SECTION III — DESCRIPTION OF PROGRAMMABLE PANELS, MEMORY, HOW TO PROGRAM & SUGGESTED PATCHES

This section details the function of the CS-80 programmable PANELS [20-45], and how to program your own patches, creating sounds literally "from scratch." Also discussed are the MEMORY panels [46] —miniaturized versions of the larger programmable panels that are used for storing four of your own programmed patches for instant recall at the touch of a button.

What the Panel Controls Do

The PANELS let you select the waveform, harmonic structure, changes in harmonics, volume changes, and basic keyboard dynamics to program an infinite variety of sounds. The same circuits controlled by these PANELS are internally controlled to obtain the preset patches; each TONE SELECTOR button simply recalls an internally-stored pattern of PANEL settings. Thus, with the PANELS, it is possible to manually duplicate any of the presets, to vary them slightly, or to depart drastically for totally unique sounds. The two main panels, PANEL I and PANEL II, are identical. Therefore, we explain just one of them.

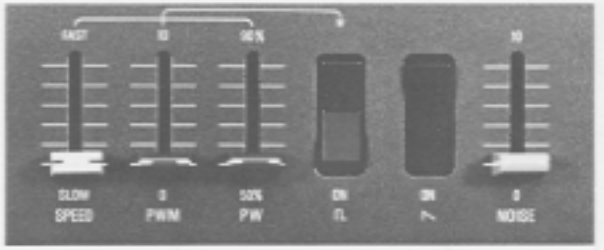
NOTE: To hear what effect the PANEL controls have as you read this section, set **all** CS-80 controls at their nominal positions (as indicated on the inside front cover), with these exceptions:

a) Set the MIX I-II lever [4] at I.
b) Press the PANEL button on row I of the TONE SELECTOR section [3].
c) Set the BRILLIANCE lever [7] at minimum brightness (up).*

We use PANEL I in these examples because it is closer to the music stand than PANEL II, hence easier to see as you read this section.

[20-25] **The VCO —**
WAVEFORMS: The VCO, or Voltage Controlled Oscillator section, creates the CS-80's four basic sounds: SQUARE WAVE, SAWTOOTH WAVE, WHITE NOISE and SINE WAVE. Turn ON the square wave ⊓ [23] and play a note. Turn OFF the square wave and turn ON the sawtooth wave ⟍ [24]. Turn OFF the sawtooth, and bring up the NOISE slider [25]. Bring down the NOISE slider, and bring up the sine wave ∿ slider [36]. Observe the difference between these sounds. (The sine wave slider, even though it is part of the VCO electronics, is located in the VCA section because pure sine waves have no harmonics, and would therefore not be changed by VCF processing.)

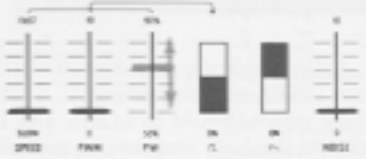
**Normally, BRILLIANCE is centered when programming, but this setting is better for initial demonstrations of filter effects.*



[22] **PULSE WIDTH** — The square wave [23] had a particular sound that might be described as "hollow." However, you can vary the sound of the square wave with the adjacent PW slider [22]. This slider affects **only** the sound of the square wave, and has no effect on the sawtooth, sine wave or noise.

With the square wave ON, play a note and very gradually push the PW slider up to 90%. This changes the Pulse Width of the square wave, which changes the harmonics for a more "nasal" sound. Now move the PW slider down to 50% again as you continue playing a note.

Try moving the PW slider back and forth (50% to 90%), doing it faster and faster as you play a note,



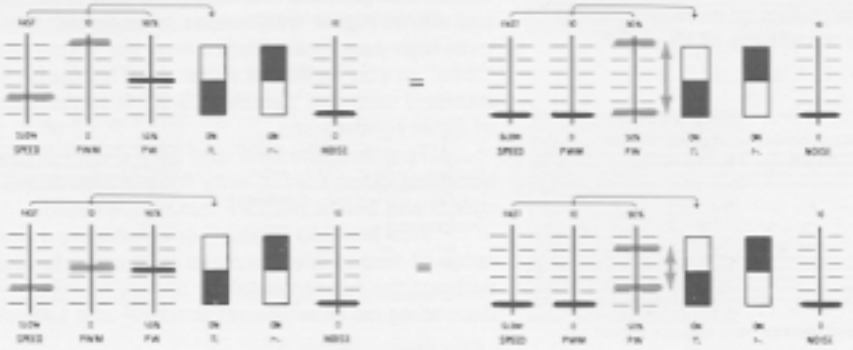
and observe the phasing-like sound. You can have the CS-80 do the same thing for you automatically, using the adjacent PWM [21] and SPEED [20] sliders.

[21] **PWM** (Green) & [22] **SPEED** (White)
PWM stands for Pulse Width Modulation. Set the PW slider at 75%, and move the PWM slider [21] up to maximum modulation (#10). Now play a note and you will hear an effect that is identical to manually moving the PW slider back and forth all the way, but very slowly. Gradually push the SPEED slider [20] from SLOW toward FAST, and notice what happens; pulse width modulation occurs faster and faster. Eventually, you will reach a speed that is much faster than you could possibly achieve by moving the PW lever back and forth with your hand. At the point when the SPEED of modulation approaches audio frequencies (20 times per second or faster), a secondary tone will be heard.

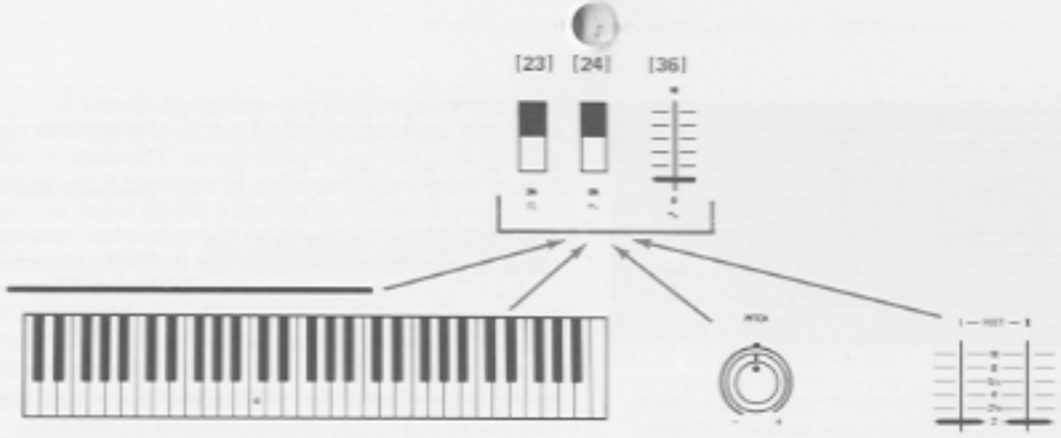
You need not use maximum effect. With SPEED at a SLOW setting, try moving the PWM slider to its mid position. This effect is like moving the PW slider only part way up, and then back down. You can also vary the basic setting of the PW slider; try setting it at mid position and then use different PWM and SPEED settings. Together, the PW, PWM and SPEED sliders are one of the keys to achieving realistic string sounds.

As you have heard, the VCO produces different basic timbres (tones), but it is equally important for it to produce pitch. Therefore, when you play various notes on the keyboard, the VCO produces different pitches. The FEET selector also affects the VCO pitch, just as it did with the preset patches.

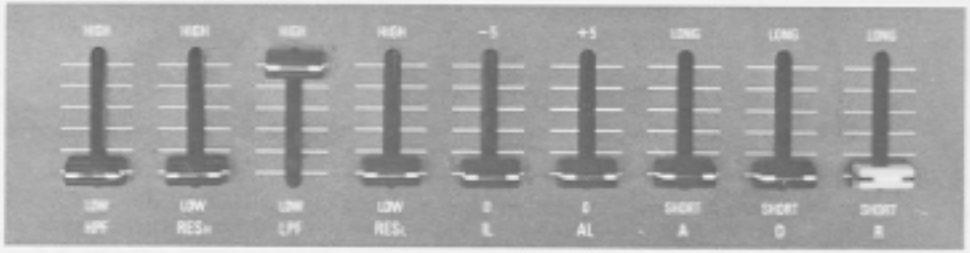
Moving up and down fully.



