

prophet-5



TECHNICAL MANUAL

SEQUENTIAL
CIRCUITS INC

About This Manual and Servicing The Prophet

The Prophet is a sophisticated instrument, and SEQUENTIAL CIRCUITS INC. issues its technical manual for use by qualified technicians only.

Of course the manual will also be read by Prophet owners and others interested in synthesizer design. And we realize it will also be used by some to modify their instruments.

While we support this innovative attitude in spirit, we cannot support it financially. Modifications or unauthorized service void the Prophet's warranty. They also invariably extend service time (thus, cost) if factory repair is required.

Familiarize yourself thoroughly with this manual before attempting any work on the Prophet. This will at least help you judge whether you should be working on it at all. If in doubt please contact our Service Department.

The manual is organized as follows:

SECTION 1 describes the Prophet's physical organization and procedure for its complete disassembly.

SECTION 2 covers principles of the system (hardware and software) design.

SECTION 3 contains complete schematics and pictorials identifying all components.

SECTION 4 explains how to tune and adjust the Prophet for optimum musicality.

SECTION 5 offers aid in identifying and correcting malfunctions.

SECTION 6 is included for you to order replacement parts from SCI.

Your response to the Manual User's Questionnaire on the next page will help us monitor our publication's usefulness.

MODEL 1000

PROPHET-5 SYNTHESIZER TECHNICAL MANUAL

By STANLEY JUNGLEIB

SEQUENTIA

SEQUENTIA

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Section I

Mechanical Procedures

1-0 GENERAL

This section shows how to remove the Prophet's main assemblies. Not all of the procedures given here should be necessary at any one time. For most service situations you will only need to separate the top and bottom panel assemblies and arrange them as shown in *Figure 1-0*. This configuration, discussed in paragraph 1-2, allows access to all trimmers on PCB 4, VOICE BOARD (*Figure 1-1*).

For more extensive service you may have to "swingout" or completely remove PCB 4. Procedures below show how to do either, also, how to remove the remaining assemblies: PCB 3, COMPUTER BOARD, PCB 2, LEFT and PCB 1, RIGHT CONTROL PANELS, PCB 6, POWER SUPPLY BOARD (PSB), and the KEYBOARD (KBD).

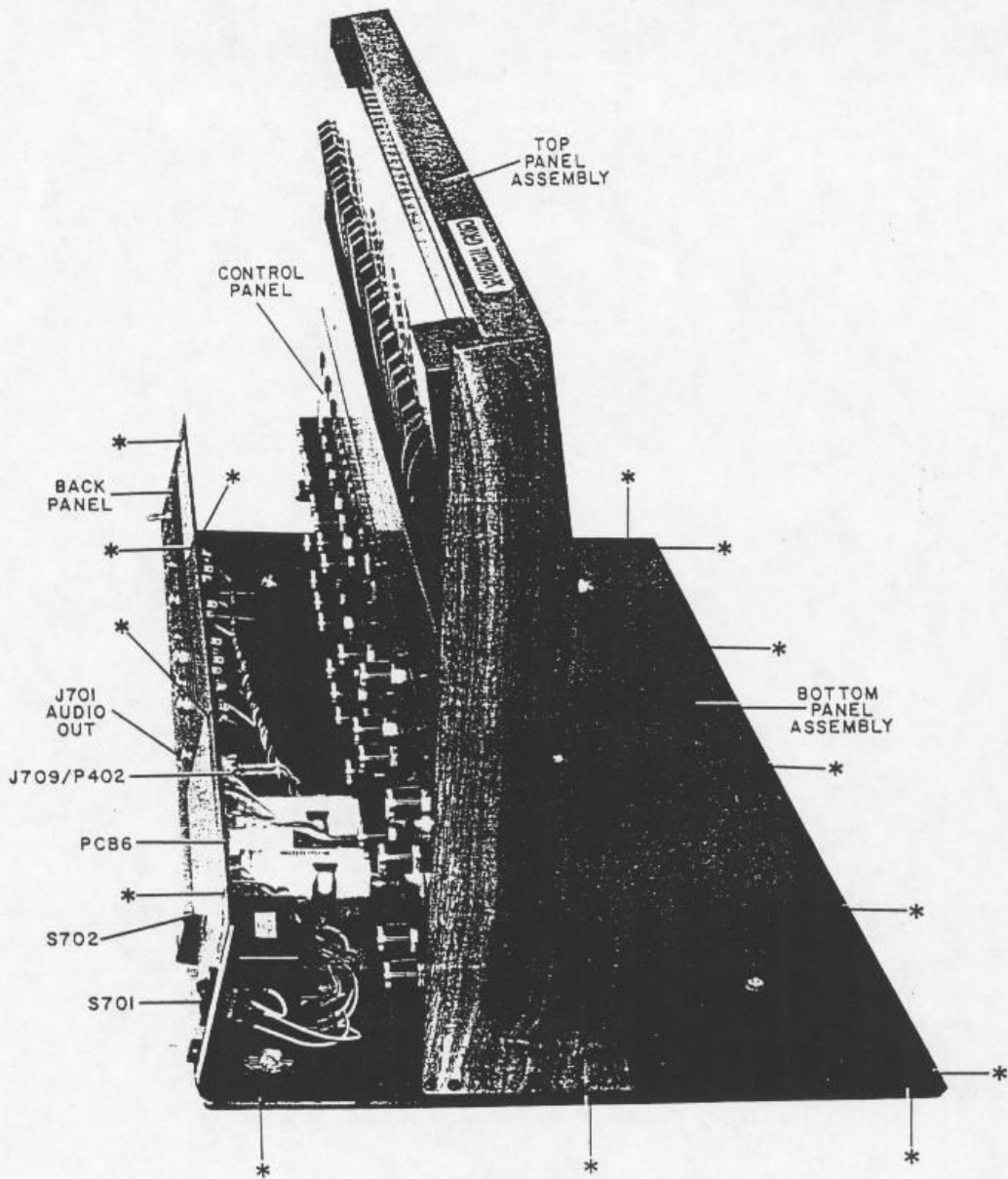
Generally, each procedure gives disassembly or removal instructions only. It is assumed that replacement procedures are just the reverse.

Sections 2-5 of this manual assume that you are familiar with the Prophet's mechanical design as covered in this section.

1-1 PRECAUTIONS

Observe the following precautions when working on the Prophet:

- To prevent damage to the top panel, keyboard, or woodwork, use a carpeted or similarly-covered work surface when opening the cabinet.
- Set S701, power switch, OFF, and check S702, 115/230V, on the back panel of units 184 and above before connecting to power outlet.
- Never switch line voltage with instrument power on.
- Trimming and tuning must, of course, be performed with power on. So, avoid the power supply primary circuitry, which conducts lethal voltages.
- Switch power off before disconnecting or connecting any internal circuitry, or removing or installing PCBs.
- Do not bend or strain the PCBs. Otherwise may cause tiny breaks in the printed circuit traces which will be extremely difficult to find.
- To replace soldered components, switch power off, remove the PCB completely from the instrument and desolder from both sides. Use a vacuum syringe or DIP desolderer. Don't overheat the pads. WORK CAREFULLY.
- Remember that in service position, the top panel assembly balances on its rear edges. Don't upset this balance by pushing too hard when trimming.



WARNING
 LETHAL VOLTAGE PRESENT
 WHEN INSTRUMENT IS ON

Figure 1-0
Service Position

1-2 SERVICE POSITION

To set up the Prophet for service first switch power off and turn instrument over to expose bottom panel. *Figure 1-0* identifies (*) screw hole locations around the perimeter of the bottom panel. Remove eleven bottom panel screws.

Holding top and bottom panel assemblies together, turn the Prophet right-side-up again. Remove four screws (*) along the top edge of the back panel. Slowly slide the top panel assembly forward — about six inches — so when raised, the control panel knobs will clear the power supply capacitors.

Raise the top panel assembly to service position shown in *Figures 1-0* and *1-1*. For best stability both top panel side back edges should rest on the bottom panel. The top panel upper edge rests on a cable from the back panel. This is normal; but a small (half-inch) prop may be added to support the top panel edge, and perhaps improve stability.

WARNING

LETHAL VOLTAGE IS PRESENT IN THE POWER SUPPLY PRIMARY CIRCUITRY. BE CAREFUL.

The instrument can operate normally in this position. As shown in *Figure 1-1*, PCB 4 is completely accessible for trimming (see Section 4).

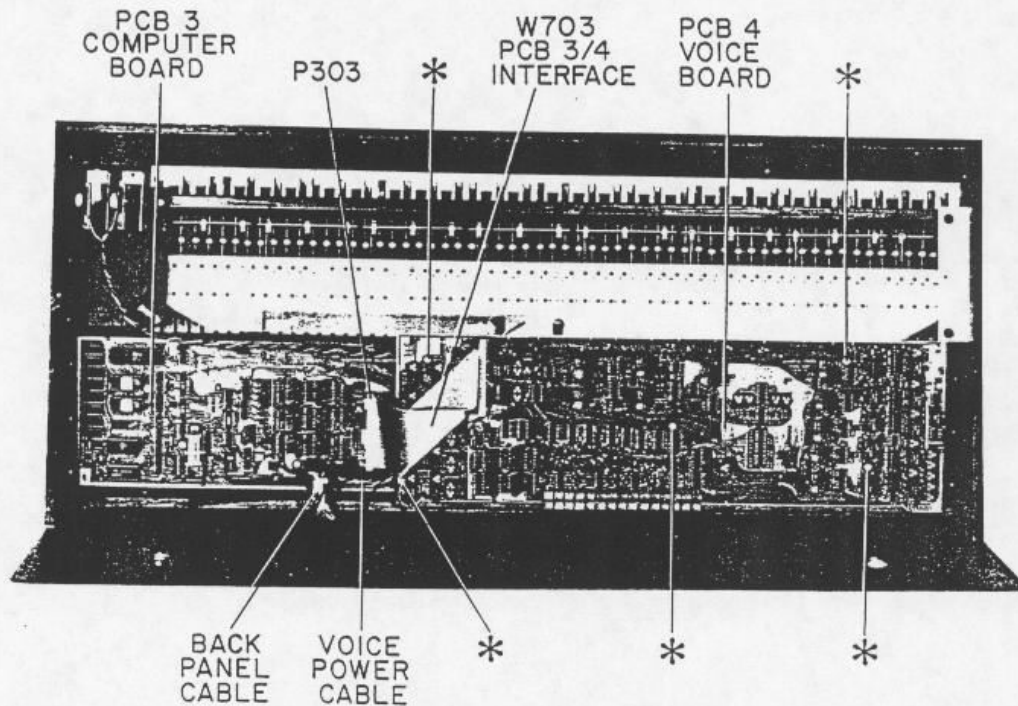


Figure 1-1
Service Position

1-3 PCB 4 VOICE BOARD SWINGOUT OR REMOVAL

Although most trimmers are accessible when the Prophet is opened, PCB 4 may be swung out to access PCB 3 trimmers which are otherwise concealed. For this setup, switch power off, remove five screws identified (*) in Figure 1-1, and position PCB 4 as shown in Figure 1-2. Do not strain the audio output cable which connects to the back panel. Power may be switched back on in this configuration.

To remove PCB 4 completely, switch power off and disconnect voice power cable at PCB 3 (Figure 1-1). Also remove W703, with a gentle "see-saw" motion at P303. Then detach audio output cable at quick-disconnects J709/P402 on back panel J701 AUDIO OUT (Figure 1-0). When reconnecting voice power cable, be sure tabs interlock.

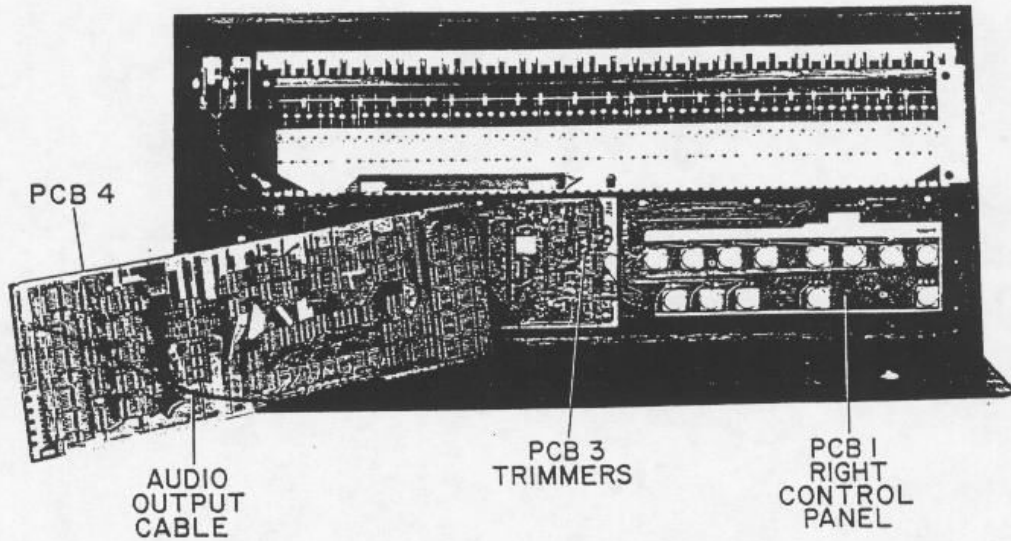


Figure 1-2
PCB 4 Swingout

1-4 PCB 3 COMPUTER BOARD REMOVAL

PCB 3 is held by the six screws identified (*) in Figure 1-3, and by direct connection to PCB 2, behind it. (See J301, Figure 1-3 and P201, Figure 1-4.) To remove PCB 3, disconnect back panel and wheel cables, remove screws, and pull at the standoff indicated, also using a "see-saw" motion to minimize stress along the board.

When replacing PCB 3 be sure J301/P201 pins are correctly mated before fastening screws. Alignment is insured by matching screw holes with their standoffs. Remember to reconnect the wheel cable, too, before replacing PCB 4. When reconnecting back panel cable, be sure tabs interlock.

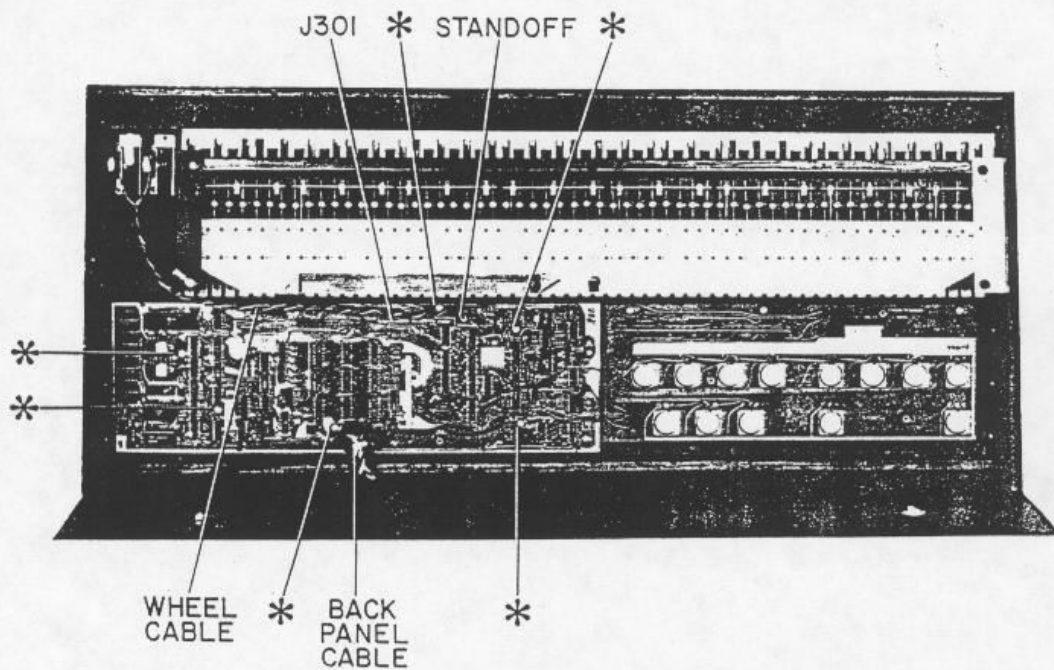


Figure 1-3
PCB 3 Removal

1-5 PCB 1 AND 2 CONTROL PANEL REMOVAL

Once PCB 3 and 4 are removed, CONTROL PANEL removal involves pulling off all knobs, unscrewing all potentiometer mounting nuts for either or both panels (using a half-inch nutdriver), and removing the screws identified (*) in Figure 1-4.

You may be able to avoid removing both panels by taking advantage of W701, the flexible interconnect between them (Figure 1-4). Also, Section 3 of this manual includes pictorials identifying panel components from the solder side — that is, as the control panels are normally mounted.

When replacing be sure all potentiometers fit correctly through the front panel and check switch action before tightening any potentiometer nut.

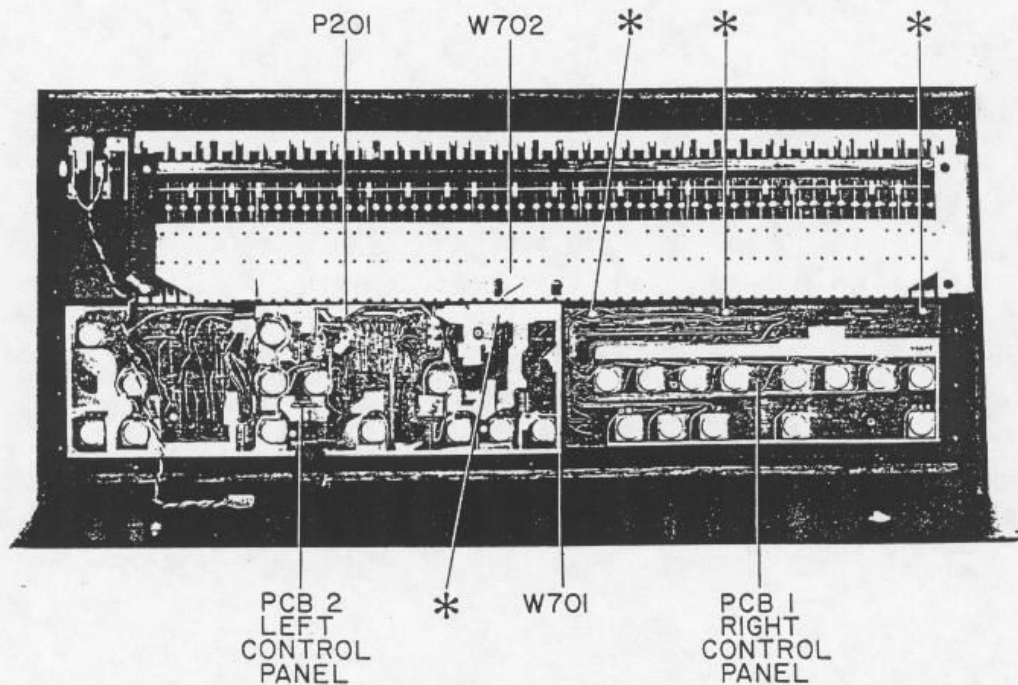


Figure 1-4
PCB 1 and 2 Removal

1-6 PCB 6 POWER SUPPLY BOARD REMOVAL

PCB 6 is held to the bottom panel assembly by two capacitor clips and by five regulator mounting screws. So, removal for component replacement requires unmounting all regulators from the back panel. *Figure 1-5* details regulator installation. Note that the regulators are electrically insulated from the back panel.

After repair, you can check power supply output before installing on back panel.

CAUTION

DO NOT OPERATE THE UNLOADED POWER SUPPLY FOR LONG PERIODS WITHOUT HEAT-SINKING THE REGULATORS. NEVER OPERATE THE SUPPLY UNDER LOAD WITHOUT HEAT-SINKING.

When replacing PCB 6 check regulator insulation from back panel with an ohmmeter before applying power.

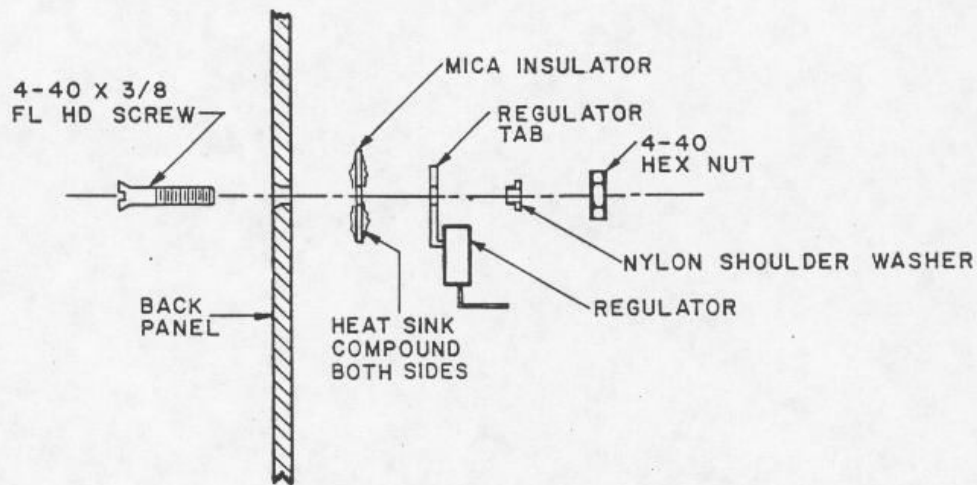


Figure 1-5
Regulator Installation

1-7 KEYBOARD REMOVAL

After removing PCBs 3 and 4, turn the top panel assembly over and disconnect W702 (Figure 1-4).

Figure 1-6 details keyboard mounting. Remove keybed supports, both ends, by first removing keybed screws then rear keyboard mounting screws. Then remove front keyboard mounting screws. The entire keyboard will slide out of the case — and back in — as shown in Figure 1-7.

NOTE

During this operation the J-wires (Figure 1-6) for the lowest and highest keys are vulnerable to damage through collision with the keyboard mounting brackets. When replacing, check J-wires at each end of keyboard for contact with bus bar. Also, remember to attach wheel ground lug.

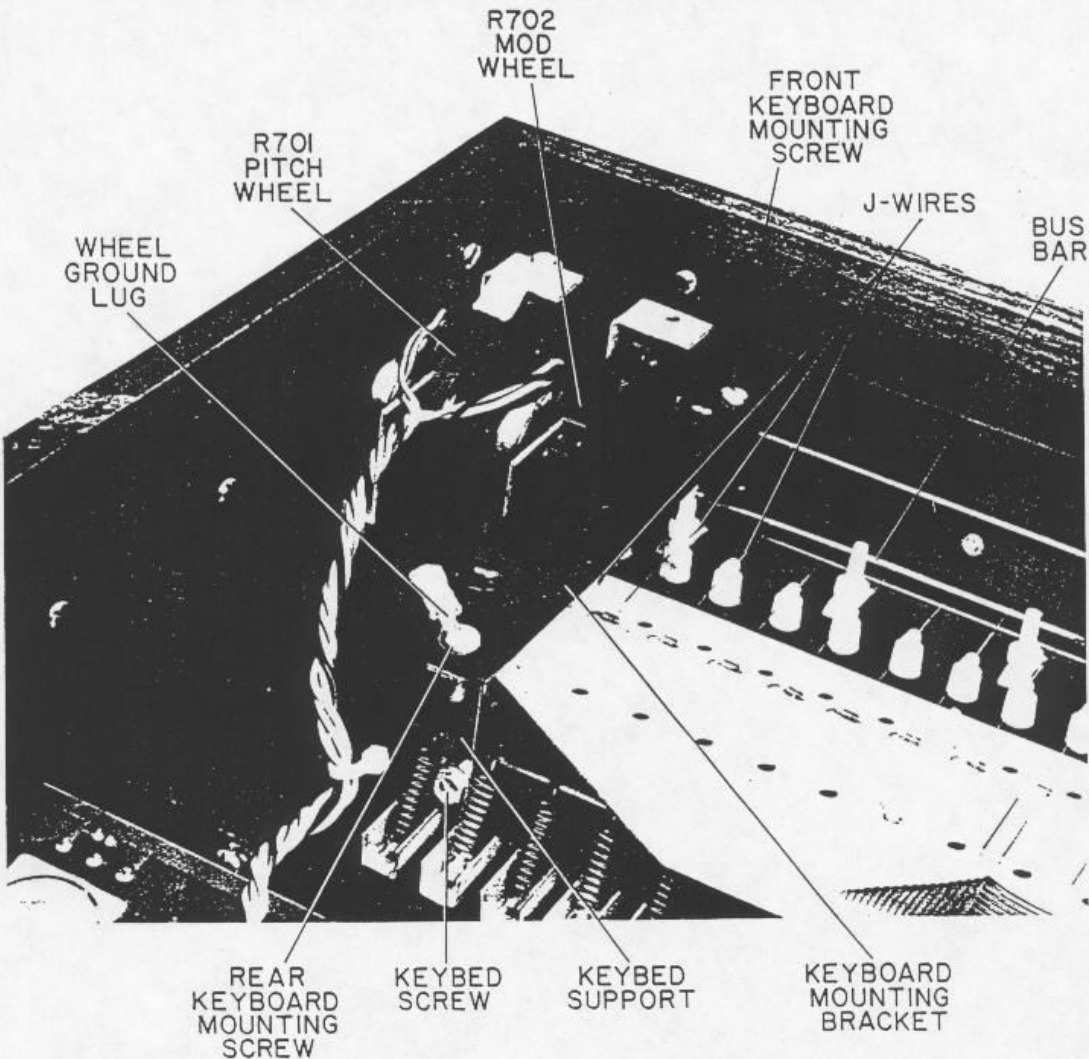


Figure 1-6
Keyboard Mounting

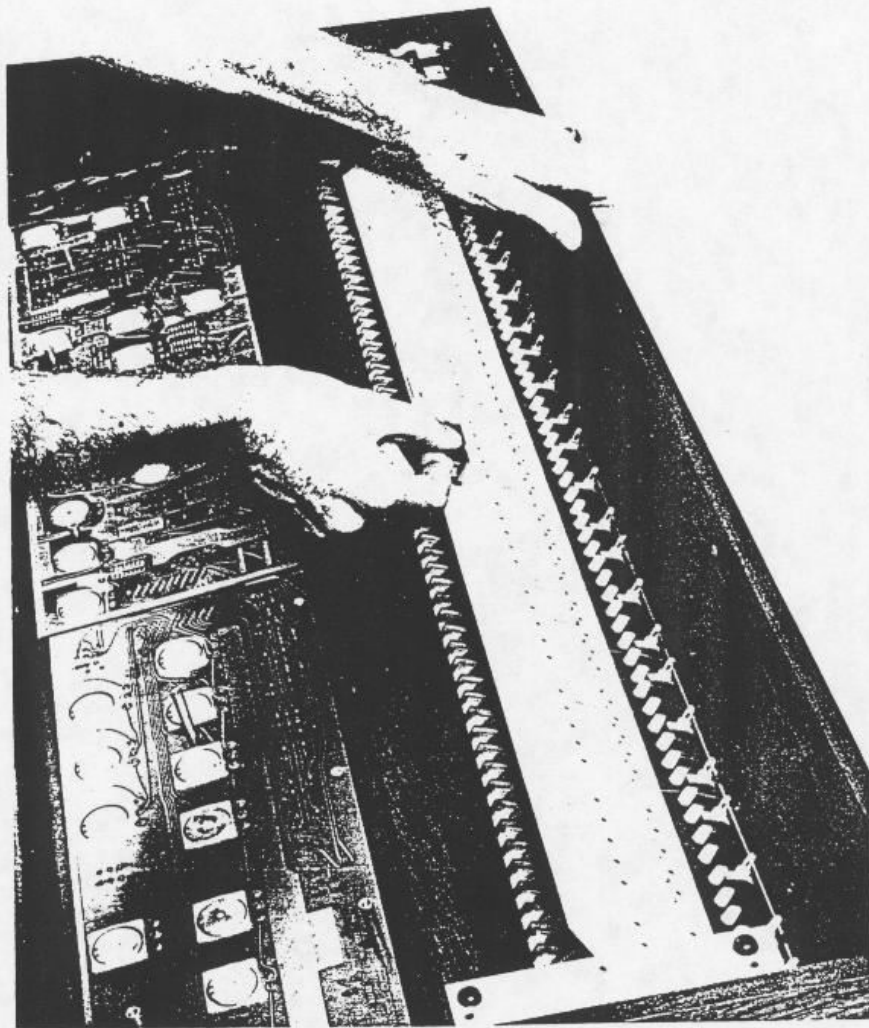


Figure 1-7
Keyboard Removal

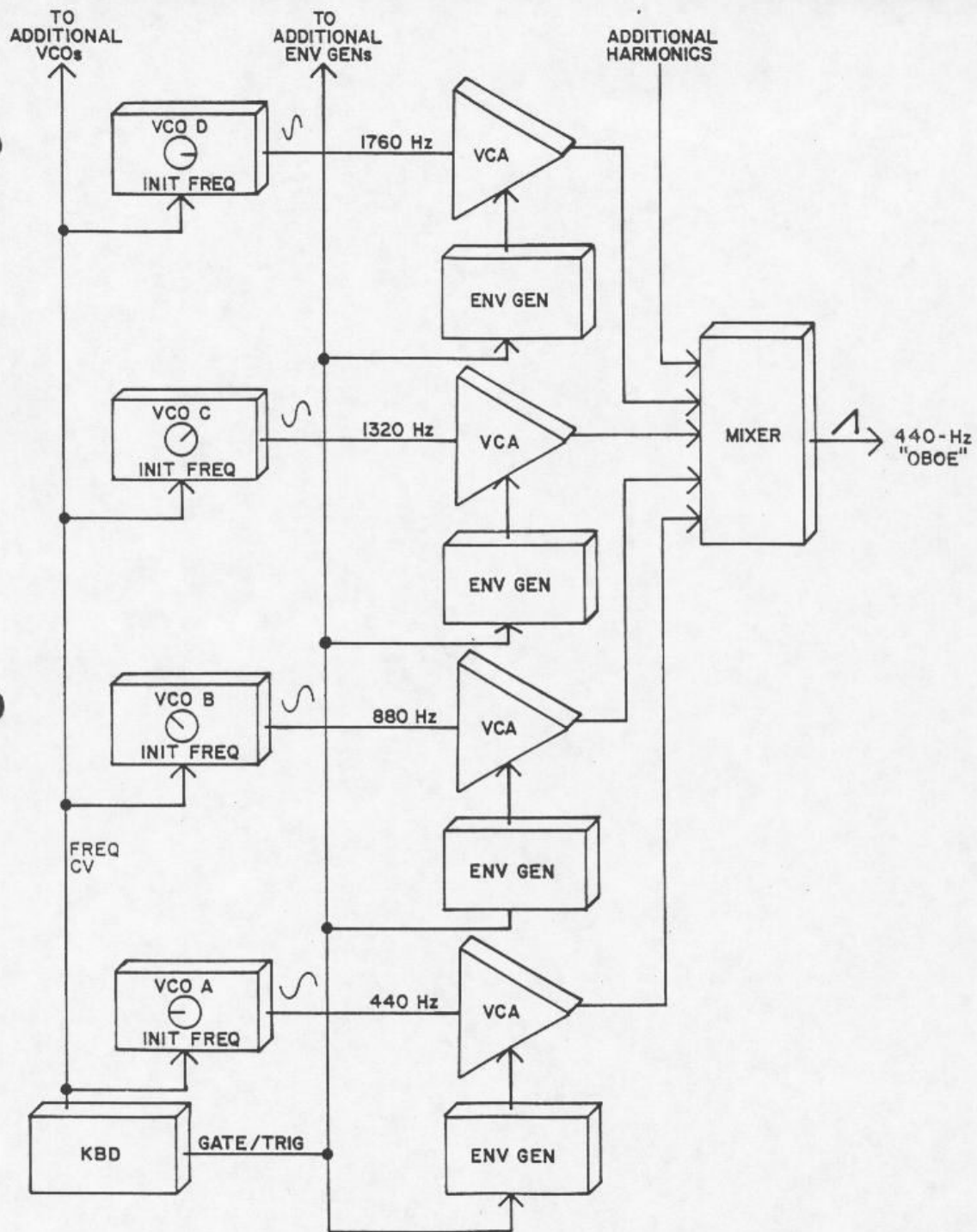


Figure 2-0
Monophonic Additive Synthesis

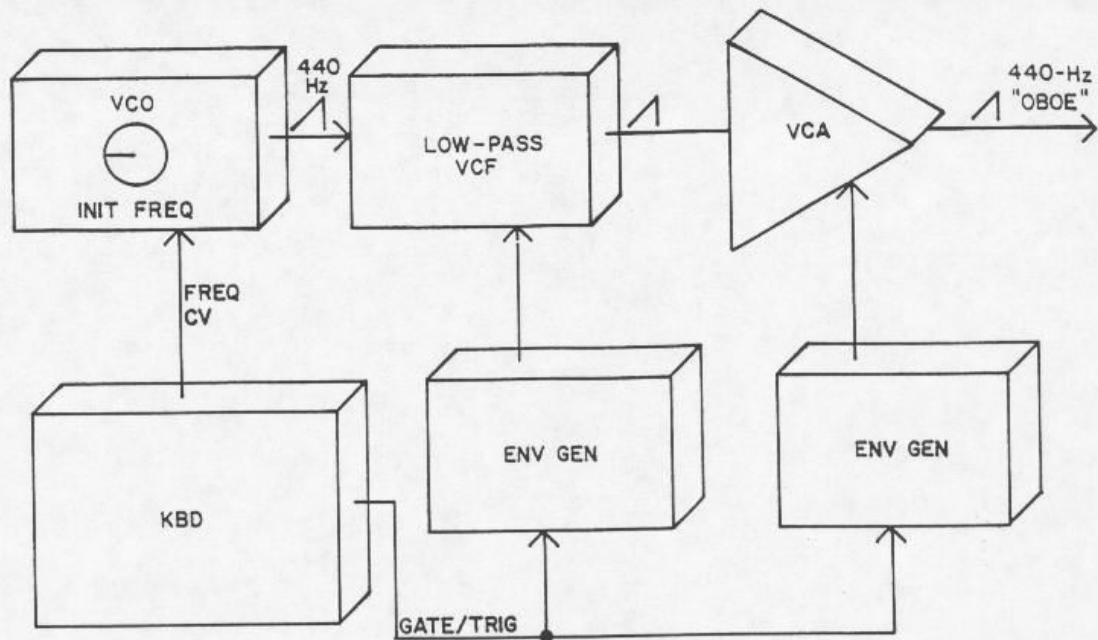


Figure 2-1
Monophonic Subtractive Synthesis

Besides a dynamic envelope, a musical voice usually has a timbre which consists of a fundamental pitch and a number of harmonics — all of varying relative strengths. Pitch and timbre synthesis raises a distinction between two techniques, shown in *Figs. 2-0* and *2-1*. The first, additive synthesis, might create a timbre by summing the output of several sine-wave VCOs for the fundamental and each harmonic. In contrast, subtractive synthesis can start with one sawtooth-wave VCO generating the fundamental with extensive harmonics, then obtain the desired timbre by subtracting unwanted harmonics with a low-pass filter.

The additive and subtractive techniques have encouraged the development of two types of instruments, roughly, “studio”, and “performance”. Since one can individually control each harmonic, additive synthesis may be potentially more accurate for synthesizing a particular sound. Whether they are additive or subtractive, studio synths may be configured from dozens of modules interconnected by “patch cords”. The modules have knobs to establish the initial settings of VC-parameters such as frequency (INIT FREQ), pulse width (PW), and resonance (RES). But the flexibility and complexity of modular synths discourages their “live” use on stage because significant sound changes often require repatching modules and precisely checking knobs. Favorite, complex sounds take a long time to create, and almost as long to recreate on a modular synth. So these often monophonic synths instead feed multi-track recorders on which polyphonic interpretations or compositions are actually orchestrated.

