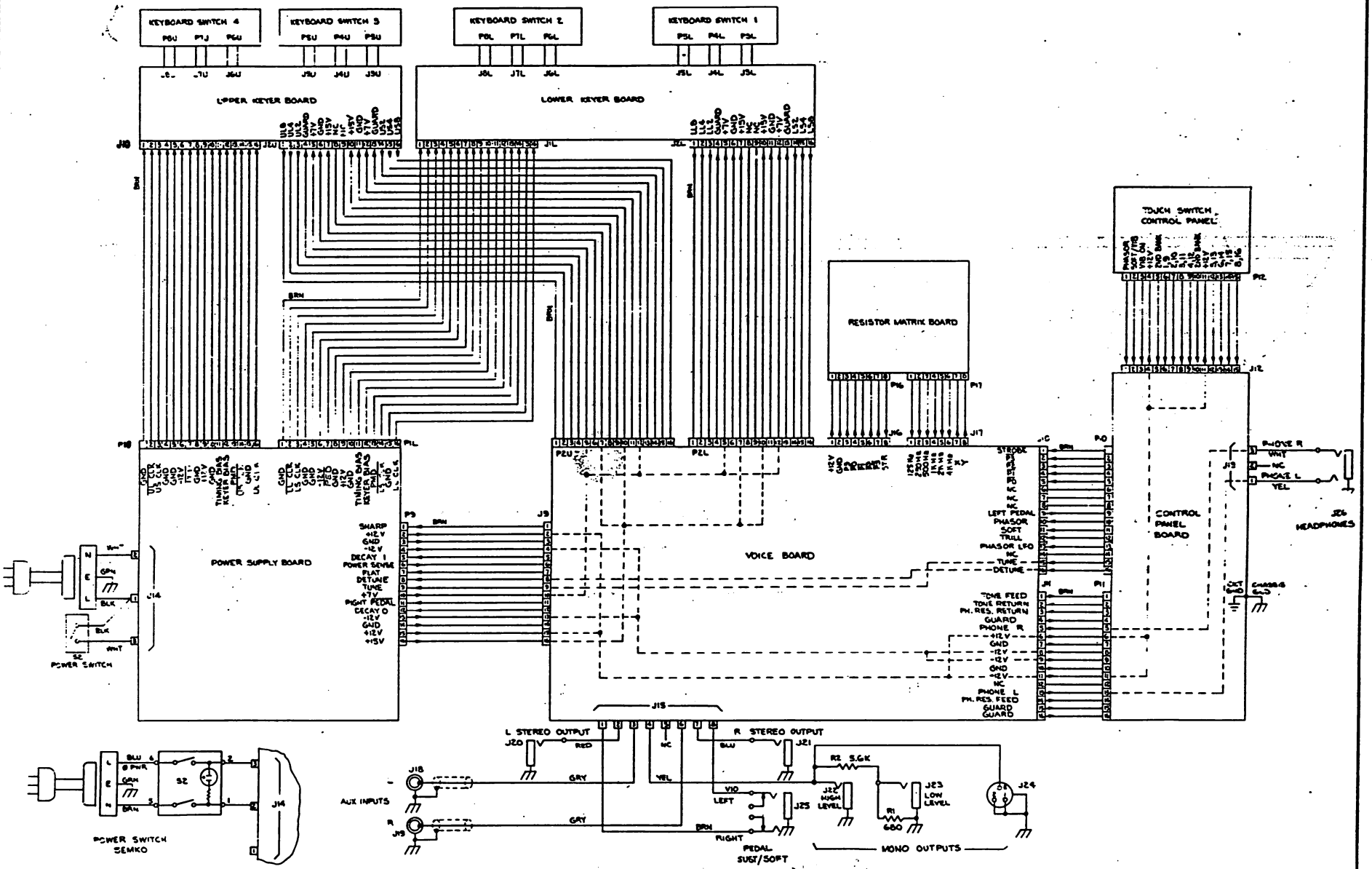




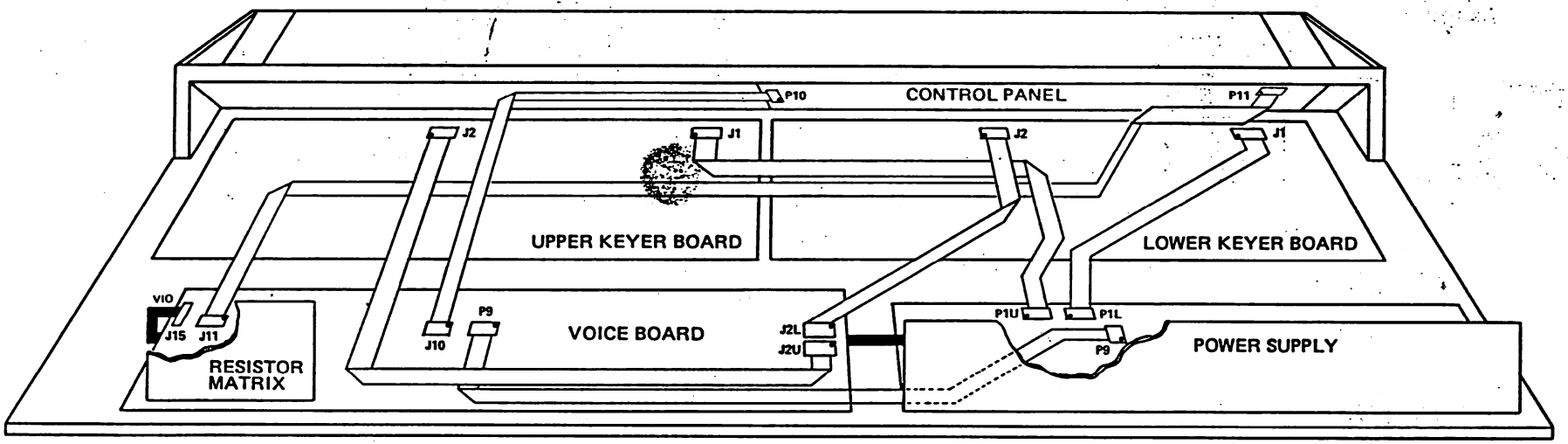




INTERCONNECTION DIAGRAM



INTERNAL CONNECTION DIAGRAM



REV 5

SHORT MIX

SHORT FILTER

LONG MIX

LONG FILTER

4 TO 2 MIX

ROM. LATCHES

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTOR VALUES ARE IN OHMS, ¼W 5%
ALL CAPACITOR VALUES ARE IN µF
(P= PICOFARADS)
DIODES ARE 4148
2. HIGHEST REF DES:
C115, CR20, PM2, Q13, R265, Z58
3. CONVENTION USED FOR SUPPLY VOLTAGE CONNECTIONS:

