

MODEL 800

**SEQUENCER
OPERATIONS
MANUAL**

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MODEL 800 DIGITAL SEQUENCER
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TABLE OF CONTENTS

INTRODUCTION	1
INTERFACE	1
BACK PANEL FUNCTIONS	2
TRIGGER IN Socket	2
VOLTAGE IN Socket	2
VOLTAGE OUT Socket	2
STOP Switch	3
FUSE	3
FRONT PANEL CONTROLS	3
MEMORY BANK SELECTOR Switches	3
POSITION Indicator	4
START RECORD Button	4
OVERFLOW Light	5
STOP RECORD Button	5
ONE-ALL Switch	5
CLOCK SPEED Control	5
DOUBLE-NORMAL-HALF Switch	5
CLOCK ON-OFF Switch	6
RESET Switch	6
STEP Switch	6
SINGLE VOLTAGE RECORD Switch	6
VOLTAGE RECORD ENABLE-DISABLE Switch	6
BASIC OPERATION	7
USING THE FOOT PEDAL	7
RECORDING AND PLAYING BACK SEVERAL SEQUENCES	7
RECORDING	7
PLAYBACK	8
SEQUENCE EDITING	8
OPERATING WITH AN EXTERNAL CLOCK	8
EXTERNAL CLOCK USAGE	9
TROUBLESHOOTING	11
MINI-MOOG	14
Mini-Moog Modifications	14
Mini-Moog Setup	14
MICRO-MOOG	15
ODYSSEY or AXXE	15
CAT	16

TABLES AND FIGURES

Table 1. Sequencer/Synthesizer Interface	12
Table 2. Sequencer/Synthesizer Control Position	12
Figure 1.	13
Figure 2.	13

MODEL 800 DIGITAL SEQUENCER OPERATIONS MANUAL

INTRODUCTION

The Model 800 Digital Sequencer is a device for recording control voltage and timing information from a synthesizer keyboard and for replaying this information to control various synthesizer parameters (usually pitch and envelope gating). The 800 therefore "stands between" the keyboard and the synthesizer (Figure 1). In record mode the 800 stores in digital memory the length of time between incoming trigger pulses as well as the input control voltage at the time of each incoming trigger pulse (Figure 2). In both record and playback mode the 800 measures time by counting pulses from an internal clock-oscillator whose frequency (speed) is continuously variable from 15 to 4500 Hertz. Sequences may therefore be recorded at one speed and played back at another without altering the control voltage information stored in the 800's voltage memory.

The 800's memory is divided into 16 banks, each capable of storing up to 16 notes. Each bank may be activated or deactivated in either record or playback mode by means of front panel switches. Activated banks will play consecutively in left to right order so that either several separate sequences (up to 16 sequences of 16 or fewer notes each) or one continuous sequence of up to 256 notes may be stored.

The 800 offers several useful editing features. Individual control voltage values may be changed by means of front panel SINGLE VOLTAGE RECORD switch. The timing of an entire sequence may be changed while retaining all control voltage values by means of the front panel VOLTAGE RECORD ENABLE DISABLE switch. Finally, the control voltage sequence may be stepped through manually by means of the front panel STEP switch.

Other features of the 800 not commonly found on digital sequencers include provision for use of an external oscillator for the sequencer clock in either record or playback mode, the ability to cascade (in parallel) several 800's in order to record multi-voice sequences in real counterpoint.

INTERFACE

Four connections are required to interface the Model 800 with a synthesizer. These connections are made through rear panel standard ¼" phone jacks labeled: TRIGGER IN, VOLTAGE IN, TRIGGER OUT and VOLTAGE OUT. The TRIGGER IN and VOLTAGE IN connections come from the synthesizer keyboard while the TRIGGER OUT and VOLTAGE OUT connections go to synthesizer modules (typically the envelope generator gate inputs and voltage controlled oscillator control voltage inputs respectively). The TRIGGER IN, TRIGGER OUT and VOLTAGE OUT jacks are accompanied by switches for choosing among various synthesizer configurations. Table 1 gives the necessary interface information for several commonly found synthesizers.