A comparison of the number of modules and interconnections depicted in *Figs. 2-0* and *2-1* shows why the subtractive configuration has become the popular technique for performance synths. Obviously, subtractive synths may be far more portable and their patches will not be as elaborate. Originally, these synths were monophonic. Or they exploited organ technology so more than one note could be played at a time. “Preset” switches that select fixed patches supplanted many modular controls. Though one could certainly change sounds quickly using them, many players found preset synths unsatisfactory because they eliminated an essential part of synth musicianship. Some manufacturers have offered partially-programmable instruments. But before the Prophet appeared it was not possible for a keyboardist to instantly select his or her own customized synth sounds and play them polyphonically.

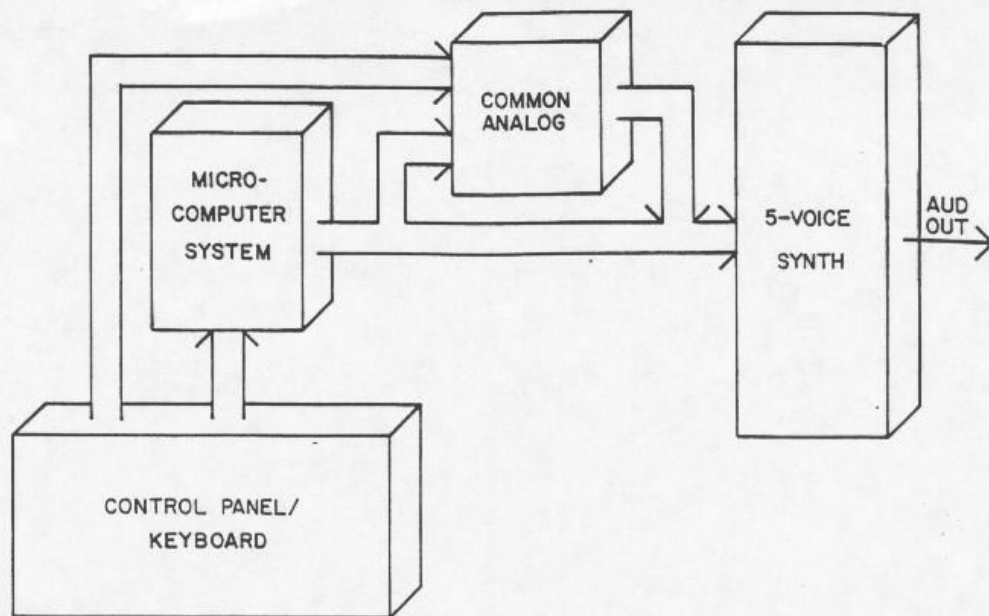


Figure 2-2
Prophet Block Diagram

2-2 THE PROPHET

The Prophet is a subtractive, performance and studio analog synth. It provides instantaneous patch repeatability and polyphonic capability without the limitations of organ technology or fixed presets.

Fig. 2-2 shows the Prophet at the most general level. Instead of controlling the synth directly, the keyboard and most controls are processed through a microcomputer system. The microcomputer system provides a way to store all of the switch and knob settings which form a patch, and solves the problem of generating five sets of independent CVs and GATEs from a single keyboard. Common analog circuitry mixes the few controls not processed by the system with processed control signals from the voices. These patch the five voices to sound fundamentally alike (homophonous) with, typically, pitch differences corresponding to (at most) five simultaneously held keys.

Fig. 2-3 specifies the principle functions of the four main blocks. Beginning with the voices, their outputs are combined and overall volume set by a VCA controlled directly from the front panel.

Each voice is a complete synth with two VCOs, a MIXER, VCF, FINAL VCA, and two ENV GENs but they are patched homophonously by common switch (S) signals and CVs. Each voice also has its own KEY CV which provides polyphonic pitch information, and GATE, which signals that the key is being held. All S signals and most CVs are generated by the computer. The common CVs include master tuning (MTUN), pitch-bend (P-BND), wheel controlled modulation (W-MOD), which are mixed in the COMMON ANALOG circuitry. The COMMON ANALOG circuitry also requires a few S signals.

The microcomputer performs the tasks of voice assignment. It decides which held keys sound which voices through their KEY CVs and GATEs. The computer assigns VOICE 1 to the first key held, VOICE 2 to the second key, and so on. After the five initial assignments the system is "last note priority". The earliest used voice is reassigned to each new note played. Repeated notes key the same voice. For example, holding C, D, E, F, and G, sustains voices 1-5, respectively. Adding A "steals" VOICE 1 from the C which "disappears", even though it may still be held.

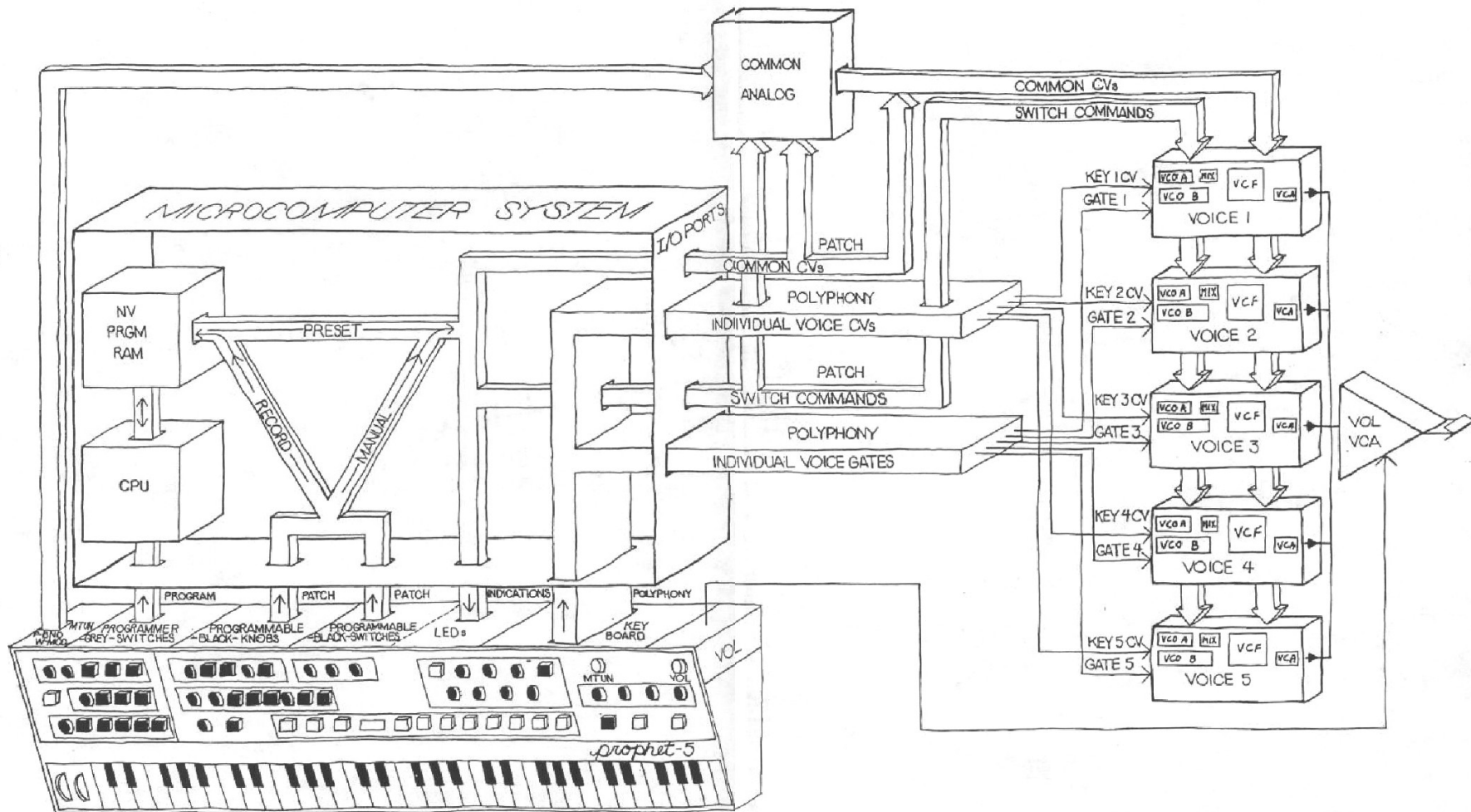


Figure 2-3
Prophet-5 Functional Diagram

In UNISON mode the KEY CVs are switched off. Instead, the UNISON CV supplies all pitch control through the COMMON ANALOG circuitry. Also the GATEs are tied together, so all ENV GENs trigger simultaneously.

Patch CVs and S signals originate from either of two places inside the microcomputer, depending upon the operational mode. The central processor unit (CPU) implements these modes, as controlled by the programmer — grey — switches. In MANUAL mode the CVs and S signals directly follow the programmable — black — knobs and switches. If desired the patch may be recorded into the non-volatile program memory (NV PRGM RAM). Then in PRESET mode, the programmer selects data in NV PRGM RAM which patches the voices.

Below, paragraphs 2-3 through 2-15 will explain the voices, common analog circuitry, control panel/keyboard, and the microcomputer system in more detail. Paragraphs 2-16 through 2-24 will then note hardware functions. Throughout these descriptions you will often read that “the computer ... (does this or that)”, without it being explained why. Very often, the reason for this is that the “why” lies in the microcomputer program itself. And except for the most general remarks, the program will not be detailed.

NOTE: The Prophet software is proprietary information. Knowledge of it is not required to either learn how the Prophet operates or to adjust or repair it.

2-3 VOICE FUNCTION

To understand what the microcomputer system does one may first learn what signals the voices require. VOICE 1 is used for explanatory purposes. (Except for circuitry on VOICE 5 enabling it to be controlled by an external sequencer, the Prophet's five voices are functionally identical).

NOTE: Throughout this manual OSC A and B stands for OSC 1 and 2 marked on the control panel. Also the terms OSC and VCO, FILT and VCF, AMP and FIN VCA, are used interchangeably.

Fig. 2-4 diagrams a single voice and should be referred to for paragraphs 2-4 through 2-9 below. Four types of functions are shown: 1) VC-modules; OSC A, OSC B, VCF, FIN VCA, and the FILT and AMP ENV GENs; 2) CV summers (SMRs) which combine the various CVs for OSC FREQ or PW, or FILT FREQ; 3) Control VCAs, each shown as a triangle with a “CV” line, used for setting audio or other CV levels; and 4) Solid-state analog switches, each shown as a box with an “S” line. A binary 1 or HIGH logic signal on the S line closes the path between the switch's input and output. These switches make it possible for binary data from the computer to patch the voices.

The only independent CV inputs to a voice are its KEY CV and oscillator BIASs. All other CVs are common to all voices. For example, the FILT ATK CV is the same for all five FILT ENV GENs.

The Prophet has two distinct and separate modulation systems, W-MOD (WHEEL-, monophonic) and P-MOD (POLY- or polyphonic). W-MOD uses a single LFO (or noise source) whose output, through the COMMON ANALOG circuitry, affects all voices identically. On the other hand, P-MOD establishes the same modulation “patch” within each voice using the five separate FILT ENG GENs or OSC Bs. The minute differences between for example, oscillator phasing, creates varied modulation between the voices. P-MOD is discussed below, W-MOD in paragraph 2-10.

2-4 OSCILLATOR A (OSC A)

OSC 1A's FREQ is controllable by four CVs. A SUM CV originates in the COMMON ANALOG circuitry. It is the sum of the W-MOD, P-BND, MTUN, OSC A INIT, and UNI CVs.

The second signal to OSC A's FREQ SMR is the KEY 1 CV, which carries polyphonic pitch information for each voice. As mentioned under 2-2, when playing in UNISON mode, KEY 1 CV is switched off and UNI CV — through A SUM CV — becomes the principal FREQ CV.

BIAS 1A is one of the ten BIAS outputs from the Prophet's tuning circuitry. Explanation of the automatic tuning process must be left until computer functions have been described. For now, it is sufficient to know that BIAS is a minute CV which corrects pitch deviations throughout the oscillator range. The BIAS has a little over a semitone in range.

Fourth, OSC A FREQ can be controlled through the P-MOD circuit. A switch applies a CV, mixed from either the FILT ENV GEN or OSC B outputs to the A FREQ SMR.

The A PW SMR combines the PW A INIT CV, which follows the setting of the OSC A PW knob, with LFO or NOISE modulation from the W-MOD circuitry. A P-MOD switch parallel to that for FREQ A functions similarly for PW A.

When activated, OSC A SYNC switch allows OSC A to tune only to harmonic frequencies of OSC B, or changes OSC A's timbre when the two are not in harmonic relation.

OSC A has positive-going sawtooth and pulse outputs switched to the MIX OSC A AMT VCA. This CV follows the MIX OSC A knob setting.

2-5 OSCILLATOR B (OSC B)

OSC B function is similar to OSC A except that OSC B can be a CV source, as well as an audio source.

A switch in the KEY 1 CV patch disables polyphonic tracking when OSC B is to be used as a fixed-frequency oscillator. In such cases a switch in the OSC B MSUM circuit also subtracts UNI CV from the B SUM CV. LO FREQ operation is also enabled by a switch in the B MSUM circuit.

OSC B PW is unaffected by P-MOD, so a summer equivalent to the A PW SMR is not required. PW B CV results from PW B INIT CV and PW B W-MOD CV, combined in the PW B MSUM.

OSC B has a bipolar triangle-wave output in addition to the positive-going sawtooth and pulse outputs. The P-MOD OSC B AMT VCA sets CV level to the destinations selected by the three P-MOD switches.

2-6 FILTER ENVELOPE GENERATOR (FILT ENV GEN)

The FILT ENV GEN is a four-stage ADSR transient CV source. GATE 1 is a binary signal which goes HIGH whenever that key to which the voice is assigned is pressed. GATE is also applied to the TRIG input through a pulse-forming network containing C402. When GATE first appears, the resulting TRIG pulse actually starts the ADSR sequence.

The ATK, DEC, and REL periods are exponentially controlled by the CVs shown. The SUS level is linearly controlled by the FILT SUS CV. The SUS period continues for as long as GATE is present (key down) after the ATK and DEC periods. The REL period starts when the GATE is turned off (key up).

FILT ENV GEN output to the FILT is normally controlled by the FILT ENV AMT VCA. As mentioned above, the P-MOD FILT ENV AMT VCA allows the FILT ENV GEN to modulate OSC A FREQ or PW. Note that the P-MOD FILT switch is a redundant path for the ENV GEN output. This switch is intended to allow OSC B to modulate the FILT.

2-7 FILTER (FILT)

There are four audio inputs to the FILT: 1) NOISE, whose level is controlled elsewhere; 2) OSC A; and 3) OSC B, whose levels are controlled by their MIX AMT VCAs. Fourth, the FILT output is fed back to the input by the RES FDBK VCA to sharpen FILT resonance.

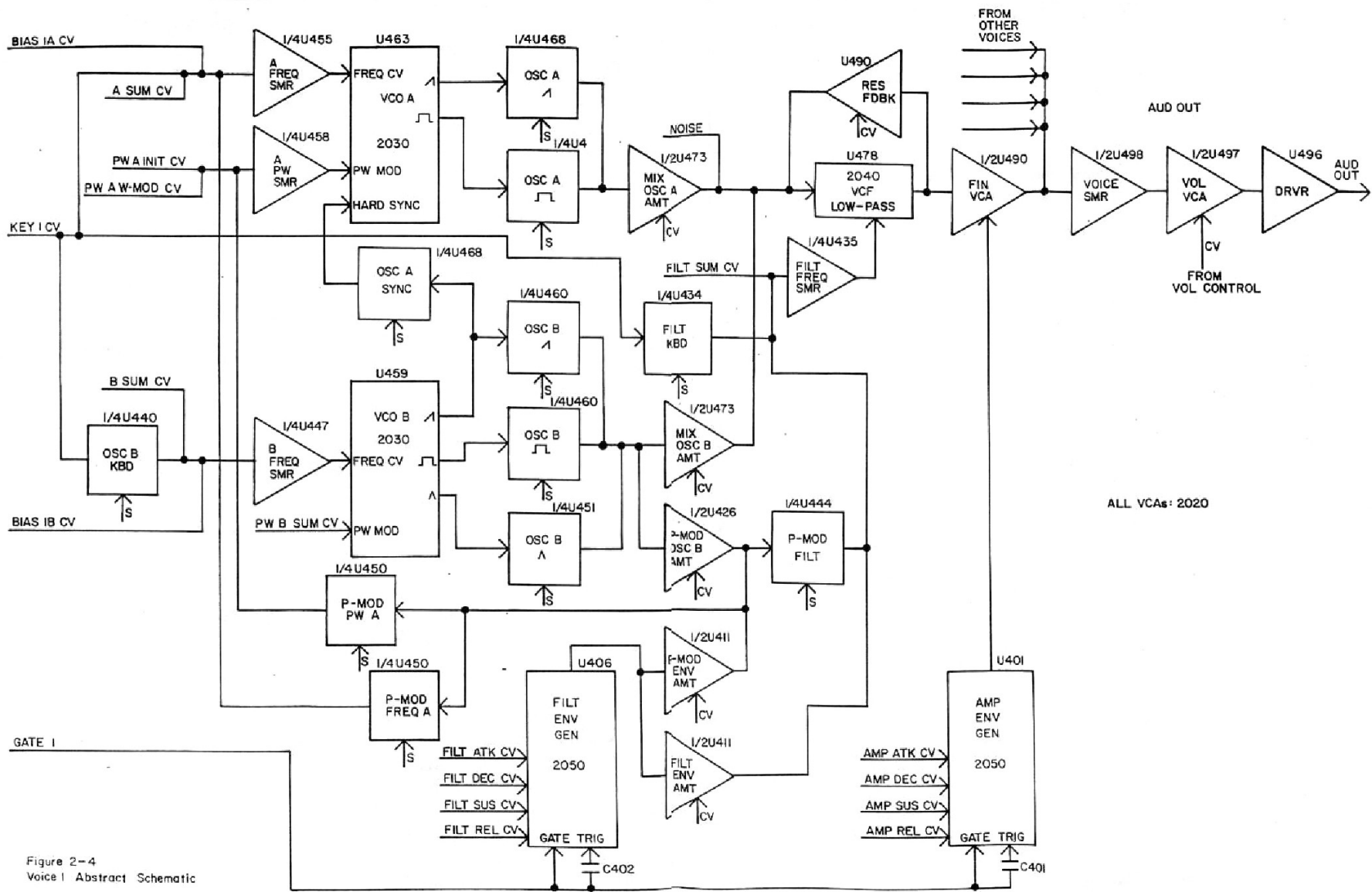


Figure 2-4
Voice I Abstract Schematic

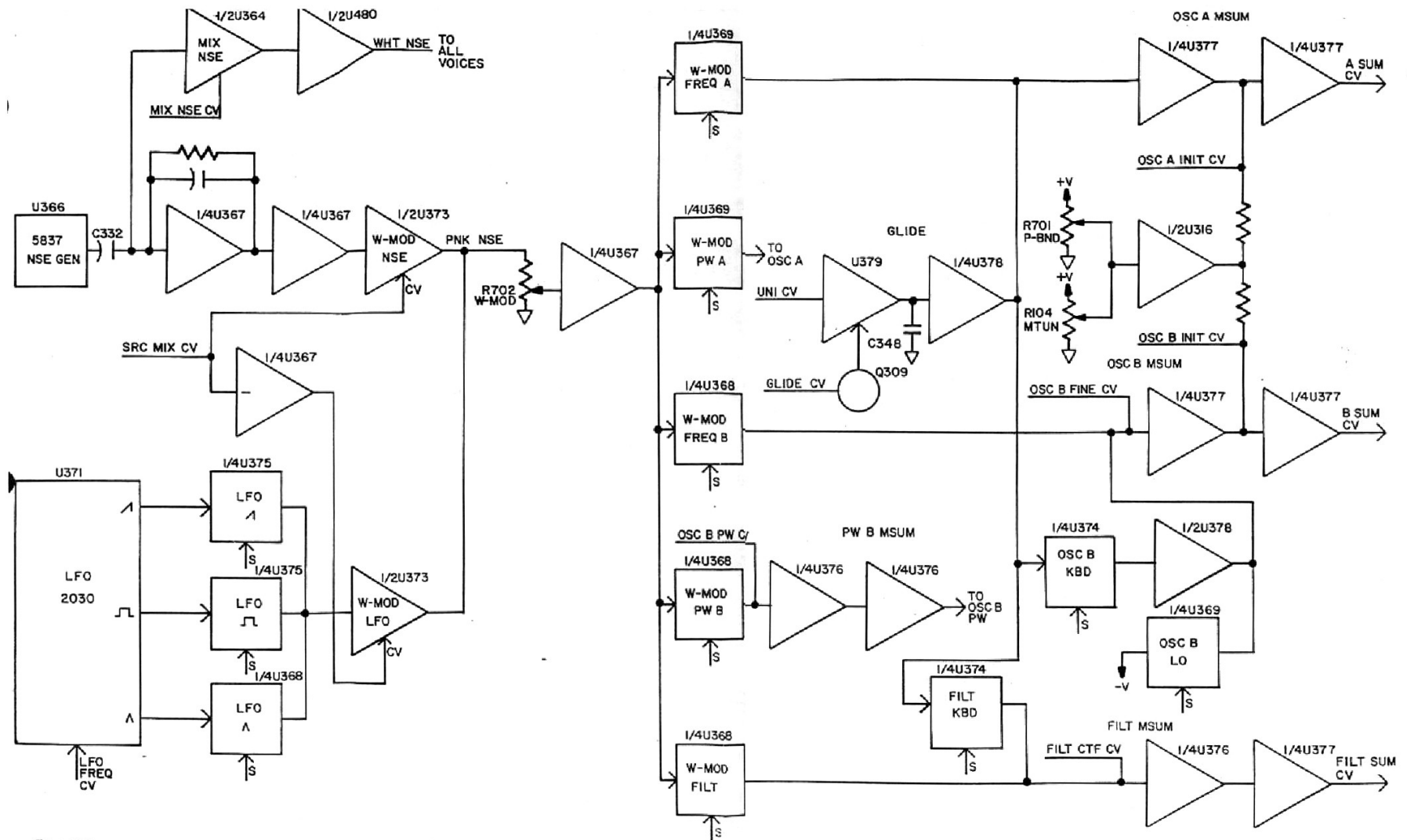


Figure 2-5
Common Analog Abstract Schematic

FILT cutoff (CTF) FREQ is controllable by several CVs combined in a SMR similar to those for OSC A and B. FILT SUM CV results from UNI, W-MOD, and FILT CTF CVs. A switch in the KEY CV path disables polyphonic tracking. In such cases a switch in the FILT MSUM circuit also subtracts UNI CV from the FILT SUM CV.

As mentioned in paragraph 2-6, the FILT ENV GEN modulates the FILT through the FILT ENV AMT VCA, and OSC B is effective through its P-MOD VCA and P-MOD FILT S.

2-8 AMPLIFIER ENVELOPE GENERATOR (AMP ENV GEN) AND AMPLIFIER (FIN VCA)

The AMP ENV GEN functions exactly like the FILT ENV GEN (paragraph 2-6). Its transient output determines the amplitude contour of the FIN VCA.

2-9 AUDIO OUT (AUD OUT)

The final audio stage sums the output from all the voices, adjusts their overall level with the VOL VCA, and amplifies the signal to drive an amplifier. (Besides by knob, volume may be controlled by an external CV source, such as a voltage pedal.)

2-10 COMMON ANALOG

The COMMON ANALOG circuitry includes the OSC A, B, and FILT master summers (MSUMs), GLIDE circuit, and the wheel which controls noise (NSE) or low-frequency oscillator (LFO) modulation (W-MOD).

The MSUMs allow simultaneous pitch control and modulation of the VOICES. ASUM CV, the common OSC A frequency CV, consists mainly of the OSC A INIT CV which follows the OSC A FREQ control. The P-BND or MTUN controls effect pitch adjustment. When in UNISON mode, the individual voice KEY CVs are switched off, and UNISON (UNI) CV follows the keyboard. Increased GLIDE CV delays quick changes in UNI CV. W-MOD output is added to A SUM CV when the W-MOD FREQ A switch is closed.

OSC B MSUM is similar to OSC A. OSC B INIT CV, P-BND, and MTUN are combined in the same manner. The OSC B KBD switch is closed for keyboard tracking in UNISON mode. For LO FREQ operation, a switch applies negative voltage to the SMR. OSC B FINE CV allows vernier frequency control of OSC B alone.

The FILT MSUM combines the FILT CTF CV, which follows the FILT CUTOFF knob, with UNI CV if FILT KEYBOARD tracking is selected.

PW A MSUM is implemented on each voice, since it includes P-MOD circuit output. PW B MSUM only needs to add OSC B PW CV with W-MOD.

The W-MOD signal switchable to OSC A, B or FILT FREQ and OSC A and B PW contains NSE or LFO output as determined by the SRC MIX CV. CV inversion to the W-MOD LFO VCA allows NSE and LFO levels to move in opposite directions. As SRC MIX CV increases, NSE output increases but LFO output decreases. Pink (PNK) NSE is used for modulation. The MIX NSE VCA adjusts white (WHT) NSE level to the voices. The LFO is similar to the voice VCOs.

2-11 MICROCOMPUTER SYSTEM

It should be clear from the above that operation of the Prophet's analog circuitry requires only some CVs, GATE signals, and logic signals for the switches.

You don't need a computer to sound the voices. In a previous synth generation the required signals might be provided by patch cords, mechanical switches, potentiometers, and a voltage-divider keyboard. But such control would not usually be programmable or polyphonic, and that is why the Prophet has a microcomputer system. "System" refers to the combination of electronic hardware and computer software, or, program.

Figure 2-6 fills out the main elements of the microcomputer system and its input and output (I/O) circuitry. If you are unfamiliar with microcomputers you might find it helpful to focus on the DATA BUS (DB). Physically, this is a set of eight parallel wires carrying digital signals between the Z-80 central processor unit (CPU), memory (PROM, RAM), and (I/O) devices.

Obviously, not all of the information transferable between data-bussed circuits will be able to be communicated simultaneously. This would be like trying to hold a telephone conversation over a party line with a dozen others. Control signals from the MEM ADR, IN PORT, and OUT PORT decoders allow "conversation" between the CPU and any one other data-bussed device by, in effect, inhibiting devices not involved with the conversation. In short, the decoder signals tell the MEM and I/O devices when they are supposed to place data on the bus, or when data is intended for them.

Let's see what takes place to sound a single key. The CPU, of course, runs everything according to unalterable program instructions contained in erasable/programmable read-only-memory (EPROM). (The program is actually a continuous "loop".) The CPU places data and addresses on those busses, and activates the -IOREQ and -WR signals. This produces CS8 from the OUT PORT DCOD, which latches the data into the keyboard, switch, and LED matrices. The matrix converts (digitizes) key strokes into binary data. The address changes, -IOREQ and, this time -RD are activated. This produces -CSE from the IN PORT DCOD, driving matrix data representing the key held on to the bus. The CPU performs calculations on the matrix data to determine the actual position of the key pressed. It then places the key number into the SCRATCH PAD RAM by supplying an appropriate address and -MREQ to the MEM ADR DCOD, and -WR.

To sound the note the key number is read from the SCRATCHPAD and latched to the digital-to analog converter (DAC) when the OUT PORT DCOD issues CSC. VDAC, an analog voltage corresponding to the latched key number, is distributed by the CV DMUX to, in this case, KEY 1 CV. CV DMUX addresses are also latched by command from the OUT PORT DCOD. Finally, the GATE signal is latched off the bus.

All of this activity is yet a minute portion of the whole loop. Of course, the program must be constantly read from EPROM. In PRESET mode, the CPU also reads patch CV and S data from the NV PRGM RAM. In MANUAL mode, the loop also includes a scan of the black switches and knobs. In either mode, data output also operates the LEDs.

Although these operations are sequential, you perceive no delay between, for example, the key-stroke and the note produced because of the speed at which the program is executed. The program loops about 100 times each second in MANUAL mode, and about 140 times in PRESET. (This amounts to about 350 to 475,000 DB operations per second.)

Paragraphs 2-12 through 2-15 describe output and input circuit functions in more detail.

2-12 CONTROL VOLTAGE (CV) and SWITCH (S) SIGNAL GENERATION

The analog circuitry and microcomputer system have been outlined. This paragraph concentrates on the form computer data must assume in order to control the voices.

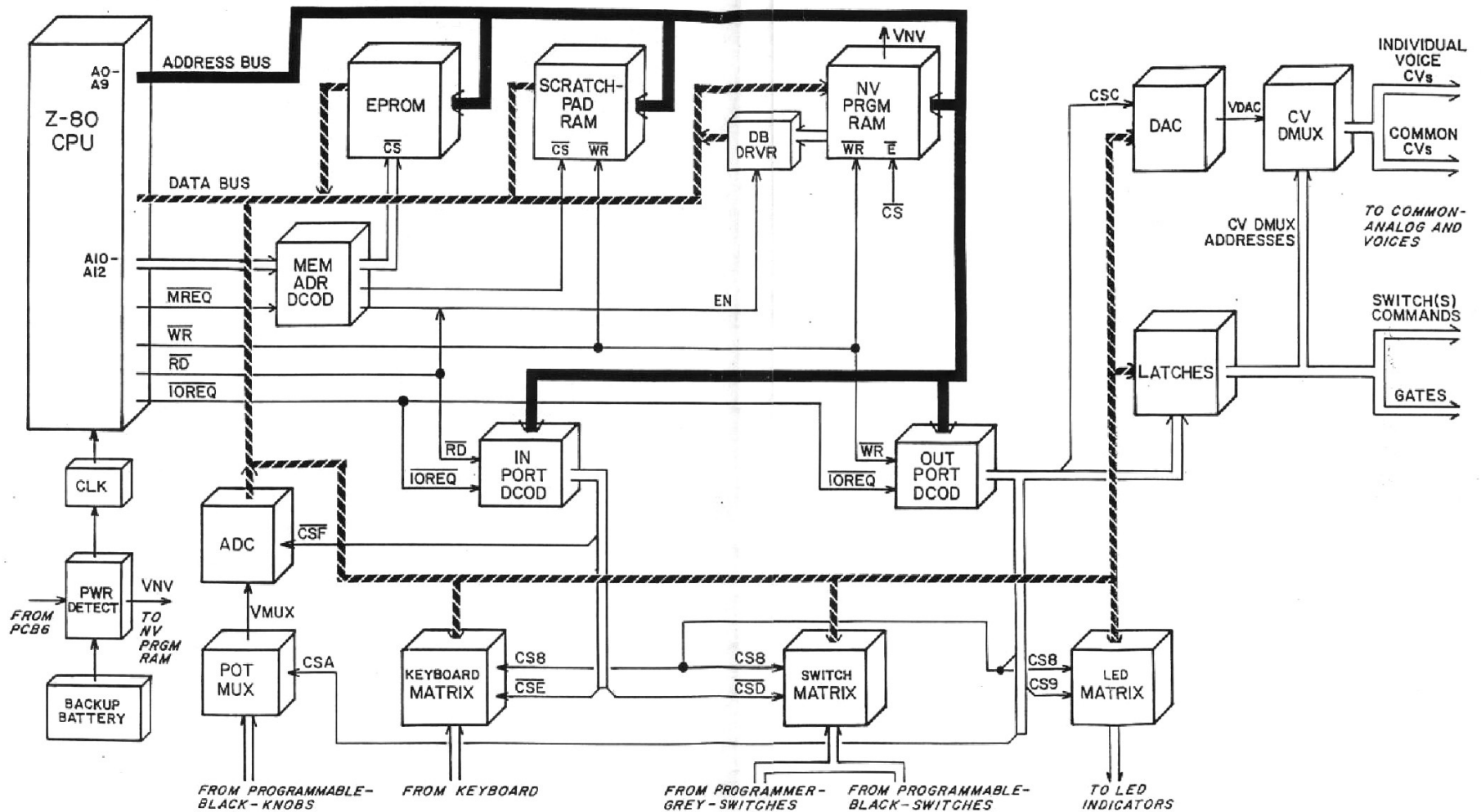


Figure 2-6
Microcomputer

Computer output consists of CV and switch (S) signals. All circuits which extract data from the micro-computer system are based on the latch. The latch is a one-address digital memory, used to hold data for an output circuit during the period when the CPU is busy with other operations. Latched data is "refreshed" every loop. For example, a single latch may capture ON/OFF commands for six switches. The switch commands remain valid until the CPU next sends data to the latch.

The DAC's basic function has already been introduced — it converts computer data to an analog voltage. But the synth requires 41 CVs. Forty-one DACs, each connected to a CV destination, could be used. More efficiently, the Prophet uses one DAC and a CV demultiplexer (CV DMUX) to distribute the DAC output, VDAC. VDAC assumes the value of all 41 CVs during each program loop. (See Figure 2-2, below). Since CV distribution is sequential, an analog equivalent to the latch is also required. Forty-one sample-and-holds perform this function. Each S/H maintains a specific VDAC value during the period when the CPU is otherwise occupied. The CV output remains constant until the S/H is strobed (refreshed) during the next loop.

To exemplify the process, suppose the FILT ATK CV is to be set to 7.083V. In MANUAL mode this value would originate directly from the control knob. In PRESET, this value would be read from the NV PRGM RAM. In either case, the CPU places the binary number 1010101 on to the DATA BUS, and the OUT PORT DCOD issues CSC. This causes the DAC LATCH Q outputs to follow the state of the DATA BUS — until the next appearance of CSC.

The latched bits drive a level amplifier consisting of transistors operated from a voltage reference. This stage insures that the normally uncritical digital signals are equal and constant. Thus, the level amp output is "precisely" low or high, following the latched bits. The R-2R ladder binary-weights the current through each ladder "rung", so VDAC, through U328, assumes the value shown. In the example, the bit pattern 1010101 converts to a VDAC of 7.083V. The current addition performed by the ladder is shown.

The exact DAC scaling is 1/12V (83.3 mV) per step. This was chosen for convenience in controlling the OSC and FILT FREQs, which are scaled at 1V/octave. With these values, each step results in a frequency change of exactly one semitone. (Which is why the OSC FREQ knobs adjust in semitones.)

The 7-bit DAC has a range of 128 steps, thus 0 - 10.583V ($127 \times 1/12V$). In actual practice the DAC MSB is not used for frequency control since only about half the full range is needed to represent either the five-octave (61 note) range of the keyboard or the OSC (INIT) FREQ knobs.

Returning to the example, the CV DMUX can be thought of as a single pole, 41 position rotary switch in which the switch position (address) is controlled by data from another set of latches. The address currently routes VDAC to the first DMUX output, to which is connected the sample and hold (S/H).

The S/H is a short-term analog memory comprised of a low-leakage capacitor and a J-FET-input operational amplifier, nicknamed a BIFET. The BIFET has an extremely high input impedance — several thousand megohms — and is configured for unity gain. With VDAC applied, the FILT ATK CV ideally equals 7.083V.

To output the next CV, first the CV DMUX address changes, the new data is latched to the DAC. In the meantime C1 holds its charge, since there is no leakage path. The S/H output voltage thus remains constant. C1's value is large enough to hold the charge for at least 10 ms (the CPU "scan" rate), but low enough so it quickly recharges to a higher or lower VDAC when it is next strobed. The process continues for the remainder of the S/Hs. In summary, though the CPU generates CVs sequentially, the S/Hs make sure that the analog circuitry never knows the difference.