↑ IMPLIES +5V MOMENTARY
↑ IMPLIES +12V
↓ IMPLIES -12V
⏚ IMPLIES +5V COMMON

ARP MODEL 3300
16 VOICE ELECTRONIC PIANO

SCHEMATIC, VOICE BOARD
1 of 2

REV 5

PHASOR

OUTPUT AMPS

HEADPHONE AMPS

PHASOR CONTROL

MUTE

ROM. LATCH CONTROL

RESONATOR BANK

INTERVAL CONTROL

ENV. FOL. CONTROL

+6V REG

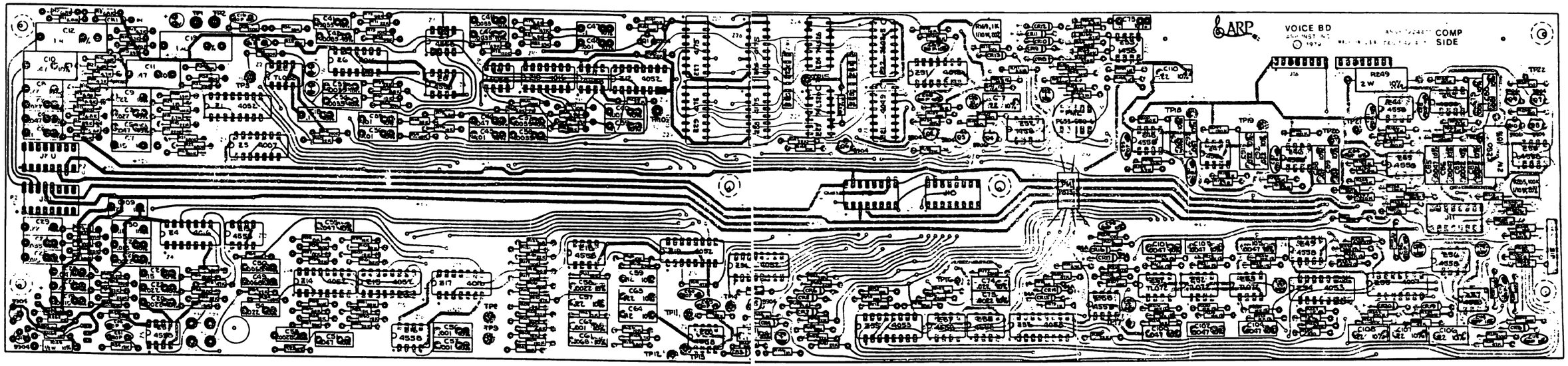
ENVELOPE FOLLOWER

RESISTOR MATRIX

ARP MODEL 3300
16 VOICE ELECTRONIC PIANO

SCHEMATIC, VOICE BOARD
2 of 2

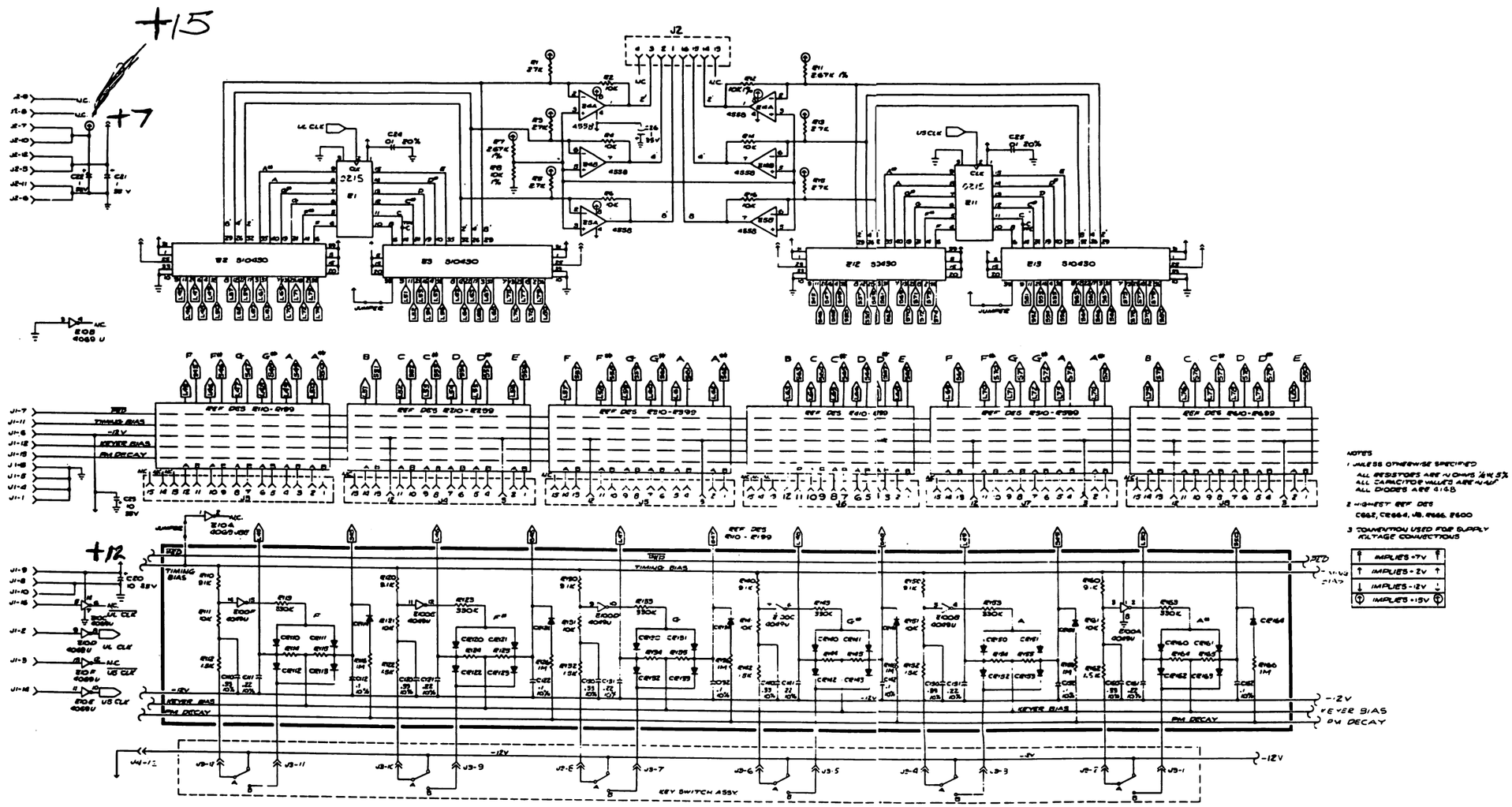
REV 6



ARP MODEL 3300
16 VOICE ELECTRONIC PIANO

ASSEMBLY, VOICE BOARD

REV 7



NOTES
1 UNLESS OTHERWISE SPECIFIED
ALL RESISTORS ARE IN OHMS ¼W 5%
