INSTRUCTION MANUAL

the CAT electronic music synthesizer

OCTAVE Electronics Inc.
32-13 STEINWAY STREET
LONG ISLAND CITY, N. Y. 11103

We at OCTAVE would like to extend our personal thanks to Leo Silvan, Ernie Moss, Jerry Weiss, Woody Comstock and Bernie Hutchins.

Above all, we would like to extend a special thanks to DAVE FREDERICKS, who supplied many of the patches in this book and whose personal help was fundamental to the successful final outcome of the CAT.

OCTAVE ELECTRONICS, INC.

Carmine J Bonanno
Vice-President

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PATCH CHARTS

INTRODUCTION

The synthesizer is a tool for manipulating the three basic parameters of sound - pitch, timbre and loudness. It conveniently places these parameters on a panel in the form of electronic devices such as oscillators, filters, transient generators and amplifiers, which are controlled by turning knobs, flipping switches, pushing sliders, playing keyboards, pressing buttons and moving pedals. When you acheive a thorough understanding of how these devices operate and relate to each other in the synthesizer system, you will be able to gain full potential from your synthesizer.

The fact that a synthesizer allows sounds to be manipulated does not imply that any sound can be simulated exactly - many sounds can't. The reason for this is that although sound manipulation is possible, it is simplified to the extent that a very complex sound, like a human voice for instance, cannot be adequately simulated.

On the other hand, some sounds are simple enough to imitate so exactly that it often becomes difficult to distinguish the real from the synthetic. For example, a flute, a guitar, bass guitar, tuba, and many other instruments can be very effectively simulated with the manipulation techniques of today's synthesizers.

Although the synthesizer possesses a phenomenal ability to imitate many conventional sounds, its greatest potential lies in its ability to create unconventional sounds which often cannot be obtained by any other means. For example it can be set to imitate the sound of a tuba and then can be changed to better suit a particular application. The point is that the sound is in <u>your</u> control and can be tapered to suit <u>your</u> needs - this being a quality that no other instrument can offer.

The creative possibilities of the synthesizer are almost infinite-limited only by your knowledge of the device and its complexity. Taking the time to fully understand the purpose of every control on the panel will allow the greatest degree of versatility to be obtained from the instrument, as well as prevent much frustration during the creative process.

The synthesizer, like any other tool, can only do its job when used properly and intelligently.

EFFECTIVELY USING A SYNTHESIZER

To effectively realize the full potential of a synthesizer it is important to use it in conjunction with an amplification system that has a frequency response wide enough to accurately reproduce its timbral range. For example, Bass amplifiers are fine for reproducing a synthesized bass guitar, but terrible for most other sounds. The reason for this is that bass amplifiers are usually not made to reproduce high frequency sounds, thus the synthesizer will tend to sound dull.

The best type of amplification system to use for synthesizer reproduction is one that utilizes both horns and bass speakers so that both the high and low range sounds can be reproduced. Of course, if such a system is not readily available, you should use whatever is handy; but keep in mind that the sounds you create on the synthesizer will greatly depend on the quality of your amplification system.

When external sound modifiers such as phase shifters, distortion units, equalizers, etc. are used with the synthesizer as additional tools in the sound manipulation process, they should be applied diligently. For example, don't synthesize the sound of a French Horn and then play it through a rotating speaker and wonder why it doesn't sound like a French Horn. On the other hand, if you synthesize an organ sound, the rotating speaker would greatly enhance it. The point to remember when using external devices is that they too must be understood, just as you should understand your synthesizer. Know when to use them and why.

The use of reverberation should not be overlooked. Often, the use of a little reverberation on a synthesized sound makes the difference between a convincing and nonconvincing simulation. For example strings simulation sounds much more realistic when played through a reverberation device since it adds a spaciousness to the sound that aids the chorus effect necessary to effectively simulate a string ensemble. However, reverberation, as any other external modifier, should be used intelligently in order to be effective. Before automatically adding reverberation to all of your sounds consider the particular application.

The final important point worth mentioning is that a synthesizer is often played with two hands - one on the keyboard and one on the control panel. This enables you to add dynamics while playing the instrument so that the synthesized sounds are more interesting. For instance, using the pitch bend on a guitar simulation or adding vibrato only during certain passages of a violin simulation, helps add a feeling of realism to the instrument. Likewise, adding glide only when needed or sweeping the filter with an external foot pedal, adds dynamics to a synthesizer passage. The synthesizer is one of the few electronic instruments that allow this dynamic variation and it should not be overlooked. Try to think along these lines and your playing technique will develop an expression that will greatly enhance the synthesized sounds.

SYNTHESIZER BASICS:

Because of the brevity of this manual, it is impossible to present an in-depth discussion of how synthesizers operate - however, it is practical and necessary to at least breifly explain some main principles. There are several excellent books available which discuss electronic music and synthesizers in a simple enough manner so that beginners can grasp the important principles needed to effectively use and understand synthesizers. Thus, if further explanations seem necessary, you are urged to refer to these sources.

SYNTHESIZER COMPONENTS:

A) OSCILLATORS: The oscillators perform two functions in a synthesizer; The main one being to generate continuous waves whose frequency corresponds to the pitch of the instrument. Two oscillators can be tuned in many different ways so that harmonies or choruses can be obtained.

The second purpose of an oscillator is to supply the basic raw timbre of the sound, known as the waveshape. The waveshapes are illustrated by the figures located underneath the audio level sliders on the CAT oscillators. The first oscillator produces a pulse wave (⊥⊥), triangle wave (/\/), sawtooth wave (/|/|), and a sub-octave square wave. The second oscillator produces a sawtooth wave (/|/|), square wave (⊓⊔), and sub-octave square wave. Note that each one of these waves has its own charactaristic sound. It is this raw sound that the synthesizer modifies to produce its final output.

Since the oscillators are a source of sound, they are logically referred to as SOUND SOURCES.

B) NOISE SOURCE: Noise is a non-pitched sound source useful for simulating trains, thunder, cymbals and other such non-pitched sounds.

C) FILTER: The filter is that part of the synthesizer which shapes the timbre of the sound sources. Most synthesizers, including the CAT, provide a LOW-PASS FILTER. This means that any overtones that lie below the cutoff frequency setting (the F_c slider controls the cutoff frequency) of the filter will pass through, while all overtones above the cutoff frequency will be diminished. Thus, by "cutting off" the upper overtones of the oscillator waveshapes, the filter allows the "mellowness" of the raw oscillator sound to be controlled.

The resonance, or "Q", of the filter allows overtones that lie in the vicinity of the cutoff frequency to be emphasized, thus producing a charactaristic "waaoow" type of timbre.

Since the filter modifies the timbre of the oscillator waveshapes, it is referred to as a SOUND MODIFIER.

D) AMPLIFIER: The last link in the synthesizer chain is the Voltage-Controlled Amplifier, or simply, VCA. This device electronically varies the loudness of the sound that comes out of the filter. Since this too is a modification of the sound, the VCA is also referred to as a SOUND MODIFIER.

E) KEYBOARD: The keyboard tells the synthesizer what you want it to do. When a key is hit, the keyboard tells the oscillators what note to play and also tells the transient generators when to produce a transient.
Since the keyboard allows control of the synthesizer, it is referred to as a CONTROLLER.