To generate switch commands, a latch alone is used. The Q outputs connect to the S control lines. The latched data 101010 would therefore close (1) three corresponding switches and leave three open (0). Unlike the DAC, the switches don't care about the actual numerical value of the data, since each switch is only connected to one bit. In other words, the same data which represent a CV value of 3.500V ($101010 \times 1/12V$) to the DAC, stands for a combination of OFF/ON commands when latched instead to switches.

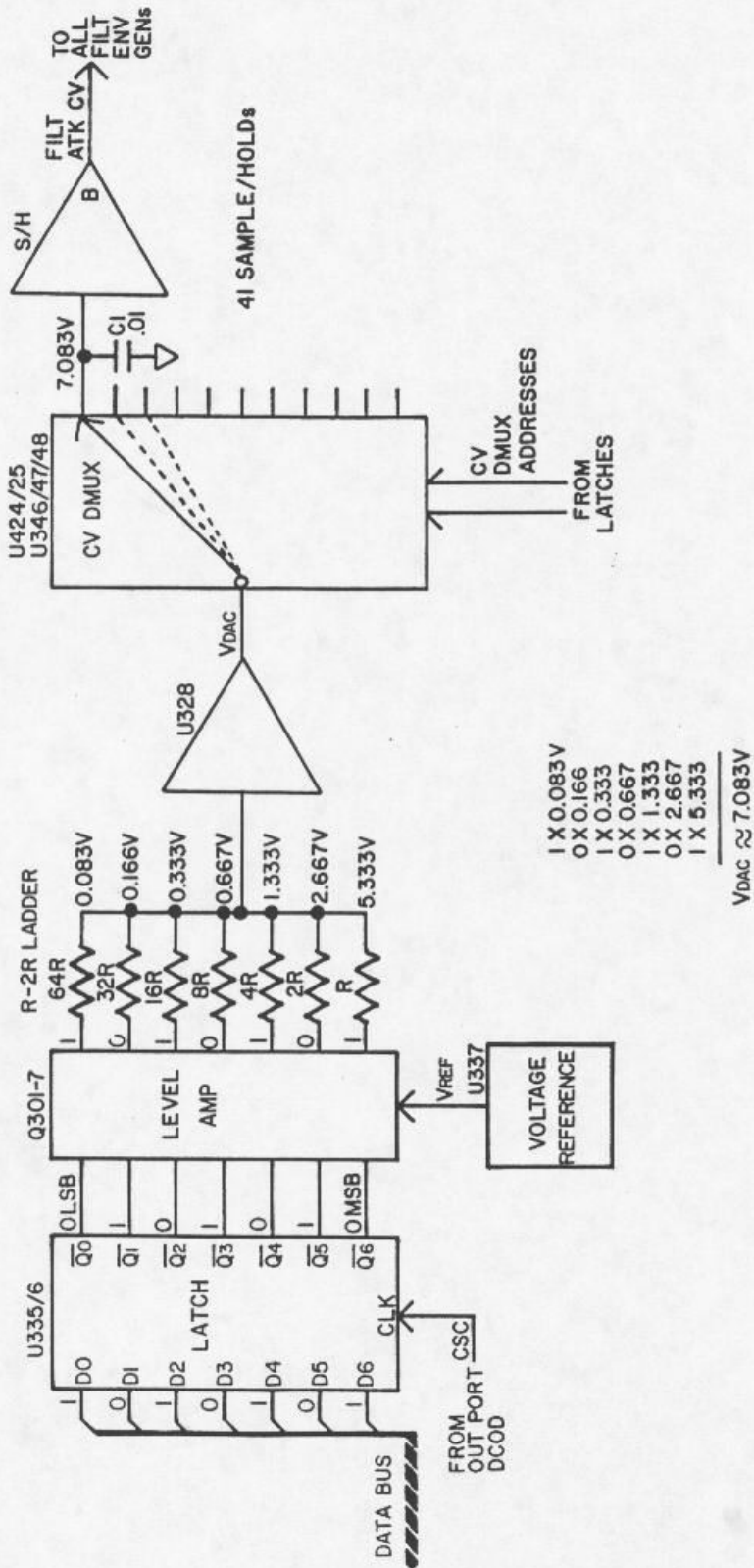


Figure 2-7
DAC and CV DMUX

2-13 CONTROL PANEL MATRICES

This paragraph describes how the computer "scans" the control panel to learn what keys or switches have been pressed, and to light the LEDs imbedded in switches (that are "ON".) *Figure 2-8* block-diagrams the control panel. You may also want to consult the schematic, SD212 (page 3-11).

A matrix is an area of signal lines with devices connected diagonally where they cross. SD212 clarifies the arrangement. Consider the keyboard matrix first. One side connects to SWITCH DRIVER latches U209/12, the other to drivers U204/5. (Bus drivers are functionally similar to latches. When clocked, they place data on the bus.) To read the keyboard, the CPU places the number 00000001 on the bus, and supplies CS8. The SWITCH DRIVERS hold the first matrix line, DX0, high. Whatever keys in the row are held will place 1 on their connecting columns, DY0 - DY7. For example, if DO is held, the number 00000100 will be driven on to the bus when -CSE appears. (If more than one key in a row is held, the CPU subtracts to find the actual combination.) After reading row DX0, the CPU activates row DX1 with the number 00000010, and CS8, and reads the matrix output again with -CSE.

The matrix diodes prevent switched bits from returning through other closed switches on the same column, which would activate other rows.

Control switches are read in the same manner as the keyboard switches, except using another driver clock, -CSD.

To light the switch LEDs, one row is activated low through inverters, and the LED DRIVER latches U208/11 supply the necessary high signals. The LEDs are therefore not constantly lit, they only seem so due to persistence effects accompanying our sight.

For PRESET operation, data representing selected switches and their corresponding LEDs is read from the NV PRGM RAM.

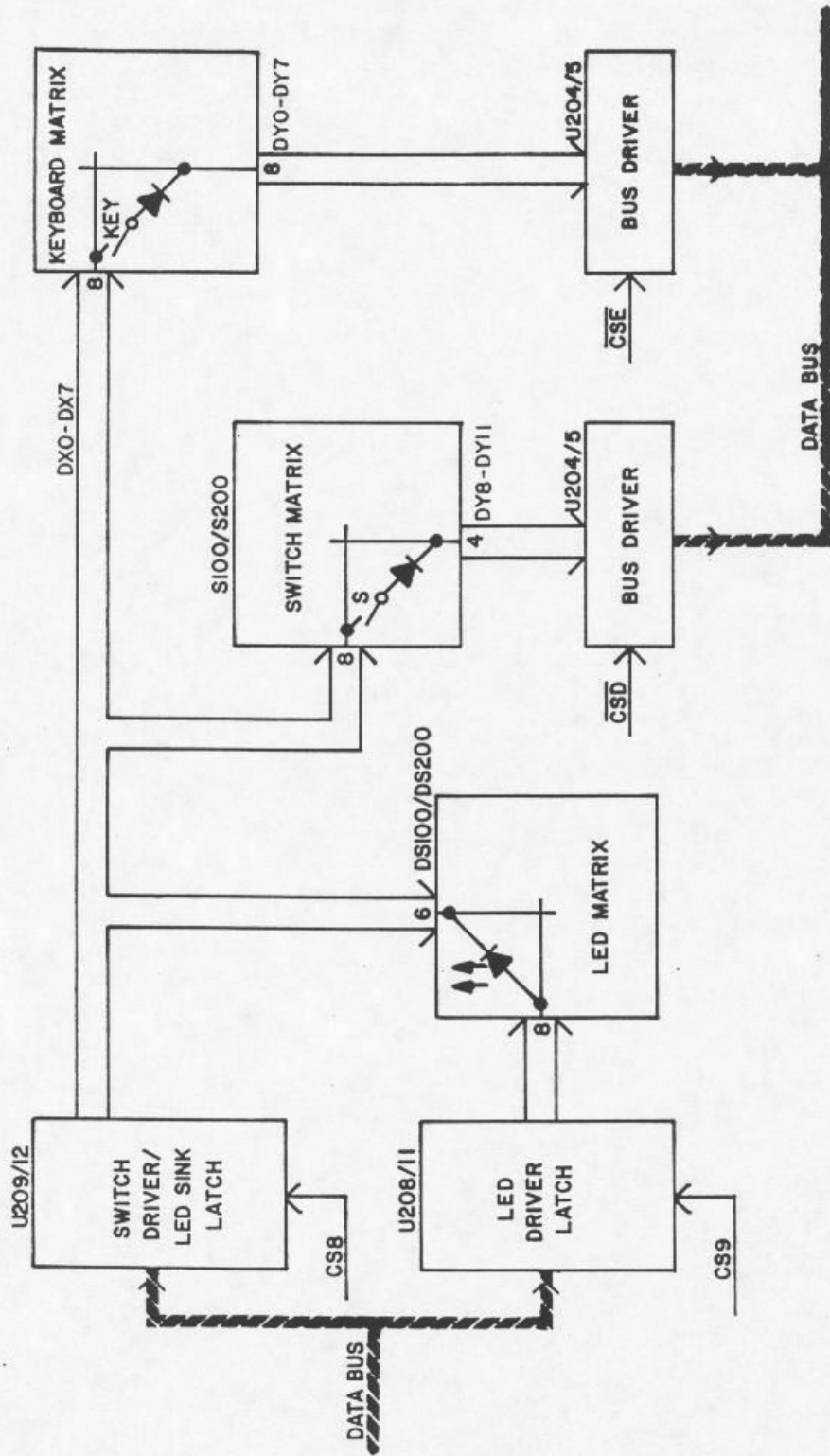


Figure 2-8
Control Panel Matrices

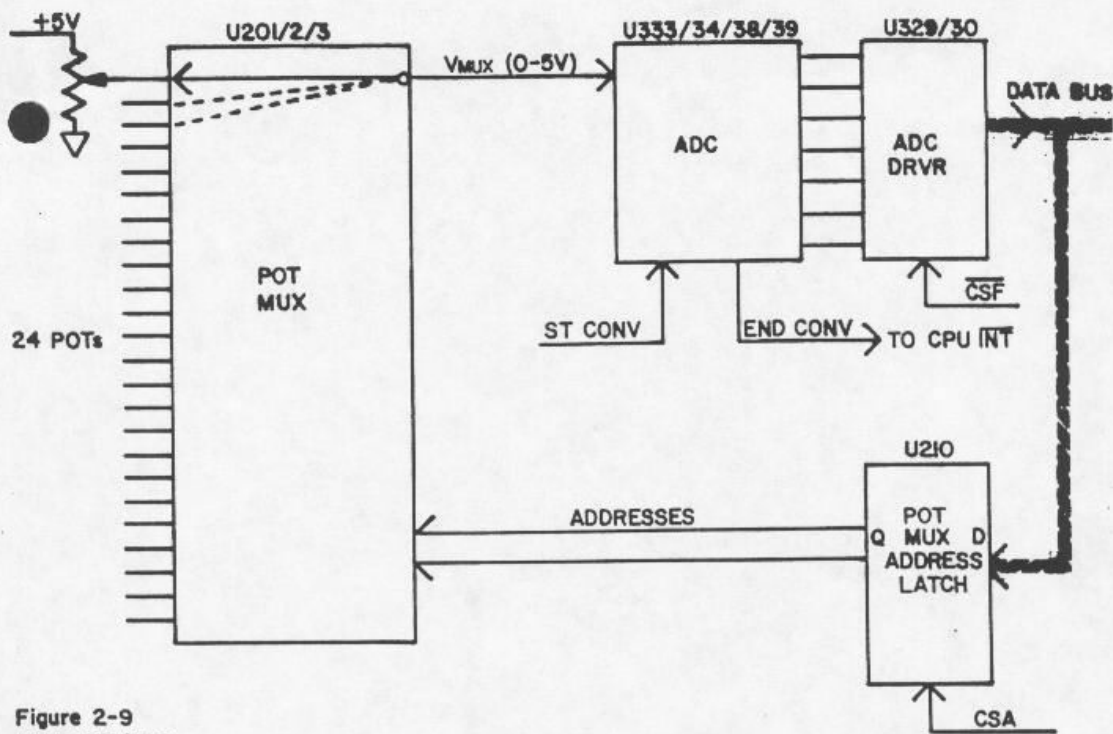


Figure 2-9
POT MUX/ADC

2-14 POTENTIOMETER MULTIPLEXER (POT MUX) AND ANALOG-TO-DIGITAL CONVERSION (ADC)

The POT MUX and ADC allow the computer to read and therefore record knob settings for a patch. They are only active in MANUAL and EDIT mode. During PRESET, data for knob settings is read from the NV PRGM RAM. Four pots are not involved in this stage: VOL, and P-BND, W-MOD, and MTUN (which are in the COMMON ANALOG circuitry). The remaining 24, all having black knobs, connect to the POT MUX.

The POT MUX and ADC can be thought of as the reciprocal of the DAC and CV DMUX. The POT MUX sequentially connects each pot wiper to the ADC, which provides a 7-bit (0 - 127) representation of its setting. Addresses specifying the POTs to be sampled are latched off of the DATA BUS by U210, when clocked with CSA from the OUT PORT DCOD. The ST CONV signal, latched elsewhere in the computer, tells the ADC to start converting VMUX. Inside the ADC a binary counter increments until an external comparator finds its analog equivalent equal to VMUX. The comparison stops the counter, and sends END CONV to the interrupt (-INT) pin of the CPU. The IN PORT DCOD issues CSF, driving the counter value on to the bus for recording into the NV PRGM RAM. The POT MUX selects the next pot, and conversion again begins with ST CONV.

Since the ADC counter increments until it matches VMUX, the conversion time for pots with higher settings will be longer than for those with lower settings. (See Waveforms 2-1, below.) Under interrupt control, the loop is not delayed by changing conversion times. The CPU will continue to execute instructions throughout the conversion period.

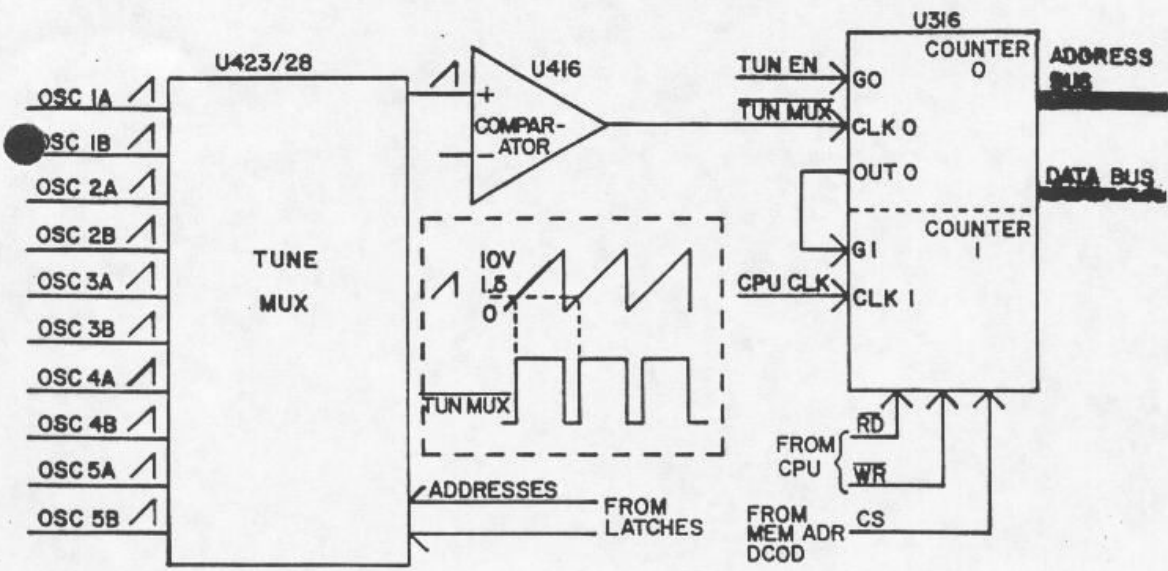


Figure 2-10
TUN MUX/TIMER

2-15 TUNE

The final circuitry to be discussed at the functional level has only been briefly mentioned before. The TUNE circuitry is a negative feedback system, using multiplexing and period measurement to minimize pitch differences between the oscillators. It does this by issuing separate BIAS CVs for each OSC (see 2-4). At the DAC the BIASES have a full range of about 10V. But this is attenuated 100:1 to provide a little over a semitone in range at the OSC. This resolution allows steps of about 1 cent (1/100 semitone).

The need for a TUNE circuit should be clear by this time. As has been shown, there are many sources of oscillator control which are summed in two different places to define the actual pitch of the ten oscillators: 1) Those summed in the COMMON ANALOG circuitry — INIT FREQ, MTUN, P-BND, W-MOD, UNI CV and FINE on OSC B — are common to each set of five OSC As and OSC Bs. 2) In the voices control sources include the COMMON ANALOG output, KEY CV, BIAS CV, INITIAL FREQ trimmer, P-MOD FREQ CV (OSC A only), and on VOICE 5, possibly an EXTERNALLY supplied FREQ CV. These are of course summed individually for each oscillator. Since all of these sources affect oscillator pitch, any can detune them. Additionally, each OSC also has a V/OCT and a HI V/OCT trimmer, which affects the tuning. Finally, any 2030 VCO can be different enough from the others to be out of tune. They age, and their pitch is affected by temperature (although this effect is reduced with temperature-compensating resistors).

There are two basic parameters to work with in tuning. One is initial frequency (INIT FREQ) that is, setting all oscillators to sound the same pitch for a particular CV sum. The other is scaling, or V/OCT, which desires a predictable pitch change to accompany a specified CV change. In the Prophet, both parameters are fine-tuned automatically on power-up, or whenever the TUNE switch is hit.

See Figure 2-10. The TUNE circuit consists of the TUNE MUX, a level comparator (LVL CPR), and two of a three-section programmable timer. The TUNE MUX sequentially connects each oscillator sawtooth output to the comparator, which converts them to pulses to clock the first timer. This counter is preset to count a specific number of oscillator cycles. OUT 0 goes low when it starts to count cycles, then high on the terminal count. The low on counter 1's gate (G) enables it to increment at the CPU clock rate — about 2.5 MHz. The high stops the counter. The resulting 16-bit number represents the period of counter 0's programmed number of cycles. The number, called REF CNT, is stored in memory.

During the TUNE routine, the computer initializes all S/Hs that affect tuning (and defeats any external CV). It has no control over the MTUN or P-BND, so these must be centered and not moved. The computer then sets OSC 1A BIAS CV to 2V, and the OSC A INIT FREQ and KEY 1 CVs to cause a pitch near 300 Hz. It then selects OSC 1A's sawtooth output through the TUNE MUX. (If for some reason an oscillator has failed, the TUNE routine cannot execute.) Counter 0 is programmed to count 1 cycle. Gating counter 1, the REF CNT will be approximately 9000. In other words the period of one cycle at 300 Hz is approximately equal to 9000 CPU clock cycles.

The CPU now sets all BIAS CVs to 0V, leaving the INIT FREQs and KEY CVs unchanged. Returning to OSC 1A it again counts one cycle period, and compares it to the REF CNT. The period will almost always be too long with 0 BIAS. It then increases the BIAS one step (83 mV), and measures the period again. The count-and-compare process continues until the oscillator count equals the REF CNT, at which point the computer saves the BIAS 1A value. This repeats for the nine remaining oscillators, so that each has a BIAS CV in memory which matches its pitch to the others at 300 Hz. The tuning routine ignores badly mistuned oscillators. If BIAS increases 100 steps without tuning the oscillator, the CPU resets it to 2V and goes on to the next oscillator.

Next, the computer obtains another set of ten biases to match the oscillators at 600 Hz, by programming counter 0 to count two cycles, and raising the INIT FREQ and KEY CVs by 1V. (Two cycles at 600 Hz should take exactly the same time as one cycle at 300 Hz). The process continues at 1200 Hz for four cycles, and at 2400 Hz for eight cycles. When done, the computer has four bias values for each oscillator at four different frequencies (40 total).

Now, when playing the computer determines the pitch each oscillator is to sound and continually corrects by applying one of the four biases. It uses the 300-Hz BIAS up to about 450 Hz, where the 600 Hz BIAS takes over. The 1200 Hz BIAS CV is used between about 900-1800 Hz, and 2400 Hz BIAS CV corrects the rest of the frequency range.

2-16 HARDWARE DESCRIPTION

The remainder of this section comments on circuitry which may not be clear from either the schematics or the more general description, above. Logic or analog circuits which should be apparent to anyone qualified to work on the Prophet, are not discussed. It is assumed throughout that the reader will follow signals continued on other sheets as explained in paragraph 3-1, DOCUMENT NOTES.

2-17 BD001 INTERCONNECTION

The diagram depicts the physical organization of the Prophet's assemblies. Symbols show on which schematics components on each PCB or assembly can be found.

The Prophet is designed for compactness and light weight. It separates into a TOP and a BOTTOM PANEL ASSEMBLY. The BACK PANEL CABLE connects PCB6, POWER SUPPLY BOARD, and the BACK PANEL INTERFACE jacks to PCB3, COMPUTER BOARD, at P301. The only other connection between the main assemblies is the AUDIO OUTPUT cable from PCB4, VOICE BOARD. This quick-disconnects from the BACK PANEL at P402. The TOP PANEL ASSEMBLY of course holds the KEYBOARD and WHEELS. PCBs 1 and 2 mount directly to the CONTROL PANEL. And PCBs 3 and 4 mount on PCBs 1 and 2 with standoffs.

PCB1, RIGHT CONTROL PANEL, contains potentiometers, switches and LEDs wired into the POT MUX and SWITCH/LED matrices on PCB2 through W701. Also through W701 passes MTUN signal which terminates on PCB3 and the VOL CV signal to the AUD OUT circuit on PCB4.

PCB2, LEFT CONTROL PANEL, contains the POT MUX and SWITCH/LED matrices. The KEYBOARD plugs in to the SWITCH MATRIX at J201. Through P201 passes the DATA BUS which conveys switch data from the matrix to the LED data and POT MUX addresses are sent to PCB2 over the DATA BUS.

Interconnection has been minimized in the Prophet by implementing the microcomputer system and analog circuitry on only two PCBs. PCB3 contains the CPU, MEMORY, MEM DCOD, I/O DCOD, ADC, DAC, COMMON ANALOG circuits and the parts of the CV DMUX which distribute the 26 common CVs.

PCB 4 contains the CV DMUX for the five KEY and ten BIAS CVs, TUNE MUX, VOICES 1-5, and AUD OUT circuit. So signal inputs through W703 60-wire ribbon include: 1) COMMON CVs, including W-MOD, 2) All voice switch (S) commands, 3) VDAC, for the INDIVIDUAL CV DMUX, 4) INDIVIDUAL CV DMUX ADDRESSES, 5) GATES, 6) VOLUME CV, from PCB1. PCB4 sends the -TUNE MUX signal back to PCB3 over W703, and AUDIO OUT over coax to the BACK PANEL.

2-18 SD211 CONTROL PANEL — POTS

There are two non-programmable and 24 programmable pots divided between PCBs 1 and 2.

R105, VOLUME, is not programmable. (Its knob is silver-colored). U381 originates the 5-V analog source to R105 through P301/J710-13 to shorting jack J707. If external dynamic control such as a foot pedal is used, it — instead of U381 — supplies CV through R105. But, normally, +5V(A) reaches R105 through J710/P301-15, J301/P201-3 and TB201/101-34. The CV set by R105 crosses PCBs 1, 2, and 3 before buffering by U498-7, which drives U497-15 VOL VCA.

Neither is R104, MASTER TUNE (MTUN) programmable. (Also a silver-colored knob.) It offsets the OSC A and B MASTER SUMMERS (MSUMs), allowing over a semitone of flat or sharp correction. The MTUN signal is summed with other pitch-changing signals by U365-7.

The remainder of the pots are wired to the POT MUX; those on PCB1 through TB101, W701, and TB201. TABLE 2-0 shows the data latched by U210 to select each pot. The bits Q1, Q2, and Q3 have a decimal value of 0 - 7. Applied to the A, B, C control of U201/02/03, they select 1 of the eight corres-

TABLE 2-0

MUX CHIP EN	DESIG	NAME	Q6/ /DB5	Q5/ /DB4	Q4/ DB3	Q3/ DB2	Q2/ DB1	Q1/ DB0	(HEX)
U201	R213	GLD	0	1	1	0	0	0	18
U201	R210	OSC B FINE	0	1	1	0	0	1	19
U201	R203	OSC A FREQ	0	1	1	0	1	0	1A
U201	R209	OSC B FREQ	0	1	1	0	1	1	1B
U201	R208	LFO FREQ	0	1	1	1	0	0	1C
U201	R212	W-MOD SRC MIX0		1	1	1	0	1	1D
U201	R202	P-MOD OSC B	0	1	1	1	1	0	1E
U201	R201	P-MOD FILT ENV	0	1	1	1	1	1	1F
U202	R101	FILT CTF	1	0	1	0	0	0	28
U202	R103	FILT ENV	1	0	1	0	0	1	29
U202	R206	MIX OSC B	1	0	1	0	1	0	2A
U202	R211	OSC B PW	1	0	1	0	1	1	2B
U202	R205	MIX OSC A	1	0	1	1	0	0	2C
U202	R204	OSC A PW	1	0	1	1	0	1	2D
U202	R207	MIX NSE	1	0	1	1	1	0	2E
U202	R102	FILT RES	1	0	1	1	1	1	2F
U203	R106	FILT ATK	1	1	0	0	0	0	30
U203	R107	FILT DEC	1	1	0	0	0	1	31
U203	R108	FILT SUS	1	1	0	0	1	0	32
U203	R109	FILT REL	1	1	0	0	1	1	33
U203	R110	AMP ATK	1	1	0	1	0	0	34
U203	R111	AMP DEC	1	1	0	1	0	1	35
U203	R112	AMP SUS	1	1	0	1	1	0	36
U203	R113	AMP REL	1	1	0	1	1	1	37

ponding inputs on each 4051. When high, the I inputs INHIBIT the 4501. So to select just one pot one, and only one, of these bits must be 0.

U210's state is undetermined on power-up, since the computer has not yet had time to initialize the POT MUX. U210 might well "come up" with more than one 0 for Q4, Q5, or Q6. In such cases, two or more pots would be connected together (at VMUX). The current surge resulting from any significant potential difference between the pots would instantly destroy the 4051s, were it not for R214/15/16.

2-19 SD212 CONTROL PANEL — SWITCH AND LED MATRICES

The SWITCH and LED MATRICES are also divided across PCBs 1 and 2. The keyboard connects to PCB2 to share bus driver packages with the switches. The LED matrix includes the elements of DS225 BANK/PROGRAM display, all 7-segment decoding done by software.

The program scans the keyboard first. Scanning places a bit across one coordinate of the switch matrix, then checks the intercepting coordinates for its appearance. The resulting number uniquely identifies a combination of switch closures. For example, the CPU sends 00000001 (1H) to U209/12 switch driver latches, with CS8 from the OUT PORT DCOD. DX0 is now 1, DX1-7 are 0. This "sets up" the lowest eight keys. Each key is located on a binary column, and closing its switch adds the corresponding bit weight to the number driven on to the bus (read) by -CSE from the IN PORT DCOD. Suppose D0 is held. DY2 would be 1, resulting in 00000100 (4H). If GO were also held, 10000100 (132H) would be read.

To scan the next eight keys, DX1 is set and the DY columns again read. The process continues for DX2-DX7. Note that three control switches are wired in the keyboard matrix. This is no problem. The computer "knows" that any number read from DX7 larger than 31H, must include one of these switch operations.

The control switches are read in similar fashion, with -CSE from the IN PORT DCOD, except S112 EDIT and S113 TUNE each drive two columns. Separately clocked sections of the U204/5 BUS DRIVERS are paralleled for hardware efficiency. The driver OUTs are tri-stated (high impedance) except when their corresponding DIS pins go low.

In the LED matrix, U213/14/15 current sinks invert DX0-DX5 to effectively ground the paths through Q201-Q208. Latched bits are inverted at the -Q outputs of U208/11, then again by the transistor switches. To light DS205 and DS204, for example, first CS8 would latch 1H, then CS9 (also from OUT PORT DCOD) would latch 3H. To operate DS225, bits latched by CS9 correspond to the display segments required. For example, to display BANK 2, CS8 latches 10H (DX4 = 1), then CS9 latches 5BH (01011011) to light segments a, b, d, e, and g. (The LEDs must be cleared to read the switches.)

2-20 SD311 COMPUTER — CPU, MEMORY, I/O

Almost the reason for the computer itself, U301-308 NV PRGM RAM may represent a large investment of the musician's time. Many steps have been taken to protect it.

With power OFF, BT301 holds RAM data by providing 2.3 V_{dd} through D304. Current drain is less than 10 μ A, giving the battery a life-expectancy of ten years.

For use when probing the computer, S301 prevents the CPU from writing into NV by disabling -WR from U311-22. When OFF, S301 also disables the TUNE routine, since BIAS values too are stored in the NV RAM. (Be sure to switch S301 back ON when done.)

Normally S703 (see SD711) prevents accidental recording into NV, by grounding the active high MEM EN signal. It is read with -CS10 at U329 (SD312).

Nothing can protect the NV PRGM RAM from memory loss if the technician shorts Vdd to ground, or disconnects it. However, the POWER DETECTION circuit can prevent power source "dropouts" as short as 10 ms from interfering with RAM write operations. The NV RAM is vulnerable to these fluctuations because with power falling, U312/13 EPROMs may cause erroneous data to be written into NV if the CPU is still being clocked. At power-off +V through J710/P301-10 drops out first, R3177/178 divides +V down to the CMOS logic threshold of 3.5V. Thus, U309-10 immediately goes high, disabling the clock at U322-6.

U309 is also powered by BT301. With power off U309-10 is high; so are U309-6 and, through D307, U309-5. U309-4 is low, holding U311-26, the CPU RESET. When power is switched on, +V will take the longest time to reach its full value. Thus after all the other voltages have developed, U309-10 goes low. This enables the clock (U322-6), holds U309-6 low and begins to pull down U309-5 through R3176. The time constant of C390 and R3176 is such that U309-4 goes high, starting U311, about 1 sec after the clock starts.

As a final measure the NV PRGM RAM -CS, which must be low to write, is not allowed to go low when power is going up or down. -CS and -WR are gated through U309-13 so U309-1 goes low only when U309-10 also detects full power. The 74C02 was chosen for lower propagation delay than the 4001, allowing the CPU to access NV PRGM RAM without having to enter WAIT states.

U319 MEM ADR DCOD selects each memory device by a gated -MREQ and the most significant address lines (see TABLE 2-1). -RD and -WR are also gated to the two RAMs. -WR clocks the memory's internal latches. -RD clocks their bus drivers. For example, the -CS from U319 -10 and -RD, enable U317/18's "A" sections.

I/O devices are selected by CSs from U323/25/26 IN and OUT PORT DCODs. U323 ANDs -RD with A0-A2. U324 ANDs -WR with A3-A5. U325 shifts logic levels to clock high-voltage (CMOS) latches U357/63/56/61/62/60. U355 similarly shifts DATA BUS levels for these latches. High-voltage latches are required to control analog switches which must pass 10-V level waveforms. Current-limiting resistors such as R3140/41/42 are installed wherever the bit controls a type 13202 switch. 13202s are used wherever a bipolar (triangle) waveform may be passed. U357 (CS6) latches the five gates. U356 (CS4) and U363 (CS5) latch CV DMUX and TUNE MUX addresses.

The SEQ GATE BFR consists of a level-shifting circuit (U322-10/11) an OR-gate and inverter. A switch on J703 SEQ GATE IN (see SD711) is read with -CS10 at U330 (see SD312). If -SEQ GATE EN is low, GATE 5 (U357-12) is switched off by the CPU, and the external device gates VOICE 5.

Addressed as a memory device, TIMER U316 contains three programmable counters. Counter 2 divides the CPU clock frequency by a large integer to provide a 440-Hz reference. It is enabled by a bit latched by U331. Counters 0 and 1 comprise the TUNE circuit, as follows.

As outlined in paragraph 2-15 the CPU first selects OSC 1A by latching the appropriate addresses with U356 (S/H A,B,C) and U363 (S/H I8). U416 LEVEL COMPARATOR (SD313) converts oscillator sawtooth to pulses which are negative in proportion to the sawtooth period. TUN EN from U331-10 then starts Counter 0, which is clocked by -TUN MUX. CLK 0 first initializes Counter 0 to 1 (cycle), from a previously loaded internal register. OUT 0 goes low on the next falling edge of CLK 0, and gates Counter 1 through inverter U321-8. TUN STATUS is 0, signifying to the CPU when latched at U317-14, that the TIMER is counting.

TABLE 2-1
MEMORY ADDRESSES

0000	-03FF	EPROM 0	U312	1K BYTES
0400	-07FF	EPROM 1	U313	1K BYTES
0800	-0BFF	EPROM 2 (NOT USED)	U314	
0C00	-0C03	TIMER	U316	4 BYTES
1000	-107F	SCRATCHPAD RAM	U315	128 BYTES
1400	-17FF	NV RAM	U301-U308	1K BYTES

CLK 1 increments Counter 1 at the CPU clock rate.

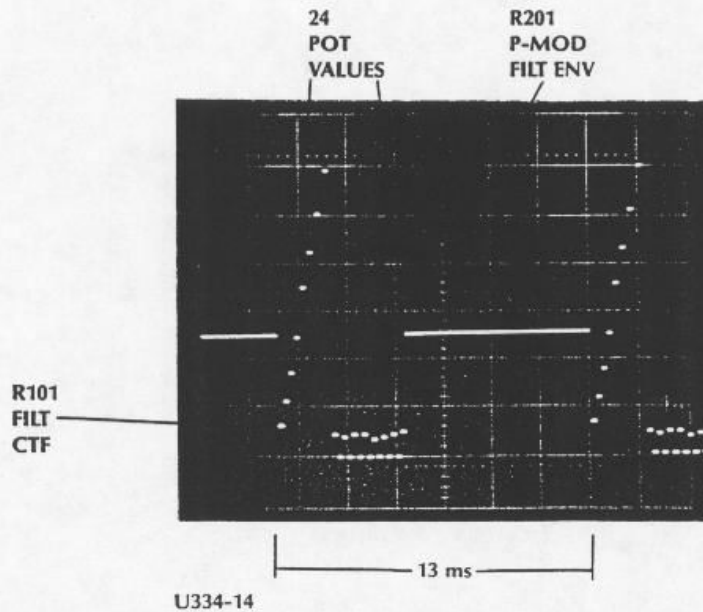
Since Counter 0 has been programmed to count 1 cycle, the next rising edge on U316-9 causes OUT 0 to go HI, stopping Counter 1, and signalling the CPU that counting has concluded. The CPU fetches Counter 1's 16-bit contents (in two 8-bit pieces) and saves this first count for reference. The periods of the remaining oscillators are measured similarly. To count each oscillator at 600, 1200, and 2400 Hz, Counter 0 is loaded with 2, 4, and 8, respectively.

2-21 SD313 ADC, DAC, COMMON ANALOG

The ADC is based on a DATEL MC8BC. It contains a binary counter and internal DAC. The counter increments until the DAC output compares to the analog voltage being measured. The comparison stops the counter and notifies the CPU to fetch the counter value through the bus drivers.

In more detail, to convert a POT value the CPU issues ST CONV to U321-4. U321-6 goes low, resetting U334's internal counter and setting status latch U333-1. U333-3 goes high, enabling U333-6 GATED CLOCK. The GATED CLOCK strobbs U334-4 at about 500 kHz, incrementing the binary counter. U334-14 ANA OUT is a ramp which lengthens with higher pot settings. See Waveforms 2-0 and 2-1. When it compares with buffered (U338) and scaled (R302) VMUX, the resulting pulse resets the latch. U333-3 goes low, interrupting the CPU which then fetches the counter value with -CSF, starts the next conversion, and returns to what it was doing.