Moving up and down part way.



Four "Controls" set the pitch of the wave you select on the VCO.



[26-34] **VCF** – The **V**oltage **C**ontrolled **F**ilter section (**VCF**) lets some of the frequencies generated by the VCO be heard and cuts out others; hence the term **filter.** The action of the filter modifies the timbre (tone) by altering the harmonic structure of the basic sounds.

All the sounds created by the VCO, except sine wave, are immediately processed by the VCF section. Of the basic sounds available from the VCO, NOISE is the richest in harmonics. White noise is actually a combination of all audio frequencies . . . all harmonics and fundamentals occuring in a continuous, random pattern. Thus, noise makes an excellent sound with which to demonstrate the effects of the VCF.

[28] **LPF** – (Green) Bring up the NOISE slider [25] to maximum (#10), and play any key. Gradually move the LPF slider down (HIGH to LOW). **The LPF (Low Pass Filter) cuts the high frequencies and allows lower frequencies to be heard:** hence the term low pass filter. Notice how the sound becomes more "dull" as you move the slider down.

[26] **HPF** – (Green) Return the LPF slider to HIGH, thus allowing all noise frequencies to get through the VCF section. Now gradually move the HPF slider up from LOW to HIGH. **The HPF (High Pass Filter) cuts the low frequencies (fundamental and lower harmonics) and allows higher frequencies to be heard:** hence the term high pass filter. Notice how the sound becomes "thin" as you move the slider up. This useful filter, standard with the Yamaha CS-80, is seldom included in other synthesizers.

Together, the HPF and LPF sliders create a **bandpass** filter; that is, only frequencies above the HPF cutoff and below the LPF cutoff are heard.

This lets you "focus" or emphasize a narrow range of frequencies, perhaps only a few harmonics without the fundamental, or a wide range of frequencies, depending on how you set the HPF and LPF sliders.

NOTE: Think of the HPF and LPF sliders as a pair of curtains that let you "see" the sound. Certain settings of the sliders (the "curtains") can "narrow" the bandpass "window" to nothing—no frequencies can pass through the filters. If you are adjusting these sliders and the sound goes away, move HPF lower and/or LPF higher to "open" the bandpass so sound can come through. (See illustrations on next page.)

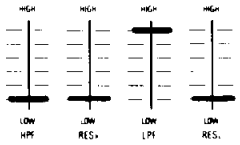
Bring down the NOISE slider, and turn on a sawtooth wave [24]. Starting with the HPF slider at LOW and the LPF slider at HIGH, gradually move the LPF slider up and down. Then move the HPF slider up and down. You are probably beginning to grasp how the VCF's two filters, HPF and LPF, affect the sound.

The HPF and LPF sliders each set one of two basic filter characteristics, the cutoff frequency. The other basic filter characteristic is **RESONANCE.** Rather than explain resonance at this point, it is easier to just demonstrate the effect. (Further explanations of filter characteristics are presented in Sections IV and V of this manual.)

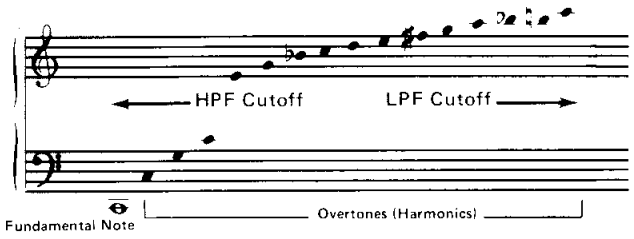
[27 & 29] **RES** – (Red) **H**igh **P**ass **F**ilter **RES**onance is set with the **RESh** slider [27], and **L**ow **P**ass **F**ilter **RES**onance is set with the **RES$_L$** slider [29]. Move both these sliders up to HIGH for maximum resonance effect, and then gradually move the HPF and LPF sliders back and forth, one at a time, while playing a series of notes. Observe the "twang" or "wah" provided by the resonance. A "wah-wah" pedal lets you do the same thing with your foot instead of your fingers.

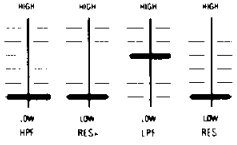
There are additional sliders in the VCF Section [30-34], but it will be easier to demonstrate their purpose if we first explain what the VCA Section does.

Musical examples of filter action. Shaded areas are NOT audible bec[illegible] they are blocked by the filters. Edge of shaded areas represe[illegible]lter cutoff point.

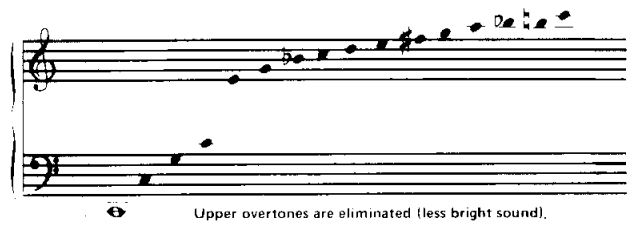


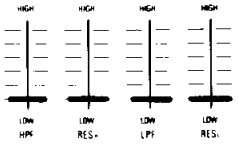
HPF & LPF filters wide open.



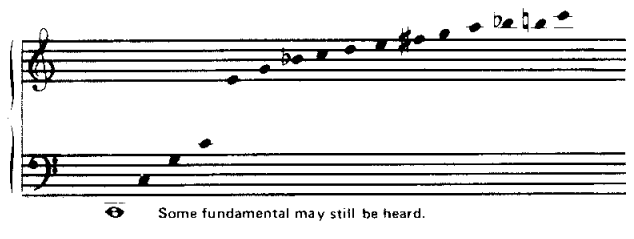


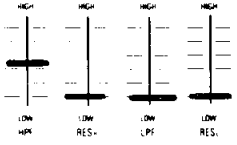
HPF wide open
LPF partially closed



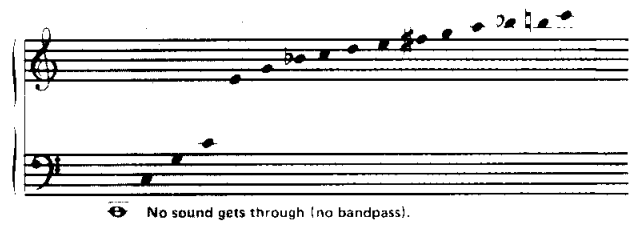


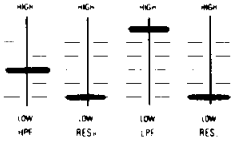
HPF wide open
LPF completely closed



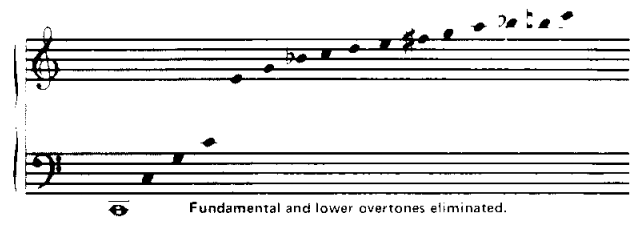


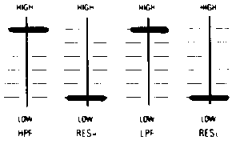
HPF partially closed
LPF completely closed