F) TRANSIENT GENERATORS: The transient generators produce a signal whose shape can be controlled by the settings of the panel sliders and whose duration depends on the length of time that a key is depressed. This transient signal is used to control different sections of the synthesizer, thus the transient generators are referred to as CONTROLLERS.

G) LOW FREQUENCY OSCILLATOR: The low frequency oscillator or LFO, produces waveshapes similar to the main oscillators, namely, square wave (⊓⊔) and triangle wave (/\/). The difference is that the LFO frequency is sub-audio — that is, it is not meant to be used as a sound source but rather as a CONTROLLER. For example, by patching the LFO triangle wave onto the oscillators, the frequency of the oscillators will change according to the shape and frequency of the LFO triangle wave, thus producing vibrato.

Other controllers such as pedals, footswitches, etc. also exist, however the main point to remember is that the synthesizer is divided into three main sections - SOUND SOURCES, SOUND MODIFIERS, and CONTROLLERS. These three sections interact with each other using the principle of Voltage Control to create the final sound.

VOLTAGE CONTROL:

Basically, the principle of voltage control means that specific synthesizer parameters can be varied in accordance with a control voltage. For instance, an oscillator can have its frequency varied by a voltage, thus it is referred to as a Voltage-Controlled Oscillator, or VCO. A filter can have its cutoff frequency controlled by a voltage, thus it is referred to as a Voltage-Controlled Filter, or VCF. Also, the synthesizer output amplifier can have its amplification varied by a voltage, thus it is referred to as a Voltage-Controlled Amplifier, or VCA.

The various synthesizer controllers produce voltages that can be used to control the sound sources and sound modifiers. The PATCH SYSTEM is the method by which these various sections are interconnected. Thus, if a transient is connected to the input of a VCO it is called "patching" the transient to the VCO. By setting various patches and changing the amount by which the controllers affect the sources and modifiers, different sounds can be created with the synthesizer.

PATCHING SYSTEM ON THE CAT SYNTHESIZER

The overall layout of the CAT synthesizer is based on the use of sliders, rotary pots and slide switches situated in such a way that many functions are visually obvious. The entire instrument has been engineered for functional simplicity. For example:

1) All of the white coded sliders control an audio signal level. (e.g.: if you turn up the white slider that is marked "noise" you will hear an audible noise signal)

2) All of the "transient generator" controls are coded grey so that their grouping is contrasted from other sliders.

3) All of the modulation attenuators are rotary controls to contrast with the sliders.

4) All of the rotary knobs have line indicators so that their position can be clearly seen from all angles.

5) All of the panel graphics are white against a black background for high contrast in less than optimal lighting conditions.

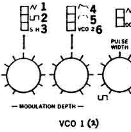
6) Wherever possible, symbols rather than words are used to indicate synthesizer functions in a simple visual manner.

7) The grouping of VCO, VCF and VCA modules is from left to right to visually correspond with the signal flow within the system.

The patching system used on the CAT is one of the most versatile and straight-forward systems in use to date. It is comprised of a system of slide switches that select the source of modulation, with rotary attenuators located directly below each switch to adjust the depth of modulation.

For example, to modulate VCO1 with the triangle wave output of the Low Frequency Oscillator (LFO), you simply switch the leftmost patch switch in the VCO1 module to the ∧ position and then turn up the knob directly below the switch to the desired modulation depth. This particular patch will modulate the frequency of VCO1 in a way that corresponds to the triangle waveshape coming out of the LFO. The rate of modulation will be determined by the setting of the LFO speed slider.

The same concept used to modulate VCO1 with the LFO triangle output is used when modulating other portions of the synthesizer with different modulation sources. The basic rundown of the patching system is as follows:



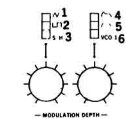
VCO 1 (2)

1) Patches LFO triangle to VCO1 (2)
2) Patches LFO square to VCO1 (2)
3) Patches Sample and Hold to VCO1 (2)
4) Patches ADSR transient to VCO1 (2)
5) Patches AR transient to VCO1 (2)
6) Patches VCO2 (1) output to VCO1 (2)
NOTE: VCO1 only
7) Patches LFO triangle to pulse width modulation input
8) Patches DC to the pulse width modulation input for manual pulse width variation.

a) Patches 1-6 will modulate the FREQUENCY of VCO1 (2)

b) Patching VCO2 (1) into VCO1 (2) will only produce a modulation if the VCO2 (1) audio level sliders are turned up.

FIG.1 Patching explanation for VCO1(2) frequency modulation.



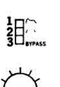
VCF

1) Patches the LFO triangle into the VCF
2) Patches the LFO square into the VCF
3) Patches the Sample and Hold to the VCF
4) Patches the ADSR transient to the VCF
5) Patches the AR transient to the VCF
6) Patches the VCO1 output to the VCF

a) These patches will modulate the CUTOFF FREQUENCY of the VCF

b) Patching VCO1 into the VCF will only produce a modulation if one of the VCO1 audio sliders is turned up.

FIG.2 Patching explanation for VCF cutoff frequency modulation.

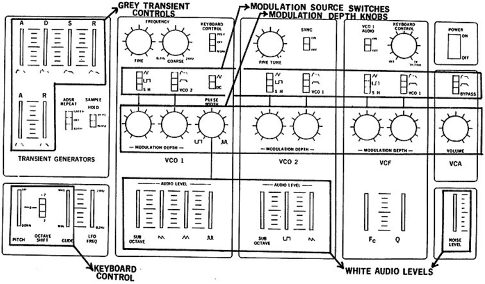


VCA

1) Patches the ADSR transient into the VCA
2) Patches the AR transient into the VCA
3) Bypasses the VCA so that the sound level on the output is constant.

NOTE: The BYPASS mode is used when making patch adjustments on the synthesizer so that you don't have to hold down a key to hear the sound being manipulated.

FIG.3 Patching explanation for VCA amplitude modulation.



CONTROL-SYSTEMS GROUPING

Fig.4 Patching on the CAT is based on slide switches that select the modulation source and rotary attenuators that control the modulation depth. Color coding of sliders helps to visually identify sections.

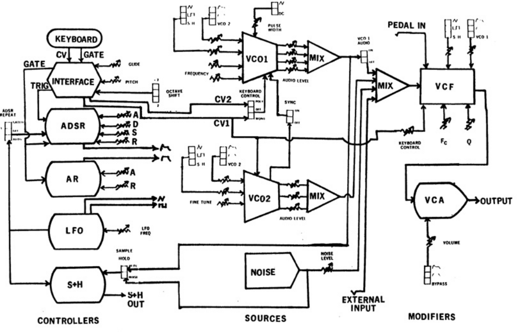
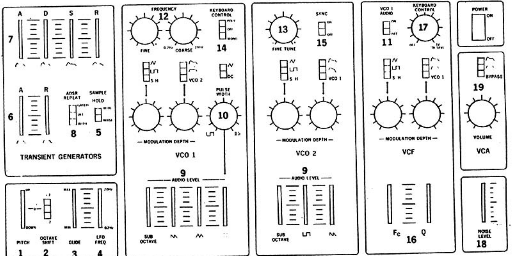


FIG. 5 System Layout of the CAT synthesizer



PANEL DESCRIPTION

Fig. 6 See itemized description of numbered panel sections.