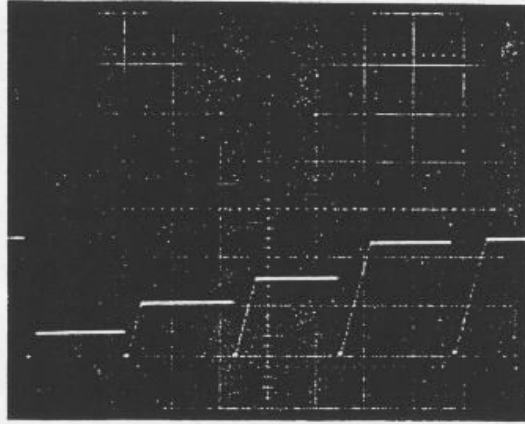
Potentiometer drift is eliminated through software "hysteresis" which watches the direction of value changes. A pot must move two bits in the same direction to qualify as a legitimate change.



V: 200 mV/div
H: 2 ms/div

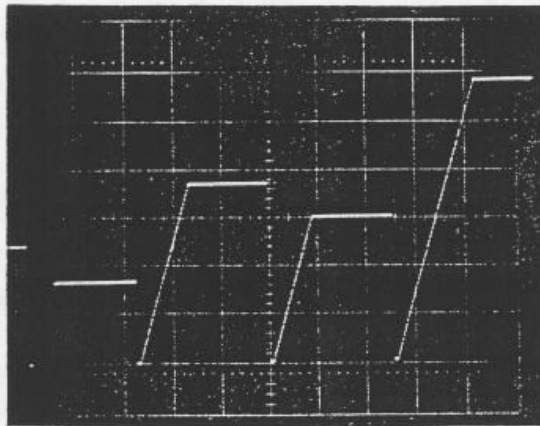
Waveform 2-0
ADC ANALOG OUTPUT

A



	R106	R107	R108	R109
FILT	ATK = 2	DEC = 2.5	SUS = 3	REL = 4

B

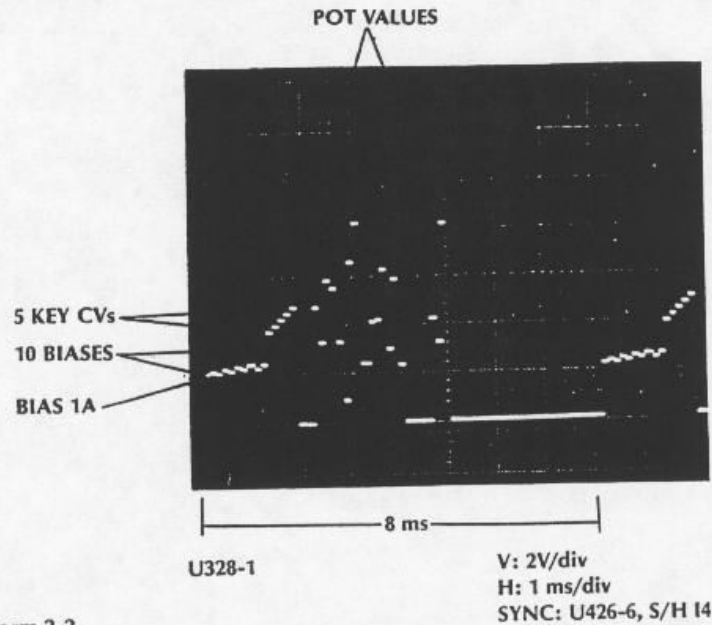


ATK = 3	DEC = 6	SUS = 5	REL = 9
---------	---------	---------	---------

U334-14

V: 200 mV/div
H: 2 ms/div (x10 MAG)

Waveform 2-1
FOUR POT CONVERSIONS



Waveform 2-2
VDAC

The DAC has been covered above. The software first latches data with CSC, waits $20 \mu\text{s}$ for the DAC to settle, strobbs the S/H with VDAC for $30\text{--}40 \mu\text{s}$, and allows the DAC to settle again to 0. This occurs 41 times in each loop. See Waveform 2-2.

It may be remembered that R337 need not be as precise as the rest of the R-2R ladder elements, since the MSB is not used for FREQ CVs. Also, the OSC FREQ CVs themselves are inverted. That is, the MSUMs require the OSC A and INIT CVs to operate 0 to -5V for a 5V octave frequency increase.

Not mentioned above, U364-1 switches the ac-coupled 440-Hz reference into the noise circuit, following U364-15 MIX NSE VCA. U367-8 filters U366 NSE GEN output to PNK NSE for modulation.

The LFO is based on the 2030 also used in the voices, discussed in paragraph 2-23. This application differs by having R378/80 fix PW at 50%, and Q308 discharge C335.

The MSUM stage consists of simple op-amp summers and BIFET buffers connected through precision-matched resistors.

The GLIDE circuit, active only in UNISON mode, consists of Q309 exponential converter, U379 transconductance amplifier, C348, and U378-1 BIFET buffer. Increased GLIDE CV delays the effectiveness of rapid UNI CV changes.

U379 is wired for unity gain through U378-1, so its voltage output, GLIDE OUT CV, should equal the input, UNI CV. D303/02 clamp the difference between these to not exceed 0.6V . C348 and U378-1 are similar to a SAMPLE/HOLD (S/H) circuit, except C348 is under more or less constant charge through U379-6. Negative current accompanies a downward UNI CV shift.

To understand the effect of Q309, consider the case where the control current at U379-5 is 0. No current will be available from U379-6. C348 holds its charge, maintaining the same GLIDE OUT CV, though UNI CV may fluctuate wildly. With a slight increase, C348 will be able to eventually match slow changes in UNI CV. Increased control current will accelerate the circuits' ability to equalize differences between UNI and GLIDE OUT CV. With maximum control current, C348 can track instan-

eous 5-V changes in UNI CV. Q309 is a matched transistor pair. One transistor is a diode-connected current source, which biases the other's emitter 0.6V above ground. If GLIDE CV is 0, the current through both emitters is equal. Control current through R3125 is maximum. Increased GLIDE CV pulls U379-5 more negative, reducing charging current to C348.

2-22 SD313 TUN MUX, S/Hs, AUD OUT

VDAC is distributed on PCB3 by the COMMON CV DMUX and on PCB4 by the INDIVIDUAL VOICE DMUX. U353-1 OSC A INIT, U354-1 OSC B INIT, U370-7 UNI, and U370-1 SEQ CV have a range of 5-V. The remaining CVs have about twice this range.

U358 SEQ CV DRVR buffers SEQ CV IN and allows for offset trimming by R303.

U416 TUN MUX LEVEL COMPARATOR output goes negative for the period the 10-V oscillator sawtooth is below the 1.5-V threshold (see Figure 2-10).

R4134 in series with U496 AUD DRVR minimizes effects of capacitive loads. R4137 reduces hum resulting when the Prophet is switched off but left connected to an energized amplifier.

2-23 SD411-415 VOICES 1-5

The following refers primarily to SD411, VOICE 1. However passive components (resistors, capacitors, diodes) designators are the same for all voices.

OSC A and B and the LFO are based on the SSM 2030 VCO (see Figure 2-11). The IC consists of two matched "logging" transistors, a precision current mirror, a low-leakage buffer, waveshaping circuits for pulse and pseudo-triangle outputs, a comparator and a discharge circuit including a capacitorless one-shot.

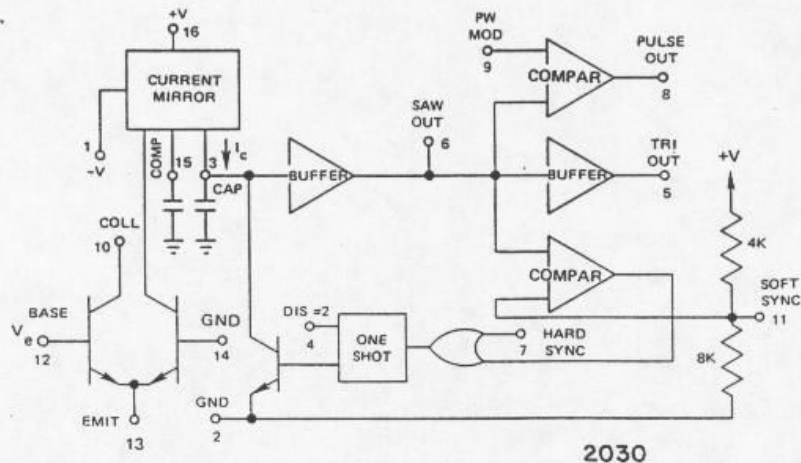


Figure 2-11
2030 VCO Block Diagram

Courtesy SSM

CV at pin 12 drives the first exponential current generator transistor, which charges the CAP (C415 or C404) through the current mirror. The direct integration yields a sawtooth. The falling edge results from the one-shot discharging the CAP when triggered by the comparator. The sawtooth is 0-10V across pull-downs R453 or R444.

U480-1 (OSC 1B, U456-7) maintains exponential control characteristics by forcing the transistor current to equal the reference current established by R449 (OSC B, R441). D402/R450 (D401/R439) compensate for the internal buffer's input bias current at the low end and the bulk-emitter resistance effect of the "logging" transistors at the high end, by providing extra base drive at high current to the sweep circuit. U480-1 (U456-7) will always be more negative than U463 (U459)-13. R414 (R412) HI V/OCT controls how much the base will be "pulled-down".

RT402/R452 (RE401/R442) mount directly to the IC to counteract the effects of increased internal transistor leakage with increasing temperature.

Integrator C415 (C404) is polystyrene for temperature stability and low leakage.

C416 (C405) compensates the current mirror, reducing possibility of high-frequency oscillation in the control circuit.

Variable width pulse output is derived by internally comparing the sawtooth to the pulse width input (pin 9). Control sensitivity is 10%/V (100% @ 0V decreasing to 0% at 10V). Pulse output is 0-7.5V across pull down R454 or R443. When switched on, OSC A's HARD SYNC input (pin 7) senses OSC B's sawtooth edge, forcing immediate discharge.

The sawtooth and psuedo-triangle output pins are both emitter-followers from the internal sawtooth. On U459 OSC 1B (and U371 LFO — see SD312), U457-7 (U372-14) produces the actual bipolar triangle by subtracting the sawtooth from the half-sawtooth obtained by biasing the psuedo-triangle emitter follower and amplifying by X2. (R306) TRI SYM adjusts the bias to set equal slopes.

On U371 LFO (see SD312), Q308 helps discharge the large-value integrator C335, required for low-frequency operation.

Figure 2-72 graphs the ideal VCO (and VCF) V/OCT function, and the corrections possible with the trimmers provided. As can be seen, the adjustments overlap. INIT FREQ raises or lowers the line. V/OCT, actually the CV summer gain, changes its slope and HI V/OCT (not present on VCFs) adjusts the function above 3 kHz.

U495-1 in OSC 1B's KEY 1 CV path decreases the effect of U440-10 OSC B KBD S.

(Note 3 shows a buffer modification installed on some Prophets to prevent OSC B mistuning due to the added load of the TRI CONV and OSC A SYNC S.)

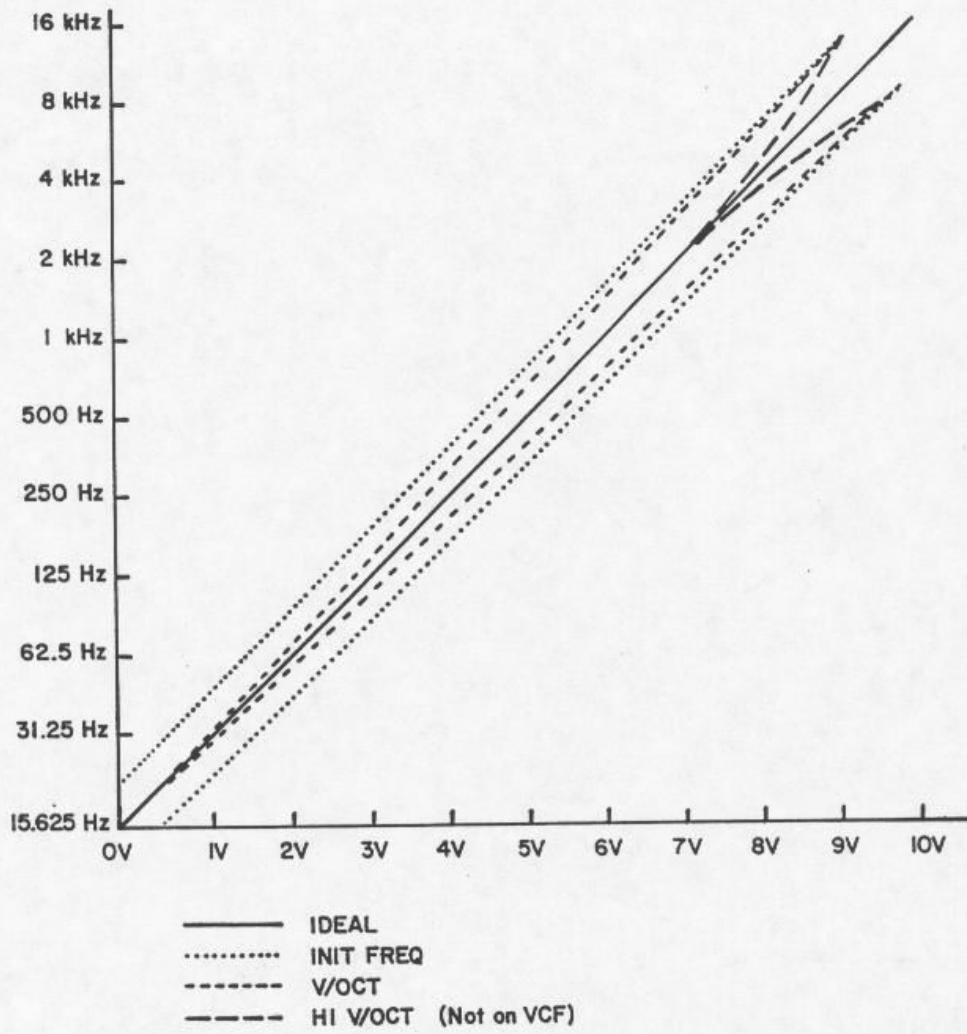


Figure 2-12
VCO/VCF Adjustments

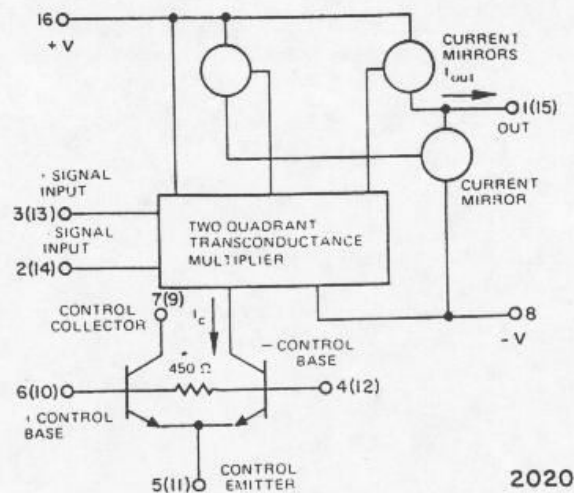


Figure 2-13
2020 Block Diagram (One Channel)

Courtesy SSM

The SSM 2020 VCA (Figure 2-13) is used in many places in the Prophet for control of audio or other CV levels. There are 7 VCAs per voice. Their inputs are ac- or dc-coupled according to the signals they are intended to pass. All are operated in linear mode by tying pins 4, 6, 7 or 12, 10, 9 together. Pins 1 and 15 are current outputs. The VCA is essentially a multiplier where the difference between its inverting and non-inverting inputs is multiplied by the CV. There should ideally be no output when there is no input. In several places, trimmers ensure this by correcting for dc offset and CV leakage (rejection).

The FILT and AMP ENV (U406, U401). GENs are based on the SSM 2050 ENV GEN (see Figure 2-14). Electronically-switched CVs charge and discharge C418 (C419) through an exponential voltage-controlled resistor. The ADSR states are defined by internal logic clocked from the GATE and TRG inputs. An ATK flip-flop (FF) is set by the TRIG pulse through C402 (C401) and reset by either -GATE or the attack comparator sensing +10V OUT. Then the ATK state = GATE AND -ATK FF, and REL = -GATE. Each state is characterized by a nominally exponential approach to a characteristic voltage: 0V for ATK, DEC, and REL, +13V for SUS.

R402 (R401) simultaneously trims TIME CONSTANT of the ATK, DEC, and REL periods.

The LOW-PASS FILTER is based on the SSM 2040 VCF, U478 (see Figure 2-15). The IC contains four identical filter stages simultaneously controlled by the same exponential function generation. Series connection implements the four-pole filter functions. U490-1 controls feedback level for filter resonance. R407 and R406 function as shown in Figure 2-12.

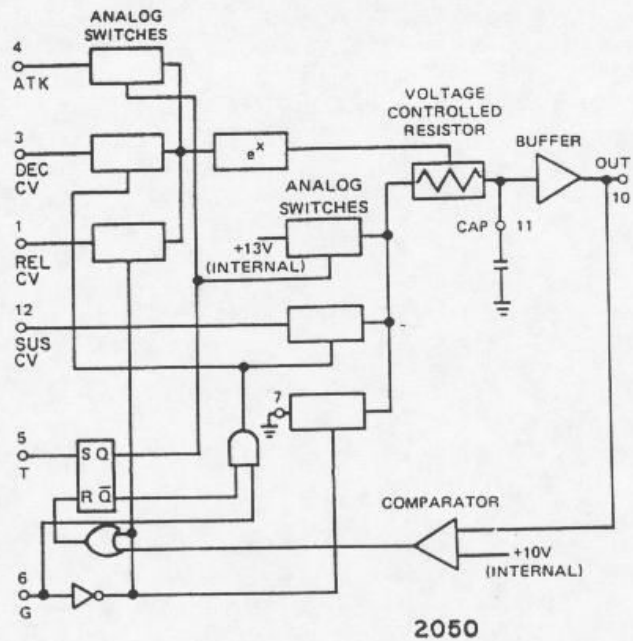


Figure 2-14
2050 ENV GEN

Courtesy SSM

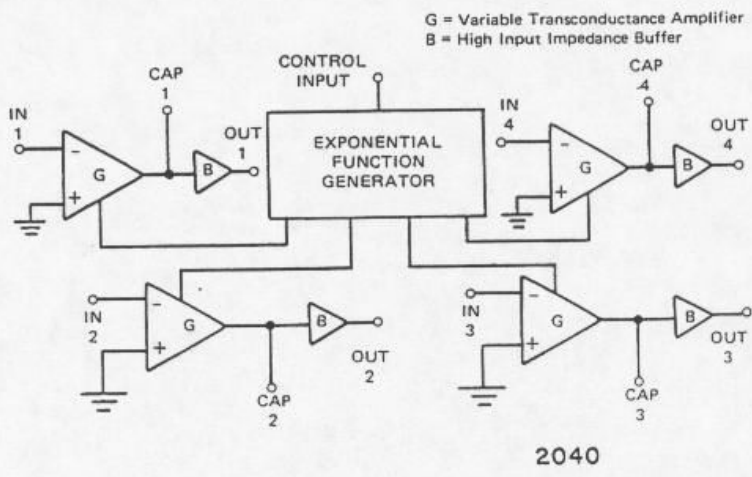


Figure 2-15
2040 VCF

Courtesy SSM

2-24 SD711 BACK PANEL AND PCB6

This diagram is straightforward. T701's secondary is rated at 2.8A. U601, U603, and U605 are rated at 1.5A. U602 is rated at 350 mA, U605 at 500 mA.

J702-J708 are grounded to the power line through the bottom panel.

Section 3

Documents

3-0 DOCUMENT LIST

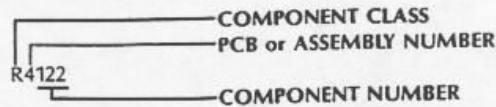
DOC No.	TITLE	PAGE	SYMBOL
BD001	INTERCONNECTION	3-3	
MA110	CONTROL PANEL	3-4	
PA210	PCB 2, COMP. SIDE	3-5	
PA210S	PCB 2, SOLD. SIDE	3-6	
PA110S	PCB 1, SOLD. SIDE	3-7	
PA110	PCB 1, COMP. SIDE	3-8	
SD211	CONTROL PANEL-POTS	3-10	A
SD212	CONTROL PANEL-SWITCH AND LED MATRICES	3-11	B
PA310U	PCB 3, ICs AND TRIMMERS	3-12	
PA310R	PCB 3, FIXED RESISTORS	3-13	
PA310C	PCB 3, CAPs, DIODES, OTHER	3-14	
SD311	COMPUTER-CPU, MEMORY, I/O	3-15	C
SD312	ADC, DAC, COMMON ANALOG	3-16	D
SD313	TUNE MUX, S/Hs, AUD OUT	3-17	E
PA410	PCB 4, TUNE MUX, S/Hs, AUD OUT	3-18	
PA416	PCB 4 TRIMMERS and OSC SAWTEETH	3-19	
PA411	VOICE 1	3-20	
SD411	VOICE 1	3-21	F
PA412	VOICE 2	3-22	
SD412	VOICE 2	3-23	G
PA413	VOICE 3	3-24	
SD413	VOICE 3	3-25	H
PA414	VOICE 4	3-26	
SD414	VOICE 4	3-27	I
PA415	VOICE 5	3-28	
SD415	VOICE 5	3-29	J
PA610	PCB 6	3-30	
SD711	BACK PANEL AND PCB 6	3-30	K
PA710	BACK PANEL	3-31	

3-1 DOCUMENT NOTES

These notes explain component designation and the use of symbols on our pictorials and schematics. For design explanation, see Section 2.

A glossary of abbreviations used on the documents appears at the back of the manual.

Component designators include three items of information:



COMPONENT CLASS is symbolized by standard letters, for example, U for integrated circuit, RT for temperature-sensitive resistor, and DS for indicator.

PCB or ASSEMBLY NUMBERS are:

- | | |
|-----------------------|----------------------------|
| 1 RIGHT CONTROL PANEL | 5 none |
| 2 LEFT CONTROL PANEL | 6 POWER SUPPLY BOARD (PSB) |
| 3 COMPUTER BOARD | 7 CHASSIS ASSEMBLY |
| 4 VOICE BOARD | |

COMPONENT NUMBERS are either sequenced according to their position on a PCB, or according to the position of its designator (callout) on the pictorials (PA documents).

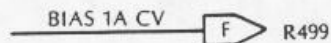
Generally, the schematics (SD documents) group together components electrically related to one another, even though they may actually be located on different PCBs. For example, the POT MUX circuitry is implemented across PCBs 1 and 2 but is drawn on a single sheet (SD211). In such cases you can rely on its designator to indicate the PCB on which a component is located. You may then easily find it from the pictorials.

PCB 4 components are designated somewhat differently from the rest. This PCB holds five essentially identical, parallel circuits. So, parallel passive components are given the same designator. For example, there are five R4122s — one per voice. Individual active components are still individually designated.

For clarity, power supply decouplers are not identified on each voice pictorial. Instead they will be found on PA 410, with other (non-voice) PCB 4 components.

A note on our rendering of bus lines and continued signals: We bus lines together to prevent long, confusing parallel runs. For example, DATA BUS lines are drawn as a single line, with individual lines symbolized DB0, DB1, DB2... where the bus "fans-in" or "fans-out" at a device. If there are no DB (or A, ADDRESS BUS) symbols, the bus lines are assumed to connect according to the device pin names.

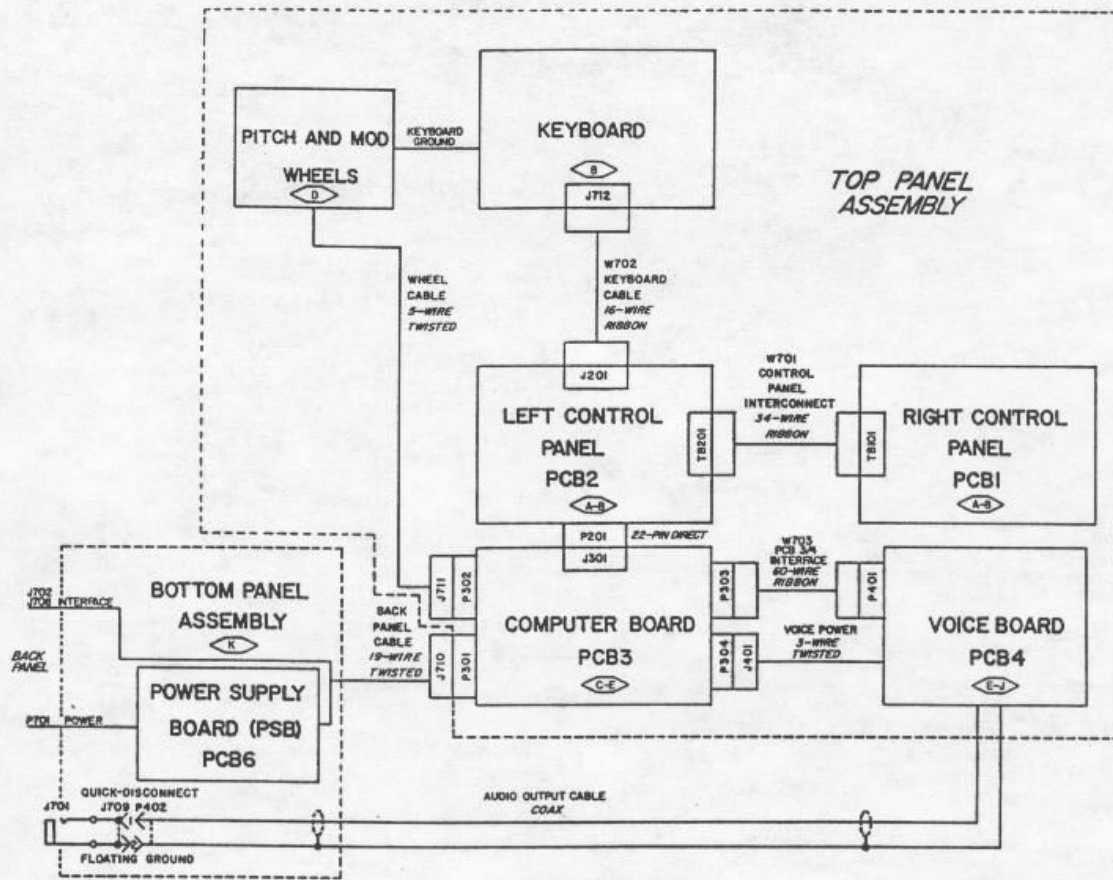
Although bussing wires reduces the number of interrupted signals, some breaking of lines on a page or continuation of signals between pages cannot be avoided. At these points you will find a symbol such as:



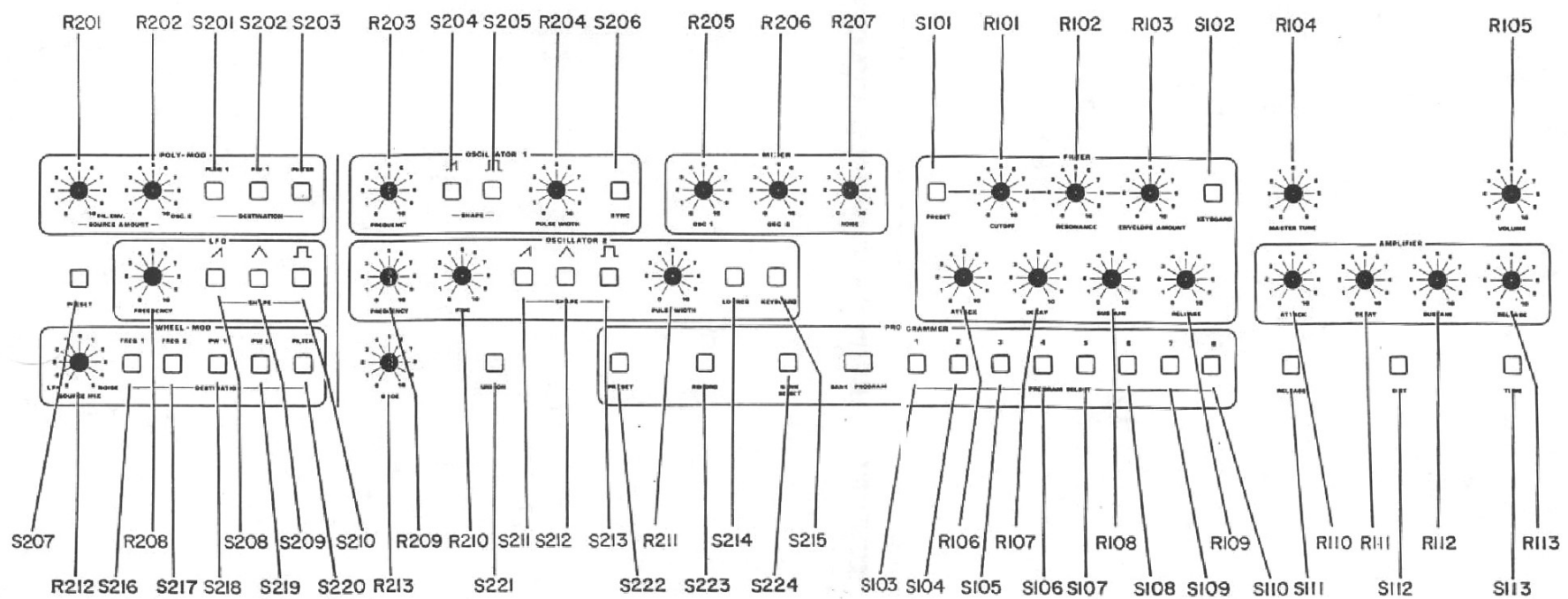
This example means that the BIAS 1A control voltage signal goes to R499 on sheet F (SD411). The sheet letter symbol is found in its margin.

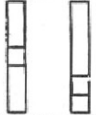
Power and ground connections for multi-device packages have been shown on the first device in the package, except where the first device is not presently used.

Unless otherwise indicated resistances are in ohms and capacitances are in microfarads.