- Note 3. When a bank has not been programmed there is only random information stored in it. Because of the wide timing range of the 800, unprogrammed banks may seem to "hang up" the machine. Actually, there is probably just a very long note and/or a high output voltage being played back. With a 5 octave range, the note being played back could be above the audio range.
- Note 4. Since the 800 is fully solid state, the sequences stored in memory will be erased whenever power is turned off or disconnected, so be careful not to pull the plug out accidentally or you will lose all of your stored sequences. If you seem to lose stored sequences occasionally without losing power, it could be the result of bad AC line power, which could cause enough of a power loss to erase the memory.
- Note 5. You should always have at least one bank selected. If none are selected, the 800 will skip around randomly selecting notes from any and all of the banks.
- Note 6. If you deselect a bank while it is playing back a sequence, it will jump to the next selected bank to the right as usual, but it will *not* reset the POSITION to 0. This means that it will jump into the middle of the next sequence somewhere according to the current POSITION. If, however, the next sequence is shorter, you may end up past its stored sequence into an unprogrammed position of the bank, and the sequencer could hang up (see note 3 above). For example, if in bank 1 you have a 13 note sequence, and in bank 2 you have a 5 note sequence, if you turn off bank 1 while it is at POSITION 9, the 800 will jump to bank 2, POSITION 9. However, only 5 notes are stored in bank 2, so POSITION 9 may not be defined.
- Note 7. The usual method of changing sequences during playback is as follows:
- Select the second sequence bank(s) while the first sequence is still playing.
 - When the first sequence is done, it will automatically skip to the second sequence and start playing it back.
 - After it starts on the second sequence, go back and deselect the first sequence bank(s).
 - From now on, only the second sequence will play back.

POSITION Indicator

The digital readout in the bottom-center portion of the front panel indicates which position (i.e., note) within the current bank is in use. The 16 available positions are numbered 0 through 15.

START RECORD Button

Pressing the green START RECORD button puts the 800 in record mode and selects position 0 of the leftmost active bank. The 800 will then begin recording when an incoming trigger pulse is received. (Therefore pressing the START RECORD button need not coincide in timing with the beginning of the sequence to be recorded, i.e., the 800 will wait for the first note.) The red LED to the right of the START RECORD button indicates when the 800 is in record mode.

OVERFLOW Light

The OVERFLOW light is active only in record mode. This light indicates that the lapsed time between incoming trigger pulses (i.e., the note duration) has exceeded the 800's memory capacity. If the OVERFLOW light comes on during recording, the entire sequence should be re-recorded at a slower clock speed (see SPEED CONTROL).

STOP RECORD Button

Pressing the red STOP RECORD button when the 800 is in record mode instantly switches the 800 to playback mode. (Pressing this button during playback has no effect.) Pressing the STOP RECORD button also causes the timing of the current note to be recorded as well as a STOP CODE which when encountered during playback causes the 800 to skip in position 0 of the next active bank to the right or the left most active bank depending on the position of the ONE-ALL switch (see ONE-ALL switch). Finally, pressing the STOP RECORD button will cause the 800 to immediately begin playing back starting with position 0 of the next active bank to the right or of the leftmost active bank depending on the position of the ONE-ALL switch (see ONE-ALL switch).

ONE-ALL Switch

The ONE-ALL switch is only effective during playback. In the ONE position (up) it will cause the 800 to cycle to position 0 of the leftmost active bank when a stop code is encountered. Therefore in the ONE position the 800 will playback only the leftmost recorded sequence. In the ALL position (down) it will cause the 800 to cycle to position 0 of the next active bank to the right when a stop code is encountered. Therefore in the ALL position the 800 will playback all recorded sequences in left to right order.

CLOCK SPEED Control

The Model 800 measures time by counting the pulses of its internal clock-oscillator. The SPEED control varies the frequency of this oscillator between approximately 15 and 4500 Hertz. Increased timing accuracy is achieved at higher clock speeds while increased maximum note duration is achieved at lower clock speeds. The 12 o'clock setting of this control together with the NORMAL position of the DOUBLE-NORMAL-HALF switch provides a good compromise setting, giving a timing accuracy of approximately .3% and a maximum note length of approximately 15 seconds.

DOUBLE-NORMAL-HALF Switch

Moving this switch down one position exactly halves the clock speed while moving it up one position exactly doubles the clock speed.

CLOCK ON-OFF Switch

In the OFF (down) position this switch prevents the Model 800 from counting clock pulses. (This switch is effective relative to either the internal or an external clock [see "Operation With An External Clock"]). In record mode with the clock off, the 800 will record 1 pulse per note. (A sequence so recorded will play back at an unuseably high speed even at the slowest internal clock speed of 15 Hertz.) In playback mode the clock ON-OFF switch provides the means for starting and stopping sequence playback.