SYSTEM DESCRIPTION

1) PITCH CONTROL - This slider shifts the pitch of the entire unit up or down by approximately one octave. A small area in the center position of the slider gives no pitch change so that returning the instrument to normal tuning from other than the centered or "0" position is simplified.

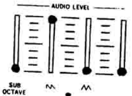
2) OCTAVE SWITCH - This slide switch shifts the pitch of the entire unit up or down by exactly 2 octaves.

> **NOTE:** When the PITCH control and OCTAVE switch are in the "0" position the instrument is tuned such that the second octave "A" note is approximately 440Hz with the VCO tuning adjustments in the 12 o'clock position.

3) GLIDE - When this slider is placed in the minimum position there is no gliding between notes played on the keyboard. As the slider is increased upwards, the glide time between notes increases. The action of this slider is defeated by using the optional "GLIDE ON/OFF FOOTSWITCH" that plugs into the rear of the unit. If a particular glide time is set with the slider and the foot switch is plugged in, you will only get gliding between notes when the switch is depressed.
The GLIDE feature on the CAT is designed so that the glide will complete even if the note is released.

4) LFO FREQUENCY - This slider determines the repetition rate of the Low Frequency Oscillator (LFO) which simultaneously puts out a triangle (/\/) and square (⊓⊔) wave, both available at various patch switches on the front panel.
Also note that the LFO-speed controls the ADSR repeat speed and the Sample and Hold (S+H) rate.

5) SAMPLE and HOLD-This switch selects the source to be sampled by the automatic Sample and Hold (S+H). In the "NOISE" position, the output from the noise generator is sampled, producing a random output pattern. In the VCO1 position, the mix setting of the VCO1 audio sliders is sampled.
Note that if you select the "VCO1" sample position and have all of the VCO1 audio sliders down, there will be no S+H output since VCO1 will not be putting out any waveforms to be sampled. For example, if you want to sample the VCO1 sawtooth, simply place the SAMPLE + HOLD switch to the VCO1 position and turn up the VCO1 audio slider labelled /|/|. This will connect the VCO1 sawtooth output to the S+H input. The sampled sawtooth wave is automatically available at all the patch switch positions labelled "S+H".



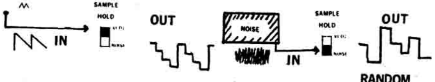


FIG. 7- Inputs and outputs of the Sample and Hold unit.

6) AR TRANSIENT GENERATOR - The Attack-Release (AR) transient generator creates a voltage transient that resembles the symbol illustra under the sliders (⌒\). The initial rising portion of this transient is called the ATTACK (A) which refers to the time it takes the transient to reach a fixed peak value after a key is depressed. When the "A" slider is fully down, this time will be minimum, corresponding to a fast attack. Likewise, as the slider is pushed up, the time will be increased, corresponding to a slow attack.

The final portion of the transient is called the RELEASE (R) which refers to the time it takes the transient to go back down to its initial value after the key is released. Again, when the slider labeled "R" is fully down, a quick release is obtained, and fully up, a long release is obtained.

The output of the AR transient generator is available at all patch switches labelled (⌒\).

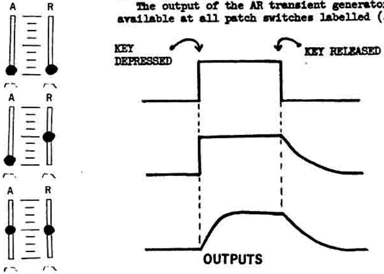


FIG. 8: AR transient generator operation.

7) ADSR TRANSIENT GENERATOR - This transient generator is based on the same principle as the AR generator except that it is comprised of four different sections (attack-decay-sustain-release) rather than only two (attack-release). The ADSR voltage transient is created every time a key is depressed and is available at all patch switches marked /⌒\ . The four different sections are governed by the sliders marked "A", (Attack), "D" (decay), "S" (sustain), and "R" (release), as explained in figure 9.

INSTRUCTION MANUAL MODIFICATIONS

THE CAT SRM SYNTHESIZER

Please add or modify the instructions in this manual as follows:

Page 10: PITCH BEND CONTROL- Calibrated to +/- 1 Octave with click-locked center dead zone.

LFO FREQUENCY- Range is 0.03Hz - 30HZ with square and SINE wave outputs.

ADD- LFO MONITOR- The light next to the LFO frequency slider is a solid state device that blinks on and off at the LFO frequency to allow visual monitoring of the LFO.

ADD- LFO DELAY- The LFO DELAY slider controls the time it takes the LFO SINE WAVE output to reach its maximum value after a key is depressed.

For example, if you modulate the oscillators with the LFO sine wave to get vibrato, an LFO DELAY setting of 0 seconds (slider fully down) would give you a continuous vibrato (no delay), while a setting of 5 seconds (slider fully up) would cause the vibrato to stop whenever you hit a key, come on slowly and finally reach its peak after about 5 seconds. This is known as delayed vibrato and any LFO DELAY setting between 0 - 5 seconds will give corresponding delay times. The delay on the sine wave will occur at all of the sine wave modulation positions in each of the synthesizer sections so that delayed filter sweeps and pulse width chorusing can be obtained.

Note that the LFO DELAY is trigger sensitive, not gate sensitive, and as such will begin a new delay on each new note depressed.

Page 13: MULTIPLE ADSR TRIGGERING- To better accomodate the polyphonic technique on the CAT SRM, the multiple triggering of the ADSR transient has been modified as per the following illustration:

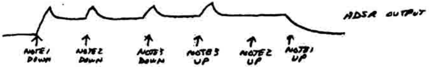


FIG 12 REVISED: Modification of the multiple ADSR trigger

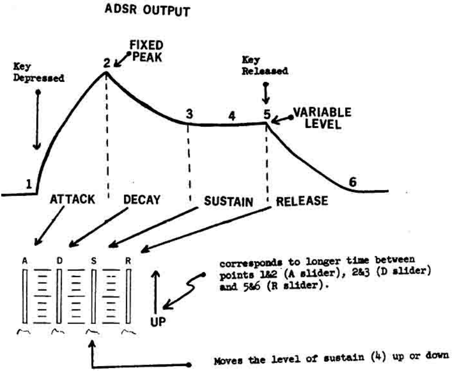


FIG. 9 Slider assignment on the ADSR Transient Generator

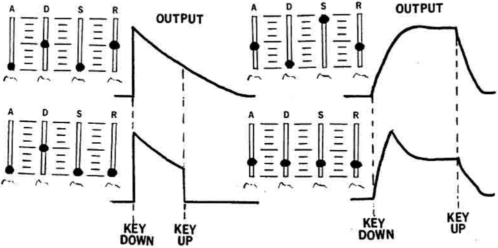


FIG.10- Four illustrative ADSR settings. (Note how the peaks on all four settings correspond to the same voltage)

NOTE: A TOUCH SENSITIVE ADSR RESPONSE on the keyboard can be obtained by utilizing the fact that the "release" portion of the transient takes over only when a key is released. Note that if you set a slow "decay" and hold down a note, the transient will decay according to the setting of the "D" slider. However, if the key is only held down for a very short time, the setting of the "R" slider will take over the transient upon release of a key. Figure 11 shows how the release time will depend on how fast the key was released since the release portion of the ADSR transient takes over at the voltage point existing at the time the key was released. Thus, a fast hit will correspond to a long decaying transient, while a key that is held for a while will correspond to a faster decaying transient.