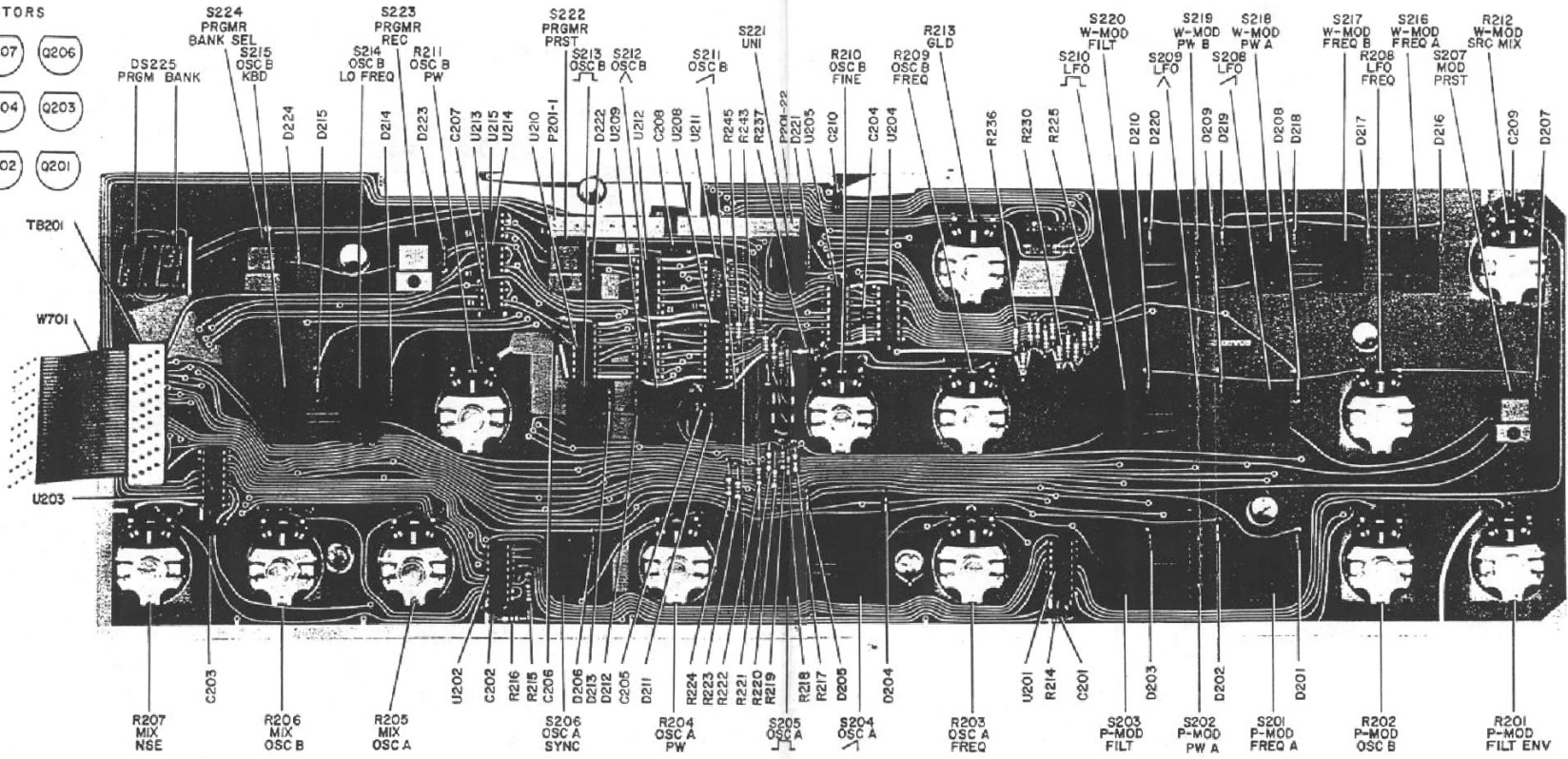
		SEQUENTIAL CIRCUITS INC	
		TITLE	
		INTERCONNECTION	
		DATE	1000
		DESIGNED BY	CHKD BY
		OWS MICHELE LANGER	93075
		APP'D BY	DATE
		APP'D BY	1-6-75
		REVISED BY	DATE
		REVISED BY	1-6-75
NO.	DATE	REVISION	SHEET 1 OF 1

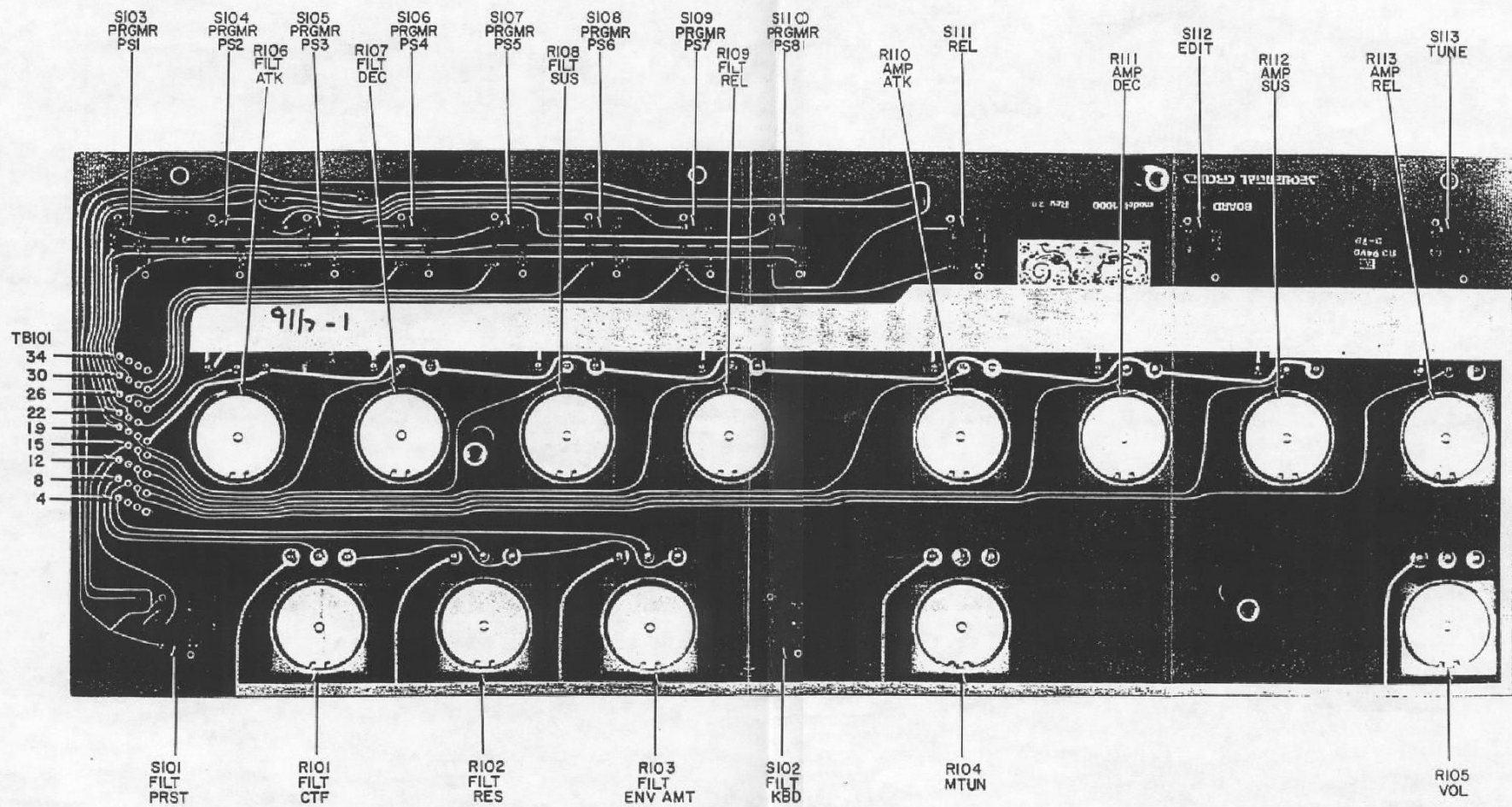


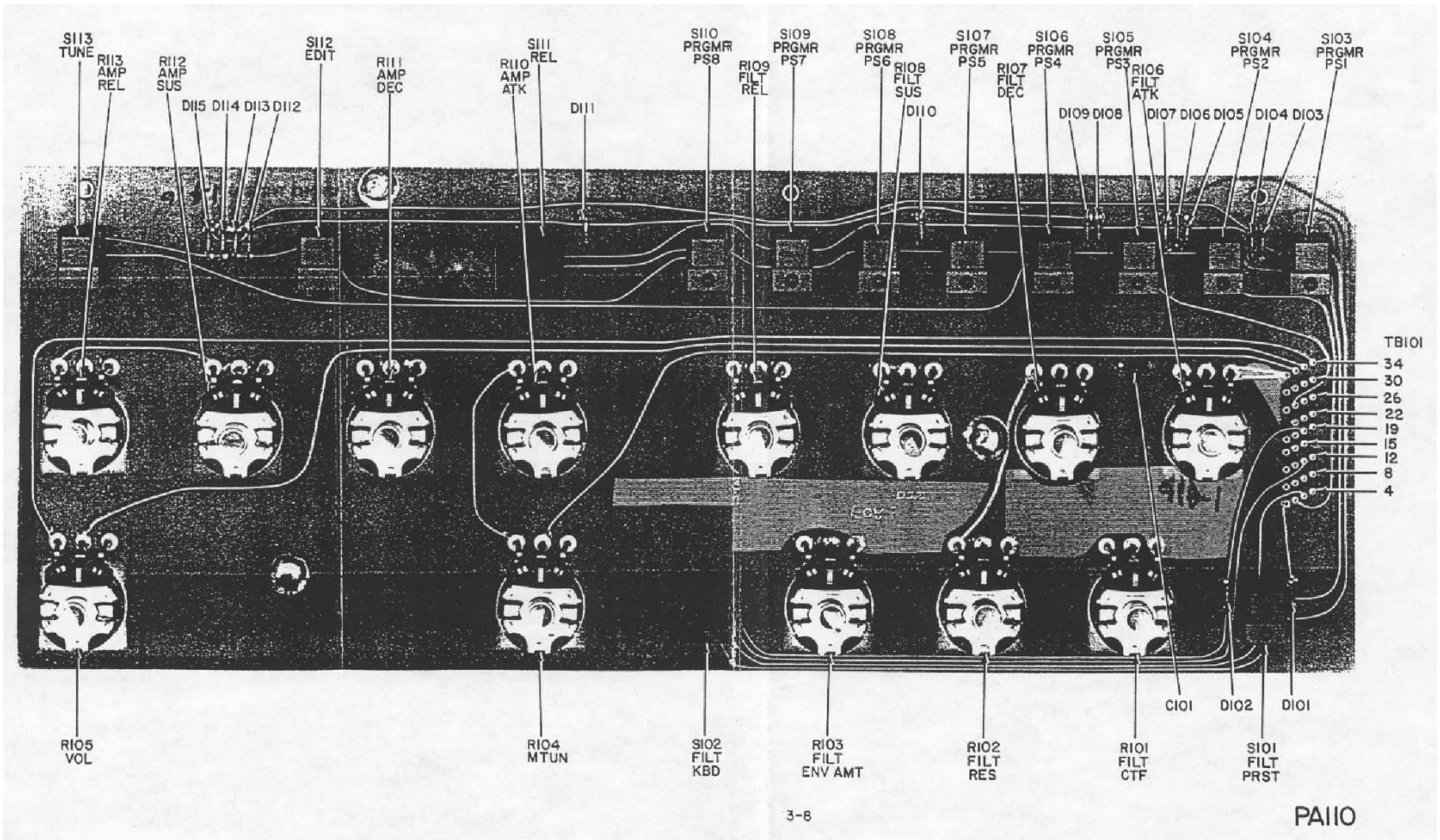
WHEELS:

 PITCH MOD
 R701 R702

TRANSISTORS

- Q208
- Q207
- Q206
- Q205
- Q204
- Q203
- Q202
- Q201

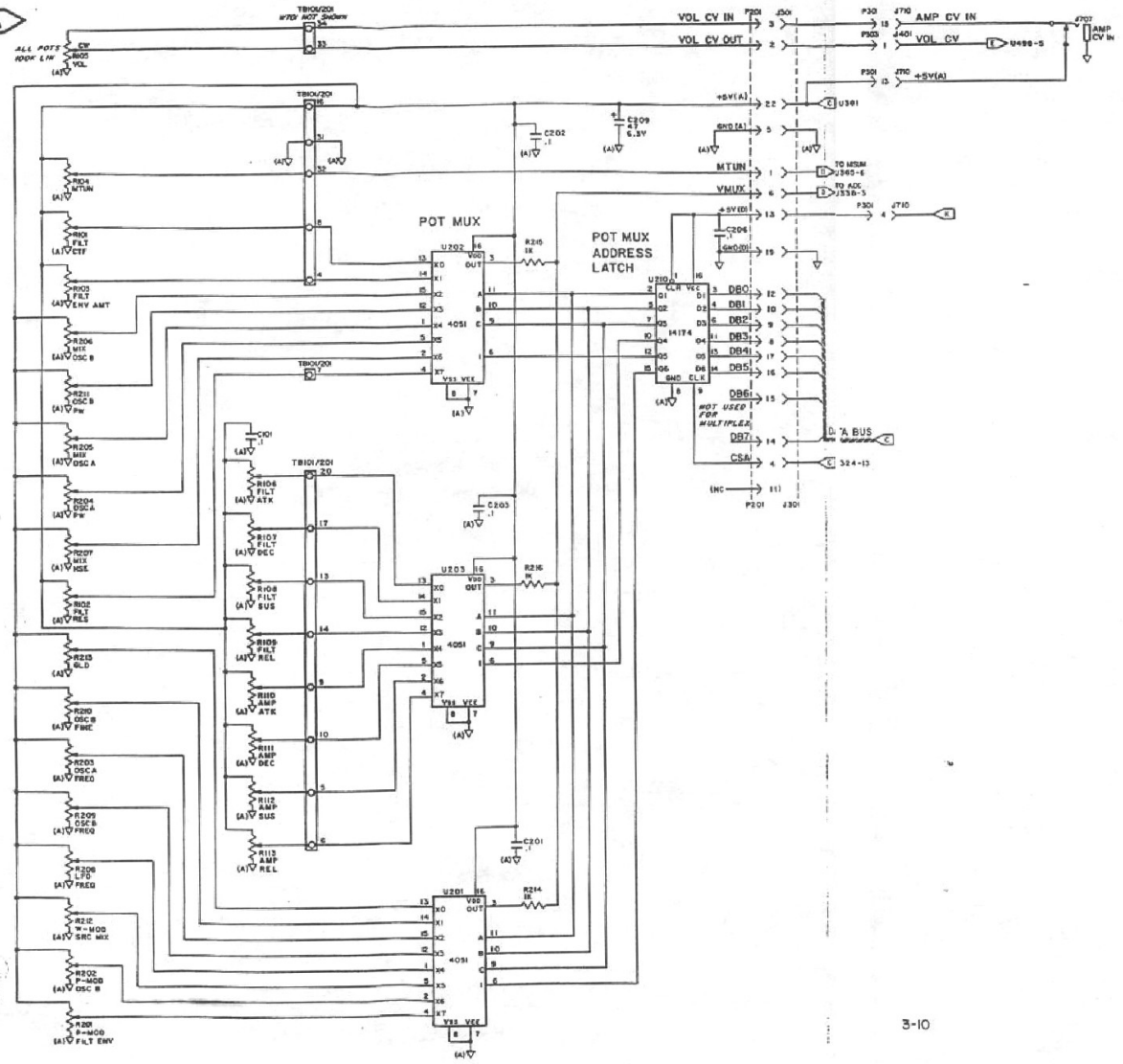






A

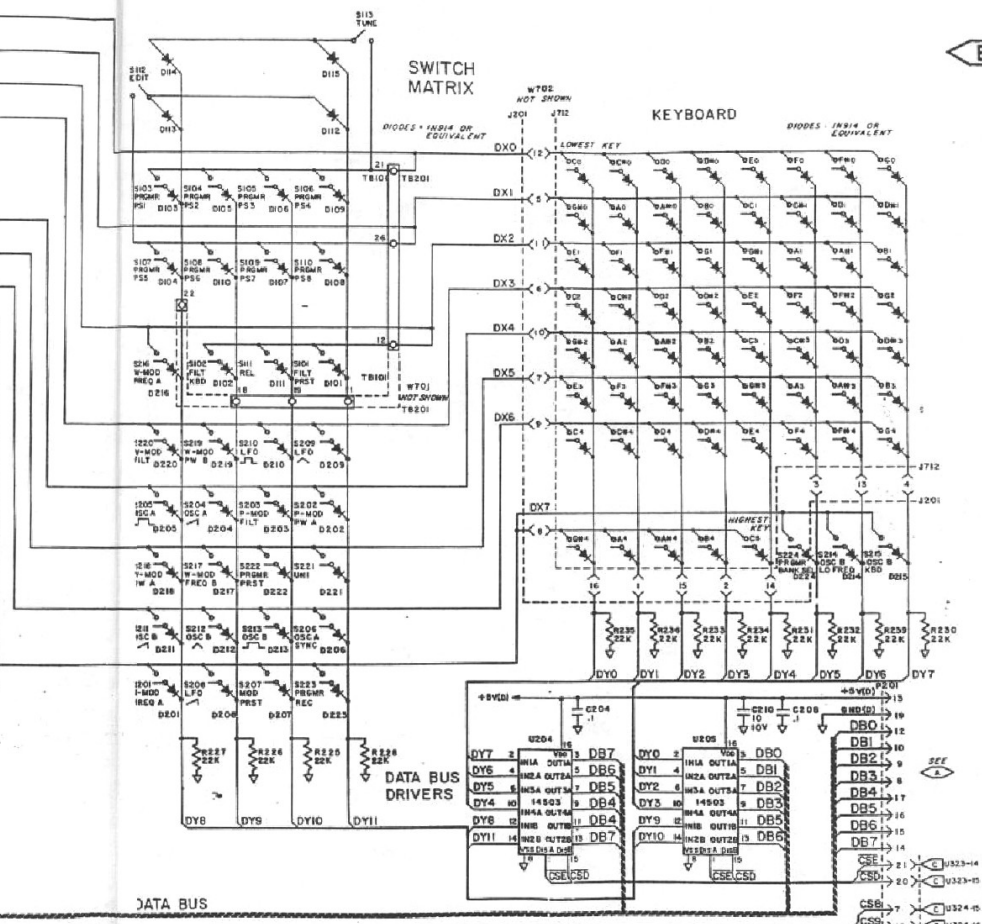
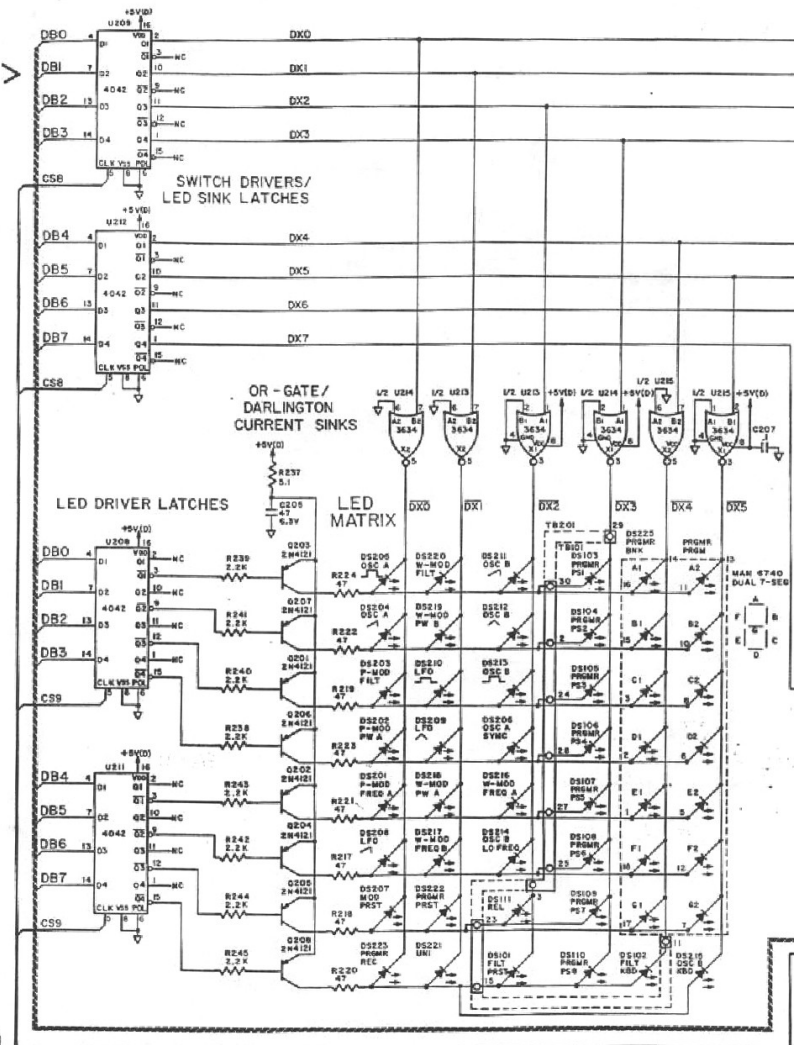
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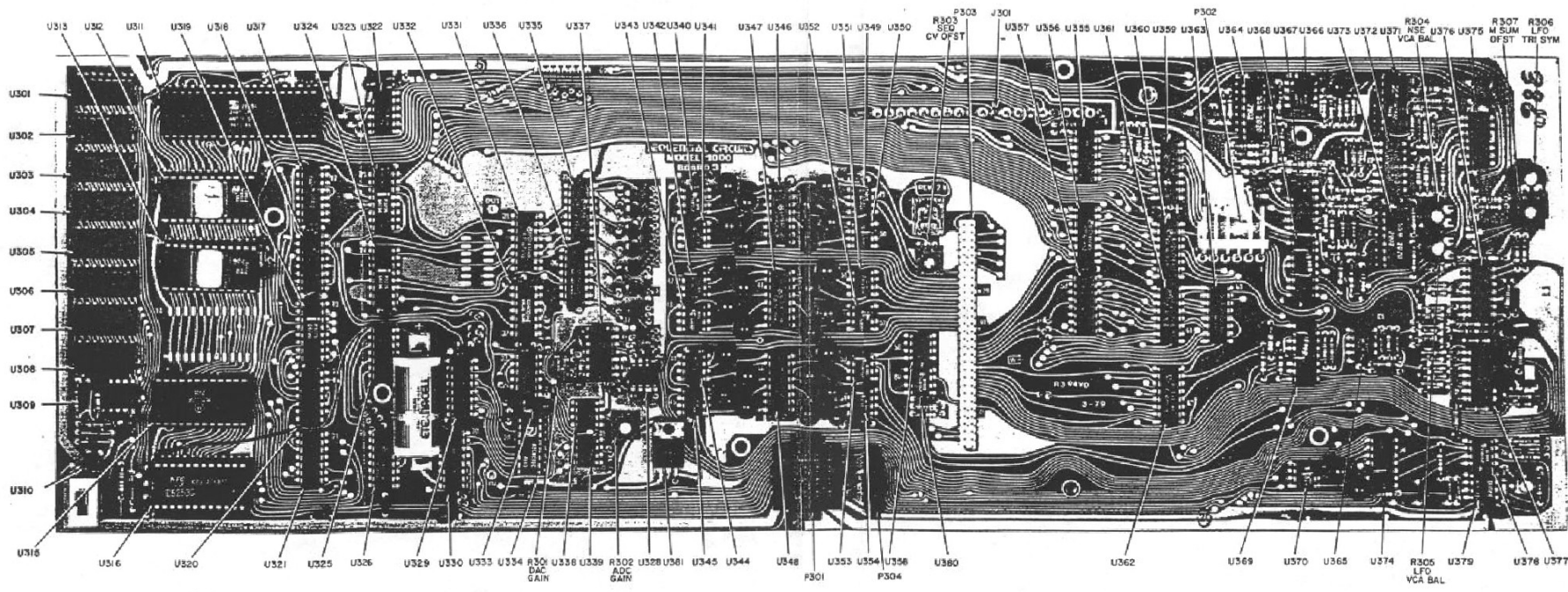
3-10

PCB1		PCB2	
LAST	NOT USED	LAST	NOT USED
C201		C200	
D115		D224	
RE15		D225	D224
S113		Z201	
TR101		P201	
		Q208	R225
		R245	
		S224	
		TR201	
		U205	U206, U207
		W201	

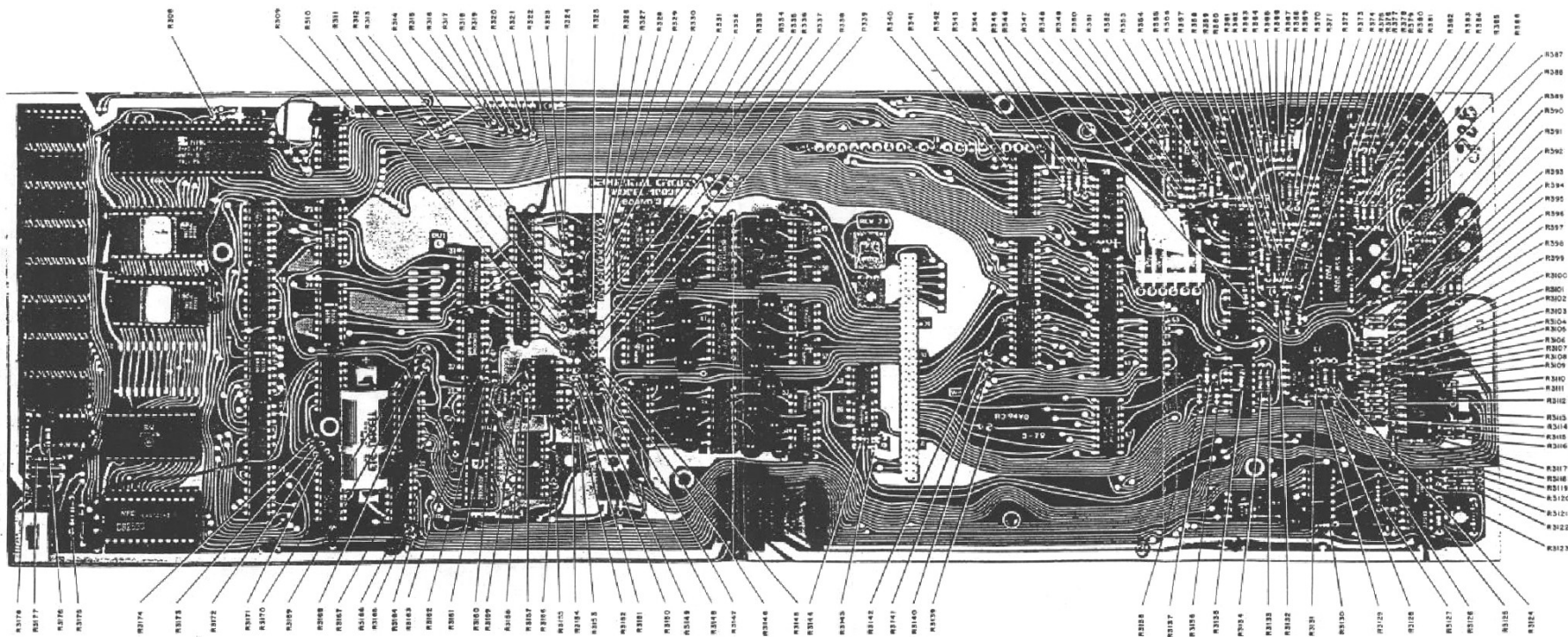
SEQUENTIAL CIRCUITS INC			
CONTROL PANEL - POTS			
REV	DATE	BY	APP'D
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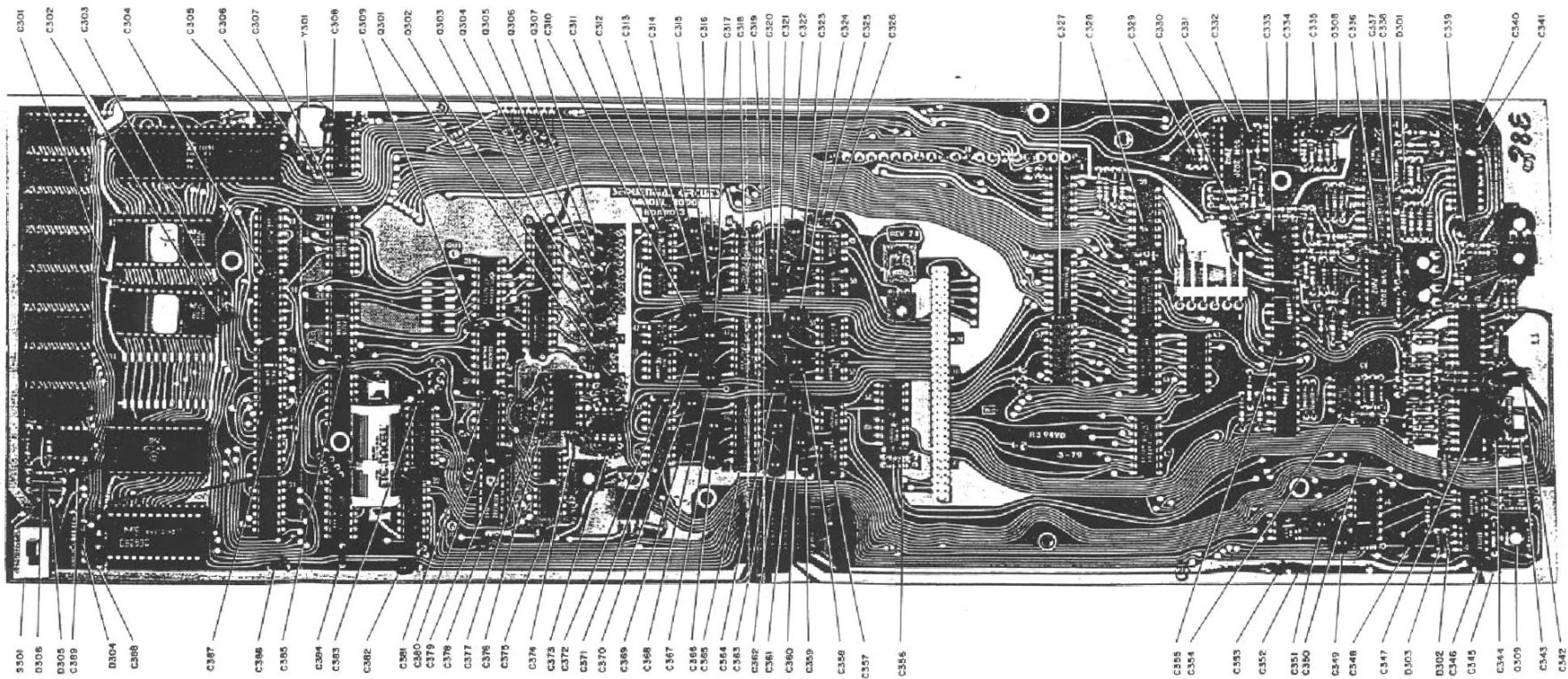
SEQUENTIAL CIRCUITS INC	
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2	CONTROL PANEL
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4	1000
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7	1000
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11	1000
12	1000
13	1000
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16	1000
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18	1000
19	1000
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22	1000
23	1000
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95	1000
96	1000
97	1000
98	1000
99	1000
100	1000



PA310U

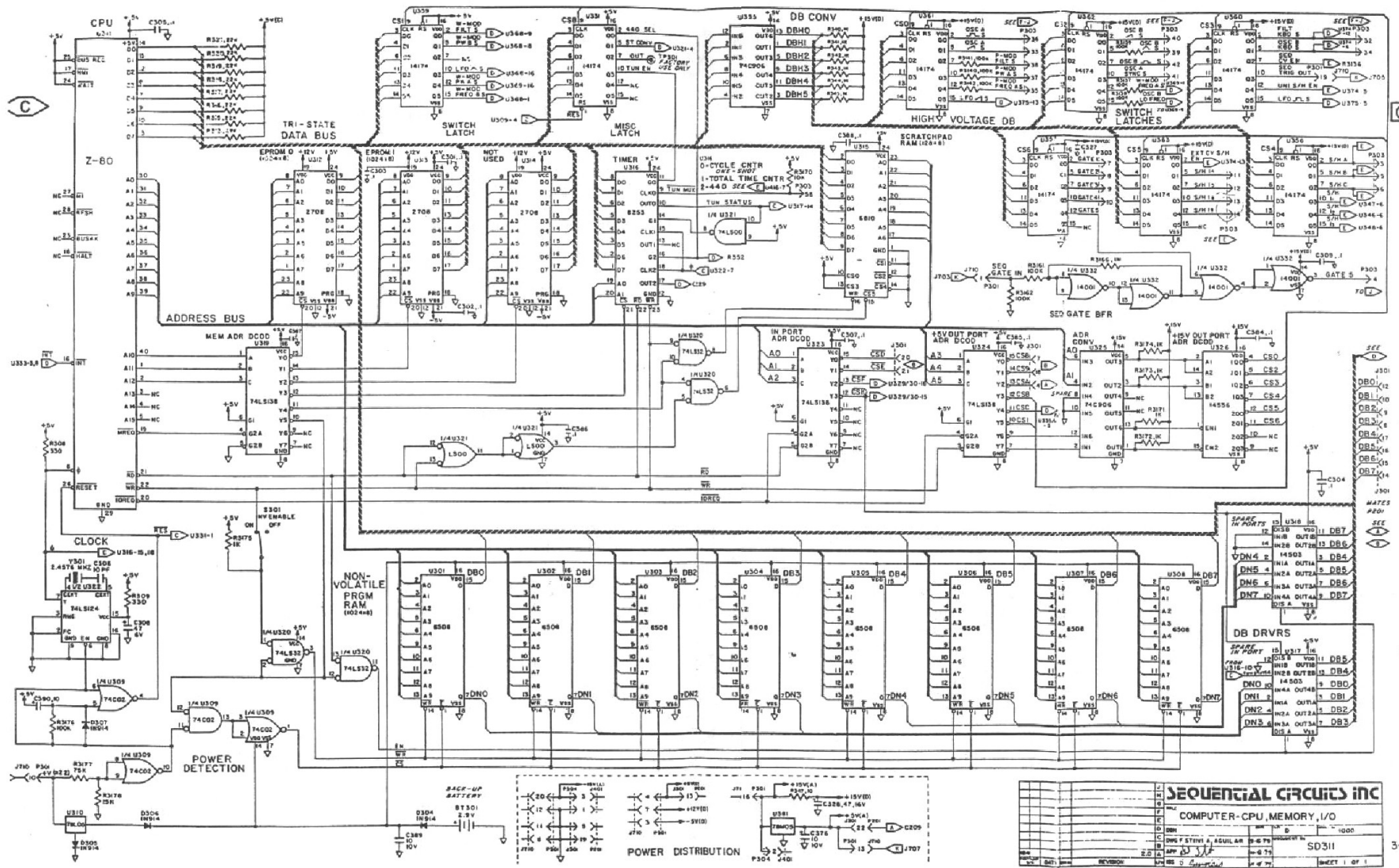


PA310R

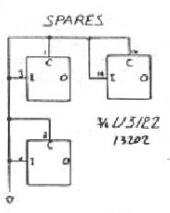
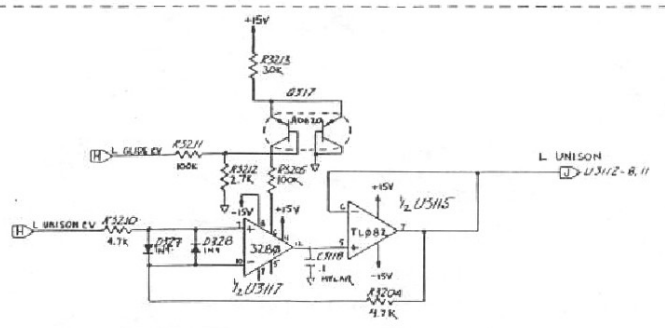
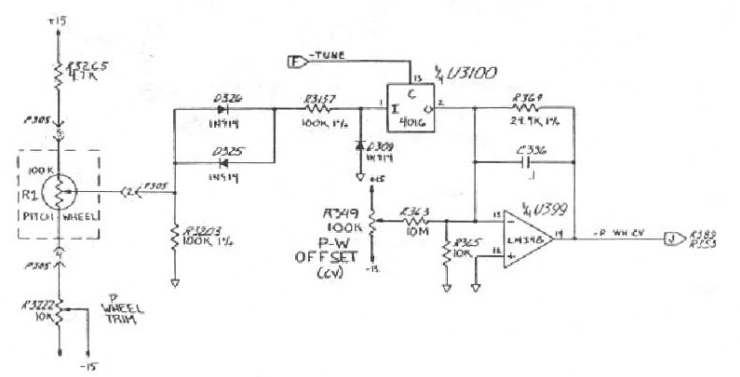
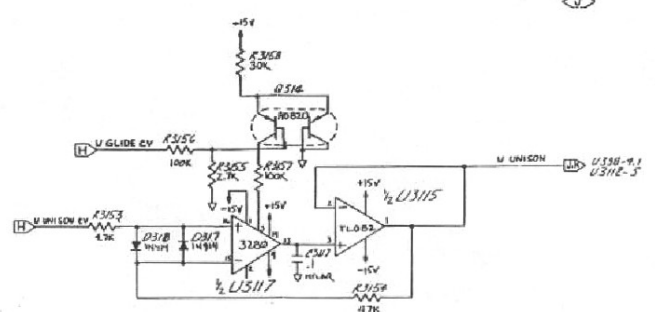
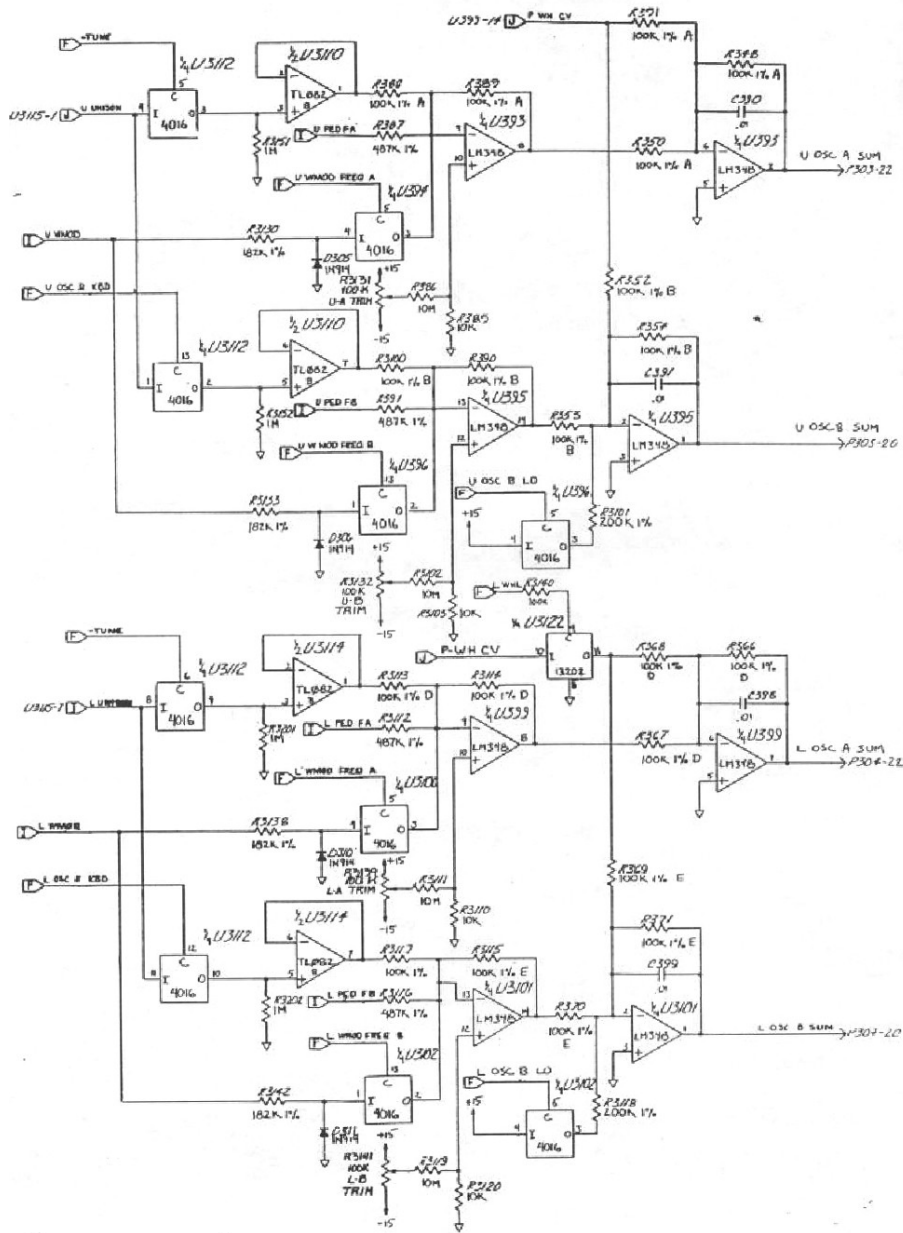