Note 1. The 800 does not automatically reset to the beginning of a sequence when the clock is turned on or off. Rather the RESET switch provides the means for sequence synchronization during playback (see RESET switch).

Note 2. The RESET, STEP and SINGLE VOLTAGE RECORD switches are momentary switches and will automatically return to the down position when released.

RESET Switch

The RESET switch is useful in playback mode only. When moved to the up position it causes the 800 to RESET to position 0 of the leftmost active bank and to return to clock count 0. Simultaneously turn the clock on and resetting the 800 provides the means for precise synchronization of sequence playback.

STEP Switch

The STEP switch is only useful in playback mode with the clock off. In this mode each time the STEP switch is moved to the up position the 800 will advance one position.

SINGLE VOLTAGE RECORD Switch

The SINGLE VOLTAGE RECORD switch is only useful in playback mode. In this mode moving the switch to the up position will cause the 800 to record whatever voltage is present at its voltage input jack in the present memory location. It therefore provides the means for editing previously recorded control voltage information.

NOTE: The SINGLE VOLTAGE RECORD switch should not be used to change the last note in a sequence as it will cause the stop code to be erased.

VOLTAGE RECORD ENABLE-DISABLE Switch

This switch is effective in record mode only. With this switch in the DISABLE (down) position the 800 will record timing information only. This provides the means for rhythm editing of a previously recorded control voltage sequence.

NOTE: Recording in the DISABLE position preserves the previously recorded stop code.

BASIC OPERATION

FOLLOWING THE STEPS BELOW WILL FACILITATE YOUR USE OF THE MODEL 800.

1. Interface the 800 to your synthesizer as per Table 1.
2. Turn the 800 on by means of the locking rear panel switch by first pulling out then moving the switch to the up position.
3. Check that the rear panel INTERNAL-EXTERNAL STOP switch is in the INTERNAL (up) position.
4. Disconnect the foot pedal (to simplify operation at first).
5. Set the synthesizer and 800 front panel controls as per Table 2.
6. Press the START RECORD button.
7. Record the desired sequence by playing it on the synthesizer keyboard. (NOTE: If a mistake is made simply press the START RECORD button again to start over.)
8. Press the STOP RECORD button remembering that the timing of the last note of the sequence is determined in this way.

The recorded sequence should now play back repeatedly exactly as recorded until the clock is turned off. (If this is not the case check the "Trouble Shooting" section, page 11, for possible setting errors.)

USING THE FOOT PEDAL

The foot pedal is connected to the 800 via the 3-connector jack in the lower lefthand corner of the rear panel. The foot pedal contains 3 pushbutton type switches which duplicate the front panel START RECORD, STOP RECORD and CLOCK ON-OFF switches. With the foot pedal connected, either the foot pedal or the front panel START and STOP RECORD switches may be used. BOTH THE FOOT PEDAL AND THE FRONT PANEL CLOCK SWITCHES MUST BE ON IN ORDER FOR THE CLOCK TO BE RECORDED. The red LED above the front panel CLOCK ON-OFF switch indicates when the clock is on.

RECORDING AND PLAYING BACK SEVERAL SEQUENCES

Following the steps below will facilitate your use of the 800 to record and playback several sequences successively.

RECORDING:

9. Follow steps 1-8 above to record the first sequence.
10. De-activate those banks used in recording the first sequence by moving their bank selector switches to the down position. (NOTE: The last bank used must be de-activated even if only partially filled.)
11. Repeat steps 6-8 above.
12. Repeat steps 10 and 11 until all desired sequences are recorded or until all banks are used.

PLAYBACK:

To playback one of the sequences just recorded, first de-activate all banks to the left of the first bank of the desired sequence then place the ONE-ALL switch in the ONE (up) position and turn the clock on. (NOTE: The beginning of playback can be synchronized by simultaneously turning the clock on and moving the reset switch to the up position.)

To obtain a smmmmoooth transition from one sequence to the next during playback, move the ONE-ALL switch to the ALL position during playback of the first sequence then during the *FIRST* playback of the second sequence return the ONE-ALL switch to the ONE position and de-activate all banks used in the first sequence.

To return to a previous sequence simply activate the banks used in that sequence.