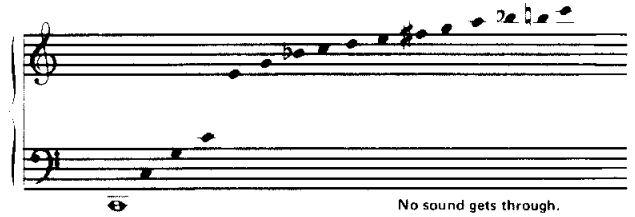


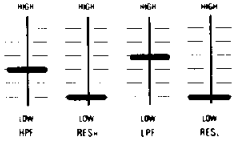
HPF partially closed
LPF wide open



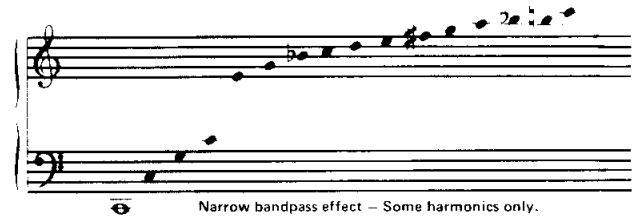


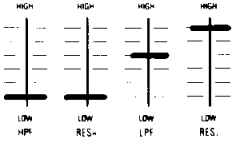
HPF completely closed
LPF wide open



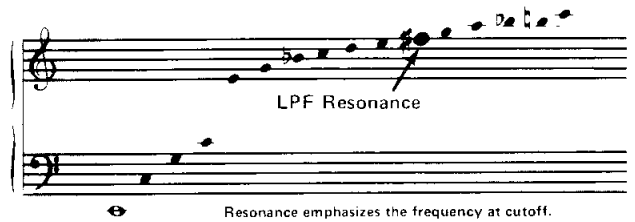


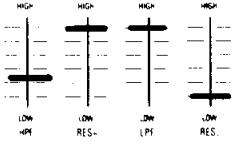
HPF partially closed
LPF partially closed



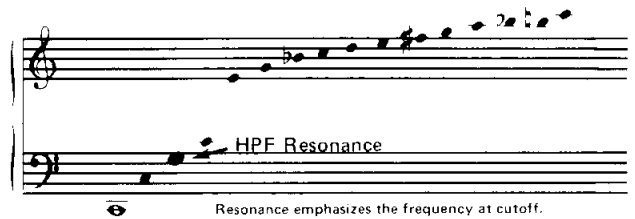


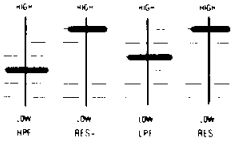
HPF wide open with no resonance
LPF partially closed with maximum resonance



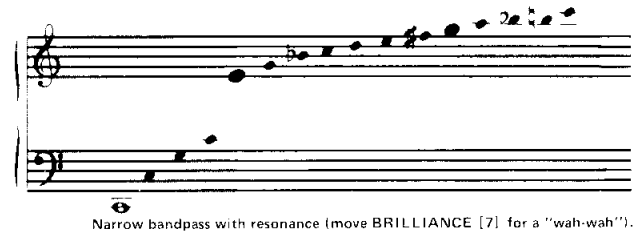


HPF partially closed with maximum resonance
LPF wide open with no resonance





HPF partially closed with maximum resonance
LPF partially closed with maximum resonance



[35-41] **VCA** – The VCA, or **V**oltage **C**ontrolled **A**mplifier, sets the volume (loudness) of the sound. The reason for using a VCA rather than a volume control, however, is that it automatically changes the volume when you play a note. This is a natural characteristic of any instrument, and is therefore important to the realism or effect of the sounds you program.

Consider the sound of a harpsichord, for example. When you play a note, the strings are plucked, so sound starts at maximum loudness (fast attack) and then falls off (decays) fairly quickly. When you blow into a trombone, the note slowly builds to maximum loudness (slow attack) as the air passes through the many feet of tubing; the sound remains at maximum loudness (high sustain level) as long as you have breath, and then it dies somewhat more quickly than it began as the vibrating column of air collapses (fast release time). These changes in loudness over a period of time are unique for each different instrument and they are known as the amplitude or volume **envelope.** The VCA is used to create an amplitude envelope for whatever sound you have generated with the VCO and modified with the VCF.

[41] **LEVEL** – (Gray) Play a note, and move the VCA LEVEL slider between #10 (maximum) and #0 (minimum). Notice that this is exactly the same as adjusting the CS-80's main VOLUME control [2].

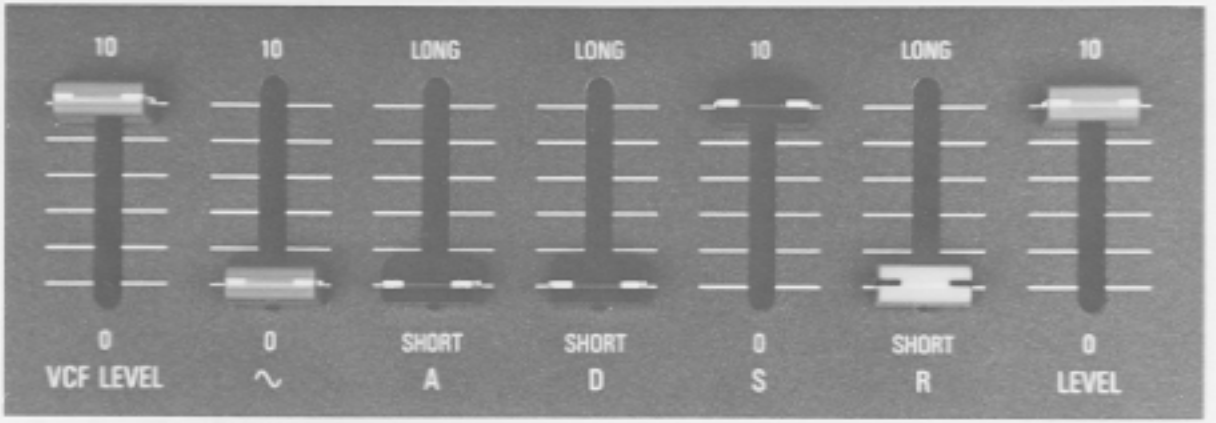
[37-40] **VCA ENVELOPE GENERATOR** – We explained that the VCA is an amplifier that automatically changes the volume; the Envelope Generator (EG) is the circuit that controls the VCA's volume (amplitude) when you play the keyboard. (No sound goes through the envelope generator itself.) The VCA's envelope generator happens to have four independently adjustable characteristics: attack time, decay time, sustain level, and release time. These are set with the **A**ttack, **D**ecay, **S**ustain and **R**elease sliders (A-D-S-R).

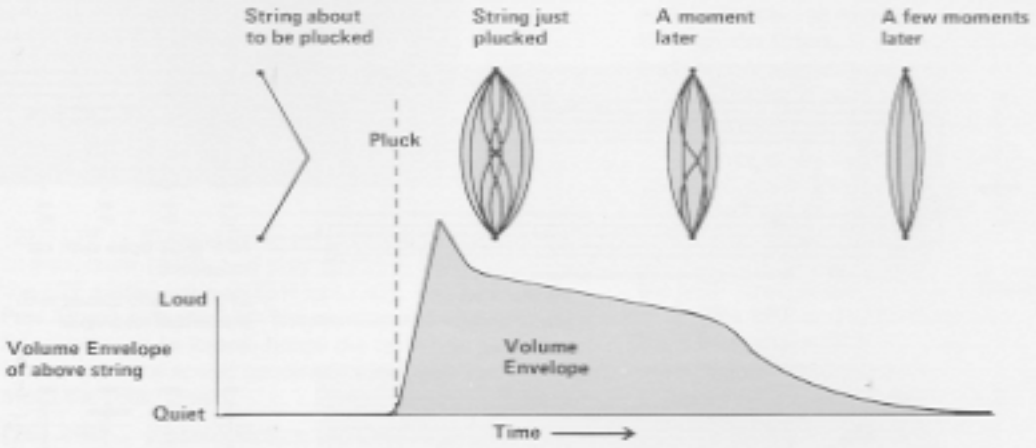
[37] **ATTACK** – (Black) ATTACK TIME defines how fast the VCA turns on to a maximum volume when you **first play** a key.

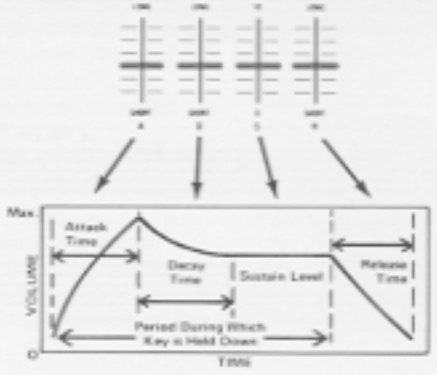
[38] **DECAY** – (Black) DECAY TIME defines how long it takes for the VCA to lower the volume as you continue to **hold down** the key.

[39] **SUSTAIN** – (Black) SUSTAIN LEVEL defines how loud the note remains while you continue **holding down** the key.