C390, D307
ON SOLDER SIDE

PA310C

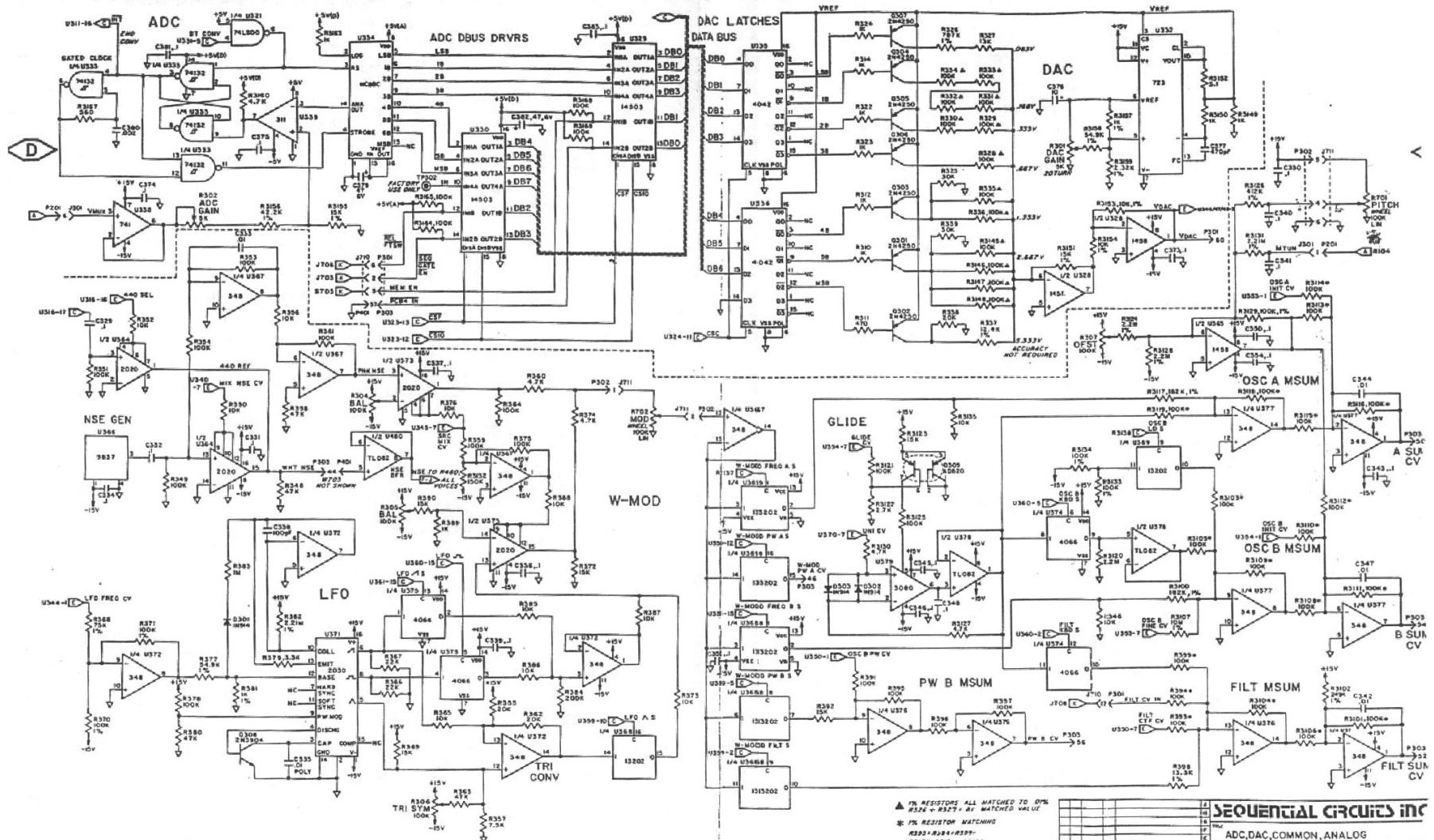


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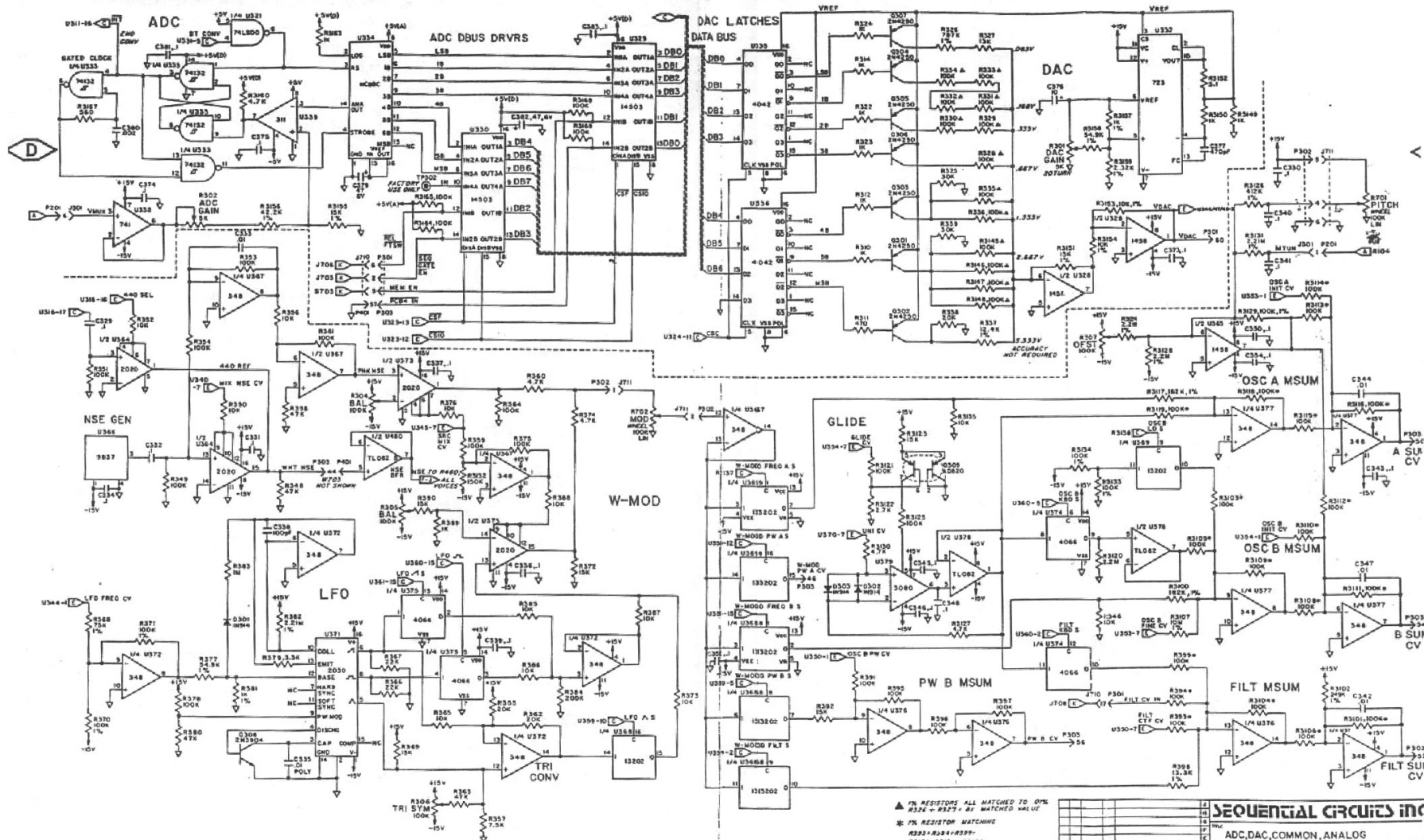
PAGE 15-16

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REV	
DATE	
BY	
CHECKED	
APPROVED	
DATE	1010
BY	
REV	SD 314



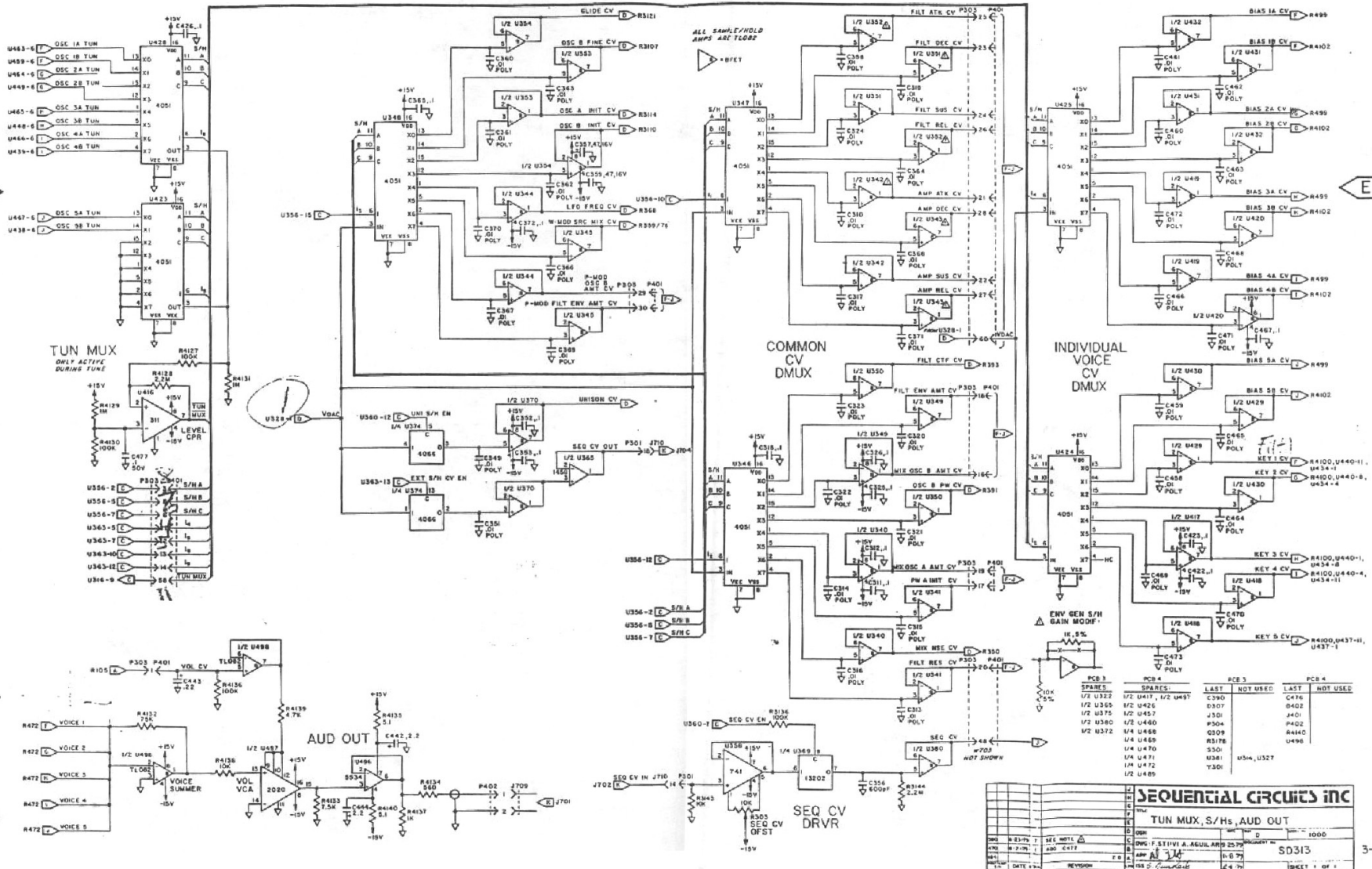
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 R304 + R310 + R310A
 R305 + R310 + R310A
 R306 + R310 + R310A
 R312 + R314 + R3115
 R316 + R318 + R319

SEQUENTIAL CIRCUITS INC			
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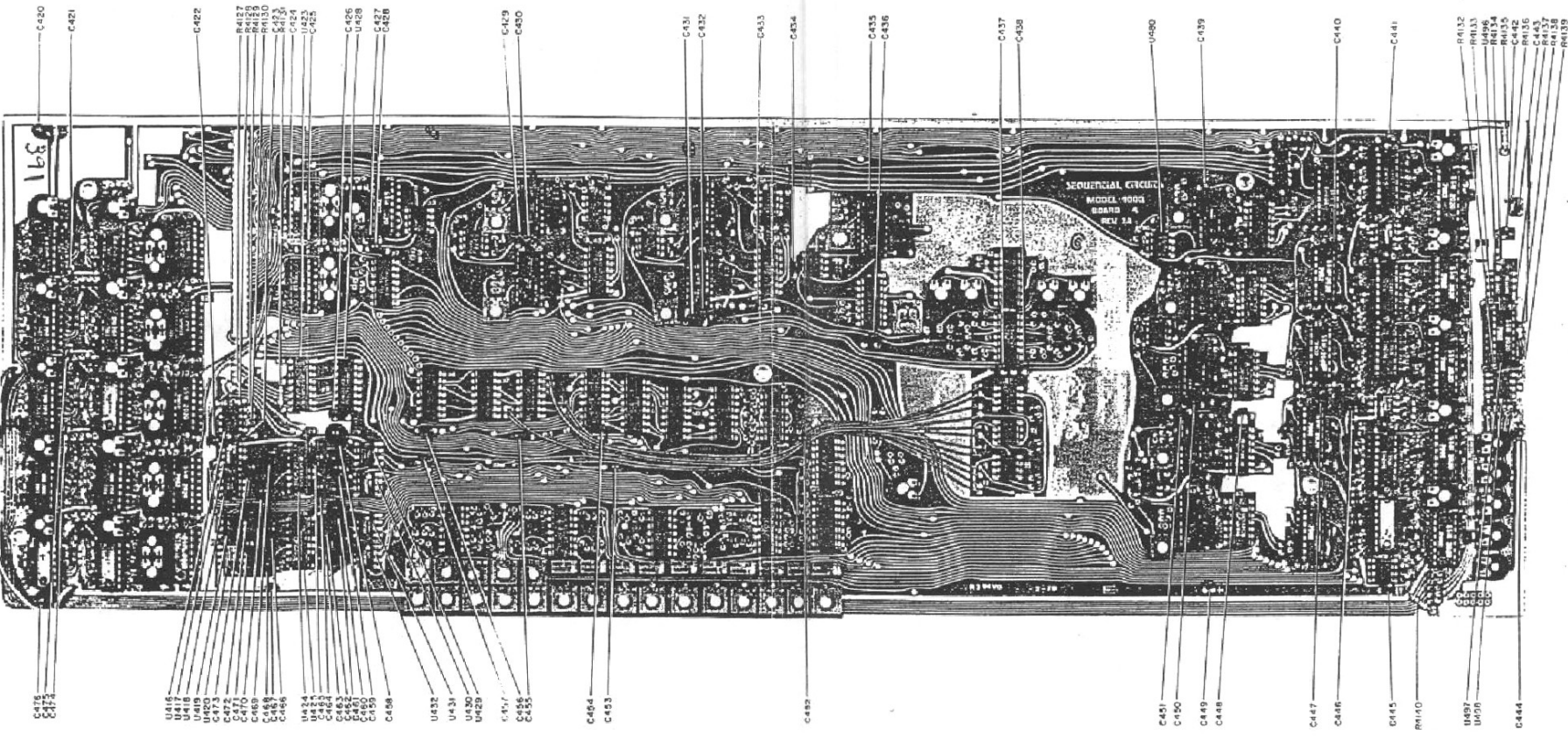
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 R306 + R310 + R316
 R312 + R314 + R315
 R316 + R318 + R319

D		E		F		G		H		I		J		K		L		M		N		O		P		Q		R		S		T		U		V		W		X		Y		Z	
SEQUENTIAL CIRCUITS INC																																													
ADC, DAC, COMMON, ANALOG																																													
REV. 01																																													
DATE: 11/11/71																																													
DESIGNED BY: S. S. HANCOCK																																													
DRAWN BY: S. S. HANCOCK																																													
CHECKED BY: S. S. HANCOCK																																													
APPROVED BY: S. S. HANCOCK																																													
SHEET 1 OF 1																																													



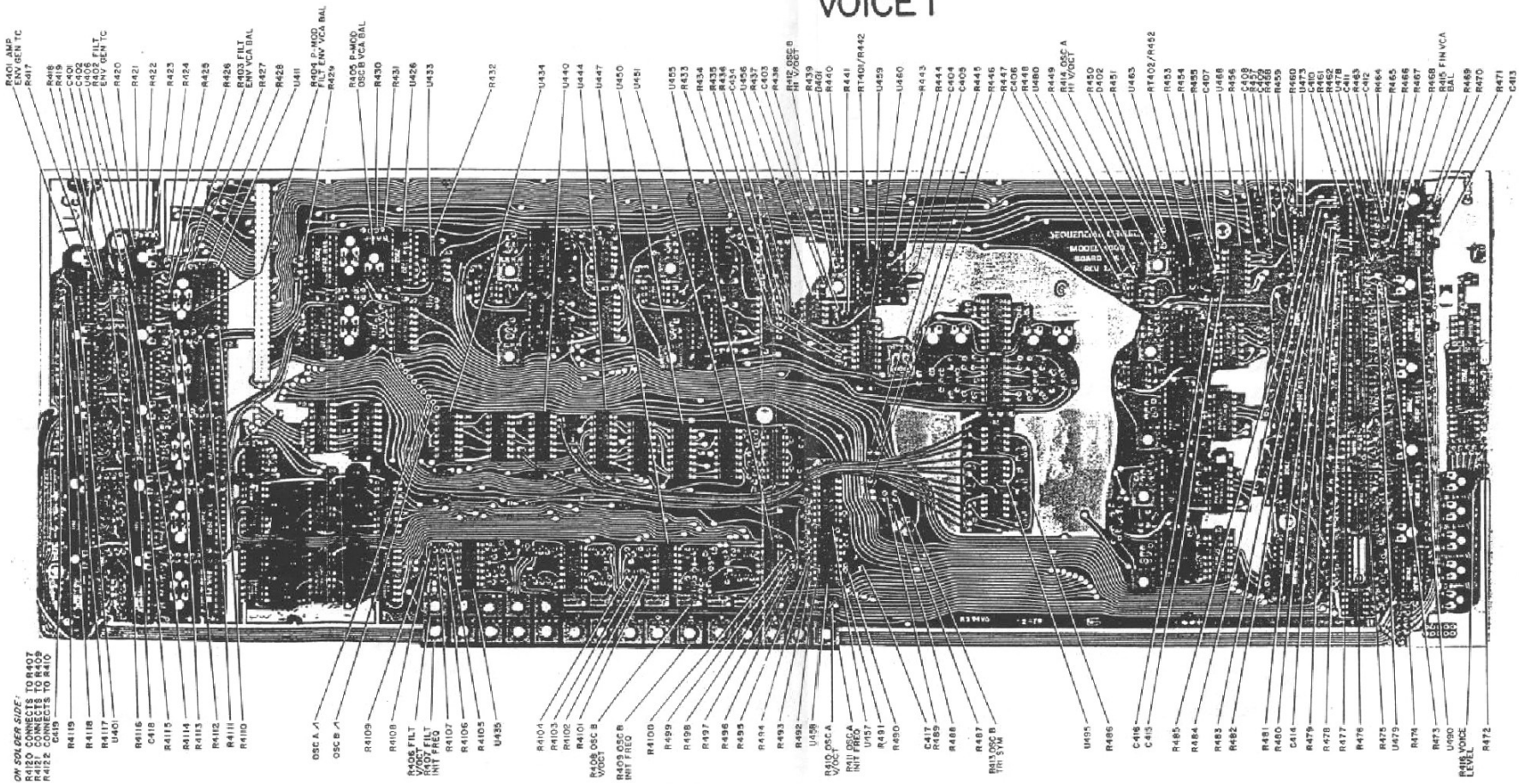
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U316	U317	U318	U319
U320	U321	U322	U323
U324	U325	U326	U327
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U988	U989	U990	U991
U992	U993	U994	U995
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PCB4
S/H, TUNE MUX
AUD OUT, DECOUPLERS



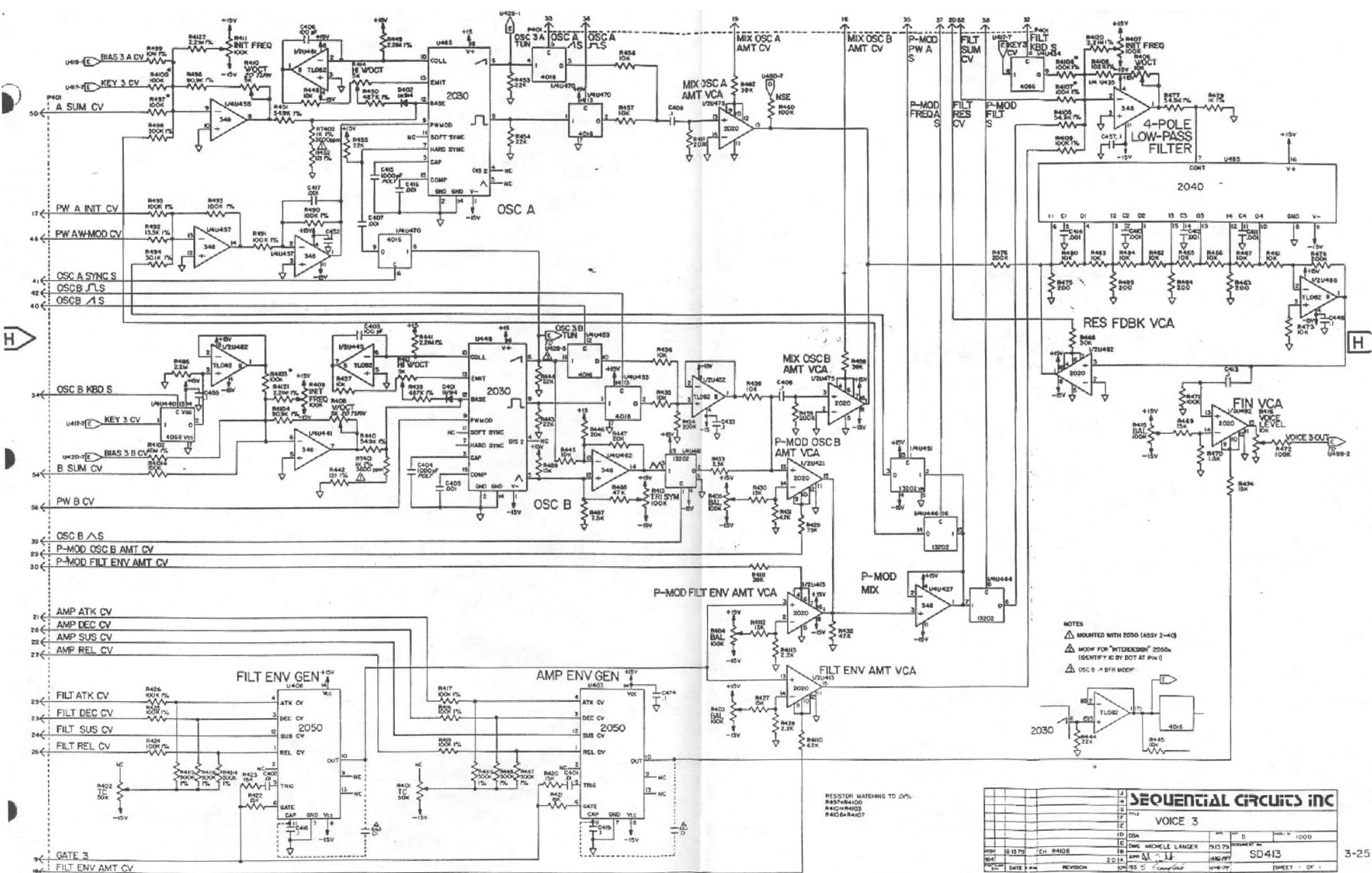
PA410

VOICE I



ON SOLDER SIDE!
 R4120 CONNECTS TO R407
 R4121 CONNECTS TO R409
 R4122 CONNECTS TO R410

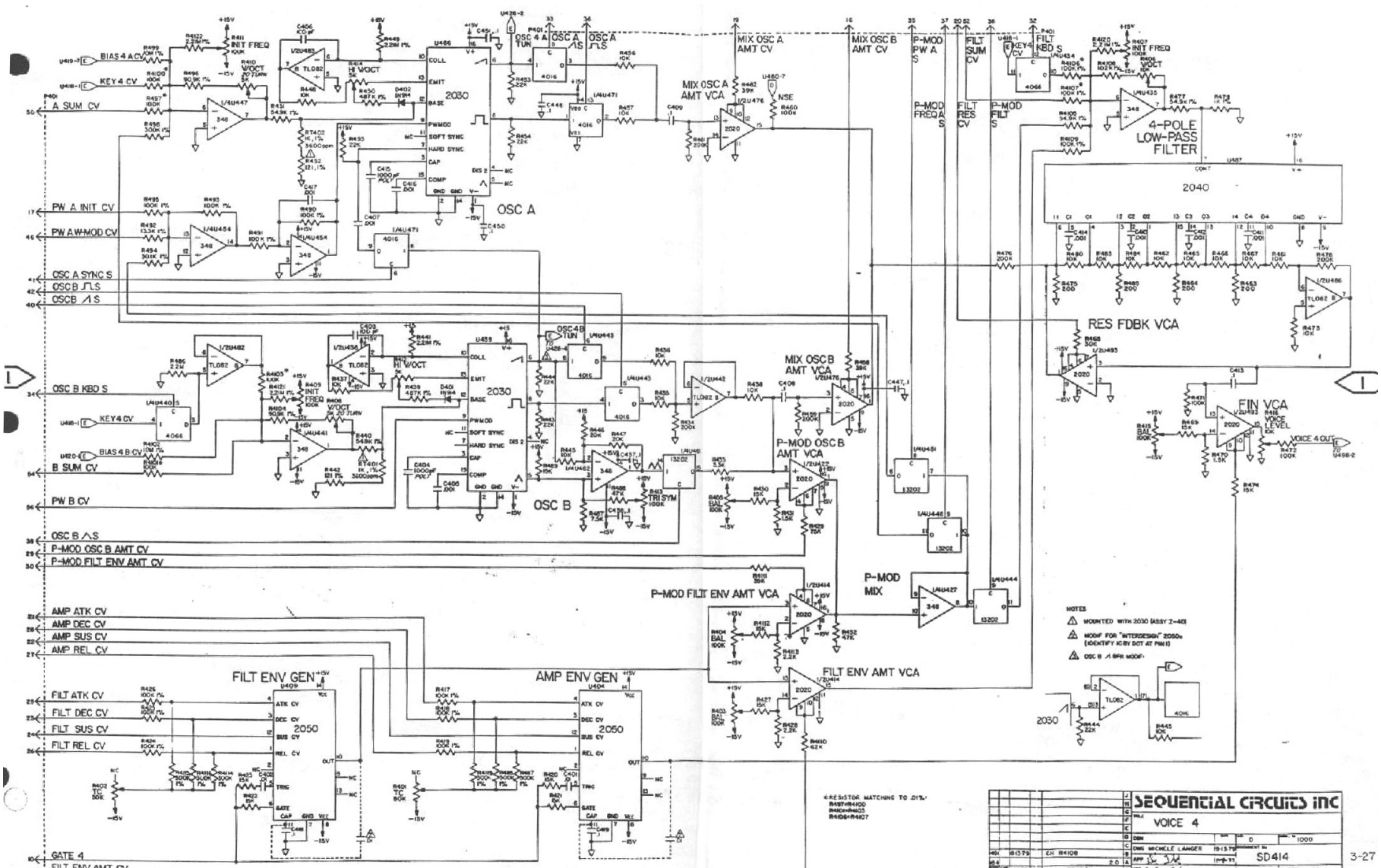
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- R4118
- R4107
- U401
- R4116
- C418
- R4115
- R4114
- R4113
- R4112
- R4111
- R4110
- OSC A A
- OSC B A
- R4109
- R4108
- R408 FILT
- R407 FILT
- INIT FREQ
- R4107
- R4106
- R4105
- U435
- R4101
- R4103
- R4102
- R4101
- R408 OSC B
- VOC1
- R409 OSC R
- INIT FREQ
- R4100
- R499
- R498
- R497
- R496
- R495
- R414
- R493
- R492
- U408
- R410 OSC A
- INIT FREQ
- U407
- R401
- R490
- C417
- R489
- R488
- R487
- R410 OSC B
- TRN SYNC
- U405
- R486
- C416
- C415
- R485
- R484
- R483
- R482
- R481
- R480
- C414
- R479
- R478
- R477
- R476
- R475
- U479
- R474
- R473
- U480
- INIT VOICE
- R472
- R417
- C413
- R417
- C401
- C402
- C403
- R420
- R421
- R422
- R423
- R424
- R425
- R426
- R425
- R427
- R428
- U481
- R429
- R430
- R431
- U426
- U433
- R432
- U434
- U440
- U444
- U447
- U450
- U451
- U455
- R433
- R434
- R435
- R436
- U456
- R437
- C403
- R438
- INIT VOICE B
- R439
- D401
- R440
- R441
- R440/R442
- U459
- U460
- R443
- R444
- C405
- R445
- R446
- R447
- C406
- R448
- U480
- R449
- INIT VOICE A
- R450
- D402
- R451
- U463
- R4402/R442
- R453
- R454
- R455
- U468
- C407
- R458
- R459
- C409
- C408
- C409
- R459
- R460
- U473
- C410
- R462
- U478
- R463
- C412
- R464
- R465
- R466
- R467
- R468
- R469
- INIT FIN VCA
- R470
- R471
- C413



- NOTES
- ▲ MOUNTED WITH 2050 (ASSY 3-4)
 - ▲ MOOF FOR "INTERDESK" 2050 (IDENTIFY IC BY DOT AT PIN 0)
 - ▲ OSC B - 4 BFR MOOF

RESISTOR MATCHING TO 0.1%
 R437R4400
 R440R4403
 R405R407

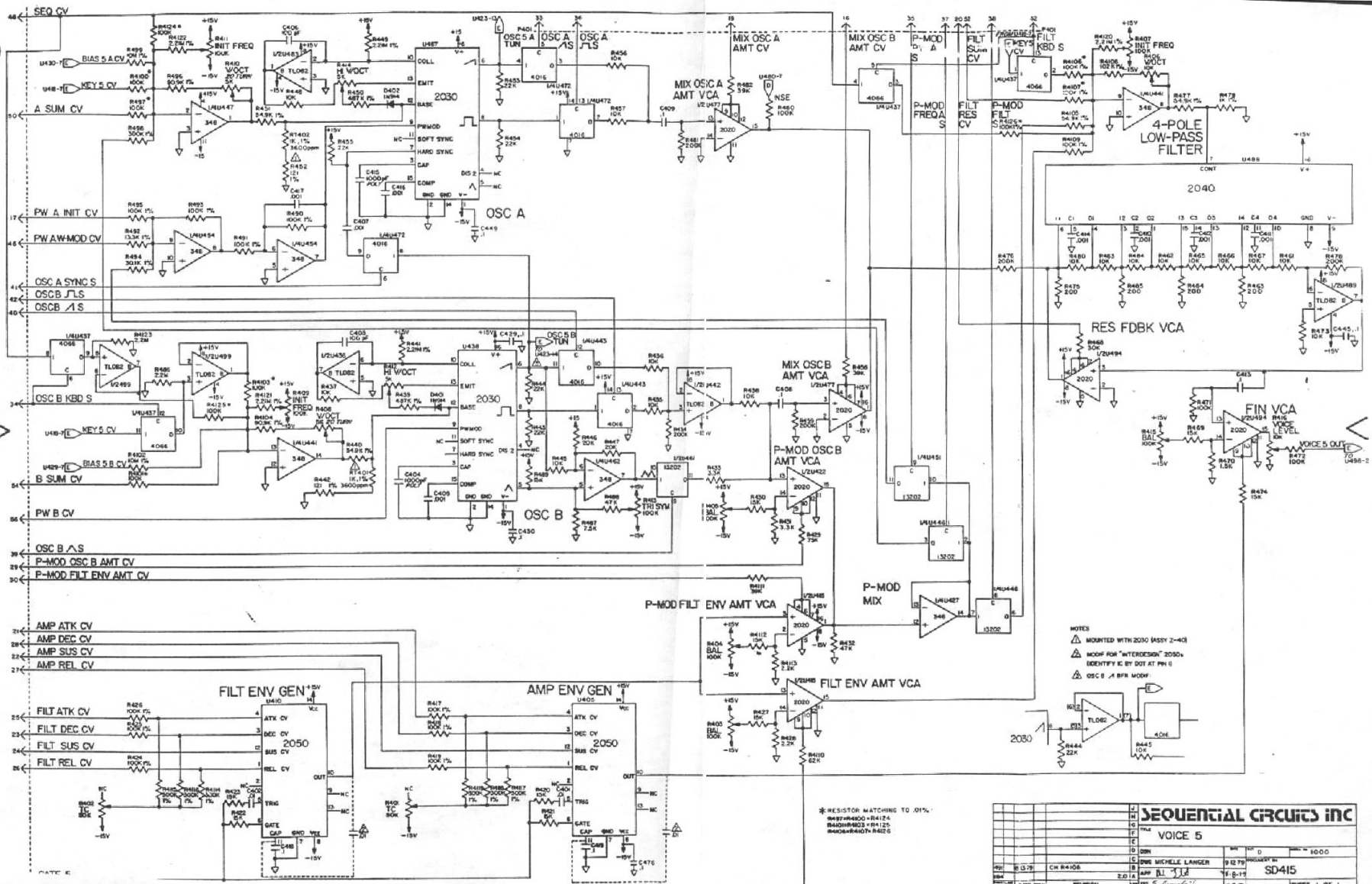
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10	2N4500	1	1000



- NOTES
- ▲ MOUNTED WITH 2030 BASSY 2-40
 - ▲ MOOP FOR INTERSECTION 2030 (IDENTIFY IC BY DOT AT PIN 1)
 - ▲ OSC B A/SR MOOP