SEQUENCE EDITING

To change the control voltage (e.g., pitch) of a single note in a sequence, turn the clock off at a convenient position to the left of the position to be changed; then use the STEP switch to move to the desired position. Next touch the key on the synthesizer keyboard corresponding to the desired new control voltage (pitch) and move the SINGLE VOLTAGE RECORD switch momentarily to the up position. (NOTE: The last note of a sequence cannot be changed in this way without erasing the stop code for the sequence.)

To re-record the time values for all notes in a sequence move the VOLTAGE RECORD ENABLE-DISABLE to the DISABLE (down) position, turn the clock on and press the START RECORD button. The note durations now played on the synthesizer keyboard will be recorded without changing the control voltage or stop code information.

OPERATING WITH AN EXTERNAL CLOCK

One of the most powerful features of the 800 is the ability to use an external source as the clock during either record or playback. Possible sources of external clocking include tape recorded "click tracks", a synthesizer VCO, a synthesizer LFO or synthesizer keyboard triggers.

An external clock is connected to the 800 via the 4-conductor "cinch jack" in the upper left corner of the rear panel using the Sequential Circuits Model 824 connector cable. When this cable is connected to the Model 800, the internal clock is automatically disconnected. When using an external clock, the 800 front panel SPEED control and DOUBLE-NORMAL-HALF switch are inactive but the clock on-off switch remains active.

Almost any relatively clean signal will serve as an external clock since the external clock input is "read" by a comparator and interpreted relative to the threshold (0 to 5 volts) set via the rear panel control to the right of the external clock input jack. Waveforms with multiple peaks can usually be handled by careful setting of the threshold control.

EXTERNAL CLOCK USAGE

For normal recording, the clock should be running at a frequency of about 200 Hz for normal accuracy and note length as described above. By using a VCO to clock the sequencer, it enables the speed of the sequence to be voltage controlled, which opens up many modulation and control possibilities. NOTE: The clock is divided to provide the actual note length of the sequence playing back when used in the normal manner as shown in Figure 2.

However, if you record with the clock ON/OFF switch off, each note will have only one count stored for timing. After hitting the STOP pushbutton, the sequence will not play back, since the clock is off. Turning the clock on will cause the sequence to play back with each and every note playing for exactly one clock time. The normal internal clock's slowest frequency is around 10-20 Hz, so that is the minimum sequence speed. With an external clock however, an LFO (low frequency oscillator) could be used to provide evenly timed note sequences with variable and controllable speeds, with note lengths limited only by the LFO's frequency range.

The other possibility is to use a regular VCO to drive the 800 into the audio range, which enables it to be used as a waveform generator. If the clock is voltage controlled, this waveform could be played just like any other oscillator. Note that the waveform frequency of the sequencer will be equal to the clock frequency divided by the number of segments in the sequence. For example, a two note sequence of one low note and one high note, recorded with the clock off, and played back with an external clock speed of 2000 Hz, will provide a square wave signal at 1000 Hz. ($2000 \text{ Hz} / 2 \text{ segments} = 1000 \text{ Hz}$).

The external clock also makes it possible to program sequences which have exact timing and as such are invaluable for use in recording studios, especially when used in conjunction with click-tracks. In this manner it is possible to synchronize the sequencer perfectly with other recorded tracks.

To record on the sequencer in this method, the keyboard trigger and voltage out should be connected to the trigger in and voltage in sockets as usual. The external clock input should be connected to another trigger source. A second keyboard's trigger output usually works the best for this, but any source can be used. Remember to adjust the LEVEL pot for this external clock. The CLOCK ON/OFF switch should be ON. Hit the RECORD button when ready, and the sequencer is now waiting for the first note. Hit the first note in the sequence on the first keyboard (the one connected to the TRIGGER IN/VOLTAGE IN). The sequencer records the voltage, and starts counting for the note length. However, since the external clock is being used, the amount that it counts is determined by the external clock pulses. If the external clock is connected to a second keyboard, then every time any key is hit, the 800 counts once. You give it as many counts as that note requires, and when done, go back to the first keyboard and hit the second note in the sequence. You then give the external clock as many pulses as that note requires. This is continued until the entire sequence is programmed. The STOP RECORD is hit after entering the count pulses for the last note.

The way to determine how many count pulses to give each note depends on the timing desired for the sequence. The usual way to compute pulses is to determine the shortest note value required in the sequence, and use it as the base count.