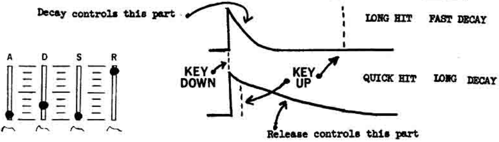


FIG. 11- A touch-sensitive ADSR setting.

NOTE: A WORD ABOUT TRANSIENT TRIGGERING
As previously stated, an AR and ADSR transient will both be produced whenever a key is hit. The CAT is designed so that the retrigger of the ADSR occurs on any key depression - even if more than one is held down. What this means is that an ADSR transient is produced if you hit a note and hold it - then if you hit another note below it (in the "mono" mode) or above it (in the "poly" mode) you will retrigger the ADSR. This feature was designed for very fast keyboard action and is lacking on many competing units.

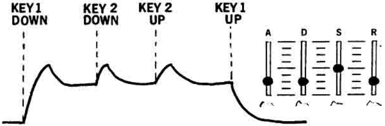


FIG. 12- The Multiple trigger on the ADSR.

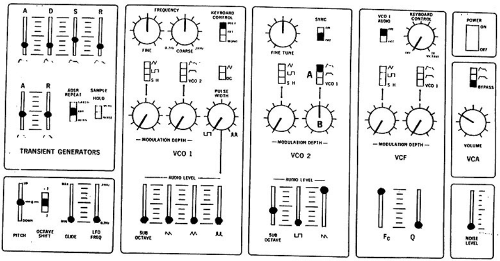


Fig. 13 ADSR patched into VCO 2

EXPERIMENTING WITH THE TRANSIENT GENERATORS

Set up the patch shown in figure 13. This patch connects the ADSR transient to VCO2 so that you can hear how the various ADSR sliders change the transient and thus vary the VCO2 frequency. When you hit a key you can hear the frequency of VCO2 change in a manner corresponding to the ADSR transient shape, as shown in figure 14. By placing the modulation depth knob B in different positions you can hear how different settings cause different depths of frequency changes.

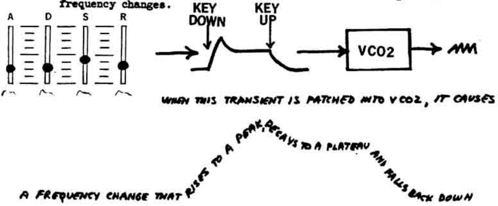


FIG. 14- The patching of the ADSR transient onto VCO2 causes a frequency change which corresponds to the transient shape.

Now place patch switch A in the AR position labelled ⌒ and set the AR generator sliders as shown in figure 15. This will cause the frequency of VCO2 to follow the AR transient and lets you hear how the AR transient reaches a constant plateau as long as a key is held down.

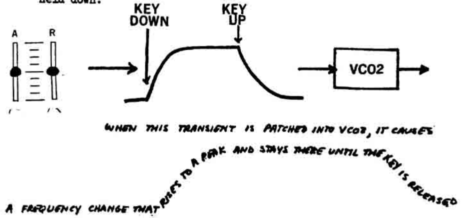


FIG. 15- The patching of the AR transient onto VCO2 causes the frequency to rise to a pea . when a key is held and to remain at that peak until the key is released.

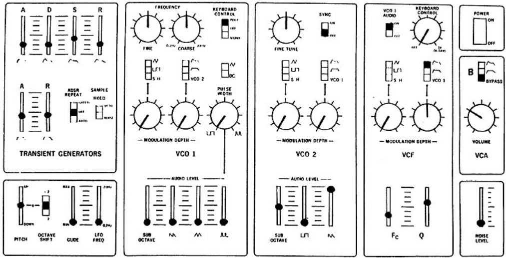


Fig. 16 ADSR patched into VCF

Now, to hear how the transients affect the VCF, set the panel as illustrated in figure 16 so that the ADSR transient is connected to the VCF modulation input. Now when you hit a key you can hear a "waaaaaoowww" type of sound that follows the ADSR transient as illustrated in figure 17.

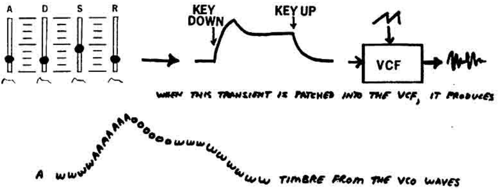


FIG. 17-The patching of the ADSR transient into the VCF produces a change in the cutoff frequency which follows the transient contour.

To hear how the transient generators affect the VCA, place switch B on figure 16 in the ADSR position labelled /⌒\. Now the sound won't come through unless you hold down a key. When a key is depressed, the loudness of the sound will change in a manner corresponding to the ADSR transient. This is illustrated in figure 18.

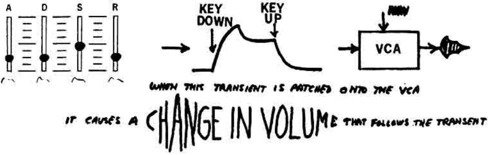


FIG. 18- The patching of the ADSR transient onto the VCA causes the loudness of the synthesizer to vary according to the transient shape.

From these three experiments, you can see that the AR and ADSR transients can change the synthesizer pitch (when patched to the VCO's), timbre (when patched to the VCF), or loudness (when patched to the VCA). The contour of these changes depends on the settings of the transient generator sliders and the depth of these changes depends on the settings of the modulation depth knobs.

8) <u>ADSR REPEAT</u>- The ADSR repeat switch causes any ADSR setting to repeat at a rate determined by the LFO speed. In the "AUTO" position, the transient constantly repeats. In the "GATE" position, the transient will only repeat when a key is held down.

NOTE: If the ATTACK or RELEASE is too long you'll get transients running into each other which will defeat the purpose of using the transient generator. Make sure that the transient lengths are compatible with the repeat rate you're using.

9) <u>VCO1 and VCO2 AUDIO LEVELS</u>-The Oscillators on the CAT have several different output waveshapes that are all available simultaneously-a feature not found on many other synthesizers. Each waveshape has its own slider so that the amplitude can be adjusted independently. This allows different waveshapes to be mixed in any ratio to form complex waveshapes useful as both controllers and sound sources. All of the waveshape sliders are coded in white since they often are used as audio sources. The particular type of wave that each slider controls is labelled directly below it.

<u>SUB-OCTAVE</u>: The suboctave slider controls a square wave that is exactly one octave below the actual oscillator frequency. This is another special CAT feature and is used to add depth to the sound.

<u>SAWTOOTH</u>(⩘)Both VCO1 and VCO2 have this waveform which has a characteristic "brassy" type of timbre. Also, when using VCO1 as a modulation source, you can use the sawtooth to "sweep" VCO2 or the VCF at any frequency set on VCO1.

<u>SQUARE</u>(⊓⊔) This slider is only on VCO2 and is used to produce a hollow or "reedy" timbre.