ALL CAPACITOR VALUES ARE IN MFD
ALL DIODES ARE 914B
2 HIGHEST REF DES
C665, CR664, U8, R666, E600
3 CONVENTION USED FOR SUPPLY VOLTAGE CONNECTIONS

↑	IMPLIES +7V
↑	IMPLIES -2V
↓	IMPLIES -12V
⊕	IMPLIES +15V

REF DESIGNATIONS	VALUE
R114, 124, 134, 144, 154, 164	10M, 10%
R115, 125, 135, 145, 155, 165	6.8M, 10%

REF DESIGNATIONS	VALUE
R214, 224, 234, 244, 254, 264	5.2M, 10%
R215, 225, 235, 245, 255, 265	3.6M, 10%

REF DESIGNATIONS	VALUE
R314, 324, 334, 344, 354, 364	6.8M, 10%
R315, 325, 335, 345, 355, 365	4.7M

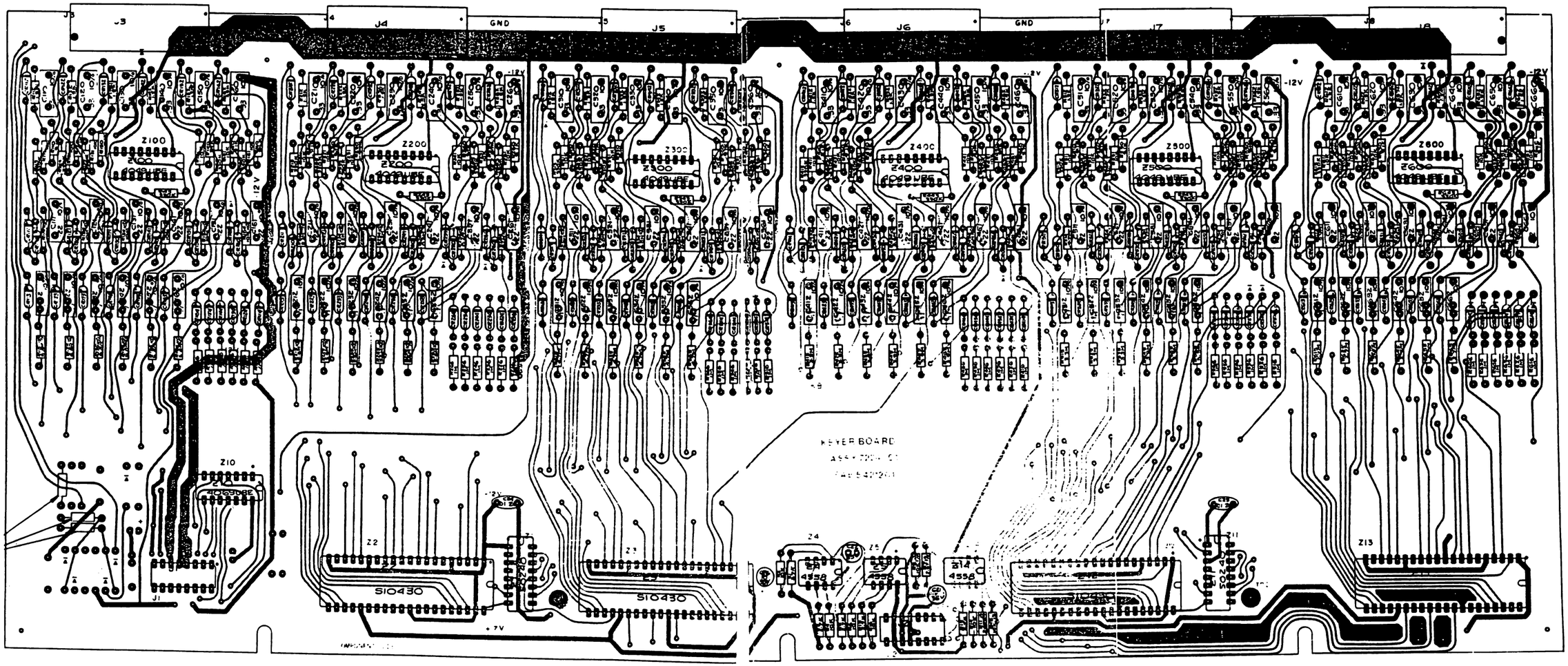
REF DESIGNATIONS	VALUE
R414, 424, 434, 444, 454, 464	1M, 10%
R415, 425, 435, 445, 455, 465	1M