[40] **RELEASE** – (Yellow) RELEASE TIME defines how quickly the note dies out after you **let go of** the key.



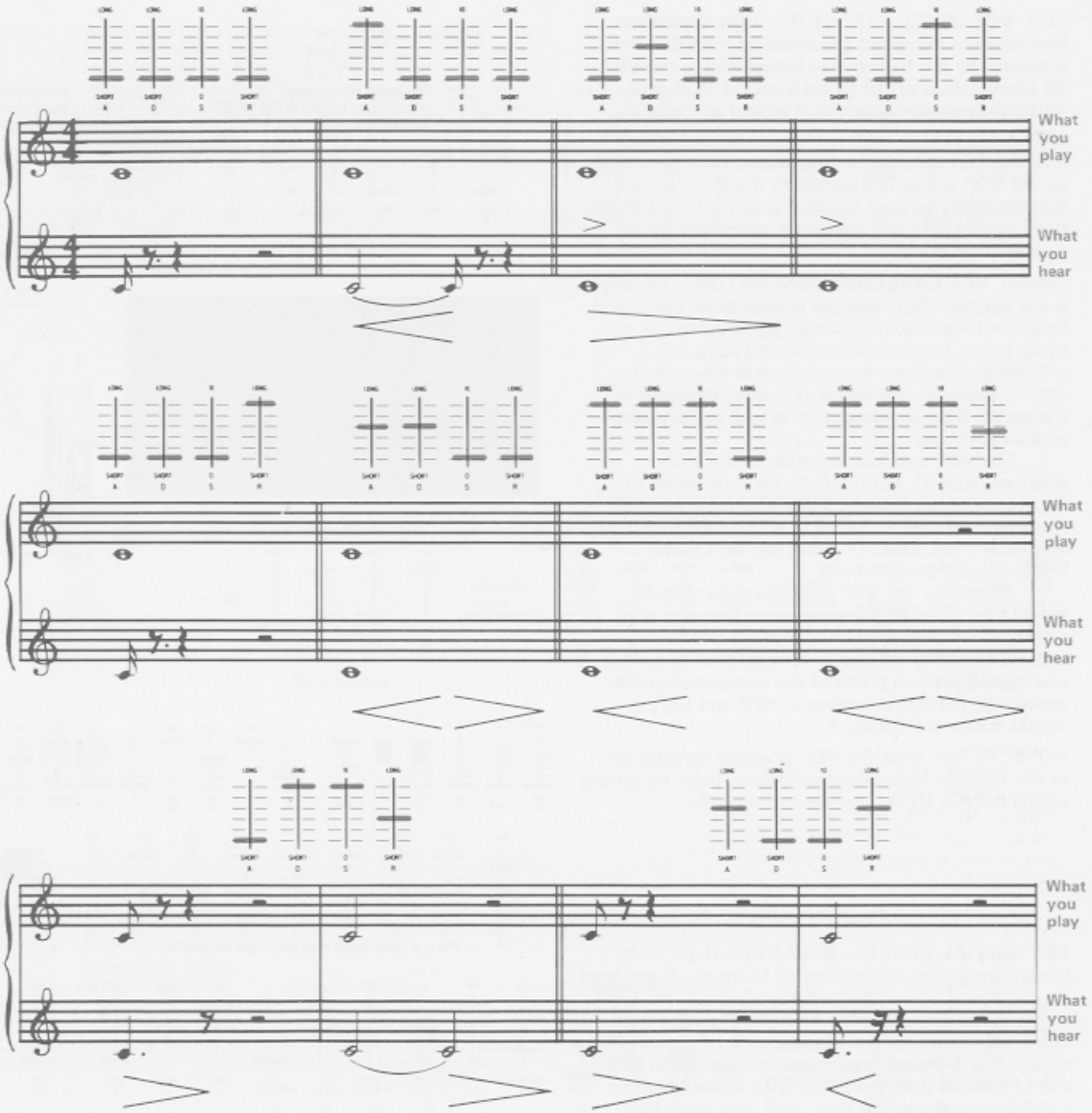




More About VCA Envelopes

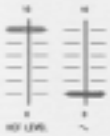
It may be easier for some players to understand the envelope in musical terms rather than with graphs or charts. The illustration to the right demonstrates how different settings of the VCA's A, D, S & R levers affect the sound. Play these examples and listen to the effect of each lever. The examples are not intended to sound like any particular instruments.

NOTE: Upper line represents the notes played. Lower line represents what you hear.



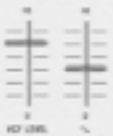
[35] **VCF LEVEL** – (Grey) This slider determines how much of the sound generated by the VCO then processed by the VCF will be introduced to the VCA. #0 (down) shuts off all sound from the VCF, and #10 (up) feeds maximum VCF output to the VCA.

[36] **SINE WAVE** – (Grey) This slider determines how much of the pure, unfiltered sine wave generated by the VCO will be introduced to the VCA. In fact, this slider may be used together with the VCF LEVEL slider to mix pure sine wave with whatever sound is coming from the VCF.



No pure sine wave; maximum sound from VCF enters the VCA.

No sound from VCF; pure sine wave enters the VCA.

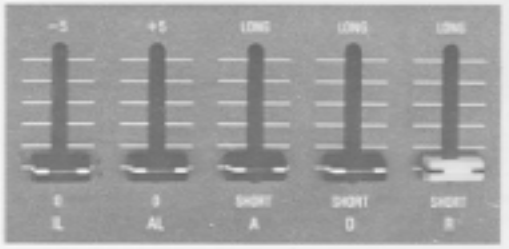


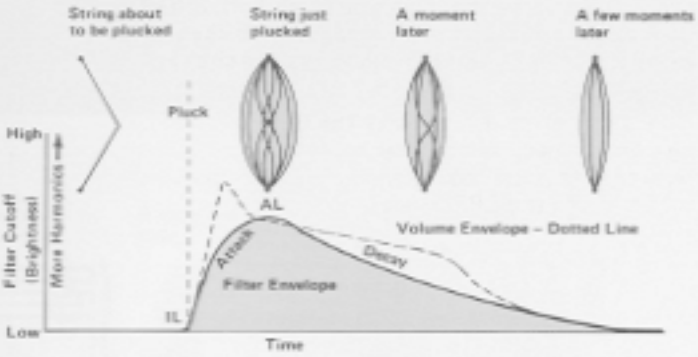
Blend of sine wave and sound from VCF enters the VCA.

[30-34] **VCF ENVELOPE GENERATOR** – Loudness is not the only thing that can change when you play a note; the tone may also change. When you pluck a guitar string, for example, the sound starts out brilliant and becomes more mellow as the note dies out. To duplicate this effect, it is often desirable to change the filter characteristics as well as the volume with an envelope.

The VCF envelope is similar to the VCA envelope (ADSR), but it affects the tone rather than the volume. Also, instead of ADSR sliders, the VCF envelope has **INITIAL LEVEL**, **ATTACK LEVEL**, **ATTACK TIME**, **DECAY TIME** and **RELEASE TIME** sliders (IL-AL-A-D-R).

In essence, the VCF envelope automatically moves the HPF and LPF sliders each time you play a note, thus changing the filter cut off and the amount of harmonics and/or fundamental frequency you hear. The exact effect of the envelope depends entirely on the actual settings of HPF and LPF, as well as RES_H and RES_L.





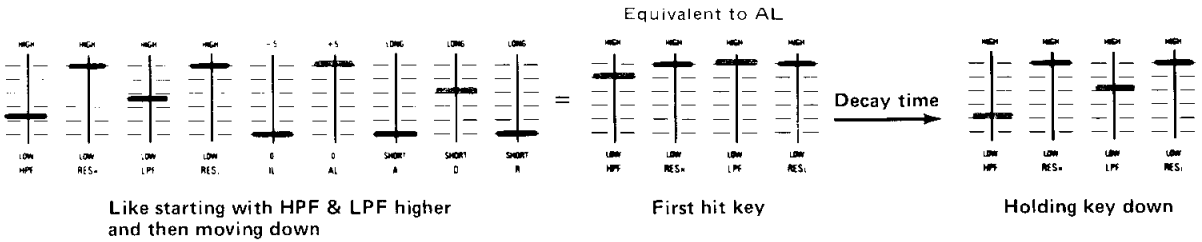
NOTE: To hear what the VCF envelope controls do as you read the following descriptions, begin by setting up the PANEL (I) as illustrated to the right.