<u>TRIANGLE</u>(∧∨)This waveshape produces a mellow timbre and is found only on VCO1. It is most useful when used in the subaudio range as a modulation source, however, it can also be used for "flutey" type sounds in the audio range.

<u>PULSE</u>(⊓⊓) The pulse is a wave whose tone is controlled by the "PULSE WIDTH" control knob located directly above it. When the modulation switch above the knob is in the "DC" position, the pulse width is manually controlled by the

setting of the "PULSE WIDTH" knob. When this knob is fully counter-clockwise, the output from the slider labelled "⊓⊔L" is a square wave, wheras when the knob is in the full closkwise position, the output is a sharp pulse wave.

When the modulation switch is in the ∿ position, the LFO triangle wave will change the pulse width at a rate govered by the LFO speed. The amount of pulse width modulation is determined by the setting of the modulation knob, where full clockwise corresponds to maximum modulation. This process of "pulse width modulation" produces a "chorus" effect and simulates the sound of two oscillators.

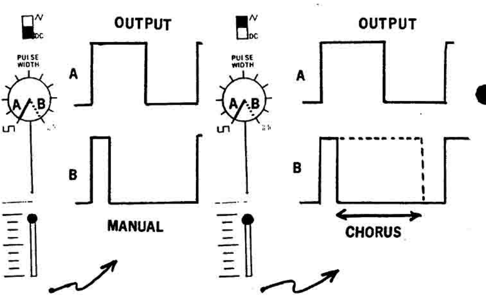


FIG. 19: Using the Pulse Width Modulation.

NOTE: USING THE AUDIO MIX AS A FOUR-NOTE SEQUENCER:
By mixing the sub-octave square wave on VCO1 with the pulse wave, a four-step wave is produced which can be used to modulate VCO2 or the VCF. When VCO1 is brought down to a sub-audio frequency, the output of VCO2 changes in correspondance with the four-step wave to produce a four-note sequence. The reason for this can be seen in figure 20. When the two waves are mixed, the resulting step-wave forms a shape that depends on the settings of the mix sliders. This shape, in addition to the modulation depth setting on VCO2, determines what notes will be played by VCO2. The speed of the note sequence is set by VCO1's frequency controls.

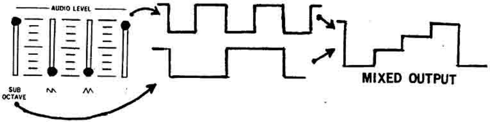


FIG. 20 - Producing a step waveshape from VCO1 which can be used to form four-note sequences from VCO2.

10) VCO1 AUDIO ON/OFF This switch turns the sound of VCO1 on or off. This feature is useful for eliminating the audio clicks associated with sub-audio waveforms when using VCO1 as a modulation oscillator.

NOTE: Sometimes VCO1 may not produce any sound even with the audio sliders up. This can be caused by inadvertently setting the VCO1 AUDIO switch to the off position. Check this first before using VCO1 as an audio source.

11) FINE/COARSE TUNE ON VCO1-VCO1 is tuned to VCO2 by first setting the "COARSE" control to the approximate note and then getting an exact setting with the "FINE" control.

12) VCO2 TUNE- This control changes the frequency of VCO2 by about +/- 1½octaves in either direction from the 12 o'clock position. When tuning VCO1 and VCO2 together, first set the VCO2 tune control to the desired note and then use the VCO1 coarse and fine controls to tune VCO1 to VCO2.

13) MONO/POLY KEYBOARD CONTROL - In the "MONO" position, VCO1 will play the lowest note hit on the keyboard. When switched to "POLY", VCO1 will play the highest note depressed. Since VCO2 will always play the lowest note depressed, having VCO1 play the highest note depressed will allow two notes at a time to be played on the synthesizer.

When the "MONO/POLY" switch is in the "OFF" position, VCO1 is not affected by the keyboard so that it will remain at any frequency set, regardless of which keys are depressed. VCO2 is always controlled by the lowest note played on the keyborad.

14) SYNC ON/OFF- The sync switch locks VCO1 onto VCO2 and effectively forms one complex oscillator out of both. There is no effect on VCO2, however, there is a drastic change in the timbral quality of VCO1. Specifically, VCO1 is forced to follow the frequency of VCO2, thus resulting in complex waveforms whose shape depend on the frequency spacing between VCO1 and VCO2. Since VCO1 has four different waveforms, each with its own characteristic "sync timbre", a large variety of sounds can be synthesized using the audio mix controls. In addition, the sub-octave generator on VCO1 locks on to chromatic scales of the fundamental frequency being generated by VCO2 so that "chromatic-melodies" can be obtained by frequency modulating VCO1 while in the sync mode.

An interesting effect can be obtained by patching the ADSR transient into VCO1 while in sync. This gives an almost "voice-like" timbre which occurs on every keyboard trigger and sounds as though it is being dynamically filtered.

NOTE: SYNC TIMBRES

The reason why the timbre of VCO1 sounds different in the sync mode than in the normal mode is because it has to "lock" on to a multiple of VCO2's frequency. From figure 21, we can see that in the normal mode (no sync), the VCO1 and VCO2 waves can be at any position in relation to each other. However, in the sync mode, the waveshapes of VCO1 are forced to fall within the constraints of VCO2's waveshapes, so that trying to tune VCO1 away from VCO2 will produce complex waves as shown.

Also note that IF VCO1 IS TUNED TO A FREQUENCY BELOW THAT OF VCO2 WHILE IN THE SYNC MODE, THERE WILL BE NO OUTPUT FROM VCO1.

Page 21: MONO/POLY KEYBOARD- The use of the mono/poly switch on VCO1 is the same as the earlier model except for the addition of the 2-NOTE MEMORY SYSTEM incorporated into the CAT SRM keyboard electronics. What this means is this:

On many other two-note synthesizers, including the earlier model CAT, if the switch were in the POLY position and two notes played, VCO1 would play the highest note and VCO2 the lowest note. Upon release of the two notes, both oscillators would jump to the last note released.

To eliminate this, the CAT SRM has TWO MEMORY SYSTEMS- one for each note in the two-note keyboard system. It works like this:

a)Place the VCO1 keyboard control switch in the POLY mode. This makes VCO1 play the highest note depressed on the keyboard. VCO2 ALWAYS plays the lowest note.

b)If one key is down, both VCO1 and VCO2 will play that note.

c)If, in addition to the first key, you press down another key, VCO1 will play the higher of the two keys and VCO2 will play the lower one.

***NOW THIS PART IS IMPORTANT!!! ***

d)If you let go of the TOP note FIRST while still holding the bottom note, VCO1 will CONTINUE TO PLAY THE TOP NOTE even though it's not down anymore. Now, if the bottom note is released (no notes down), VCO2 will continue to play the bottom note. This means that the two-note interval continues to play and the oscillators didn't both jump to the last note released- which is what certain other two-note synthesizers do.

e)Now if a key is depressed, VCO1 and VCO2 will both play that note and you're back at point b above.

f)BUT now go back to point c with 2 notes down and instead of letting go of the top note first, you first let go of the bottom note and hold the top note. THIS WILL CAUSE VCO2 to jump to the note still held and so both oscillators will play the same note. To understand why the instrument was designed this way consider what would happen if VCO2 stayed at the lower note after release. It would be impossible to quickly "trill" between two notes by holding the upper note and bouncing the lower note. You'd have to lift your fingers off of both notes and alternately hit the upper and lower keys that are being trilled.