REF DESIGNATIONS	VALUE
R514, 524, 534, 544, 554, 564	4.7M
R515, 525, 535, 545, 555, 565	3.3M

REF DESIGNATIONS	VALUE
R614, 624, 634, 644, 654, 664	3.9M
R615, 625, 635, 645, 655, 665	2.7M

ARP MODEL 3300
16 VOICE ELECTRONIC PIANO

SCHEMATIC, UPPER KEYER BOARD

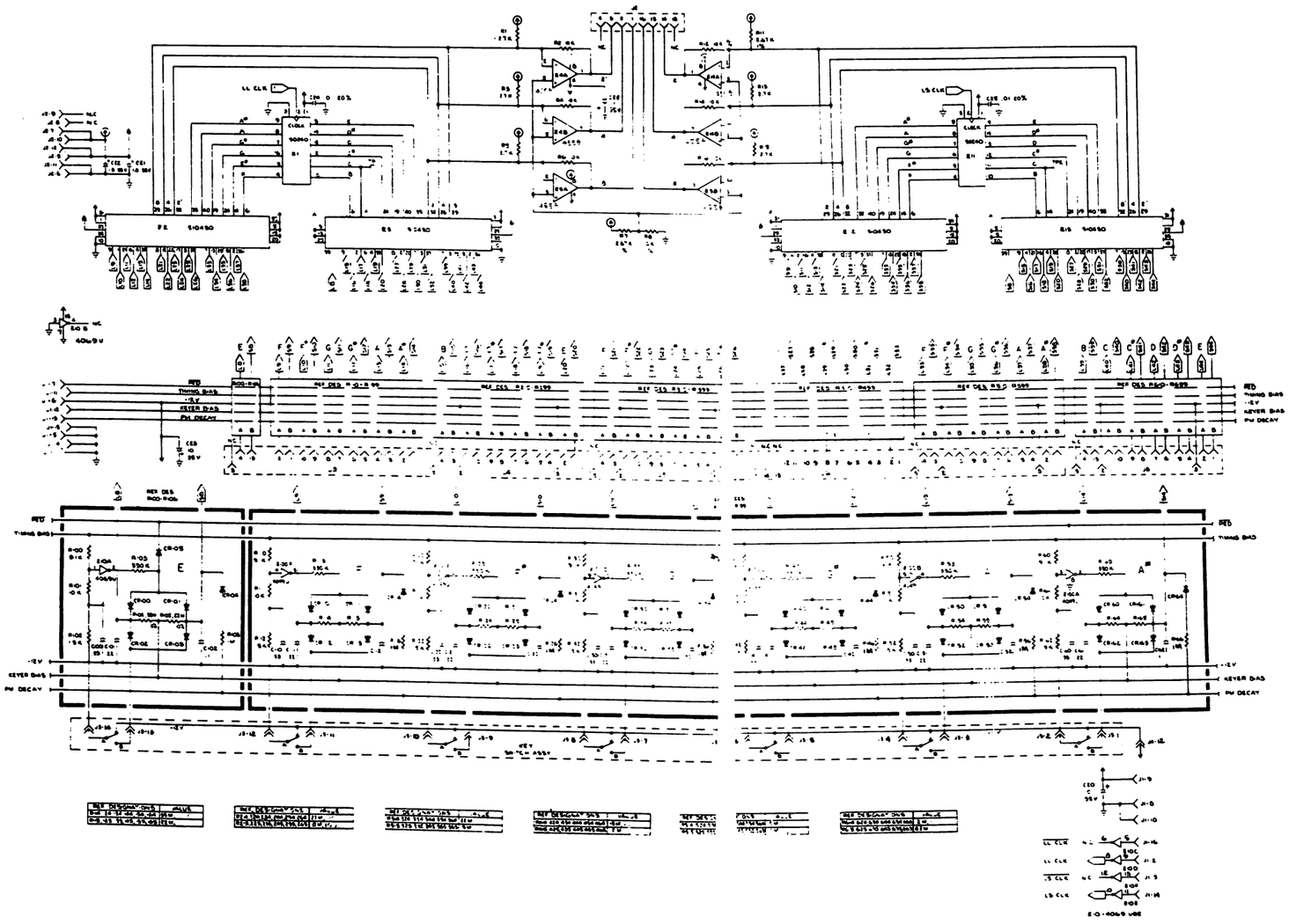


REV 7

ARP MODEL 3300
16 VOICE ELECTRONIC PIANO

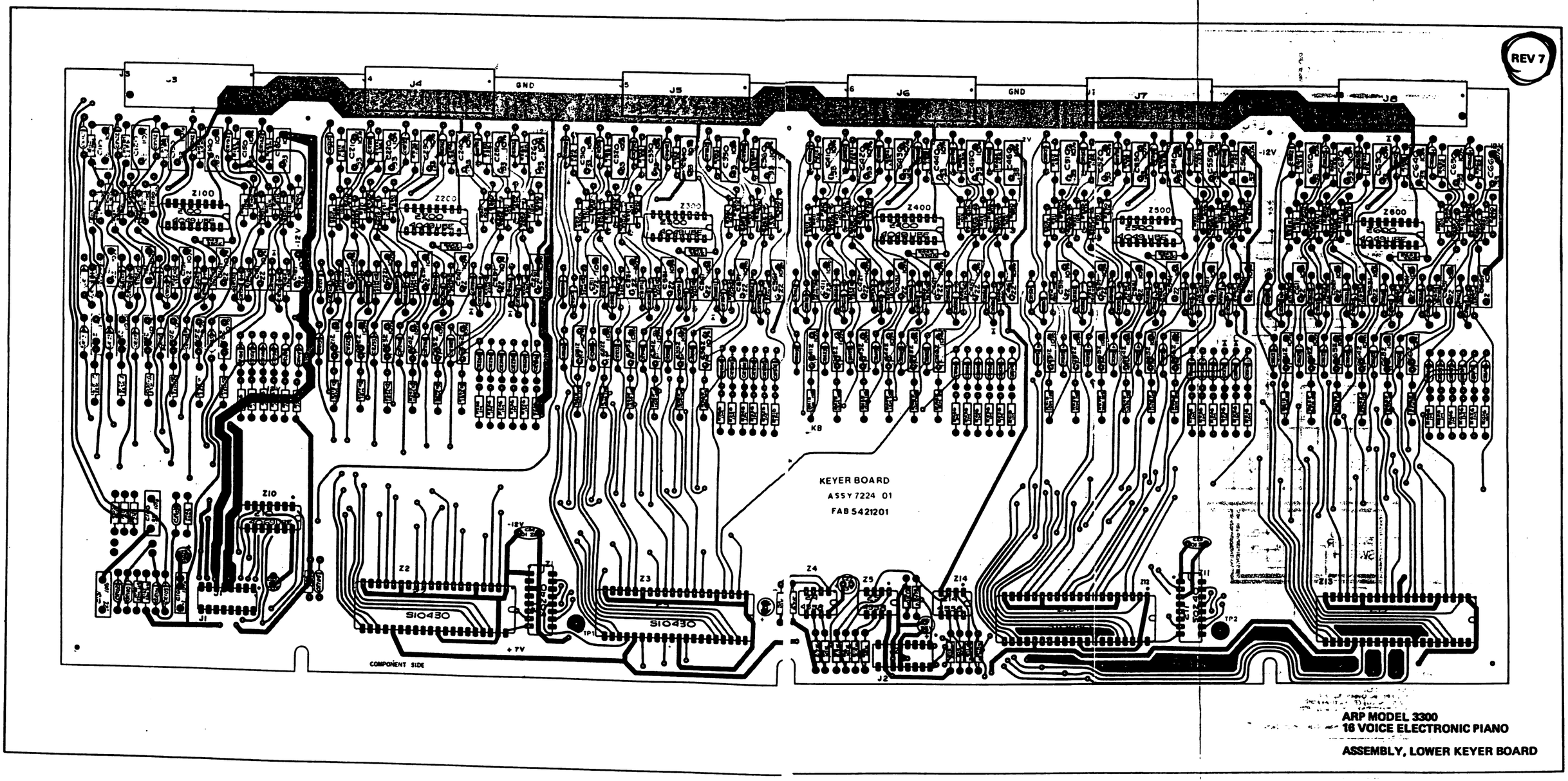
ASSEMBLY, UPPER KEYER BOARD

REV 7



ARP MODEL 3300
16 VOICE ELECTRONIC PIANO

SCHEMATIC, LOWER KEYER BOARD



ARP MODEL 3300
16 VOICE ELECTRONIC PIANO

ASSEMBLY, LOWER KEYER BOARD

REV16

PHASOR LFO

AUDIO CONTROLS

TUNING CONTROLS

VIBRATO LFO, SWITCH

VOICE SELECT LOGIC

VOICE LED DECODER