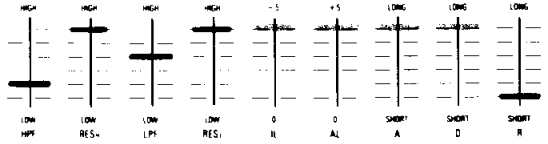
[30] **INITIAL LEVEL** – (Black) With **IL** set at #0 (down) there is no effect. Moving IL up to –5 and then playing a note causes the sound to start out "mellow" (more fundamental and less harmonics) and to then move into the sound you have set with HPF and LPF sliders. It is as though you began by moving the HPF and LPF sliders a bit lower and then moved them up together as you play the note until they reach the "steady" setting.

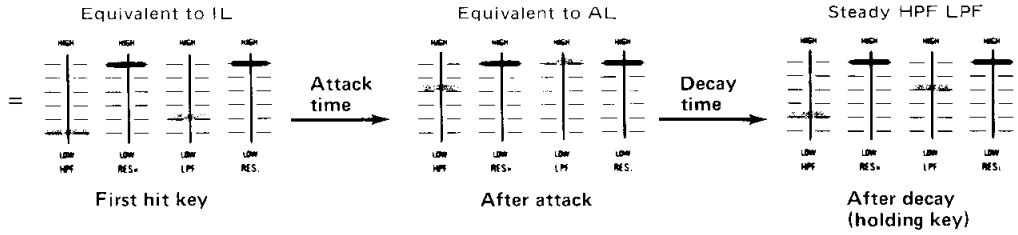
[31] **ATTACK LEVEL** – (Black) With **AL** set at =0 (down) there is no effect. Moving AL up to +5 and then playing a note causes the sound to get "thinner" (less fundamental and more harmonics) and to then move back to the sound you have set with the HPF and LPF sliders. It is as though you moved the HPF and LPF sliders up past the "steady" setting and then brought them down together.

[32] **ATTACK TIME** – (Black) The **A** slider adjusts how long it takes for the filter envelope to move from the "fattest" sound to the "thinnest" sound (these points being set by the IL and/or AL sliders). SHORT (slider down) causes a fast move that sounds like a "blip," whereas LONG (slider up) causes a gradual change in tone.

[33] **DECAY TIME** – (Black) The **D** slider adjusts how long it takes for the filter envelope to move from the "thinnest" sound to the "steady" sound set with the HPF and LPF sliders.

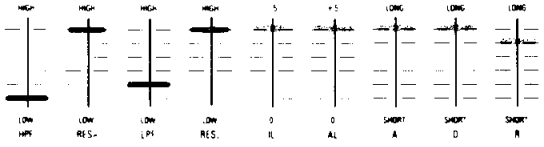


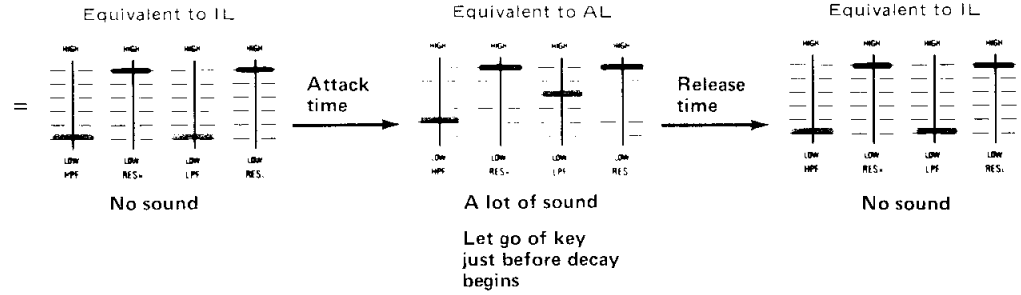




[34] **RELEASE TIME** – (Yellow) The **R** slider adjusts how long it takes for the filter to return to the **IL** setting after you let go of the key or keys. If the **IL** slider is set at =0 (down), then **R** sets how long it takes for the filter to return to the "steady" setting after you release the key. If **IL** and **AL** are both at =0, then **R** has no effect.

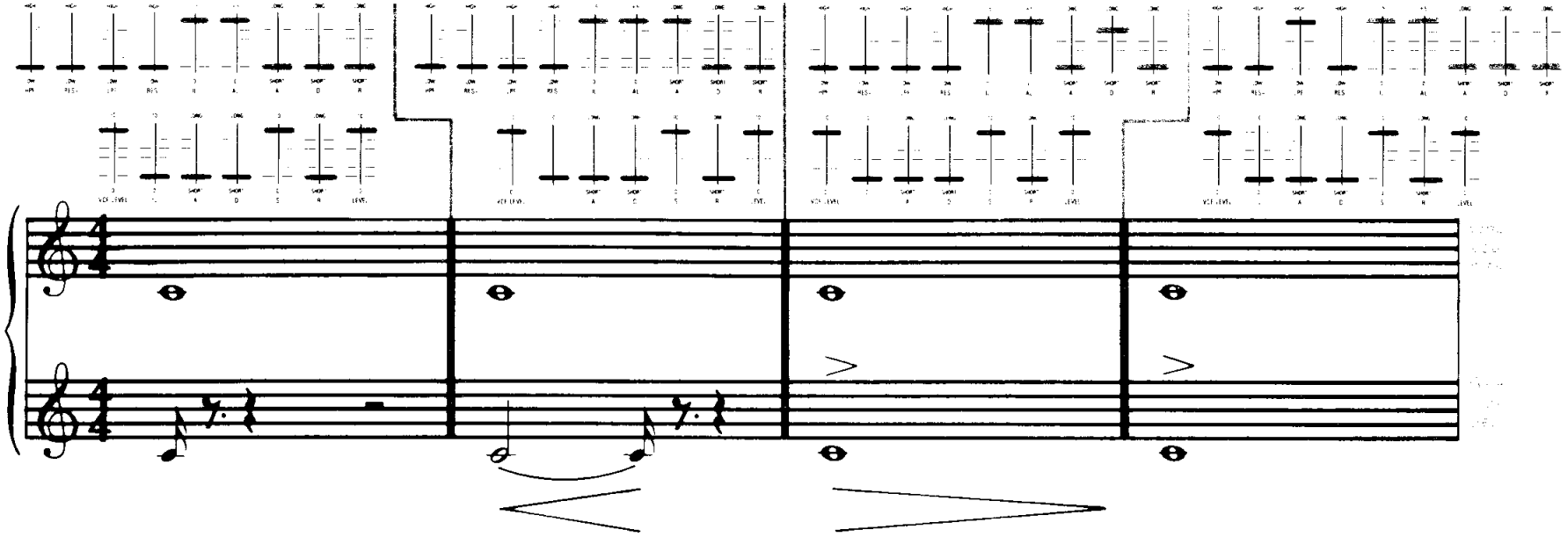
By experimenting with the VCF envelope, you will find that many useful effects can be achieved, including whistle and rushing wind. Brass sounds are greatly enhanced by the use of IL and AL with moderate attack and decay times. To get a very sharp "blip" for extremely percussive sounds, set AL up to +5 and set attack and decay at the shortest time (down). You will also find that the VCF envelope and VCA envelope can be manipulated together to get still more variations in effect.