For example, suppose a sequence requires half notes, quarter notes, and eighth notes. The eighth note is the shortest note used, so we can assign a base count - 1 for an eighth note. In this case, a quarter note will require 2 counts, and a half note will need four counts. Hence, any time a half note is required in a sequence, four counts are required.

NOTE: On each new note in a sequence, the internal timing counters start at one count, not zero. Hence, if 4 counts are desired, only 3 external pulses are required. If only one count was needed, then no external pulses are required. (This is also the reason recording with the clock off as described earlier gives one count per location.)

If the shortest note was still an eighth note in a particular sequence, but you need a note of 3/16 duration, then a sixteenth note is required for the base count. An eighth note would then be two counts, a 3/16 note would be three counts, a quarter note 4 counts, etc. (remember to subtract tone while programming count pulses.)

For playback, the external clock should be connected to a timing source; an LFO, a click track, etc. The LEVEL pot will have to be adjusted for this source. The sequencer will use these to count down each note to determine its length. Remember that the internal clock only goes as slow as around 10 Hz, so that if these sequences are to be played back using the internal clock, many more counts per location will be required to enable a slower playing of the sequence. (i.e., 20 counts per location with a 20 Hz clock would give new notes every second.) This is why an external clock is easier for this application.

TROUBLE SHOOTING

Symptom	Possible Error
Sequence does not playback when STOP RECORD button is pressed.	Clock is off.
Sequencer does not record when START RECORD button is pressed.	Faulty interface or rear panel INTERNAL-EXTERNAL stop switch is down.
Sequencer records rhythms but not control voltages.	SINGLE VOLTAGE RECORD switch is down.
During recording the synthesizer does not follow the keyboard.	Rear panel VOLTAGE OUTPUT switch is down.
During recording the synthesizer plays back stretched intervals.	Rear panel VOLTAGE OUTPUT switch is up.
Sequencer records wrong pitches.	Synthesizer keyboard portamento is on.
Pressing STOP RECORD button causes playback of wrong sequence.	ONE-ALL switch is in ALL (down) position.
Synthesizer envelopes are not properly triggered.	TRIGGER OUTPUT switch in wrong position.
Synthesizer sounds a tone continuously.	Synthesizer envelope sustain not set at 0 level.
Some notes are missed (not recorded).	Synthesizer keyboard provides only gates (Moogs, CATS, etc.). Be sure to lift your finger completely off a key before hitting the following key.

Table 1. Sequencer/Synthesizer Interface

	Trigger In	Switch	Voltage In	Trigger Out	Switch	Voltage Out	Switch
Mini-Moog	Decay pedal jack (3/16") Cord #829	1	CV Out (must be added)	Input External S-Trigger Cord #825	3	Oscillator	2
Micro-Moog	S-Trigger out Cord #826	2	Keyboard out	S-Trigger In Cord #825	3	Oscillator	2
ARP 2600	Keyboard Trigger	1	Keyboard CV	S/H Gate Switch down	2	Oscillator Key- board CV Inputs	1
ARP Odyssey	Trigger Out	1	CV Out	Gate In	2	CV In Unplug Voltage Out to record	1
ARP AXXE	Trigger Out	1	CV Out	Gate In	2	CV In	1
Oberheim 2 and 4 voice	Gate Out	1	CV Out	Gate In	1	CV In	1
Modular Systems (Moog, Eu, Aries, Roland, Arp, etc.)	Keyboard Trigger Out	1	Keyboard CV Out	ADSR Gate In	1, 2 or 3	Oscillator CV	1
Prophet 5 and Prophet 10	Trigger Out	1	Voltage Out	Gate In	2	Voltage In	1

Table 2. Sequencer/Synthesizer Control Position

MODEL 800	
Control	Position
Bank Selector Switches One-All Switch Voltage Record Enable-Disable Clock On-Off Switch Double-Normal-Half Switch Speed Knob	Up (Active) Up (One) Up (Enable) Up (On) Center (Normal) 12 O'clock
SYNTHESIZER	
Control	Position
Keyboard Portamento Envelope Sustain Level Envelope Attack Envelope Release (final decay)	OFF Zero Short (at first) Short