SWITCH CIRCUIT CONTROL PANEL

PHASOR SWITCH

DEBOUNCE LOGIC

PEDAL + VIBRATO LOGIC

NOTES:
1. UNLESS OTHERWISE SPECIFIED: ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5% ALL CAPACITOR VALUES ARE IN μF (M MICROFARADS) ALL DIODES ARE LIGHT EMITTING, FLV160(RED)
2. HIGHEST REF DESIGNATIONS: R74, C11, R46, CR20, Q6, P1, J18
3. CONNECTIONS USED FOR SUPPLY VOLTAGE CONNECTIONS:
   - IMPLIES +12V
   - IMPLIES -12V
   - IMPLIES +12V DECOUPLED

ARP MODEL 3300
16 VOICE ELECTRONIC PIANO

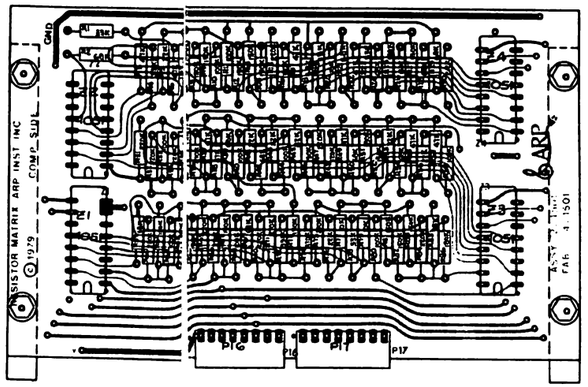
SCHEMATIC, CONTROL PANEL

REV 2

NOTES:
1. UNLESS OTHERWISE SPECIFIED: ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%
2. HIGHEST REF DES: CR61, R74, P17