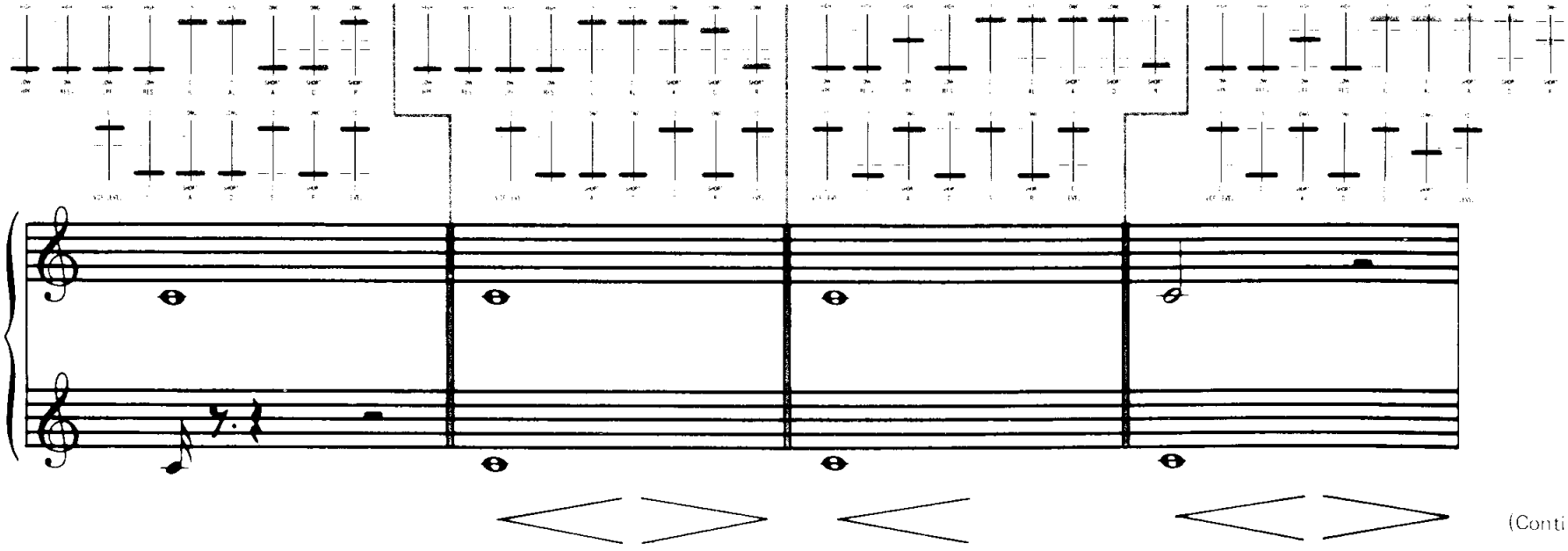




The musical examples provide an alternative to the preceding charts for understanding the VCF envelope. (Switch on the VCO's sawtooth wave when playing the examples.)

NOTE: In these illustrations, hairpins represent changes in filter response, not level. The VCA envelope settings are shown below the VCF settings to save space.





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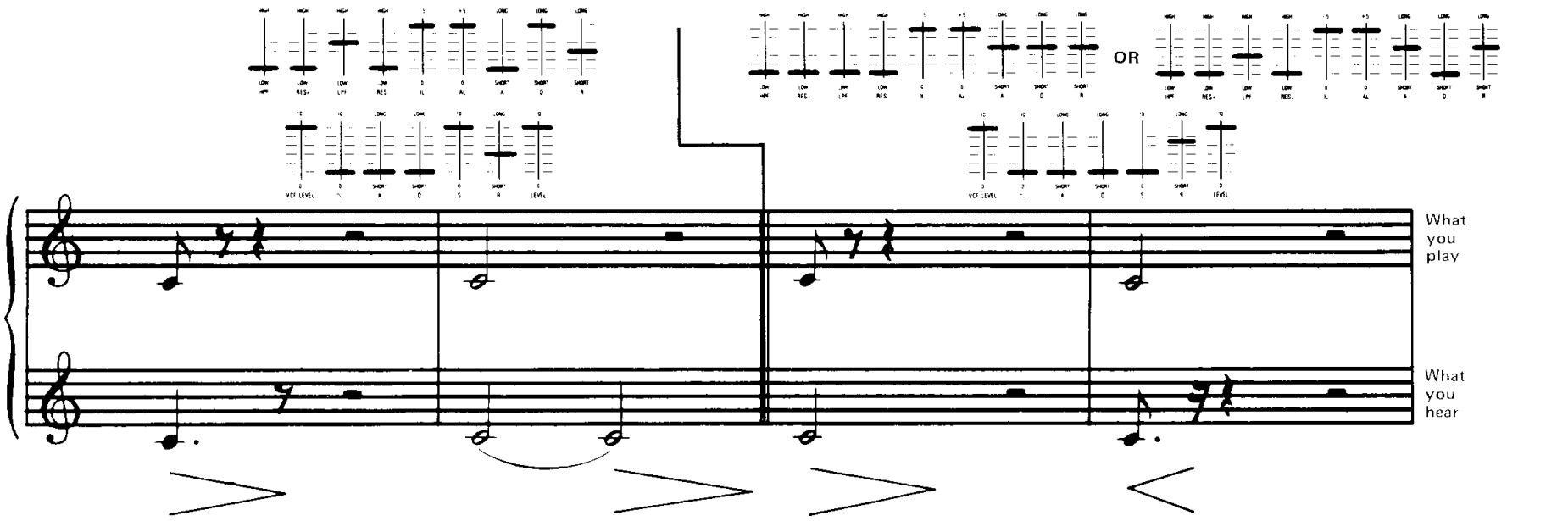


[42-45] **TOUCH RESPONSE** – Touch response (keyboard dynamics) allows you to achieve the ultimate in realistic musical expression. This section allows you to change the LEVEL (volume) and the BRILLIANCE (harmonics) by playing the keyboard differently. With the sliders down at #0, there is no touch response, while up at #10 the effect is maximum.

INITIAL – "Initial" means that the amount of effect is determined by how fast and hard you **initially** strike the key. INITIAL BRILLIANCE [42] makes the notes brighter the harder you hit the key, and INITIAL LEVEL [43] makes the notes louder the harder you hit the key.

AFTER – "After" means that the amount of effect is determined by how hard you press a key **after** it hits bottom. Thus, AFTER BILLIANCE [44] and AFTER LEVEL [45] are similar to INITIAL BRILLIANCE and LEVEL, but are sensitive to key pressure rather than key stroke velocity.

Some instruments are not touch sensitive, such as a harpsichord. Thus, you would keep these sliders at minimum to simulate realistic playing. Other instruments change more in level than in tone when you play harder, such as a piano. Still other instruments change as much in tone as in level, such as wind instruments. To simulate tightening the embouchure on a reed, you might use AFTER BRILLIANCE.

[46] **MEMORIES** – The memories are beneath a hinged cover which bears a simplified block diagram of the CS-80. (A detailed block diagram and a copy of the simplified block diagram may be found in Section V.)

Memories 1 through 4 are miniaturized versions of programmable panels I & II, minus the detailed labeling. Once you develope a patch you want to save, you can transfer the settings to a memory by visually lining up the memory's sliders and switches as closely as possible to those on the Panel. "Fine tuning" the memory patch against the panel-programmed patch is easier if you follow this guideline:

1. If you are using PANEL II, transfer it to MEMORY 1 or 2.
2. If you are using PANEL I, transfer it to MEMORY 3 or 4.
3. Press the TONE SELECTOR buttons [3] corresponding to the PANEL and MEMORY involved.
4. Compare the two patches by moving the MIX lever [4] from I to II.

If you've read the previous section and experimented with the PANEL controls, you probably understand what they do, but how do you go about programming a specific sound you want to hear?

There are many approaches to getting a sound, and the one we suggest here is no better or worse than others; if another technique works for you, use it. Before you attempt to program a given sound, turn off all effects not on the Programmable panel . . . that is, begin with the nominal settings pictured in the cover illustration.

General Approach

First, think of a sound . . . get it in your mind. Once you "hear" it in your head, you can begin to analyze what basic musical elements make up that sound, and therefore how to set up the same basics with the synthesizer.

Three basic elements make up any musical sound: pitch, timbre and volume. These correspond to the VCO, VCF and VCA sections. If you want to get a sound resembling an acoustic instrument, consider how that instrument generates sound.

What is the basic pitch, the playing range? Use the FEET selector [5] to set the keyboard to an appropriate pitch range.

What is the basic waveform or tone? You set this with the VCO. If the sound resembles woodwinds (reed instruments), use the SQUARE WAVE [23] and try different PULSE WIDTH [22] settings. For strings, add PULSE WIDTH MODULATION [20 & 21] or use SAWTOOTH [24]. SAWTOOTH is also useful for brassy sounds. NOISE [25] alone is good for wind, thunder, sizzle and other special effects. It can be mixed sparingly with other VCO sounds to add breath. Use SINE WAVE [36] for colorless or "pure" sounds.