Figure 1

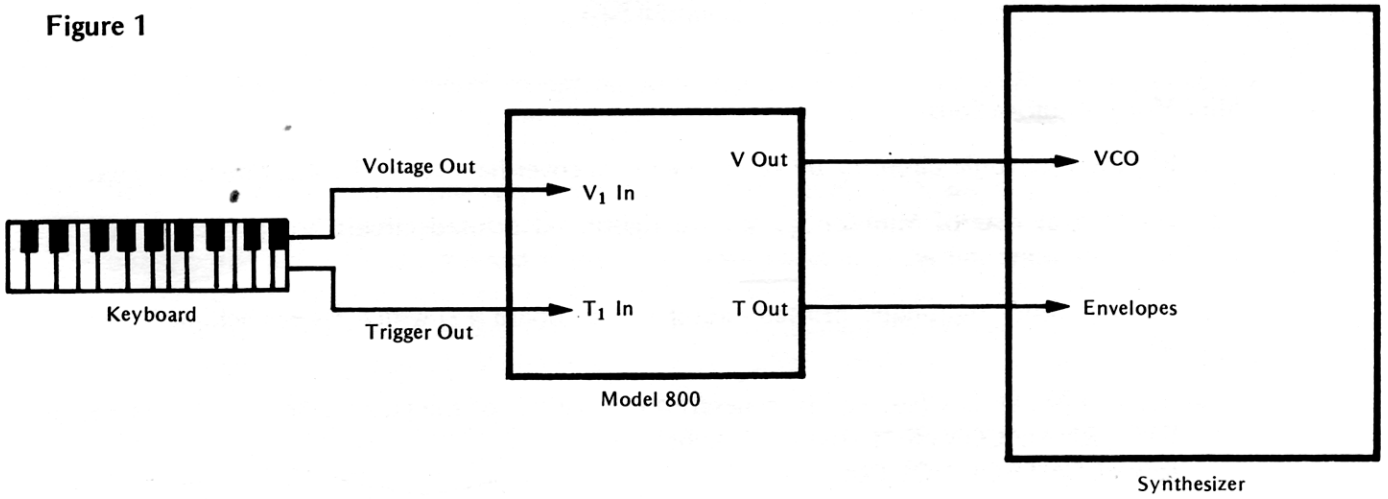
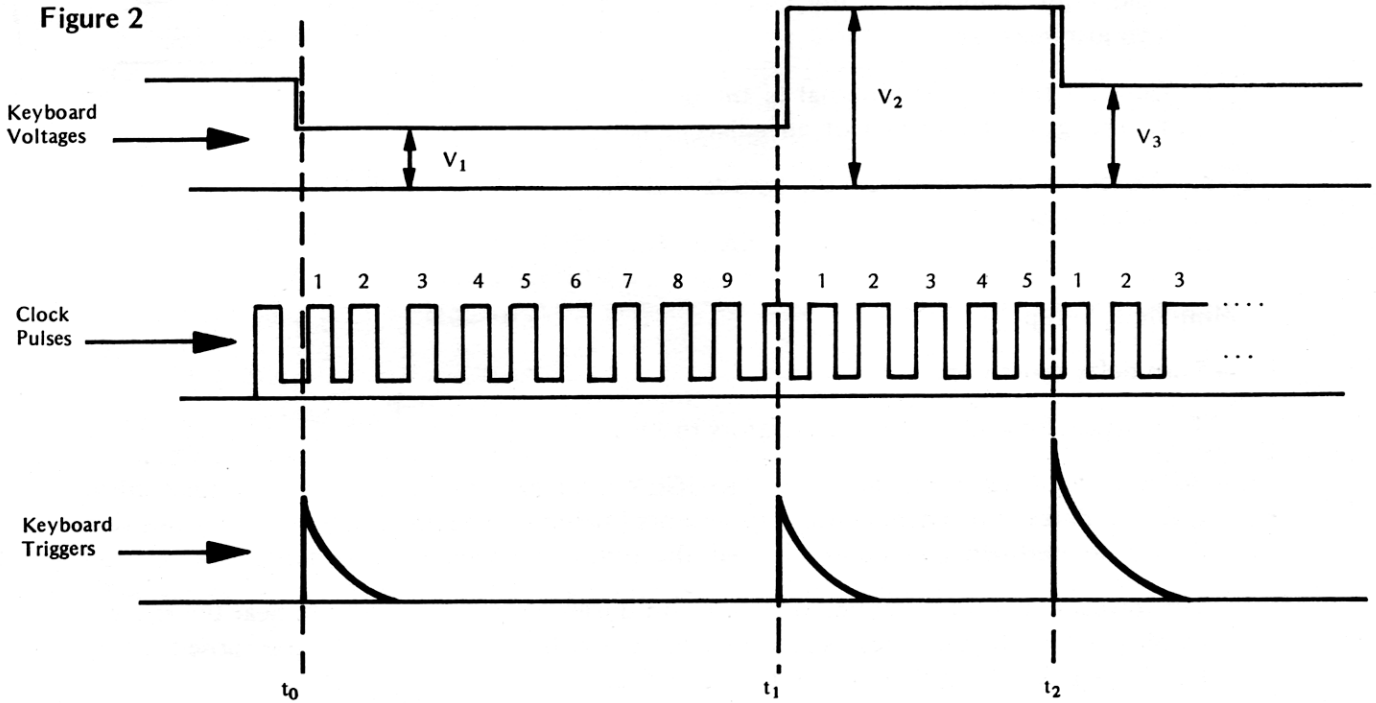