*RESISTOR MATCHING TO .01%
R437R440
R400R403
R400R407

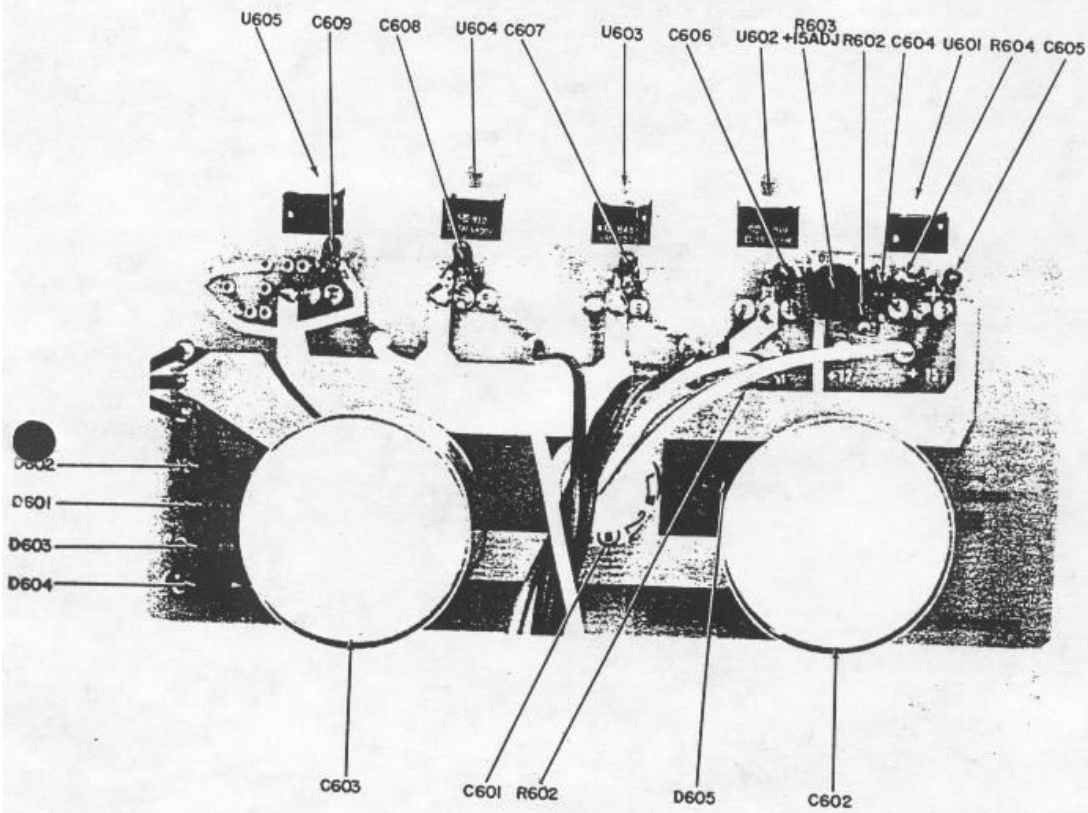
SEQUENTIAL CIRCUITS INC	
FILE	VOICE 4
DESIGNER	CHS MICHELE LANGER
DATE	11-13-79
REV	3
APP	SD414
DATE	11-27
REVISION	REV 3
SHEET 1 OF 1	



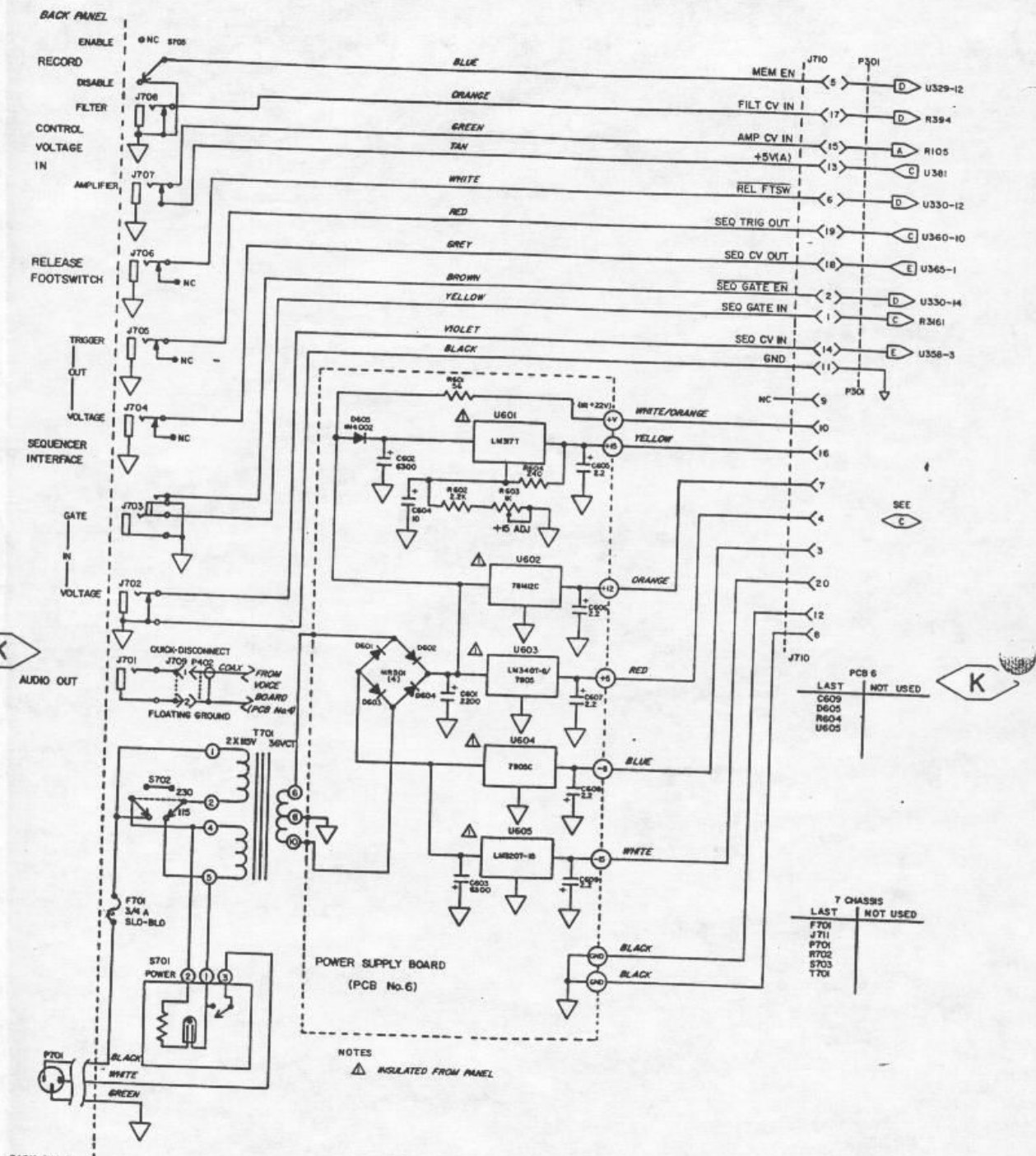
- NOTES
- ▲ MOUNTED WITH 2030 (ASSY 2-43)
 - ▲ MOUNT FOR "INTERSECT" 2050.
 - IDENTIFY IC BY DOT AT PIN 6
 - ▲ OSC B A BFR MOUNT.

* RESISTOR MATCHING TO .01%
 R497-R480 = R4124
 R480-R483 = R4125
 R483-R487 = R4125

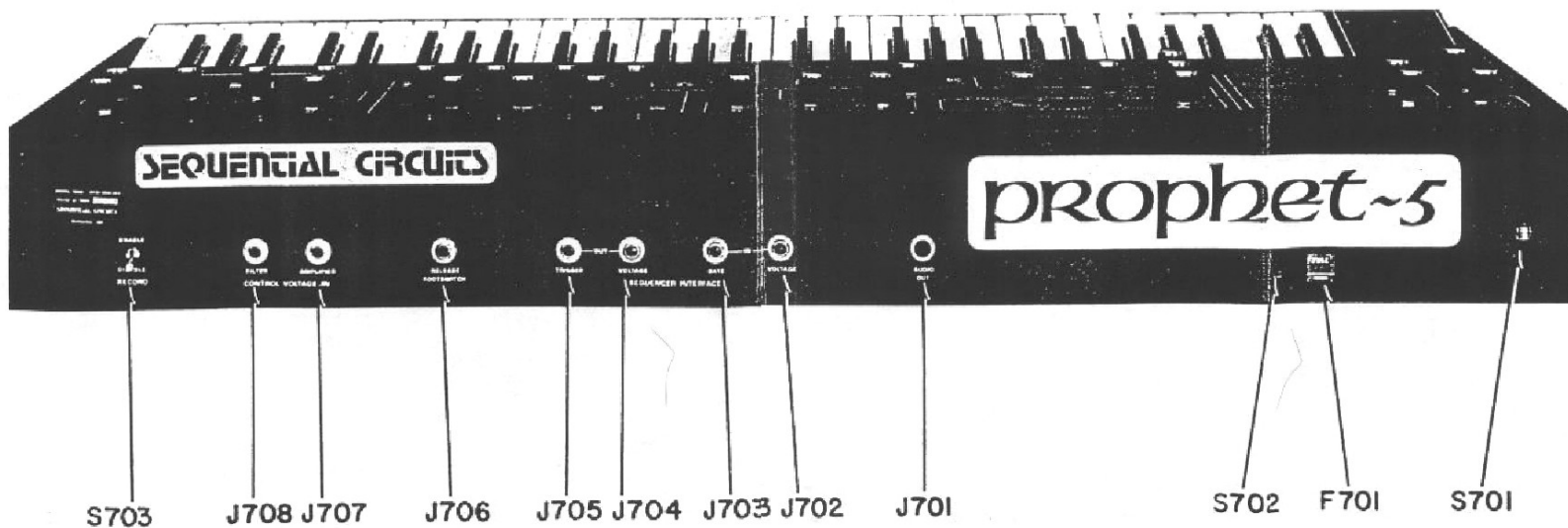
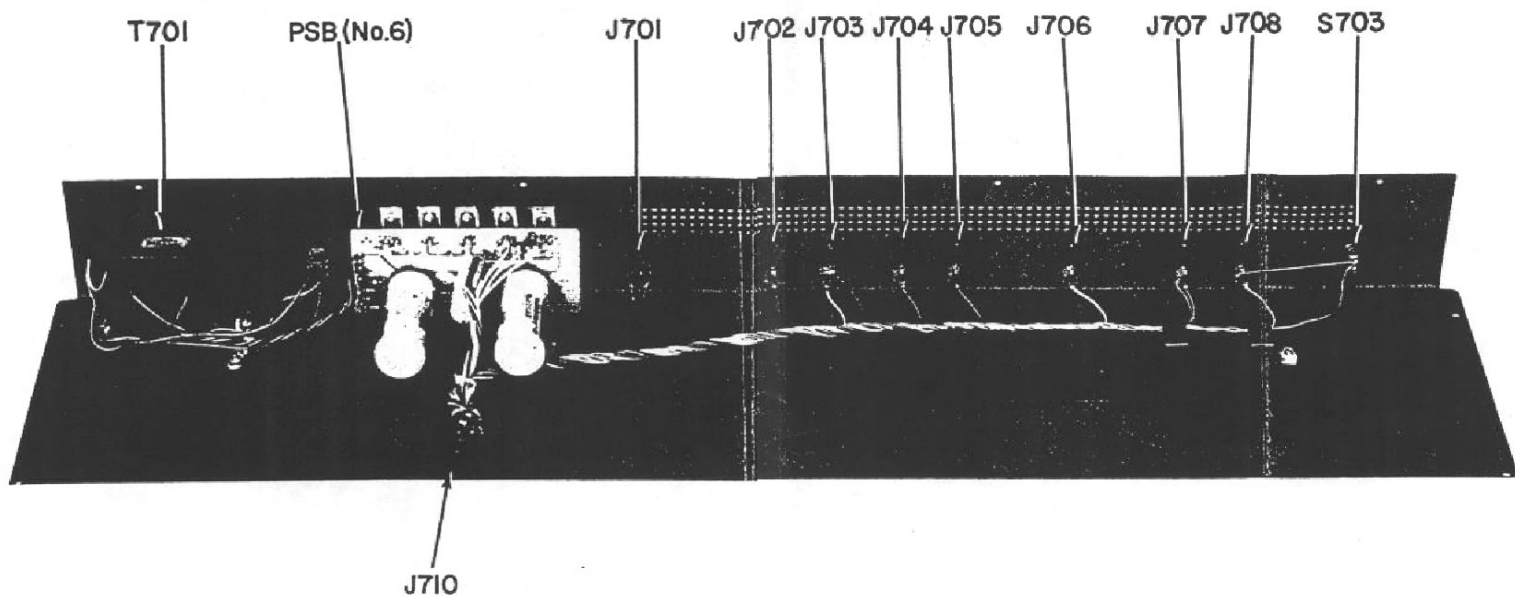
SEQUENTIAL CIRCUITS INC	
VOICE 5	
DESIGNED BY	DAVE MICHELLE LANGER
DATE	8-22-79
APP'D BY	AL J. J.
REVISED	REV 5 1/24/82
PROJECT	SD415
SHEET 1 OF 1	



PA610



SEQUENTIAL CIRCUITS INC	
BACK PANEL AND PCB6	
DSN	REV C
DRG MICHELE LANGER	9-7-79
APP <i>[Signature]</i>	8-8-79
DATE	REV
DATE	REV



PA710

Section 4

Trimming and Tuning

4-0 GENERAL

Prophet trimming and tuning is a sensitive procedure which as a rule should not be done more than necessary. Prophets are carefully adjusted at the factory, where many trimmers are sealed to prevent misadjustment by vibration or accident. You will rarely be able to make an audible improvement upon these trims — unless a malfunction has occurred or a part has been replaced. If you do try to achieve all of the ideal settings described below when no repairs have been involved, you may succeed only in correcting for the difference between our and your DVMs or room temperature.

These procedures are ordered for a Prophet assumed to be 100% electrically functional but completely untrimmed. But this does not mean you should completely retrim whenever something doesn't sound right. Rather, for example, isolate "a tuning problem" to a specific voice (see para. 4-9) and correct the errant oscillator. Of course you should familiarize yourself with the entire trim procedure before attempting it on the Prophet. Make a "dry run", using the schematics and pictorials in Section 3.

A complete retrim begins with the power supply, then scales the DAC and ADC on PCB 3. PCB 3 VCAs are balanced (BAL), the LFO triangle symmetry (TRI SYM) checked, and the OSC A and B Master Summer (MSUM) offset is trimmed. PCB 4 is then installed, the amplifier and filter envelope generators (AMP and FILT ENV GEN) timed, VCA BALs and OSC B TRI SYMs set. Then the voices are tuned — filters before oscillators — and the Prophet closed. This raises the oscillators to normal temperature. The Prophet is again opened for "hot tuning" and the oscillators are fine-tuned as quickly as possible. Finally, the overall voice levels are matched. When using the Prophet with an external sequencer, an accessory trimmer prevents detuning of VOICE 5.

Mechanical procedures required for trimming are covered in Section 1. Consult schematics (SD) and pictorials (PA) in Section 3, as required to locate components mentioned. MA110 shows all controls, PA310U shows PCB 3 ICs and trimmers, and PA416 shows PCB 4 trimmers and oscillator sawtooth outputs. Key designators are shown on SD212; CO is the lowest, C5 the highest. Trimming serves as an initial troubleshooting procedure. When normal indications can't be achieved, see Section 5 for service information.

4-1 PREPARATION

You will need a 4-1/2 digit DVM and a quality dc-triggered oscilloscope, preferably with a 10X horizontal amplifier section. As usual, dual-trace capability helps. A frequency counter can be used instead of a scope for tuning, but this method is generally much slower so we don't recommend it. The procedures include directions for trimming by ear alone where this is possible. However, while it is possible to tune the Prophet by ear alone we can't recommend that either. The Prophet has its own A-440 reference, which is activated by holding S103, PROGRAM SELECT 1 and pressing S104, PS2 simultaneously.

NOTE: EACH PROCEDURE BELOW IS SELF-CONTAINED AND REQUIRES THAT THE CONTROLS BE SET AS LISTED IN TABLE 4-0. Note also that the Prophet presets to program 1-1 whenever power is switched on. This means that you will have to switch off PRESET mode and check the switches whenever you power-up (after powering-off to swing out PCB 4, for example).

TABLE 4-0
BASIC TRIM SETUP
(See MA110, Section 3)

POLY-MOD SECTION			MIXER SECTION		
R201	FILT ENV	0	R205	OSC A	10
R202	OSC B	0	R206	OSC B	0
S201	FREQ A	OFF (UNLIT)	R207	NOISE	0
S202	PW A	OFF	FILTER SECTION		
S203	FILT	OFF	S101	PRESET	OFF
S207	MOD PRESET	OFF	R101	CUTOFF	10
LFO SECTION			R102	RESONANCE	0
R208	FREQ	0	R103	ENV AMT	0
S208	SAWTOOTH	OFF	S102	KEYBOARD	ON
S209	TRIANGLE	OFF	R106	ATTACK	0
S210	PULSE	OFF	R107	DECAY	0
WHEEL-MOD SECTION			R108	SUSTAIN	0
R212	SRC MIX	0 (LFO)	R109	RELEASE	0
S216	FREQ A	OFF	AMPLIFIER		
S217	FREQ B	OFF	R110	ATTACK	0
S218	PW A	OFF	R111	DECAY	0
S219	PW B	OFF	R112	SUSTAIN	10
S220	FILT	OFF	R113	RELEASE	0
OSCILLATOR A			S111	RELEASE	OFF
R203	FREQ	0	PROGRAMMER SECTION		
S204	SAWTOOTH	ON	S222	PRESET	
S205	PULSE	OFF	S223	RECORD	OFF
R204	PW	0	S224	BANK SEL	X
S206	SYNC	OFF	S103-S110	PRGM SEL 1-8	X
OSCILLATOR B			OTHER		
R209	FREQ	0	R104	MASTER TUNE	5 (CENTERED)
R210	FINE	0	R105	VOLUME	AS NEEDED
S211	SAWTOOTH	OFF	R213	GLIDE	0
S212	TRIANGLE	OFF	S221	UNISON	ON
S213	PULSE	OFF	S112	EDIT	X
R211	PW	0	S113	TUNE	X
S214	LO FREQ	OFF	R701	PITCH WHEEL	CENTERED
S215	KEYBOARD	OFF	R702	MOD WHEEL	MINIMUM

4-2 R603 +15V ADJUSTMENT

R603 (see SD711) balances the +15V and -15V supplies. Its setting should not be changed unless U601 or U605 have been replaced. To do so will unbalance all VCAs which are trimmed for CV rejection as well as offset all oscillator and filter CVs. Positive and negative supply readings under load should be 15.0 +/- 0.5V. Readings outside of this range may indicate a malfunction.

To check the supply, remove cabinet screws as discussed in para. 1-2. Slide top panel assembly forward only. Do not raise to "service position". The supply voltages are marked on PCB 6 (see PA610).

If required, note -15-V reading (e.g. -15.375) and trim R603 so +15-V reading matches (e.g. +15.375).

4-3 R301 DAC GAIN

The overall gain for the DAC affects the voltage scaling on all sample and holds (S/Hs). Scaling affects, most importantly, all of the oscillator V/OCTs. Therefore if all the oscillators are sharp or flat in V/OCT, R301 (see SD312) can be adjusted. Conversely, if all V/OCT are fine and you trim R301, then you'll make all V/OCTs sharp or flat.

Start in BASIC TRIM SETUP, TABLE 4-0. To set DAC GAIN:

1. With DVM, probe U370-7, UNISON CV S/H.
2. Switch off S221, UNISON.
3. U370-7 should measure a small "offset" voltage. Note the offset and its polarity (e.g. +0.003V).
4. Switch on S221, UNISON.
5. Key B4.
6. Trim R301 to read exactly 5.000V +/- the offset voltage read in step 3 (e.g. 5.003V).
7. To recover offset voltage for checking trim, switch off S221, UNISON.

4-4 R302 ADC GAIN

R302 (see SD312) determines the range of control panel pots which are quantized by the ADC. ADC gain can be set by ear by adjusting for an exact five-octave range of either OSC FREQ knob.

Start in BASIC TRIM SETUP, TABLE 4-0. By ear:

1. With R203, OSC A FREQ, set to 0, key C5.
2. Turn R203 to 10 and key C0.
3. If required, repeat steps 1 and 2 and trim R302 so the two keystrokes sound the same pitch.

With instruments:

1. With DVM, probe U353-1, OSC A INIT FREQ CV S/H.
2. With R203, OSC A FREQ, set to 0, U353-1 should measure in the 5-V range (e.g. +5.252V).
3. Turn R203 to 10.
4. R302 trims in 83-mV increments. Trim to the voltage measured in step 2 minus exactly 5.000V (e.g. 5.252 - 5.000 = 0.252V).

4-5 R304 WHEEL-MOD NOISE VCA BALANCE

R304 (see SD312) is best trimmed by ear.

Start in BASIC TRIM SETUP, TABLE 4-0.

1. Turn R212, W-MOD SRC MIX, to 10(NOISE).
2. Switch on S216, W-MOD FREQ A DESTINATION.
3. Turn R203, OSC A FREQ, to 10.
4. Key C0 and advance R702, MOD wheel, with same hand.
5. Trim R304 so OSC A pitch does not change as you advance R702. You can still hear the base pitch even with the noise modulation.

4-6 R305 WHEEL-MOD LFO VCA BALANCE

R305 (see SD312) is similar to R304 (para. 4-5).

Start in BASIC TRIM SETUP, TABLE 4-0. By ear:

1. Switch on S216, W-MOD FREQ A DESTINATION.
2. Turn R203, OSC A FREQ, to 10.
3. Key C0 and advance R702, MOD wheel, with same hand.
4. Trim R305 so OSC A pitch does not change as you advance R702.

With instruments, VCAs are trimmed so that with maximum CV applied there will be no output (0.000V) when there is no input. Perform steps 1 - 3, above, then:

4. With DVM, probe U373-15.
5. Trim R305 so U373-15 reads 0.000V.

4-7 R306 LFO TRIANGLE SYMMETRY

R306 (see SD312) may be trimmed by ear, but instruments are preferred.

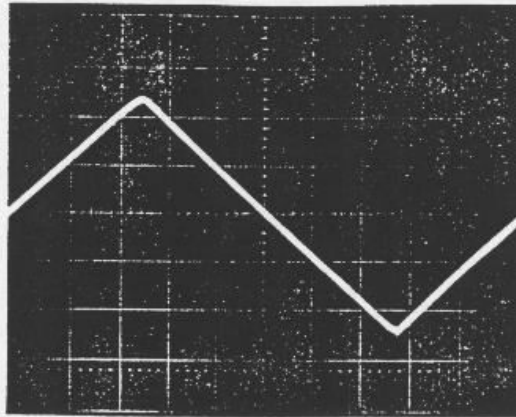
Start in BASIC TRIM SETUP, TABLE 4-0. By ear:

1. Turn R203, OSC A FREQ, to 10.
2. Switch on S209, LFO triangle.
3. Set R208, LFO FREQ, to about 5.
4. Key C0 and advance R702, MOD wheel, with the same hand. Listen for smooth rise and fall of OSC A pitch (frequency modulation).
5. If required, trim R306 to remove "glitch" in modulation.

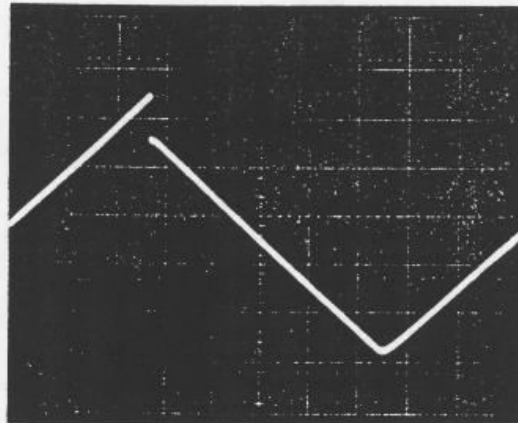
With instruments:

1. Turn R208, LFO FREQ, to 10.
2. With scope, probe U372-14. Note that U372 is mounted upside down.
3. The triangle waveform should look balanced, like Waveform 4-0A. Non-symmetry looks like Waveform 4-0B. Trim R306 (see PA310U) if required to balance.

A
TRIMMED



B
UNTRIMMED



Waveform 4-0
TRIANGLE SYMMETRY

4-8 R307 MASTER SUMMER OFFSET

R307 (see SD312) adjusts the range of the OSC A and B MASTER SUMMERS (MSUMs). It can only be trimmed with instruments.

Start in BASIC TRIM SETUP, TABLE 4-0.

1. With DVM, probe U377-1, A SUM CV.
2. Key C0.
3. Trim R307 so U377-1 reads -5.500V.

4-9 TRIMMING THE VOICES

As above, the following procedures are ordered as if the Prophet were going to be completely retrimmed. But since there are 80 trimmers on PCB 4 you will probably want to avoid this situation.

Unnecessary trims can be avoided by tracing problems to specific voices. There are two ways to do this. You can mute individual voices by turning down its R416, VOICE LEVEL, trimmer (see para. 4-20). Then when playing in UNISON, only the unmuted voices will be heard while all the envelope generators, for example, will be triggered simultaneously. Or, you can keep track of the voice assignments. Switch on S221, UNISON, hit a note, then switch off S221. This resets the voice counter. The voices will now be assigned sequentially 1, 2, 3, 4, 5 to the first five different keys hit. The TUNE routine also resets the voice counter.

Note that the same trimmers for separate voices have the same designator. For example, each voice has a R401 — and the five settings should match. The procedures usually spell out the trim only for VOICE 1 (V1), and VOICES 2 - 5 (V2 - 5) are trimmed similarly.

4-10 R401 AMPLIFIER ENVELOPE GENERATOR TIME CONSTANT

R401 adjusts the range of the AMP ENV GEN ATTACK, DECAY and RELEASE periods. It is trimmed for comparable timing between the voices. Over periods less than 1 sec. the envelopes will closely match. Longer ATK, DEC or REL periods normally increase differences between the voices.

Start in BASIC TRIM SETUP, TABLE 4-0.

1. Turn R112, AMP SUS, to 0.
2. With DVM, probe U342-1, AMP ATK CV S/H.
3. Trigger scope from J705, SEQ TRIG OUT.
4. Set scope timebase to .1s/div.
5. With scope, probe U401-10, VOICE 1 AMP ENV GEN OUT.
6. On Prophets S/N 590 and above check for ENV GEN S/H Gain Modification (see SD313). The modification adds 1K resistors between U342-1/2, U343-1/2, U343-6/7.
7. Adjust R110, AMP ATK, so the DVM reads as close to 6.250V as the quantized voltage steps will allow. If the S/H Gain Modification has been installed, adjust R110 for a DVM reading close to 6.875V.
8. Key repeatedly and measure ATK period on scope.
9. Trim R401 for 0.9-sec ATK period. Note that these trimmers have a wide range and it does not take much movement to drastically change the TC, so be careful and go slow when trimming.
10. Probe U402-10, U403-10, U404-10 and U405-10 to trim R401s for VOICES 2 - 5. If scope is dual-trace, VOICES 2 - 5 can be referenced to VOICE 1.

NOTE: The ATK timing will measure differently on different scopes. It is not so important that the ATK period is absolutely 0.9 sec, as it is that the five voices match each other. Also note that the 2050s are heat sensitive, and will drift slightly. This is usually inaudible, so don't worry about it.

4-11 R402 FILTER ENVELOPE GENERATOR TIME CONSTANT

R402 functions similarly to R401 (para. 4-10).

Start in BASIC TRIM SETUP, TABLE 4-0.

1. With DVM, probe U352-7, FILT ATK CV S/H.
2. Trigger scope from J705, SEQ TRIG OUT.
3. Set timebase to .1s/div.
4. With scope, probe U406-10, VOICE 1 FILT ENV GEN OUT.
5. On Prophets S/N 590 and above check for ENV GEN S/H Gain Modification (see SD313). The modification adds 1K resistors between U351-6/7, U352-1/2, and U352-6/7.
6. Adjust R106, FILT ATK, so the DVM reads as close to 6.250V as the quantized voltage steps will allow. If the S/H Gain Modification has been installed, adjust R106 for a DVM reading of 6.875V.
7. Key repeatedly and measure ATK period on scope.
8. Trim R402 for 0.9-sec ATK period. Note that these trimmers have a wide range and it does not take much movement to drastically change the TC, so be careful and go slow when trimming.
9. Probe U407-10, U408-10, U409-10 and U410-10 to trim R401s for VOICES 2 - 5. If scope is dual trace, VOICES 2 - 5 can be referenced to VOICE 1.

4-12 R403 FILTER ENVELOPE AMOUNT VCA BALANCE

Like all VCA BALs, R403 is trimmed so that with maximum CV applied, there will be no output (0.000V) when there is no input signal.

Start in BASIC TRIM SETUP, TABLE 4-0.

1. Turn R103, FILT ENV AMT, to 10.
2. With DVM, probe U411-15, VOICE 1 FILT ENV AMT VCA.
3. Hold a key.
4. Trim R403 for 0.000-V reading. These trimmers are sensitive and it may not be possible to set exactly 0.000V, but get as close as you can.
5. Probe U412-15, U413-15, U414-15, and U415-15 to trim R403s for VOICE 2 - 5.

4-13 R404 POLY-MOD FILTER ENVELOPE AMOUNT VCA BALANCE

R404 functions similarly to R403 (para. 4-12).

Start in BASIC TRIM SETUP, TABLE 4-0.

1. Turn R201, P-MOD FILT ENV AMT, to 10.
2. With DVM, probe U411-1, VOICE 1 P-MOD FILT ENV AMT VCA.
3. Hold a key.
4. Trim R404 for 0.000-V reading. These trimmers are sensitive and it may not be possible to get exactly 0.000V, but get as close as you can.
5. Probe U412-1, U413-1, U414-1, and U415-1 to trim R404s for VOICES 2 - 5.

4-14 R405 POLY-MOD OSCILLATOR B AMOUNT VCA BALANCE

R405 functions similarly to R403 (para. 4-12).

Start in BASIC TRIM SETUP, TABLE 4-0.

1. Turn R202, P-MOD OSC B AMT, to 10.
2. With DVM, probe U426-1, VOICE 1 P-MOD OSC B AMT VCA.
3. Trim R405 for 0.000-V reading.
4. Probe U421-1, U421-15, U422-1 and U422-15 to trim R405s for VOICES 2 - 5.

4-15 R413 OSCILLATOR B TRIANGLE SYMMETRY

R413 functions similarly to R306 (para. 4-7).

Start in BASIC TRIM SETUP, TABLE 4-0. By ear:

1. Switch off S221, UNISON.
2. Switch off S215, OSC B KEYBOARD.
3. Turn R209, OSC B FREQ, to 10.
4. Switch on S212, OSC B TRIANGLE.
5. Turn R206, MIX OSC B, to 10.
6. Isolate VOICE 1 (para. 4-9) and hold a key.
7. If required, trim R413 for minimum harmonics.
8. Repeat steps 7 and 8 for VOICES 2 - 5.

With instruments, perform step 1 - 4 above, then:

5. Probe U457-7 with scope. Note that U457 is mounted upside down.
6. The triangle waveform should look balanced, with equal slopes (see Waveforms 4-0). Trim R413 if required to balance.
7. Probe U462-8, U462-14, U462-1 and U462-7 to trim R413s for VOICES 2 - 5.

4-16 R415 FINAL VCA BALANCE

R415 functions similarly to R403 (para. 4-12).

Start in BASIC TRIM SETUP, TABLE 4-0. By ear:

1. Turn R205, MIX OSC A, to 0.
2. Isolate VOICE 1 (para. 4-9).
3. Increase R105, VOL, to louder than normal.
4. While striking key repeatedly, trim R415 for minimum key clicks.

With instruments:

1. Turn R205, MIX OSC A, to 0.
2. Hold (or tape) a key.
3. With DVM, probe U490-15, VOICE 1 FIN VCA.
4. Trim R415 for 0.000-V reading.
5. Probe U491-15, U492-15, U493-15 and U494-15 to trim R415s for VOICES 2 - 5.

4-17 FILTER TUNING

The filters are tuned at full resonance, where they oscillate with a pure sine wave. (The filters are not temperature-compensated, so they will drift and they will never track as well as the oscillators.)

Start in BASIC TRIM SETUP, TABLE 4-0. By ear:

1. Switch off S204, OSC A SAWTOOTH.
2. Turn R102, FILT RES, to 10.
3. With DVM, probe U350-7.
4. Adjust R101, FILT CUTOFF, for as close to +3.083-V reading as the quantized voltage steps will allow.
5. Record this patch in an unused memory location. Verify that there is no change in the DVM reading.
6. Isolate VOICE 1 by turning down VOICE 2 - 5 R416, VOICE LEVELS.

7. Ready a tuning fork or if available, set up an external A-440 reference. It is not desirable to use the Prophet's A-440 reference for filter tuning since it will tend to sync the resonating filter.
8. Key C3, trim V1-R407 FILT INIT FREQ, to resonate at A-440.
9. Key C5, trim V1-R406 FILT V/OCT, so the filter resonates exactly two octaves higher.
10. R407 and R406 interact, so repeat steps 8 and 9 until no improvement is possible.
11. Raise VOICE 2 LEVEL with its R416.
12. Zero-beat V2-R407/6 against VOICE 1 while repeating steps 8 and 9. 2 - 6 beats-per-second is acceptable.
13. Lower VOICE 2 LEVEL and repeat steps 11 and 12 for VOICES 3 - 5.

With instruments, perform steps 1 - 5 above, then:

6. Adjust scope timebase to 440 Hz. If you sync the scope to the Prophet 440 Hz reference, be sure to switch the reference back off.
7. With scope, probe U479-1, V1 FILT BUFFER.
8. Key C3, and trim V1-R407 to display exactly one complete cycle. Use X10 magnification, if available.
9. Key C5, and trim V1-R406 to display four complete cycles.
10. R407 and R406 interact, so repeat steps 8 and 9 until no improvement is possible.
11. Probe U479-7, U486-1, U486-7, and U489-7 to trim R407/6s for VOICES 2 - 5.

4-18 OSCILLATOR TUNING

Although the procedure is included here for reference an oscillator's INITIAL FREQUENCY should not have to be trimmed except when it has been replaced. These trimmers need only bring the oscillators close enough to each other for the computer to fine-tune them with the TUNE routine.

Computer tuning (auto-scaling) usually corrects sufficiently for playing. There will always be some beating or phasing between the voices. If not excessive, these imperfections "naturalize" or "warm" the Prophet's sound. Therefore, if the Prophet is badly out of tune, there is probably a component failure. Carefully investigate all possible causes before retuning.

Before trimming the oscillators, you may want to check four or five of them to see if they are all flat or sharp the same amount. If they are, then you can trim R301 DAC GAIN to change the V/OCT on all the oscillators at one time. This could save you a lot of time with individual oscillators.

NOTE: Be careful if you decide to use this method, since trimming DAC GAIN incorrectly will mis-adjust all CVs issued by the computer.

Start in BASIC TRIM SETUP, TABLE 4-0.

1. Switch off S221, UNISON.
2. Switch on S215, OSC B KBD.
3. Turn R206, MIX OSC B to 10.
4. Key D#3 and note pitch.
5. Key C0 and adjust R203, OSC A FREQ for pitch heard in step 3. This is about 6.5 on the dial.
6. Switch on S211, OSC B SAWTOOTH.
7. Adjust R209 OSC B FREQ to same pitch as OSC A.
8. Turn R213, GLIDE, to 5.
9. Record this patch in an unused location. These procedures will refer to this patch as 5-1.
10. Press S112, EDIT.
11. Key C0 and note pitch.
12. Key C2 and adjust R203 and R209, OSC A and B FREQ, for pitch heard in step 11. This is about 3 on the dial.
13. Record this patch. It will be referred to here as 5-2.
14. While holding S103, PROGRAM SELECT 1, press S109, PS7. This causes all of the BIAS S/H voltages to be set at approximately 2V. In other words, it defeats the TUNE routine.