What is the timbre, the tone color? This is set with the VCF. An "open" sound with lots of harmonics, like clarinet, suggests the HPF [26] is LOW and the LPF [28] is HIGH. A sound with body but less brilliance, like piano, suggests the HPF is still LOW, but LPF is closed down partially. A very rich, but muted sound, like a string bass, suggests the HPF is still LOW, but LPF is closed down quite a ways toward LOW.

Step-by-Step Examples of Programming

We have presented a handful of patches for you to try, along with very brief explanations of why the controls are set as they are. Because everyone conceives of and plays sounds differently, and because normal component tolerances make it impossible to give "absolute" control settings, you'll want to vary the settings to "fine tune" the sound to your taste. Become aware of what each control does to the patch, and you will soon find that you don't need to write down patches . . . you'll instinctively know how to set all the controls. Remember that the overall BRILLIANCE control [7] and RESONANCE control [8] may be used to further change a patch once it has been set.

NOTE: The patches shown for Strings, Harpsichord, Flute, and other sounds which also appear as Preset Patches are non-identical to the presets. There are many different ways to "get a sound," and the programming examples shown here were chosen because they fall in a logical progression with a minimum change of control settings. Orchestral instruments are used only because they provide a good frame of reference; the CS-80 can be used to make an infinite variety of unique sounds once the basic principles are understood.

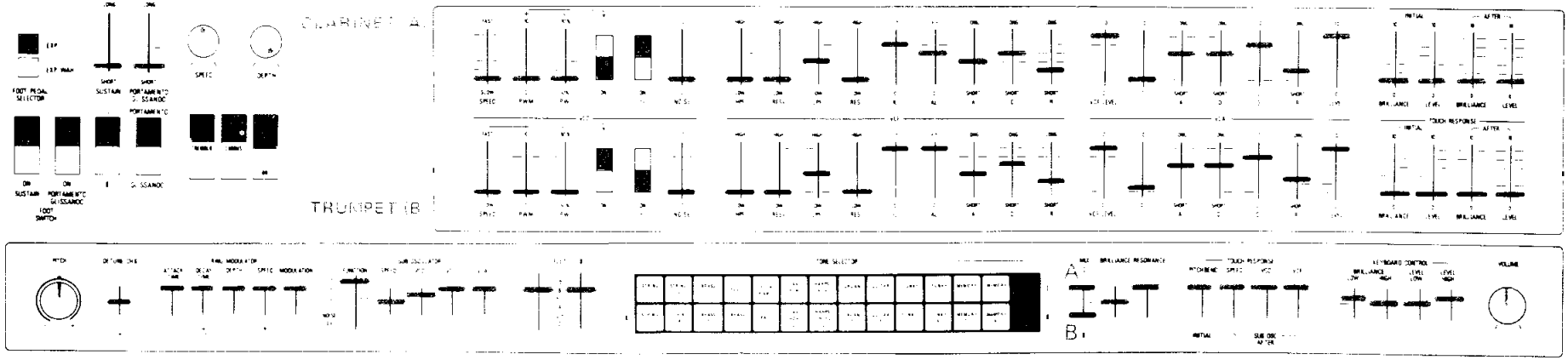
NOTE: All panel settings remain unchanged from one patch to the next, unless otherwise noted. Those settings which do change from the previous patch are marked in color on the patch diagrams.

Clarinet

A square wave [23] with 50% pulse width [22] is used because it simulates a single reed instrument by generating odd-order harmonics (3rd, 5th, etc.). The LPF slider [28] should be set so the sound is clarinet-like; wide open would be too bright, and mid way up is about right. VCF envelope [30-34] is used because VCA envelope alone [37-40] would sound too much like a calliope or a keyboard instrument. Moderate VCA envelope Attack [37] and Release [40] times simulate the gradual build up and collapse of the air column in a true clarinet. Vibrato is provided by modulating the VCO with a sine wave in the Sub Oscillator [11]. The VCO lever should first be fully engaged so the maximum effect can be heard while the speed is set. After the desired vibrato speed is achieved, the VCO modulation should be reduced for a more realistic effect (excess vibrato often leads to a synthetic sound). You may wish to advance the Touch Response Section [42-45] Initial or After Brilliance and Level sliders, in which case it is probably a good idea to lower the LPF slider slightly.

Trumpet

Change from square wave to sawtooth wave [24] to include even-order harmonics for a richer sound. The rest of the patch is almost identical to the clarinet, except the VCF envelope's IL [30] and AL [31] sliders are moved all the way up; this starts the filter cutoff at a lower frequency and moves it to a higher frequency than before. The result is a wider change in harmonic content which is more trumpet like. For brass sounds that are "darker" than this trumpet, use slightly longer attack [32 & 37] and release times [34 & 40], and lower the LPF slider [28] somewhat. For more of a coronet or "wah" sound, raise the RES_L control [29].



Flute

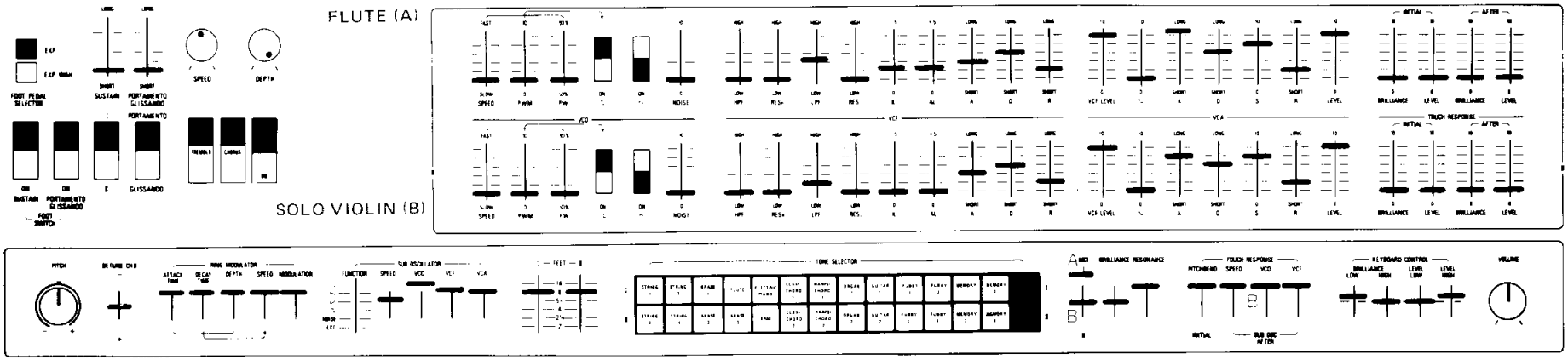
The sawtooth is still an appropriate waveform, but fewer harmonics are desired, so the LPF slider [28] should be lowered. As harmonics are cut out by lowering the LPF filter cutoff, the waveform actually begins to resemble a sine wave. It is necessary to turn up the overall Volume [2] because much of the sound is being filtered out. VCA envelope is used exclusively, so the IL [30] and AL [31] sliders are lowered all the way to "turn off" the filter envelope (A, D & R then have no effect, and may be left in position for other patches). The major distinction between the trumpet and flute, other than filter cutoff frequency, is the change in Sub Oscillator modulation [11]; VCO modulation should be greatly reduced or turned off altogether, and instead replaced by VCF modulation.

Another way to program a flute is to completely ignore the VCO and VCF Sections, lower the VCF slider [35] and use sine wave [36] instead. VCA envelope then defines the note exclusively. However, no instrument is quite as perfect as the sine wave, and this patch tends to sound artificial. The quasi-sine wave generated with a heavily filtered sawtooth wave tends to be more realistic.

Solo Violin

This patch is almost identical to the flute patch, with the addition of VCO modulation. Overall tone may be changed somewhat with the Brightness lever [7]. The sub oscillator with sine wave VCF modulation, plus Touch Response VCO, give realistic vibrato only on those notes when it is needed.

NOTE: Consider the foregoing patches and what changes occurred in the sound as relatively few changes were made on the programming panel. Observe that a different waveform or IL-AL setting account for the most dramatic changes.