ARP MODEL 3300
16 VOICE ELECTRONIC PIANO

SCHEMATIC, RESISTOR MATRIX



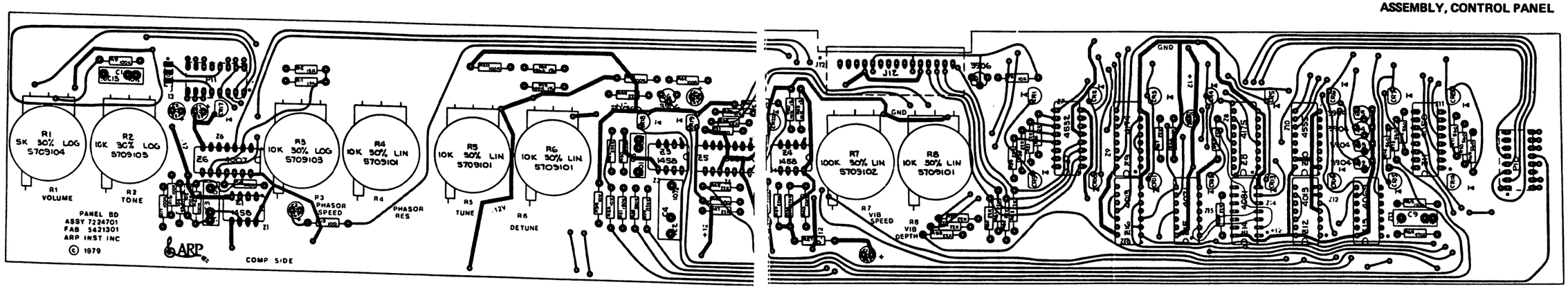
REV 3

ARP MODEL 3300
16 VOICE ELECTRONIC PIANO

ASSEMBLY, RESISTOR MATRIX

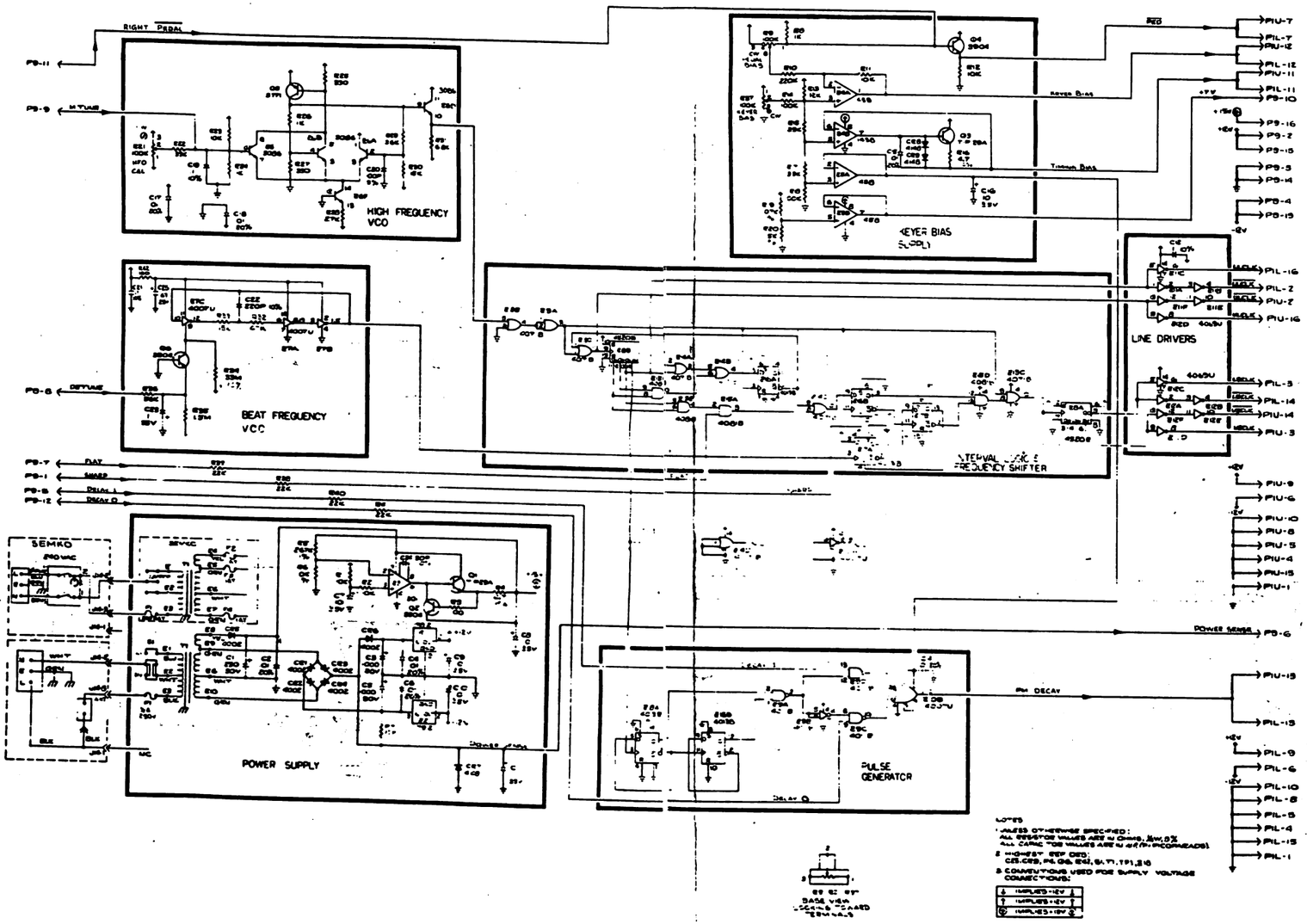
ARP MODEL 3300
16 VOICE ELECTRONIC PIANO