THE IMPORTANT THING TO REMEMBER IS THAT THE 2 NOTE MEMORY BUILT INTO THE KEYBOARD REQUIRES A SIMPLE TECHNIQUE FOR IT TO RESPOND PROPERELY. WHEN YOU WANT THE TWO NOTES TO BE MEMORIZED, LET GO OF THE UPPER ONE FIRST. This requires a bit of "hand rolling" technique that is very simple to adapt to.

WHEN YOU DON'T WANT THE TWO NOTES TO BE MEMORIZED, LET GO OF THE BOTTOM ONE FIRST. This will cause VCO2 to jump to the higher note so that quick passages in the poly mode are possible.

IN THE "MONO" MODE, THE SYNTHESIZER RETURNS TO A ONE-NOTE-AT-A-TIME, LOW-NOTE PRIORITY.

Remember that analog synthesizers like the CAT SRM CANNOT HOLD A NOTE FOREVER. Because of this, if the synthesizer is in the POLY mode and a single note is played, both oscillators will play that note and will eventually beat if the note is not depressed again so that the memories are refreshed. This is because the two memories cannot possibly "forget" the note by the exact same amount and since VCO1 is connected to one memory and VCO2 is connected to another memory, their frequencies will not vary by the same amount. After a long enough period of time, the frequencies will differ enough for beating to occur. Again, this beating stops as soon as the memories are refreshed- that is, when the note is again depressed.

This beating doesn't happen in the MONO mode because both VCO1 and VCO2 are connected to the same memory. So, even though the memory is "forgetting the note" at the same rate as in the POLY mode, both oscillator frequencies change by the exact same amount- thus beating does not occur even though the note is gradually changing.

It's important to remember that this POLY beating is not due to oscillator drift; it is a memory loss that is common and normal and will probably never be noticed because it is so gradual. Usually, if a note is to be held for a long period of time without depressing the key, and the gradual beating cannot be tolerated, the MONO mode would be used.

Page 24: ADD VCO1 PEDAL INPUT- VCO1 can be controlled by the same type pedal used for sweeping the VCF by inserting it into this jack. This allows foot control of bending and sync-sweep.

NOTE- The VCO1 and VCF pedal inputs can be used to modulate the VCF and VCO1 with external signals. The pedal input jacks are stereo type with the ring being the pedal power and the tip being a 1V/Octave 100Kohm input to the device. A mono jack plugged into the pedal inputs will safely short out the pedal power and allow access for modulation on the tip of the jack.

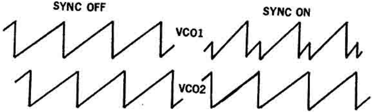


FIG. 21- VCO1 and VCO2 sawtooth waves in and out of sync. Note that the sync mode makes the waves become SYNChronized to each other.

15) FILTER CUTOFF (F_c) AND RESONANCE(Q)-

The voltage controlled filter (VCF) used on the CAT is a -24dB/octave, four-pole, lowpass type with adjustable resonance (Q). The action of the filter is to cut off all frequencies above the initial frequency setting (F_c).

With the "Q" control all the way down, moving the "F_c" slider up lets more harmonics get through the filter so that the timbre of the sound becomes brighter. As the F_c slider is brought down, less harmonics pass through the filter and the timbre sounds mellower.

The "Q", or resonance, emphasizes any harmonics that lie around the cutoff frequency, F_c. If the "Q" is turned up to a bit more than midway, moving the F_c slider will produce a "waaaooowww" type of timbral change. If the Q is turned up to maximum, the VCF will oscillate and not allow any other sounds to come through.

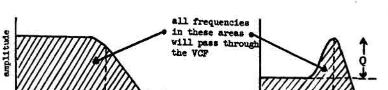


FIG. 22- VCF response is such that all harmonics above the F_c setting are attenuated.

16) KEYBOARD CONTROL-

The cutoff frequency, F_c, of the VCF can be controlled by the keyboard if desired. When the "KEYBOARD" CONTROL" knob is in the "0" position, the F_c will remain at the slider setting, unaffected by any notes played on the keyboard. When the "KEYBOARD CONTROL" knob is on the 1V/octave position, the F_c will track the keyboard notes just like an oscillator. This means that if F_c is set at 100Hz with the low C key depressed, then F_c will change to 200Hz when the next octave C is depressed and to 400Hz when the octave C above that is depressed. The pitch bend slider and octave switch will also affect the F_c in a manner which parallels their effect on VCO1 and VCO2. If the "KEYBOARD CONTROL" knob is placed anywhere inbetween the maximum and minimum settings, the keyboard will affect the F_c in a microtonal manner: for instance, the control may be set to change F_c by one octave for every two octave difference on the keyboard.

NOTE: PLAYING THE VCF AS AN OSCILLATOR:

By turning the "Q" slider up all the way, the VCF will oscillate and will produce a low distortion sine wave whose initial frequency is set by the F_c control. In this mode, the filter can be played as an oscillator by turning the "KEYBOARD CONTROL" to 1V/octave response so that a calibrated octave response can be obtained from the keyboard.

In the oscillation mode, the audio from VCO1 and VCO2 can't get through the filter so that they can no longer be used as oscillators. Also note that the calibrated octave response of the VCF does not have as wide a range as that of the oscillators so that the playing range of the filter is limited.

However, the fact that the VCF can be controlled microtonically by turning down the "KEYBOARD RESPONSE" knob allows the synthesizer to produce microtonal scales if so desired. This is a useful aspect since VCO1 and VCO2 have no facilities for microtonal operation.

17) NOISE LEVEL: This slider controls the amount of white noise that is mixed into the VCF. Note that the slider is coded white to indicate an audio level.

18) <u>VOLTAGE</u>
<u>CONTROLLED</u>
<u>AMPLIFIER(VCA)</u>: The VCA is the last "link" in the synthesizer chain and it controls the loudness of the unit. The patching on the VCA is to either the ADSR or AR transient generators. On "BYPASS", the VCA is effectively out of the circuit and the sounds of the synthesizer will always come through. The output level of the entire unit is set by the knob labelled "VOLUME".

19) <u>AUDIO</u>
<u>OUTPUTS</u> (on back panel)- The High level output on the back of the synthesizer should be used for connections to line level inputs on amplification equipment. The low level output is used when plugging the synthesizer into guitar amplifiers and microphone inputs of P.A. systems.

20) <u>SERIES PATCH JACKS</u> (on back panel)- To connect two synthesizers in series, use a stereo cable to plug the "TO SLAVE" jack on the master synthesizer to the "FROM MASTER" jack on the slave synthesizer. Note that this patch automatically disconnects the keyboard on the slave synthesizer so that both synthesizers are controlled by the keyboard on the master synthesizer. The pitch bend slider and octave switch on the master synthesizer will not affect the slave.

NOTE: When two or more synthesizers are to be used in series, it may sometimes be necessary to recalibrate the keyboard responses so that all of the synthesizers will respond identically. If this adjustment should ever become necessary it should be performed only by a factory authorized service center.