Figure 2

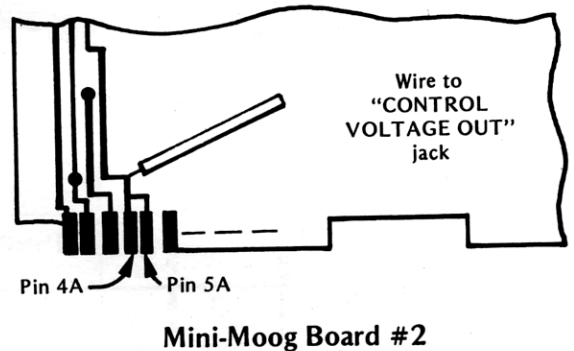


Time	Recorded Information
t_0	V_1 Begin Sequence
t_1	V_2 9 pulse count for V_1
t_2	V_3 5 pulse count for V_2

MINI-MOOG

Mini-Moog Modifications

1. Expose electronic circuitry by removing metal cover held on by 18 sheet metal screws.
2. Looking at rear of Mini-Moog, remove right-hand printed circuit board (Board #1). Set aside temporarily.
3. Remove other right-hand printed circuit board (Board #2) which resides behind Board #1.
4. Install a phone jack (such as Switchcraft #12) just left of the jack labeled "LOUDNESS EXTERNAL CONTROL INPUT". Label this jack "CONTROL VOLTAGE OUT".
5. On Board #2, solder a 14 inch wire to the etching point shown in the Figure.
6. Solder the other end of this wire to the jack you just installed.
7. Connect the ground terminal of the new jack to the ground terminal of an adjacent jack.
8. Replace both printed circuit boards and the metal cover.



Mini-Moog Setup

- Turn delay switch on.
- Turn attack on both contour generators to zero.
- After a sequence is playing back, TRIGGER OUT switch position 1 can be selected to give complete control over contour generators (including attack). When recording, position 3 must be used. When position 3 is used, the attack pots must be turned off.
- The lowest note on the keyboard must be hit during playback in order to hear the sequence playback in the same key as recorded. Note that the sequence can be transposed to any key by simply hitting that key on the keyboard.
- Since a switch trigger is really a gate, while recording make sure that you completely release the previous key in a sequence before hitting the next key. Otherwise, the sequencer cannot "see" the second note, since the synthesizer does not put out a separate gate.

MICRO-MOOG

The following applies to *later model Micro-Moogs* (with keyboard scale pot included on back panel):

Before connecting the sequencer, place the micro in drone mode, and connect a patch cord from the keyboard voltage out to the oscillator control voltage in. Play octaves on the keyboard while adjusting the keyboard scale pot, until exact octaves are heard. This calibrates the keyboard for sequencer use. Now connect the sequencer as shown in Table 1. Note that in order to record on the sequencer, the S-trigger in cable on the Micro must be disconnected. Reconnect for playback of the sequencer. An SPDT switch can be wired into the Micro to make and break this connection by flipping the switch rather than disconnecting the cable. Also, as with a Mini-Moog, the lowest note on the keyboard must be hit in order to play back the sequence in the key recorded. This may also be wired into the switch if desired.