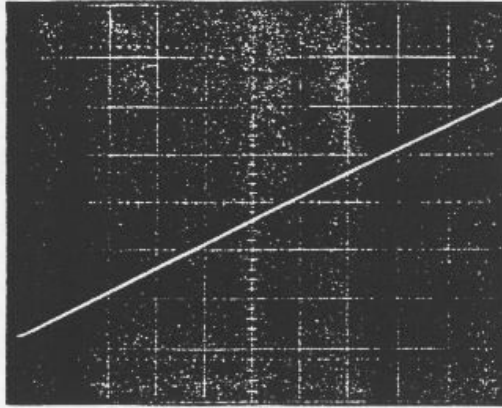
15. While holding S103, PS1, press S108, PS6. This activates "special UNISON" mode. Rather than from U370-7, the UNI CV will now appear through the five KEY CV S/Hs on PCB4. This reduces resistor mismatch effects in the ten OSC CV SUMMERS on PCB 4.
 NOTE: Both the "bias-setting" (PS1/7) and "special UNISON" (PS1/6) modes will remain active either until power is switched off or the TUNE routine is activated. Since the GLIDE circuit is connected to the UNI CV S/H, GLIDE will not operate in special UNISON mode. Therefore, if you hear glide when tuning, special UNISON has not been activated, or has been deactivated by some other operation.
 NOTE: A peculiarity of special UNISON mode is its effect on PRESET. If special UNISON is activated and PRESET is switched off then on, you must restrike the program select (PS) of whatever patches you are using for tuning. Special UNISON also affects voice assignments, so voices can only be isolated reliably with the method of muting R416, VOICE LEVELs.
16. With a scope, verify that the ten oscillator bias CVs are active and pure dc at about 2V. The biases may either be checked on PCB4 or 3, as listed in TABLE 4-1.

TABLE 4-1
 BIASES

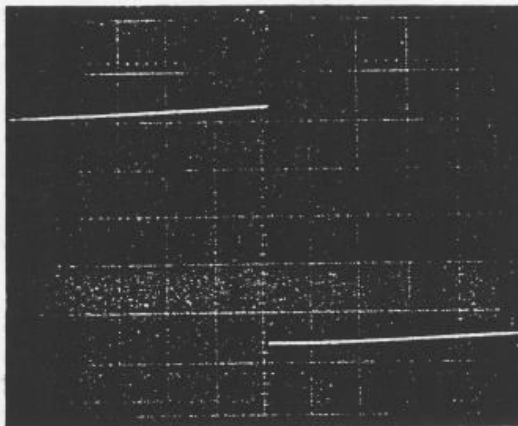
OSC	S/H	RESISTOR
1A	U432-7	R499
1B	U431-7	R4102
2A	U432-1	R499
2B	U432-1	R4102
3A	U419-1	R499
3B	U420-7	R4102
4A	U419-7	R499
4B	U420-1	R4102
5A	U430-7	R499
5B	U429-7	R4102

17. For what follows, it will be convenient to key C5 with a footswitch. If available, connect between the top bus bar section and the anode (non-banded end) of the ninth diode from the top of the keyboard (E4).
18. As shown in Section 3, there are ten plated-through holes on PCB 4 which have the individual sawtooth outputs of all ten oscillators, no matter what the status of the machine. Probe these holes when tuning with scope or meter.
19. Switch off S211, OSC B SAWTOOTH.
20. Switch off S221, UNISON.
21. Switch on A-440 reference (PS 1/2).
22. With scope, probe U480-7 A-440/NSE BUFFER, and set for stable trace.
23. With scope, probe OSC 1A SAWTOOTH.
24. Key F#2 and trim V1-R411, OSC 1A INIT FREQ, to 440 Hz.
25. Switch off A-440 Reference.
26. Now key C0 (which should be about 155.5 Hz), and set scope up as follows: Trigger on the negative edge. Set vertical amp to 2V/div., and timebase to 2 ms/div. Set up display one complete sawtooth, as in Waveform 4-1. Now select x10 (or x5) time-scale magnification, and turn horizontal position counter clockwise until the falling edge is centered on the screen, as in Waveform 4-2A. On some scopes it may be necessary to adjust the time scale vernier to center the edge. Increase trace intensity if required to clarify falling edge. With this scope setup, the falling edge of all octave Cs should be in exactly the same position if the oscillator is in tune.
27. Select patch 5-1 and switch scope timebase to 0.5 ms/div.
28. Probe the OSC sawtooth outputs, key C0, and trim the four remaining R411s, OSC A, and five R409, OSC B INIT FREQs for centered falling edge.
29. With scope, probe OSC 1A sawtooth.
30. Select patch 5-2 and return scope timebase to 2 ms/div.
31. Alternately key C0 and C5 (with footswitch, if used) and trim V1-R410, OSC 1A V/OCT so falling edge of both notes is centered on the scope. See Waveforms 4-2A and B.

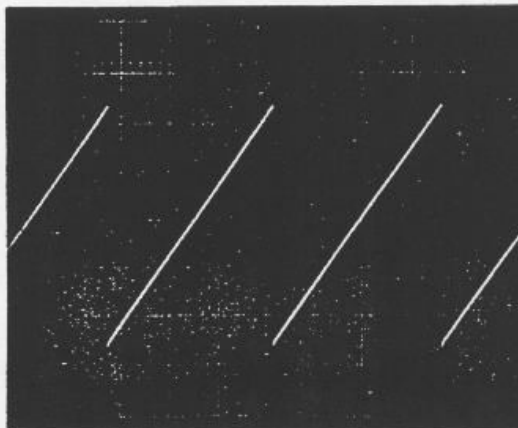
Waveform 4-1
OSCILLATOR TUNING, step 26



A
C0



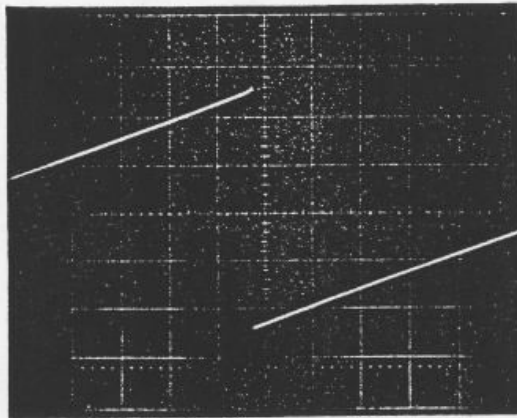
B
C5



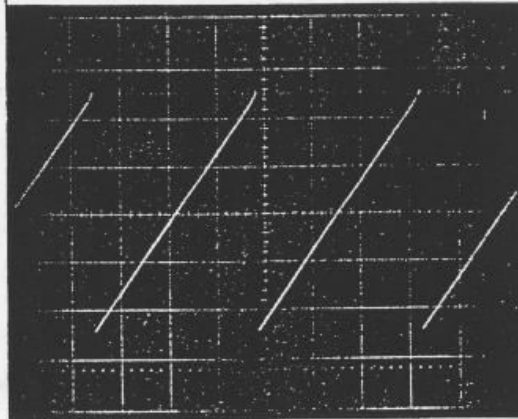
Waveform 4-2
OSCILLATOR TUNING, steps 26-31

32. Select patch 5-1 and switch scope timebase to 0.5 ms/div.
33. Alternately key C3 and C5 and trim V1-R414, OSC 1A HI V/OCT so falling edge of both notes is centered on the scope. See Waveforms 4-3A and B.
34. Since these adjustments interact, repeat steps 32-35 until no improvement is possible.
35. Probe the remaining oscillators, and trim as in steps 32 - 36. For the five OSC Bs, trim R408 V/OCT and R412 HI V/OCT.
36. Select patch 5-2 and switch scope timebase to 2 ms/div.
37. Now close-up the Prophet and let it sit for 10 - 15 minutes before continuing. It is not necessary to replace the cabinet screws. Ideally, continue in a very warm room to more closely simulate operating conditions. Final tuning must be done as quickly as possible, to minimize frequency drift from changing temperature.
38. Probe the ten OSC sawteeth and trim their V/OCTs for centered falling edge while keying C0 and C5.

A
C3



B
C5



Waveforms 4-3
OSCILLATOR TUNING, steps 32-35

4-19 R416 VOICE LEVEL

As mentioned in para. 4-9, R416 can be used to isolate the voices. To set VOICE LEVELS at the end of the trim procedure, start in BASIC TRIM SETUP, TABLE 4-0.

Switch off S221 UNISON. Turn all R416s fully clockwise. Play polyphonically to determine which voice is softest, then turn the other four voices down to match. This can be done either by ear or with instruments.

4-20 R303 SEQUENCER CV OFFSET

R303 should only be trimmed once the Prophet is determined to be in tune. It is set so the particular sequence or other CV source being used does not detune VOICE 5.

Section 5

Service Notes

5-0 GENERAL

It should be possible for the qualified technician to service the Prophet using the schematics and standard troubleshooting techniques. The comments below suggest general approaches to correct typical symptoms in each sub-circuit.

CAUTION: Observe the precautions in paragraph 1-1 of this manual.

5-1 POT MUX/ADC

Control knob malfunctions are most likely failures of U201-03. However, any data bus problem could cause incorrect pot multiplexing. See Table 2-0. Dirty pots may "jump". Clean them or replace with 10-100K linear taper. If several pots jump, check the ADC GAIN and U334 ADC itself. Observe VDAC while turning knobs to check their effect on the staircase.

5-2 KEYBOARD (KBD)

Most keyboard problems are caused by dirty, bent, or broken J-wires.

Dead notes not caused by J-wires, usually occur in groups of eight, making it easy to isolate the problem matrix row or column.

Also, check W702 keyboard cable. Check for CS8 and -CSE.

5-3 SWITCH MATRIX

If a switch does not function its LED will also probably not light and the problem must be in the switch matrix. If a switch LED lights, but the function is not enabled, the problem must be in the corresponding output latch or analog circuitry.

Check operation of other switches to isolate malfunction to a single row or column.

Check for CS8 and -CSD.

5-4 LED MATRIX

If the Prophet powers-up with a few bright LEDs, but doesn't operate, you can assume the computer isn't running.

Some owners may notice a slight difference in brightness between the BANK and PROGRAM numerical displays. This is normal, resulting from different scan times for each display.

If a switch LED doesn't indicate switch status (on or off), check that the switch is indeed functioning. For example, if S213 enables OSC B PULSE but DS213 doesn't light, check operation of LEDs connected in the same matrix row or column: DS203 10, DS105, and the c-segments of DS225. If they didn't work, the problem might be R219, Q201, R240, or U208.

Check for CS8 and CS9.

5-5 COMPUTER

See also paragraph 5-6.

Most computer malfunctions are caused by failures of devices connected to the data bus. (Waveforms 5-0A and B show a normal bus line.) For example, any shorted latch input may prevent that entire data line from ever being a 1. Shorts between data lines will confuse the computer terribly. If you suspect a data bus problem, try to pick out the lines with questionable levels. Low should be 0-500mV. High should be 4-5V (3.5V for CMOS). Reading of 1 or 1.8V, for example, indicate a failure. First, check +12V and -5V supplies. Then remove any socketed (computer) device: U322 clock, U312/13 EPROMs, or the appropriate 6508 — WHICH WILL CLEAR THE PROGRAM MEMORY! If this doesn't locate the problem, you will have to cut traces to all other data-bussed devices until correct levels are restored. Note that a short on the high voltage data-bus, DBH, will not usually affect computer operation. But it will be easy to check each latch for malfunctioning switch (S) bits, GATE bits, or S/H addresses.

CS0 is the earliest CS, so maybe used for "loop sync".

If the computer "dies" seemingly randomly, you might check U322 CPU CLOCK for intermittents. Also check that J710 and P301 are firmly interlocked. If the computer doesn't come up at all, the problem could be a tuning problem. Pull W703 and try again. If the panel now lights normally (after 5-7 seconds) check either OSC 1A — which can hang up the TUNE routine, if dead — or U301-08.

If computer TUNEs too quickly, or not at all, check U316. Bad 6508s may also cause erratic tunings, since they hold the BIAS values.

5-6 NON-VOLATILE PROGRAM MEMORY

NOTE: The NV PRGM RAM is well-protected, but not foolproof. Technicians should warn players that their programs can be lost through the course of repair, and encourage them to back-up their patches with diagrams. Panel blanks are available from the factory.

CAUTION: Any Vdd short will clear the program memory.

If programs will not record, check BT301, Vdd, and whether -CS, U309-1 remains high throughout power-up or down. The briefest pulse here may erase a few bytes.

C389 should be able to hold Vdd for a few minutes — but we don't guarantee it. This may allow you time to insert a microammeter in series with BT301. Total current draw should be about 10 μ A or less. A single, bad 6508 can draw as much as 50 μ A.

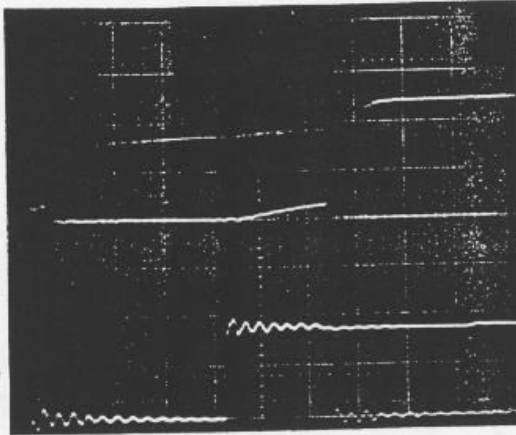
WARNING: BT301 may explode if shorted for any period of time — though it will usually "just" vent noxious gases.

A

DB7

V: 2V/div
H: .2 μ s/div

U319-9

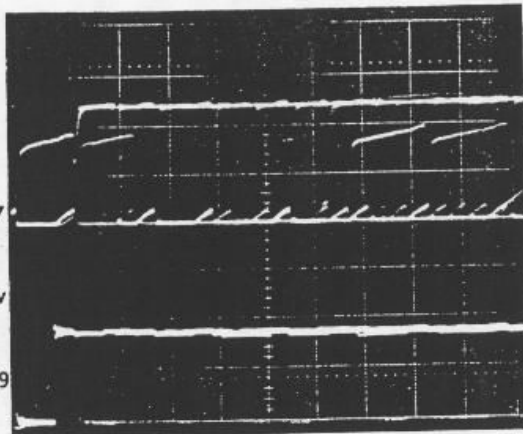


B

DB7

V: 2V/div
H: .1 μ s/div

U319-9



Waveform 5-0
DATA BUS (7)

5-7 DAC, CV DMUX, S/Hs

You may find extra resistors in the DAC ladder. They may connect from a collector of Q301-07 to U328-2 to "lower" the bit value, or to U328-6 to "raise" the bit. 10 megohms corrects about 6 mV error. Don't change or remove these resistors.

Also, don't substitute Q301-07, 2N4250s.

VDAC itself is very informative. You will see the voltage levels strobed to the forty-one S/Hs in order. Check suspected 4051s for S/H ABC and I addresses and VDAC at pin 3.

S/H output can be expected to "droop" up to 1/2-mV after 7 ms. Droop greater than this is usually TL082 failure (input leakage).

Shorted or leaky capacitors will, of course, cause excessive droop. Open caps make the S/H output pulse.

Both sides of a TL082 usually fail at the same time. Leakage causes the output to look like an inverted sawtooth.

5-8 COMMON ANALOG

R3123 may be 20-22 kilohms to extend slowest glide rate.

The MSUM LM348s may be suspected for problems affecting all OSC A, OSC Bs or FILT FREQs.

5-9 AUDIO OUTPUT

The control path for U497-15 VOLUME VCA passes through J707 AMP CV IN jack. Check J707 (see SD211, SD711) when troubleshooting for no audio output. (Also check quick-disconnects P402/J709 on J701.)

5-10 VCOs

WARNING: Switch power off while removing or installing PCB4. Otherwise, there is danger of "blowing" devices through accidental grounding at a standoff.

In general, component failures can be quickly cured by isolating the affected voice and comparing it — waveforms, voltage readings — to the other four voices. For example, to find a "bad" oscillator match OSC A and B FREQs (OSC B KBD ON) and play in UNISON. Alternately turn down R416 VOICE LEVEL trimmers to isolate the problem voice. Check the oscillator summers (e.g. OSC 1A, U455-1) against one another. If they are basically the same the fault is probably the particular 2030 VCO itself.

Obviously, suspect the COMMON ANALOG circuitry for problems affecting all oscillators, or just the OSC As or Bs.

5-11 VCAs

The 2020 has a current output — there must be a load to measure any significant voltage.

CV input is actually a transistor base with a grounded emitter, so the voltage should not exceed 0.7V. Otherwise, the 2020 is bad.

5-12 ENV GENs

Section 6

PARTS LIST

PCB 1 ASSEMBLY Z-27

DESIG.	DESCRIPTION	MFG. PART NO.
C101	.1uF CERAMIC	C-16
D101-D115	1N914	D-5
DS101-DS111	SEE S101-S111	
R101-R113	100K LINEAR POT	R-208
S101-S109	GREY SWITCH W/LED	S-29
S110, S111	BLACK SWITCH W/LED	S-28
S112, S113	GREY SWITCH	S-31
HARDWARE QTY.		
1	CIRCUIT BOARD	M-62
3	1/4" STANDOFF	M-111

PCB 2 ASSEMBLY Z-28

C201-C204	.1uF, CERAMIC	C-16
C205	47uF, 6.3V, TANTALUM	C-30
C206-C208	.1uF, CERAMIC	C-16
C209	47uF, 6.3V, TANTALUM	C-30
C210	10uF, 10V	C-31
D201-D224	1N914	D-5
DS201-DS223	SEE S201-S223	
DS225	MAN 6740	L-5
J201	16-PIN SOCKET	J-7
P201A	10-PIN PLUG	P-25
P201B	11-PIN PLUG	P-24
Q201-Q208	2N4121	T-9
R201-R213	100K, LINEAR POT	R-208
R214-R216	1K, 1/4W, 5%	R-8
R217-R224	47, 1/4W, 5%	R-43
R225-R236	22K, 1/4W, 5%	R-40
R237	5.1, 1/4W, 5%	R-46
R238-R245	2.2K, 1/4W, 5%	R-34

S201-S206	BLACK SWITCH W/LED	S-28
S207	GREY SWITCH W/LED	S-29
S208-S221	BLACK SWITCH W/LED	S-28
S222	GREY SWITCH W/LED	S-29
S223	ORANGE SWITCH W/LED	S-30
S224	GREY SWITCH	S-31
U201-U203	4051	I-211
U204-U205	4503 (14503)	I-216
U208-U209	4042	I-227
U210	4174	I-228
U211, U212	4042	I-227
U213-U215	3634	I-232

HARDWARE QTY.

1	16-PIN SOCKET	J-7
1	CIRCUIT BOARD	M-63
4	3/8" STANDOFF	M-113
2	7/16" STANDOFF	M-118

PCB 3 ASSEMBLY Z-29

BT301	2.9V	E-40
C301-C305	.1uF, CERAMIC	C-16
C306	10pF, DISC	C-2
C307	.1uF, CERAMIC	C-16
C308	47, 6V, TANTALUM	C-30
C309	.1uF, CERAMIC	C-16
C310	.01uF, POLY	C-11
C311, C312	.1uF, CERAMIC	C-16
C313-C317	.01uF, POLY	C-11
C318	.1uF, CERAMIC	C-16
C319-C324	.01uF, POLY	C-11
C325-C327	.1uF, CERAMIC	C-16
C328	47, 16V, TANTALUM	C-32
C329-C332	.1uF, CERAMIC	C-16
C333	.01uF, MYLAR	C-12
C334	.1uF, CERAMIC	C-16
C335	.01uF, POLY	C-11
C336, C337	.1uF, CERAMIC	C-16
C338	.1uF, CERAMIC	C-16
C334	.01uF, MYLAR	C-12
C345, C346	.1uF, CERAMIC	C-16
C347	.01uF, MYLAR	C-12
C348	.1uF, CERAMIC	C-16
C349	.01uF, POLY	C-11
C350	.1uF, CERAMIC	C-16
C351	.01uF, POLY	C-11
C352-C355	.1uF, CERAMIC	C-16
C356	600pF, DISC	C-7
C357	47, 16V, TANTALUM	C-32
C358	.01uF, POLY	C-11

C359	47, 16V, TANTALUM	C-32
C360-C364	.01uF, POLY	C-11
C365	.1uF, CERAMIC	C-16
C366-C371	.01uF, POLY	C-11
C372-C375	.1uF, CERAMIC	C-16
C376	10uF, 10V, TANTALUM	C-31
C377	470pF, DISC	C-6
C378	10uF, 10V, TANTALUM	C-31
C379	47, 6V, TANTALUM	C-30
C380	.002uF, MYLAR	C-9
C381	.1uF, CERAMIC	C-16
C382	47, 6V, TANTALUM	C-30
C383-C388	.1uF, CERAMIC	C-16
C389, C390	10uF, 10V, TANTALUM	C-31
D301-D307	1N914	D-5
J301A	10-PIN JACK	J-31
J301B	12-PIN JACK	J-32
P301	20-PIN PLUG	P-29
P302	6-PIN PLUG	P-26
P303	60-PIN PLUG	P-13
P304	3-PIN PLUG	P-30
Q301-Q307	2N4250	T-3
Q308	2N3904	T-2
Q309	AD820	T-8
R301	5K, TRIMMER	R-215
R302	5K, TRIMMER	R-211
R303	10K, TRIMMER	R-210
R304-R306	100K, TRIMMER	R-217
R307	100K, TRIMMER	R-212
R308, R309	330, 1/4W, 5%	R-4
R310	1K, 1/4W, 5%	R-8
R311	470, 1/4W, 5%	R-6
R312	1K, 1/4W, 5%	R-8
R313	22K, 1/4W, 5%	R-40
R314	1K, 1/4W, 5%	R-8
R315-R321	22K, 1/4W, 5%	R-40
R322-R324	1K, 1/4W, 5%	R-8
R325	30K, 1/4W, 5%	R-16
R326	787K, 1/4W, 1%	R-111
R327	13K, 1/4W, 5%	R-13
R328-R336	100K, 1/4W, 1%	R-110
R337	12.4K, 1%	R-127
R338	20K, 1/4W, 1%	R-15
R339	30K, 1/4W, 5%	R-16
R340-R345	1K, 1/4W, 5%	R-8
R346	10K, 1/4W, 5%	R-12
R347	10, 1/4W, 5%	R-47
R348	47K, 1/4W, 5%	R-18
R349	100K, 1/4W, 5%	R-25
R350	10K, 1/4W, 5%	R-12
R351	100K, 1/4W, 5%	R-25
R352	10K, 1/4W, 5%	R-12
R353, R354	100K, 1/4W, 5%	R-25
R355	20K, 1/4W, 5%	R-15
R356	10K, 1/4W, 5%	R-12
R357	7.5K, 1/4W, 5%	R-37
R358	47K, 1/4W, 5%	R-18

R359	100K, 1/4W, 5%	R-25
R360	4.7K, 1/4W, 5%	R-11
R361	100K, 1/4W, 5%	R-25
R362	20K, 1/4W, 5%	R-15
R363	47K, 1/4W, 5%	R-18
R364	100K, 1/4W, 5%	R-25
R365	10K, 1/4W, 5%	R-12
R366, R367	22K, 1/4W, 5%	R-40
R368	75K, 1/4W, 1%	R-129
R369	15K, 1/4W, 5%	R-14
R370, R371	100K, 1/4W, 1%	R-110
R372	15K, 1/4W, 5%	R-14
R373	10K, 1/4W, 5%	R-12
R374	4.7K, 1/4W, 5%	R-11
R375	100K, 1/4W, 5%	R-25
R376	10K, 1/4W, 5%	R-12
R377	54.9K, 1/4W, 1%	R-114
R378	100K, 1/4W, 5%	R-25
R379	3.3K, 1/4W, 5%	R-36
R380	47K, 1/4W, 5%	R-18
R381	1K, 1/4W, 1%	R-101
R382	2.21M, 1/4W, 1%	R-116
R383	1M, 1/4W, 5%	R-29
R384	200K, 1/4W, 5%	R-26
R385-R388	10K, 1/4W, 5%	R-12
R389	1K, 1/4W, 5%	R-8
R390	15K, 1/4W, 5%	R-14
R391	100K, 1/4W, 5%	R-25
R392	15K, 1/4W, 5%	R-14
R393, R394	100K, 1/4W, 1%	R-110
R395-R397	100K, 1/4W, 5%	R-25
R398	13.3K, 1/4W, 1%	R-119
R399	100K, 1/4W, 1%	R-110
R3100	182K, 1/4W, 1%	R-128
R3101	100K, 1/4W, 1%	R-110
R3102	249K, 1/4W, 1%	R-130
R3103, R3104	100K, 1/4W, 5%	R-25
R3105	100K, 1/4W, 1%	R-110
R3106	100K, 1/4W, 5%	R-25
R3107	10M, 1/4W, 1%	R-117
R3108-R3116	100K, 1/4W, 1%	R-110
R3117	182K, 1/4W, 1%	R-128
R3118, R3119	100K, 1/4W, 1%	R-110
R3120	2.2M, 1/4W, 5%	R-30
R3121	100K, 1/4W, 5%	R-25
R3122	2.7K, 1/4W, 5%	R-35
R3123	15K, 1/4W, 5%	R-14
R3124	2.21M, 1/4W, 1%	R-116
R3125	100K, 1/4W, 5%	R-25
R3126	412K, 1/4W, 1%	R-124
R3127	4.7K, 1/4W, 5%	R-11
R3128	2.21M, 1/4W, 1%	R-116
R3129	100K, 1/4W, 1%	R-110
R3130	4.7K, 1/4W, 5%	R-11
R3131	2.21M, 1/4W, 1%	R-116
R3132	150K, 1/4W, 5%	R-41
R3133, R3134	100K, 1/4W, 1%	R-110

R3135	10K, 1/4W, 5%	R-12
R3136-R3142	100K, 1/4W, 5%	R-25
R3143	10K, 1/4W, 5%	R-12
R3144	2.2M, 1/4W, 5%	R-30
R3145-R3148	100K, 1/4W, 1%	R-110
R3149, R3150	1K, 1/4W, 5%	R-8
R3151	13K, 1/4W, 1%	R-13
R3152	5.1, 1/4W, 5%	R-46
R3153, R3154	10K, 1/4W, 1%	R-108
R3155	15K, 1/4W, 1%	R-112
R3156	42.2K, 1/4W, 1%	R-132
R3157	1K, 1/4W, 1%	R-101
R3158	54.9K, 1/4W, 1%	R-114
R3159	2.23K, 1/4W, 1%	R-103
R3160	4.7K, 1/4W, 5%	R-11
R3161, R3162	100K, 1/4W, 5%	R-25
R3163	1K, 1/4W, 5%	R-8
R3164, R3165	100K, 1/4W, 5%	R-25
R3166	1M, 1/4W, 5%	R-29
R3167	560, 1/4W, 5%	R-42
R3168, R3169	100K, 1/4W, 5%	R-25
R3170	10K, 1/4W, 5%	R-12
R3171-R3175	1K, 1/4W, 5%	R-8
R3176	100K, 1/4W, 5%	R-25
R3177	75K, 1/4W, 5%	R-22
R3178	15K, 1/4W, 5%	R-14
S301	C56206L2	S-33
TP301, TP302	ELCO PINS	P-20
U301-U308	6508 NV	I-226
U309	74C02	I-230
U310	78L05	I-403
U311	Z-80 CPU (MOSTEK 3880)	I-25
U312	2708 EPROM 0	I-27
U313	2708 EPROM 1	I-28
U314	2708 (NOT USED)	
U315	MCM6810P R/W	I-26
U316	D8253C COUNTER	I-414
U317, U318	MC14503B	I-216
U319	74LS138N (P3205, P8205)	I-117
U320	74LS32N	I-107
U321	DM74LS00N	I-101
U322	74LS124N	I-116
U323, U324	74LS138N (P3205, P8205)	I-117
U325	MM74C906N	I-231
U326	MC14556B	I-229
U328	MC1458P	I-303
U329, U330	MC14503B	I-216
U331	MC14174B	I-228
U332	MC14001B	I-201
U333	DM74132N	I-24
U334	MC88C	I-316
U335, U336	MC14042B	I-227
U337	LM723CN	I-401
U338	UA741CP	I-305
U339	LM311N	I-301
U340-U345	TL082CP (TL072CP, LF353)	I-312
U346-U348	MC14051B	I-211

U349-U354	TL082CP (TL072CP, LF353)	I-312
U355	MM74C906N	I-231
U356, U357	MC14174B	I-228
U358	LM741CN	I-305
U359-U363	MC14174B	I-228
U364	SSM2020	I-308
U365	MC1458P	I-303
U366	MM5837N	I-315
U367	LM348N	I-313
U368, U369	LF13202N	I-314
U370	TL082CP (TL072CP, LF353)	I-312
U371	SSM2030	I-309
U372	LM348N	I-313
U373	SSM2020	I-308
U374, U375	MC14066B	I-233
U376, U377	LM348N	I-313
U378	TL082CP (TL072CP, LF353)	I-312
U379	CA3080E	I-306
U380	TL082CP (TL072CP, LF353)	I-312
U381	78M05	I-404
Y301	2.4576 MHz CRYSTAL	E-39
HARDWARE QTY.		
12	16-PIN SOCKET	J-7
1	40-PIN SOCKET	J-16
4	24-PIN SOCKET	J-17
1	CIRCUIT BOARD	M-64
2	¼" STANDOFF	M-112

PCB 4 ASSEMBLY Z-30

DESIG.	DESCRIPTION	MFG. PART NO.
C401, C402	.01uF, DISC	C-29
C403	100pF, DISC	C-4
C404	1000pF, POLY	C-27
C405	.001uF, MYLAR	C-8
C406	100pF, DISC	C-4
C407	.001uF, MYLAR	C-8
C408, C409	.1uF, 50V, CERAMIC	C-16
C410-C412	.001uF, MYLAR	C-8
C413	.1uF, 50V, CERAMIC	C-16
C414	.001uF, MYLAR	C-8
C415	1000pF, POLY	C-27
C416, C417	.001uF, MYLAR	C-8
C418, C419	.1uF, 50V, CERAMIC	C-16
C420	47uF, 16V, TANTALUM	C-32
C421-C438	.1uF, 50V, CERAMIC	C-16
C439	2.2uF, 25V, TANTALUM	C-21
C440, C441	.1uF, 50V, CERAMIC	C-16
C442	2.2uF, 25V, TANTALUM	C-21
C443	.22uF, 35V, TANTALUM	C-18
C444	2.2uF, 25V, TANTALUM	C-21
C445-C457	.1uF, 50V, CERAMIC	C-16
C458-C473	.01uF, POLY	C-11
C474-C477	.1uF, 50V, CERAMIC	C-16
D401, D402	1N914	D-5
J401	3-PIN JACK	J-28
P401	60-PIN HEADER	P-13
P402A	MOLEX PIN	P-16
P402B	MOLEX PIN	P-17
R401, R402	50K, TRIMMER	R-216
R403-R405	100K, TRIMMER	R-217
R406	10K, TRIMMER	R-210
R407	100K, TRIMMER	R-214
R408	5K, TRIMMER	R-215
R409	100K, TRIMMER	R-214
R410	5K, TRIMMER	R-215
R411	100K, TRIMMER	R-214
R412	5K, TRIMMER	R-211
R413	100K, TRIMMER	R-217
R414	5K, TRIMMER	R-211
R415	100K, TRIMMER	R-217
R416	10K, TRIMMER	R-218
R417-R419	100K, 1/4W, 1%	R-110
R420-R423	15K, 1/4W, 5%	R-14
R424-R426	100K, 1/4W, 1%	R-110
R427	15K, 1/4W, 5%	R-14
R428	2.2K, 1/4W, 5%	R-34
R429	75K, 1/4W, 5%	R-22
R430	15K, 1/4W, 5%	R-14
R431-V1, 2, 4	1.5K, 1/4W, 5%	R-9
R431-V3	4.7K, 1/4W, 5%	R-11
R431-V5	3.3K, 1/4W, 5%	R-36
R432	47K, 1/4W, 5%	R-18
R433	3.3K, 1/4W, 5%	R-36
R434	200K, 1/4W, 5%	R-26

Section 7

GLOSSARY

NOTE

This list covers abbreviations appearing on SCI documentation, except that integrated circuit devices are generally shown with the manufacturer's abbreviations. Refer to the device data sheet as required.

A	address bus
A	VCO A
A	Ampere
(A)	analog (for power or common)
ac	alternating current
ADC	analog-to-digital converter
ADSR	attack/decay/sustain/release (ENV GEN)
AH	address bus, high-voltage
AMP	FIN VCA
AMT	amount
ATK	attack
ATT	attenuation, attenuator
B	VCO B
B	bit number (ADC and DAC)
BANK	bank
BFR	buffer
BT	battery
C	capacitor
°C	Centigrade
CB	circuit breaker
CLK	clock
CLR	clear
CMP	compensation
CNT	count
CNTR	counter
COMP	computer
CONT	control
CONV	conversion, converter
CPR	comparison, comparator
CPU	central processor unit
CS	chip select
CTF	cutoff
CTR	center
CV	control voltage

D	data
D	diode
(D)	digital (for power or common)
DA	diode array
DAC	digital-to-analog converter
dB	decibel
DB, DBUS	data bus
DBH	data bus, high-voltage
DCOD	decoding, decoder
DI	data in
DIP	dual in-line plastic (package)
DIS	disable
DISCHG	discharge
DMUX	demultiplexing, demultiplexer
DO	data out
DN	data, non-volatile
DRVR	driver
DS	indicator (LED)
DX	switch matrix row
DY	switch matrix column
EDIT	edit
EN	enable
ENV	envelope
EQ	equalization, equalizer
EXT	external
F	Farad
F	fuse
°F	Fahrenheit
FDBK	feedback
FILT	filter
FIN	final
FINE	fine
FOA	(FACTORY USE ONLY)
FREQ	frequency
FTSW	footswitch
GATE	gate
GEN	generator
GLD	glide
Hz	Hertz
IN	input
INIT	initial
I/O	input/output
J	jack (female pins)
K	kilo-
KBD	keyboard
L	lower
LD	load
LED	light-emitting diode
LFO	low frequency oscillator
LFT	left
LIN	linear
LSB	least significant bit
LVL	level

m	milli-
M	mega-
MIX	mixer
MOD	modulation
MSB	most significant bit
MSUM	master summer
MTUN	master tune
MUX	multiplexing, multiplexer
n	nano-
N	non-inverting input
NC	no connection
NC	normally closed contact
NO	normally open contact
NSE	noise
NV	non-volatile (memory)
OFST	offset
OSC	oscillator (VCO)
OTA	operational transconductance amplifier
OUT	output
p	pico-
P	plus (male pins)
P-	poly (modulation)
PBND	pitch bend
PCB	printed circuit board
PED	pedal
PNK	pink
PNL	panel
POT	potentiometer
PRGM	program
PRGMR	programmer
Q	transistor
QA	transistor array
R	resistor
RA	resistor array
RAM	random-access memory
REC	record
REF	reference
REG	regulation, regulator
REL	release
RES	resonance
RGT	right
RIP	ripple clock
RS	reset
RST	restart
S	switch
S	analog switch signal
SEL	select
SEQ	sequencer
SRL	serial
S/H	sample and hold
SHT	sheet
SMR	summer
S/N	signal-to-noise ratio
S/N	serial number
SRC	source
STRB	strobe

SUS	sustain
SYM	symmetry
SYNC	synchronization, synchronizer
SYNTH	synthesizer
T	transformer
TB	terminal board
TC	time constant
THRS	threshold
TP	test point
TRI	triangle (Wave)
TRIG	trigger
TUN	tune
u	micro-
U	integrated circuit
U,	upper
UNI	unison
V	Volts
V(A)	V supply, analog circuit
V(D)	V supply, digital circuit
VCA	voltage-controlled amplifier
VCF	voltage-controlled filter
VCO	voltage-controlled oscillator
VDAC	DAC output voltage
VMUX	POT MUX output voltage
V/OCT	volts-per-octave
VOL	volume
W	wiring or cable
W-	wheel (MOD)
WHT	white
Y	crystal