21) <u>FILTER PEDAL INPUT</u> (on back panel)- The optional filter pedal plugs into this jack with a stereo cable. The pedal sweeps the cutoff frequency of the VCF by an amount determined by the "SENSITIVITY" setting on the pedal. This is useful for "hands-free" filter manipulation and is very effective in live performances.
Also note that the filter pedal input can be used to modulate the VCF with an external source. The response will be approximately 1 volt/octave and the input impedance is 100 K. The control point is at the tip of the stereo input jack so that a mono $\frac{1}{4}$" plug will simply eliminate the pedal power and allow connections to external modulation sources through the tip of the mono plug.

USING YOUR CAT SYNTHESIZER

To set-up your CAT synthesizer, first connect the power cord to a grounded A.C. outlet and place the power switch in the "ON" position so that the indicator inside the switch lights up. The output of the CAT should then be connected to a suitable amplification system. Use the output marked "low" for guitar amplifiers and other low level inputs. The output marked "HIGH" should be used in conjunction with high level inputs such as external inputs on home organs, line inputs on stereos and P. A. systems. By setting the panel to a desired patch, the synthesizer will be ready to play. The volume control located in the VCA section will control the overall volume of the unit.

Tuning the Oscillators-

THE SYNTHESIZER SHOULD BE LEFT ON FOR AT LEAST 10 MINUTES BEFORE FINAL TUNING SO THAT THE INTERNAL CIRCUITRY CAN THERMALLY STABILIZE. Tuning the oscillators prior to warm-up will result in a drifting tune setting and will require returning after the 10 minute warm-up interval.

When tuning the oscillators together, the tuning procedure should be performed on the highest C note in the range to be used since oscillator beating is more pronounced at higher frequencies.

Tuning VCO1 and VCO2 to unison:

1. Place the VCO1 "Audio on/off" switch in the "OFF" position so that there is no audible output from VCO1.
2. Place the F_c slider on the VCF all the way up so that all of the harmonics are allowed to pass through the filter.
3. Put the VCA patch switch in the "BYPASS" position so that a note need not be depressed to hear the sound.
4. Press the highest C on the keyboard and set the octave switch to the desired range while keeping the pitch bend slider in the "O" position.
5. Turn up only the sawtooth (⩘) slider on the VCO2 audio levels.
6. Use the VCO2 tune control to set VCO2's frequency to the proper pitch for the instruments you are playing with. Note that with VCO2's tuning control in the 12 o'clock position VCO2 is approximately tuned to standard pitch so that deviating from this setting should be minimal for standard tuning.
7. After tuning VCO2, turn on the VCO1 audio switch and place the VCO1 sawtooth (⩘) slider in the full up position with the other VCO1 audio sliders fully down. The only sounds you should hear now are the sawtooth waves from VCO1 and VCO2.
8. Place the VCO1 "KEYBOARD CONTROL" switch in either the "POLY" or "MONO" position (depending on how you intend to to play the keyboard).
9. Use the VCO1 "COARSE" tuning knob to set the VCO1 frequency approximately equal to the VCO2 frequency (the frequencies are the same when zero beating between the two oscillators occurs) and then use the VCO1 "FINE" tuning adjustment to tune VCO1 so that it is exactly tuned to VCO2.

Tuning VCO1 and VCO2 to intervals:

To tune the oscillators to an interval, follow the above procedure except for the following deviations:

a) Place the VCO1 "KEYBOARD CONTROL" switch in the "POLY" position so that VCO1 will play the highest note pressed on the keyboard.

b) When tuning the oscillators in step 9, play a middle C note and the desired interval note above middle C at the same time (e.g. if you are tuning to a fifth, you would press C and G). VCO2 will now play the C and VCO1 will play the higher note. Now tune the two oscillators to unison while holding down both notes and when you only play one note at a time they will automatically be tuned to the interval you were holding down.

Patching with the Charts-

When setting up a patch, it is best to start with all of the panel controls at their minimum setting and systematically scan the panel to set all of the controls. Leave the "PITCH BEND" slider in the "0" position. Turn the volume of the instrument fully off until you are ready to hear the patch so that you won't be distracted during the setting-up procedure.

Remember that all synthesizers produced cannot possibly be exactly the same - so all of the patch control settings will be approximate for your synthesizer.

Use the patch charts only as a guide- your ear should be the final judge of tonal quality. If a control is not marked on the chart, it should be set to minimum. Pay close attention to each setting- a sound can be completely changed by forgetting to set a control.

The amplifier used to arrive at these patches had its tone control settings set to the "flat" position and had reverb, as indicated on some patches. However, the tone control settings for your particular application should be determined by your ear.

Finally, remember that a synthesized sound should be played in context. A trumpet sound should be played like a trumpet player would play the actual instrument. Playing a trumpet patch like a guitar patch will definitely not sound like a trumpet. Keep the pitch range the same as the real instrument and try to add the same type of expression that would be used by a musician playing the real instrument. Synthesizing a sound is not enough for it to be convincing- it must also be applied with the same feeling as the natural instrument. Keeping this in mind should greatly help your synthesizer playing.

SOME "PROBLEMS" THAT REALLY AREN'T

1) NO SOUND AT ALL:
   a) Is the instrument plugged in?
   b) Is the power-switch light on?
   c) Is the VCA volume turned up?
   d) Is the VCF F_c turned up enough to let sound through?
   e) Are the audio levels (white sliders) turned up?
   f) Is the output of the synthesizer connected to an amp?
   g) Is the amp operating correctly?
   h) If the ADSR sliders are all down and the ADSR is patched into the VCA you'll only hear a "tick" when a key is hit.

2) NO SOUND FROM VCO1:
   a) Is the VCO1 AUDIO ON/OFF switch in the "ON" position?
   b) Are any VCO1 audio sliders turned up?
   c) Is the VCO1 frequency set in the audio range?
   d) Is the "SYNC" on with VCO1 tuned below VCO2?

3) FILTER DOESN'T TRACK KEYBOARD:
   a) Is the "KEYBOARD CONTROL" on the VCF turned up?

4) VCO1 DOESN'T TRACK KEYBOARD
   a) Is the POLY/MONO switch in the "OFF" position?

5) NO S+H CONTROL TO ANY SECTION:
   a) Is the "S+H" source switch on the "VCO1" position with all of the VCO1 audio sliders down?
   b) Is the S+H sampling the output of VCO1 with VCO1 tuned below VCO2 in the SYNC mode?
   c) Is the modulation depth knob turned up?

6) ONLY ONE OSCILLATOR PLAYS:
   a) Is the "SYNC" switch on?
   b) Is the VCO1 audio on/off switch on?
   c) Are the white audio level sliders for both oscillators up?

7) SOUND ALWAYS COMES THROUGH EVEN WITH NO KEYS DEPRESSED.
   a) Is the VCA on "BYPASS"?
   b) Is the ADSR repeat on with a long "Release" setting so that the transients run into each other? If so, this will cause a constant output when patched into the VCA.

TECHNICAL SPECIFICATIONS: CAT Synthesizer MODEL 1853

Output Level: High level output 20 volts Peak to Peak maximum with all audio sliders up and F_c full up.

Low level output 2 volts Peak to Peak maximum with all audio sliders up and F_c full up.