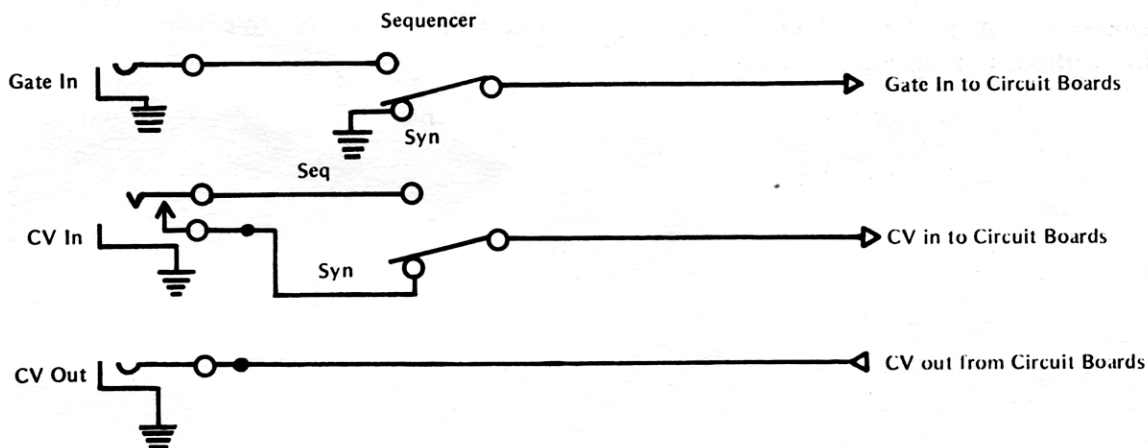
Earlier Model Micros:

On these models, a pot must be added to the oscillator Control Voltage In in order to calibrate the oscillators for the sequencer. A 20K trimmer (10 turn) pot can be used in series with the Control Voltage In to make this calibration. Follow the tuning instructions for later Micro-Moogs, only turn the added trimmer pot rather than the keyboard scale pot.

ODYSSEY or AXXE

To use the 800 with a standard ARP Odyssey or Axxe, make the patches according to Table 1.

In order to record on the 800 or to play the Odyssey or Axxe keyboard normally, the CV In and Gate In connections on the Odyssey or Axxe *must* be removed. Then, to play back the 800, the cables are plugged back in. With a minor modification, a DPDT switch may be wired into the synthesizer to perform this switching function, so that a simple flip of a switch is all that is needed to select between the sequencer or the synthesizer keyboard. The schematic for this modification is as follows:



The switch is shown in the synthesizer keyboard position, which is also the position for *recording* on the 800. The other position is for *playback* of the 800 or for using any other external control devices. Some Odyssey or Axxe synthesizers will give out multiple triggers occasionally on certain notes. This is observed by hitting a hole one time on the keyboard during recording and seeing the 800 Position display count more than once. It can also be heard on playback as quick multiple notes where only one was played. Cleaning the keyboard contacts and/or adjusting your playing style will usually cure this problem.

For newer Models:

If it continues to do this, there is another solution. Rather than using the Trigger Out of the synthesizer, use the Gate Out. When recording, this means that you must completely lift your finger off the previous key prior to hitting the next key to get discrete gate signals. Otherwise, the 800 will not see the second note. This usually requires a slight variation in your playing style. Also, since the Gate Out of the synthesizer is not debounced it is necessary to add the "debouncing capacitor" in the Model 800. A .02 μ farad capacitor in the position shown on the circuit board diagram will perform this function. To install the capacitor, remove the 3 screws on the top cover, and remove the cover. Locate the 2 capacitor lead holes on the circuit board. Trim the capacitor leads to approximately $\frac{1}{2}$ ", insert the two leads into the two holes, and solder them from the top. Reinstall the cover with the 3 screws. When this capacitor is installed, however, the 800 will no longer be able to recognize a trigger signal from the synthesizer since it is too quick for the debouncing circuit. Hence, you have the choice of which way to go, Gate Out or Trigger Out, for your particular application.

CAT

The CAT synthesizer requires the use of two stereo cables, each split to two mono cables. One stereo side is plugged into the "TO SLAVE" jack on the CAT. The mono cable connected to the tip of the stereo jack goes to the Trigger In (switch position 1) on the sequencer, and the band connected cable goes to the Voltage In. The stereo end of the other cable is plugged into the "FROM MASTER" jack on the CAT. The tip's mono plug is connected to the Trigger Out of the sequencer (switch position 1), and the band cable is connected to the Voltage Out jack (switch position 1).

In order to record, the "FROM MASTER" cable must be removed. For playback, simply reinsert that plug. A DPDT switch can be wired internally to the CAT to perform this function without unplugging the cable.