ASSEMBLY, CONTROL PANEL



REV 17

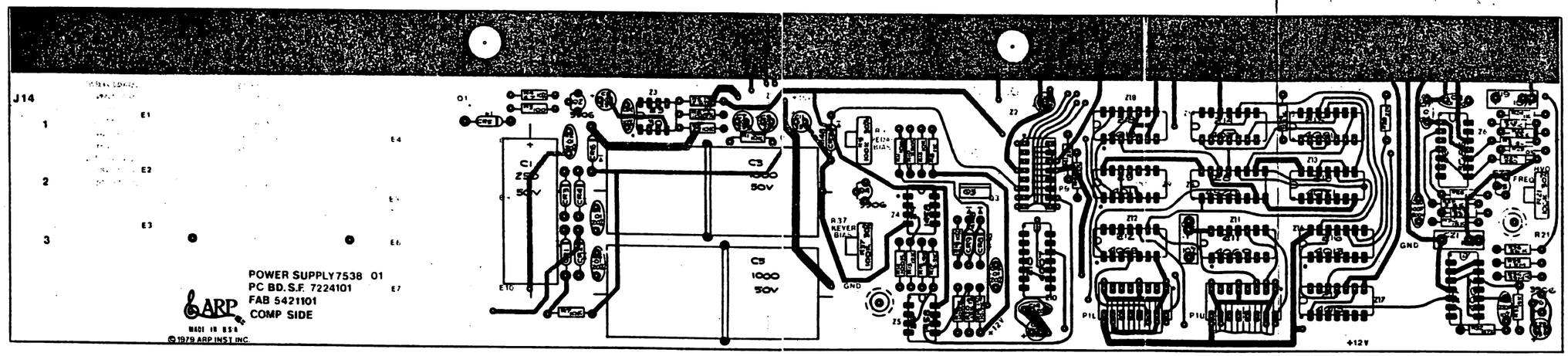
REV 5



ARP MODEL 3300
16 VOICE ELECTRONIC PIANO

SCHEMATIC, POWER SUPPLY

REV 5



SECTION 10 PARTS LIST

CONTROL PANEL BOARD

REFERENCE	ARP PART NUMBER	ARP/MFG NUMBER	DESCRIPTION
C7, 8, 11	1103005	——	CAP ELECT 10UF 35V +50-10%
C10	1103201	——	CAP ELECT 1UF 35V 20%
C2	1103203	——	CAP ELECT 4.7UF 35V 20%
C6	1103401	——	CAP ELECT 3.3UF 35V 100-10%
CR1-17, 19, 20	1201101	——	DIODE LIGHT EMITTING RED
CR18	1201102	——	DIODE LIGHT EMITTING GREEN
Q2-5	1302901	2N3904	TSTR NPN GP
Q1, 6	1303001	2N3906	TSTR PNP GP
Z5	1400401	CA3086	IC TSTR ARRAY
Z1, 3, 4	1401101	LM1458	IC OP AMP
Z6	1404201	CD4007AE	IC CMOS PR PLUS INVERTER
Z12, 16	1404402	CD4013BE	IC DUAL D FF SET/RESET
Z15	1405101	CD4071BE	IC GATE 4 X 2I OR
Z13	1405801	CD4069UBE	IC HEX INVERTER
Z11	1409601	CD4050BE	IC HEX BUFFER CONVERTER
Z7	1408301	CD4532BE	IC ENCODER 8 BIT PRIORITY
Z14	1411301	CD4081BE	IC GATE 4 X 2I AND
Z8	1411601	MC4175BCP	IC QUAD D FLIP FLOP
Z9	1411701	MC14174BCP	IC HEX D FLIP FLOP
Z10	1411801	CD4555BE	IC DUAL 1 OF 4 DECODER
J12	2106802	——	CONN FLAT COND 15P
P10	2200811	——	RIBBON CABLE 16P 28"
P11	2200813	——	RIBBON CABLE 16P 52"
R4, 5, 8	5709101	——	POT ROT LIN 10K 30%
R7	5709102	——	POT ROT LIN 100K 30%
R2, 3,6	5709103	——	POT ROT LOG 10K 30%
R1	5709104	——	POT ROT LOG 5K 30%

LOWER KEYER

C20, 23	1103005	——	CAP ELECT 10UF 35V +50-10%
C21, 22, 26	1103201	——	CAP ELECT 1UF 35V 20%
CR100-105, 110-114, 120-134, 140-144, 150-154, 160-164, 210-214, 220-224, 230-234, 240-244, 250-254, 260-264, 310-314, 320-324, 330-334, 340-344, 350-354, 360-364, 410-414, 420-424, 430-434, 440-444, 450-454, 460-464, 510-514, 520-524, 530-534, 540-544, 550-554, 560-564, 610-614, 620-624, 630-634, 640-644, 650-654, 660-664	1200301	1N4148	DIODE SIGNAL
Z1, 11	1405701	MK50240	IC TOP OCTAVE DIVIDER
Z10	1405801	CD4069UBE	IC HEX INVERTER
Z4, 5, 14	1406401	LM4558	IC OP AMP DUAL
Z100, 200, 300, 400, 500, 600	1411401	CD4049UBE	IC HEX INVERTER
Z2, 3, 12, 13	1411501	S10430	IC DIVIDER/KEYER
J1, 2	2102706	——	SOCKET DUAL IN LINE 40P
J3-8	2102703	——	SOCKET DUAL IN LINE 16P
	2106802	——	CONN FLAT COND 15P