Patching: To Slave- Stereo cable output supplies control voltage and gate control signals to slave unit.

connections: Ring- control voltage output from keyboard (unsampled) buffered and calibrated to 1 volt per octave. Output impedance = 1 Kohm

Tip- gate output High = 7 volts (uncalibrated)
Low =-7volts (uncalibrated)
output impedance = 1 Kohm

From Master- stereo cable input disconnects keyboard on slave unit and replaces it with control voltage and gate from master unit.

connections: Ring-control voltage input to internal keyboard sample and hold circuitry.
Minimum control voltage= 0 Volts
Maximum control voltage= 7 Volts

Tip-Gate input
Maximum Gate High = 7 Volts from 1 Kohm source
Minimum Gate Low = -7 Volts from 1 Kohm source

NOTE: Trigger signal is derived from changes in control voltage so that a high slew rate control voltage signal is necessary for proper internal triggering of transient generators.

Filter Pedal Input: Supplies voltage bias to external pedal for manual filter cutoff modulation.
Ring = pedal bias, -15VDC @10Kohm output Z
Tip = filter Voltage Control input
uncalibrated 1V/Octave @100Kohm input Z
Max input =+/- 10VDC

External Audio Input: Max input =4 Vpp
input Z= 100Kohm

ADSR: Attack -2 ms.- 5 sec.
Decay- 1 ms.- 7 sec.
Sustain- 0-100% Peak
Release- 1 ms.- 7 sec.

AR: Attack - 2ms. - 7 sec.
Release- 1ms. - 7 sec.

L.F.O.: Frequency= 0.2Hz- 20Hz continulously variable
output triangle and square wave

VCO1: Range in "Keyboard off" mode approximately 0.2Hz-6 Khz
Waveforms: Sub-octave square, sawtooth, triangle and variable width pulse
Pulse width modulation: Manual 10%- 60%
Auto maximum 90%- 10%

Tuning range: Coarse approximate 8.5 octaves
Fine approximate ½ octave

VCO2: Tuning range: Approximate 3 octaves
Waveforms: Sub-octave square, square, sawtooth

Noise: White noise (uncalibrated spectrum)

VCF: Cutoff range- approximate 20 Hz- 20Khz
Approximate maximum useable Q= 40
Keyboard response- 0V/Octave- 1V/Octave, continuously variable

Sample and Hold: Samples VCO1 mix or Noise source at LFO rate

Pitch Bend Approximately +/- 1 Octave (uncalibrated) with center dead band.

Octave switch: +/- 2 Octaves calibrated

Glide: Approximate Maximum glide time- 2 sec./octave

Power: 100V- 130V AC or 220V- 250V AC 50/600Hz @17 watts
Internal fuse, o.25A @120VAC

Size: 24" wide x 6" high x 19 3/4" deep Weight: 23 lbs.

Cabinet: Molded 1/16" steel frame with "spatter coat" finish.
T-moulding edge stripping on wood-grained 3/4" side panels
G-10 glass/epoxy circuit boards

Keyboard: 37 notes with gold plated buss bars and key contacts.

TECHNICAL SPECIFICATIONS: CAT SRM synthesizer

Output Level: High Level Output- 25 Vpp maximum

Low Level Output- 2.5Vpp maximum

Patching: To Slave- Stereo cable output provides unsampled control voltage and gate voltage signals to slave unit.

connections- RING=Control voltage output
UNSAMPLED, buffered keyboard voltage
Output impedance = 1Kohm
Range = 0 - 3V, 1v/octave calibrated

TIP =Gate signal output
Gate high = +15V uncalibrated
Gate low = 0 V
Output impedance = 1Kohm

From Master- Stereo cable input disconnects keyboard on slave unit and replaces it with control voltage and gate from Master unit.

RING=Control voltage input (sampled or unsampled)
Input impedance greater than 2Mohm
Minimum Control Voltage = -5V
Maximum Control Voltage = +10V

TIP =Gate input
Input impedance greater than 5Kohm
Minimum high level for turn on = 6V
Maximum low level for turn off =1.5V

NOTE: Trigger signal is internally derived from changes in gate and control voltage levels. For proper triggering of slaved CAT synthesizer with other than OCTAVE products, control voltages must have no glide and may be either sampled or unsampled.

Filter Pedal Input: Supplies voltage bias to external pedal for manual foot control of filter cutoff frequency.

RING= pedal bias= +15VDC @ 330ohm output Z
TIP = Voltage Control Input for filter cutoff
Calibrated 1V/Octave input sensitivity
Input impedance = 100Kohm
Input voltage range= +/-10VDC

VCO 1 Pedal Input: Supplies voltage bias to external pedal for manual foot control of VCO 1 frequency.

RING= pedal bias = +15VDC @ 330ohm output Z
TIP = Voltage Control Input for VCO 1 frequency
Calibrated 1V/Octave input sensitivity
Input impedance + 100Kohm
Input voltage range= +/- 10VDC

External Audio Input: Maximum input before distortion = 3Vpp for max output
Input impedance = 100Kohm

ADSR: Attack time = 3msec. - 6 sec.
Decay time = 2msec. - 7 sec.
Sustain = 0 - 100%peak
Release time= 2msec.- 7 sec.

AR: Attack time = 3 msec. - 7 sec.
Release time= 2 msec. - 7 sec.

Low Frequency Oscillator (LFO): Frequency range =0.03Hz - 30Hz
Sine and Square wave outputs

VCO1: Range- Keyboard off- 0.2Hz - 2.1Khz
Keyboard on - 0.2Hz - 16Khz

Waveforms: Sub-Octave Square, sawtooth, triangle, and variable width pulse.

Pulse Width Modulation- Manual = 50% - 3%
Auto = 50% - 3%

Tuning Range- Coarse = 12 octaves (approx.)
Fine = +/- 1 semitone (approx.)

VCO2: Tuning Range- 2.5 octaves (approx.)
Waveforms- Sub-Octave Square, sawtooth, Square

Noise Source: white noise (uncalibrated spectrum)

VCF: Cutoff Range = 5Hz - 27KHz approx.
Useable resonance (Q)= 40 approx.
Keyboard response= 0 - 1V/octave, continuously variable

Sample and Hold: Samples VCO1 mixer or Pink noise source internally derived.
Sampling rate determined by LFO.

Pitch Bend: Calibrated +/- 1octave with center dead band and click stop.

Octave Switch: Calibrated +/- 2octaves

Glide: Approximate maximum glide time = 1.5 seconds/octave

Power: 100 - 130 VAC (internally modifiable to 200- 250 VAC) 50/60Hz
17 Watts
Internal fuse = 1/8 A @ 100- 130VAC
1/16A @ 200- 250VAC

Size: 24" (61.0 cm) wide 19.5" (49.5 cm) deep 6" (15.2 cm) high

23 lbs (10.4 Kg)net weight

Construction: G-10 Glass epoxy circuit boards, gold plated key contacts and buss bars. 1/16" steel frame with scuff resistant spatter coat baked enamel finish, stained wood side panels.

$5.99

INSTRUCTION MANUAL

the CAT
electronic music synthesizer

OCTAVE Electronics Inc.
32-73 STEINWAY STREET
LONG ISLAND CITY, N. Y. 11103
Tel. 212 - 278-7422 - 7423