REFERENCE	ARP PART NUMBER	ARP/MFG NUMBER	DESCRIPTION
UPPER KEYER			
C20, 23	1103005	——	CAP ELECT 10UF 35V -50-10%
C21, 22, 26	1103201	——	CAP ELECT 1UF 35V 20%
CR110-114, 120-124, 130-134, 140-144, 150-154, 160-164, 210-214, 220-224, 230-234, 240-244, 250-254, 260-264, 310-314, 320-324, 330-334, 340-344, 350-354, 360-364, 410-414, 420-424, 450-454, 460-464, 510-514, 520-524, 530-534, 540-544, 560-564, 610-614, 620-624, 630-634, 640-644, 650-654, 660-664	1200301	1N4148	DIODE SIGNAL
Z1, 11	1411901	AY-3-0215	IC TOP OCTAVE DIVIDER
Z10	1405801	CD4069UBE	IC HEX INVERTER
Z4, 5, 14	1406401	LM4558	IC OP AMP DUAL
Z100, 200, 300, 400, 500, 600	1411401	CD4049UBE	IC HEX INVERTER
Z2, 3, 12, 13	1411501	S10430	IC DIVIDER/KEYER
J1, 2	2102703	——	SOCKET DUAL IN LINE 16P
J3-8	2106802	——	CONN FLAT COND 15P
	2102706	——	SOCKET DUAL IN LINE 40P
PEDAL ASSEMBLY			
C1, 2	1103005	——	CAP ELCT 10UF 35V 50-10
	5709201	——	SWITCH LEAF
RESISTOR MATRIX			
Z1-4	1404901	CD4051BE	IC SINGLE 8 CHAN MULTIPLEXER
VOICE BOARD			
R169	1001603		POT ROT TRIM 1K 1/5W 30%
R205	1001605	——	POT ROT TRIM 100K 1/5W 30%
C66, 76	1103005	——	CAP ELECT 10UF 35V -50-10%
C111, 112	1103006	——	CAP ELECT 22UF 6.3V +50-10%
C1, 15, 17, 70, 72, 97, 99	1103201	——	CAP ELECT 1UF 35V 20%
CR14-17	1200101	1N34A	DIODE GE
CR1, 3-13, 18-20	1200301	1N4148	DIODE SIGNAL
Q1-3, 5-8, 11, 12	1302901	2N3904	TSTR NPN GP
Q4, 9, 10	1303001	2N3906	TSTR PNP GP
Q13	1305501	TIP-29A	TSTR NPN PWR
Z32, 33	1401101	LM1458	IC OP AMP
Z3, 55	1404201	CD4007AE	IC CMOS PAIR PLUS INVERTER
Z31	1404402	CD4013BE	IC DUAL D FF SET/RESET
Z4, 6, 10, 17	1404501	CD4016BE	IC QUAD BILAT SWITCH
Z23, 30	1406002	———	IC RES NETWORK 8P 22K
Z35, 36, 54	1406201	CD4053BE	IC TRIPLE 2 CHAN MULTIPLEXER
Z5, 7-9, 11, 13, 16, 18, 20, 37, 38, 43-50, 56-58	1406401	LM4558	IC OP AMP DUAL
Z24, 25	1408901	SN74LS26	IC GATE 4 X 2I NAND
Z2	1409001	TL082	IC OP AMP DUAL FET
Z1, 12, 14, 15, 19, 34	1409501	CD4052BE	IC DUAL 4 CHAN MUX
Z51-53	1410801	TL072	IC OP AMP DUAL FET
Z21	1411401	CD4049UBE	IC HEX INVERTER
Z26-29	1411601	MC14175BCP	IC QUAD D FLIP FLOP
J9-11	2102703	——	SOCKET DUAL IN LINE 16P
P2L	2200806	——	RIBBON CABLE 16P 15"
P2U	2200812	——	RIBBON CABLE 16P 22"
PM2	2602401	——	PHOTO CELL 6 CELL
PM1	2602501	——	PHOTO CELL 1 LED
Z22	5709401	——	IC ROM 256 BIT

POWER SUPPLY

REFERENCE	ARP PART NUMBER	ARP/MFG NUMBER	DESCRIPTION
Q1	1305501	TIP-29A	TSTR NPN PWR
Z2	1403801	MC7912CP	IC -12V REGULATOR
Z1	1410901	MC7812CP	IC +12V REGULATOR
F1	1700404	——	FUSE PIGTAIL SLO-BLO ¼A 250V
S1	1903501	——	SWITCH SLIDE DPDT 115V/230V
	2101401	——	JACK RCA
P1U	2200814	——	RIBBON CABLE 16P 18"
P1L	2200806	——	RIBBON CABLE 16P 15"
P9	2200811	——	RIBBON CABLE 16P 28"
T1	5709001	——	TRANSFORMER POWER 120/240V
R9, 21, 37	1000916	——	POT ROT TRIM 100K ¼W 30%
C3, 5	1101301	——	CAP ELECT 1000UF 50V 75-10%
C1	1101702	——	CAP ELECT 250UF 50V 50-10%
C7-10, 16	1103005	——	CAP ELECT 10UF 35V 50-10%
C11, 23	1103201	——	CAP ELECT 1UF 35V 20%
CR7-9	1200301	1N4148	DIODE SIGNAL
CR1-6	1202101	1N4002	RECT 100V 1A
Q2, 46, 6	1302901	2N3904	TSTR NPN GP
Q3	1305501	TIP-29A	TSTR NPN PWR
Q5	1306101	2N5771	TSTR PNP SWITCH HIGH SPEED
Z6	1400501	CA3086	IC TSTR ARRAY
Z9	1400601	CD4011UBE	IC GATE 4 X 2I NAND
Z3	1400801	LM301AN	IC OP AMP
Z4, 5	1401101	LM1458	IC OP AMP DUAL
Z7, 10	1404201	CD4007AE	IC CMOS PR PLUS INVERTER
Z13, 14	1405101	CD4071BE	IC GATE 4 X 2I OR
Z8	1405201	CD4520BE	IC DUAL BINARY UP COUNTER
Z11, 12	1405801	CD4069UBE	IC HEX INVERTER
Z16-18	1404402	CD4013BE	IC DUAL D FLIP FLOP SET/RESET
Z15	1411301	CD4081BE	IC GATE 4 X 2I AND