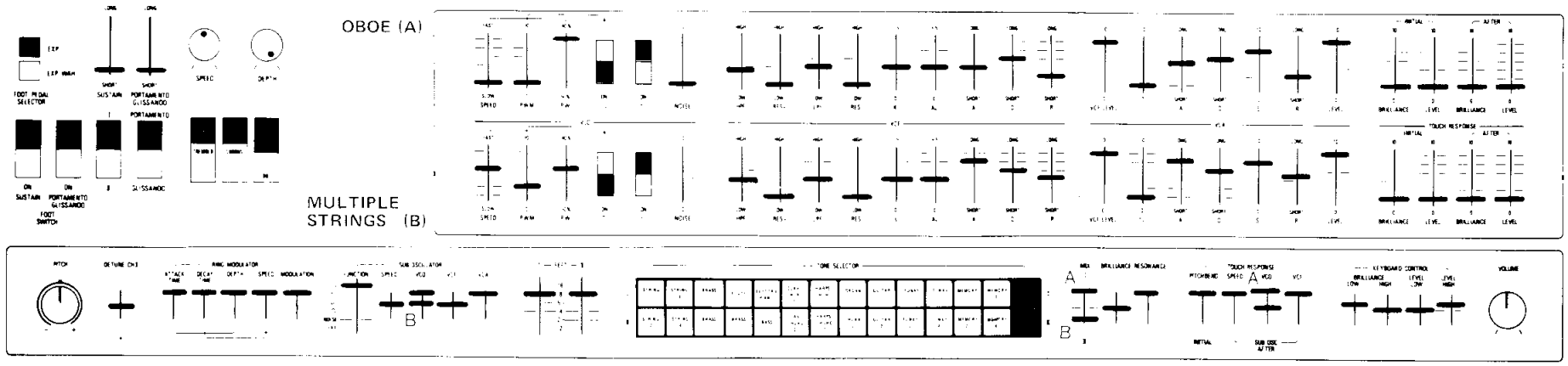


Oboe

Turn off the sawtooth wave and switch to the square wave [23]. Use 90% pulse width [22] which eliminates specific harmonics, as would be the case with a double-reed instrument. The LPF slider [28] is raised slightly to allow higher harmonics to be heard, and HPF [26] is also raised to obtain a thinner sound by attenuating some of the fundamental frequency (this creates a narrow bandpass). IL and AL [30 & 31] are raised to introduce some filter envelope which simulates tonal changes that occur due to changing embouchure. Some low pass resonance [29] may be added if desired, but AL [31] should then be lowered to avoid a "wah" sound.

Multiple Strings

Temporarily turn off the Sub Oscillator VCF modulation [11] and Touch Response VCO [12] so that the rate of pulse width modulation can be easily heard. Reduce the pulse width [22] to about 70%, and set pulse width modulation [21] at maximum so that the speed [20] can be determined. Once the speed is set, reduce the amount of PWM to taste. Now vibrato can be reintroduced by means of the sub oscillator VCO lever [11]. The mixture of these two types of modulation, PWM and sub oscillator VCO, give the effect of more than one instrument playing. For even richer strings, repeat this same patch on the second panel, setting one panel's Feet slider [5] at 16' and the other at 8', and detuning channel II slightly [6]. On the channel set at 16', the amount of PWM [21] and its speed [20] should be lowered because lower pitched strings do not have as much modulation as shorter strings. The VCF and VCA attack times [32 & 37] and release times [34 & 40] are lengthened to simulate the bowing of strings as opposed to the quicker initiation of sound in an oboe.



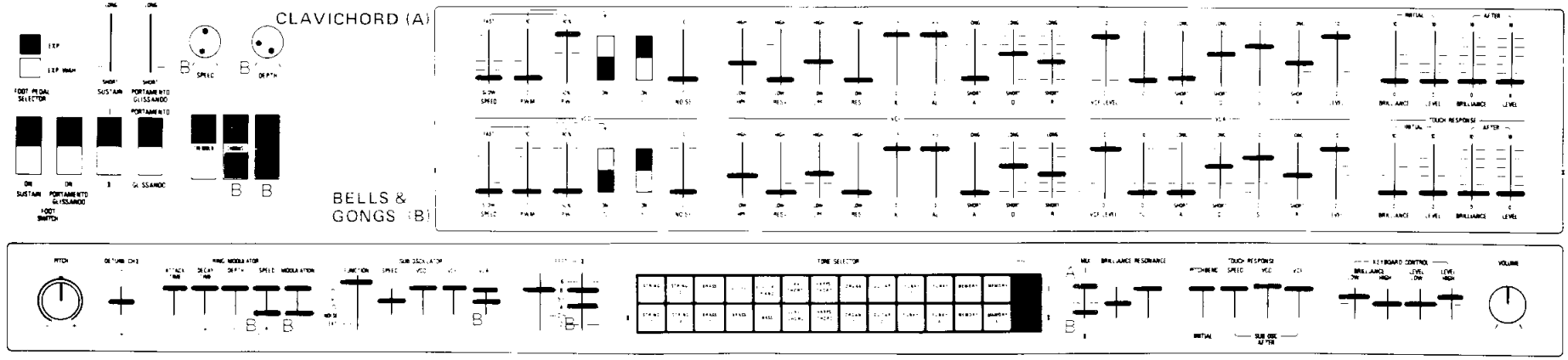
Clavichord

Lower the PWM slider [21] all the way, and raise the pulse width to 90% [22]. Remove all sub oscillator modulation. VCF and VCA envelope Attack times [32 & 37] are both set at minimum for a plucked sound. While either VCF or VCA attack could be used alone, together they provide a more natural sound, simulating the change in harmonics that occurs as a string is plucked and then settles down (VCA envelope alone sounds more synthetic). Resonance [29] may be added, but the AL should then be lowered somewhat to avoid a "wah" sound.

Bells & Gongs

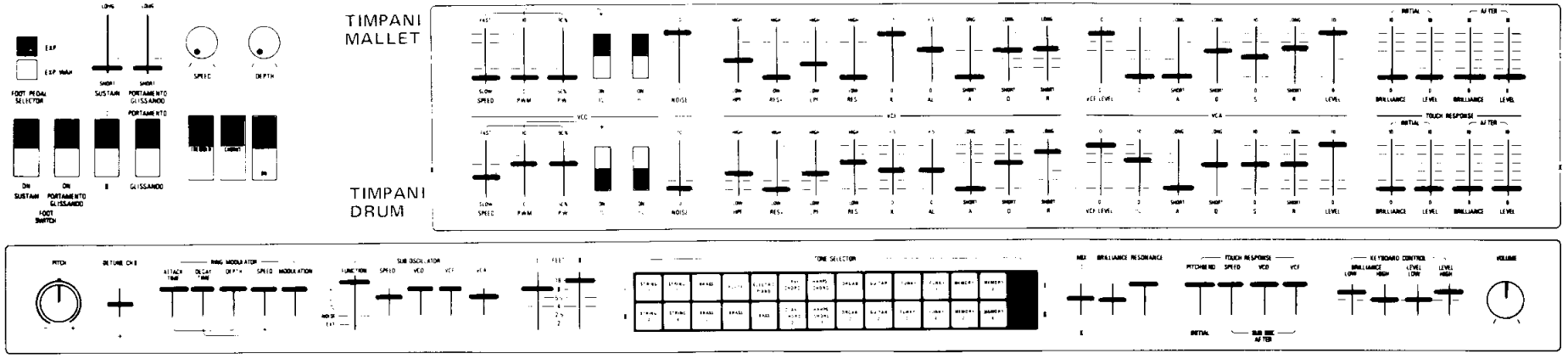
Move the pulse width [22] back to 50%, and fully engage the Ring Modulator [16] Speed and Modulation controls. If desired, add sub oscillator [11] modulation of the VCA, and/or Chorus [15]; with Chorus, use only moderate Depth. For bells, the Feet selector [5] should be set at a higher pitch, 4' or above; 8' or below is useful for gong sounds (Brilliance [7] should also be adjusted for gongs).

NOTE: In the last four patches, the filter cutoff settings have remained approximately the same (band-pass filter). The vast majority of changes in sound were due to changes in square wave duty cycle (pulse width) and in envelope settings.



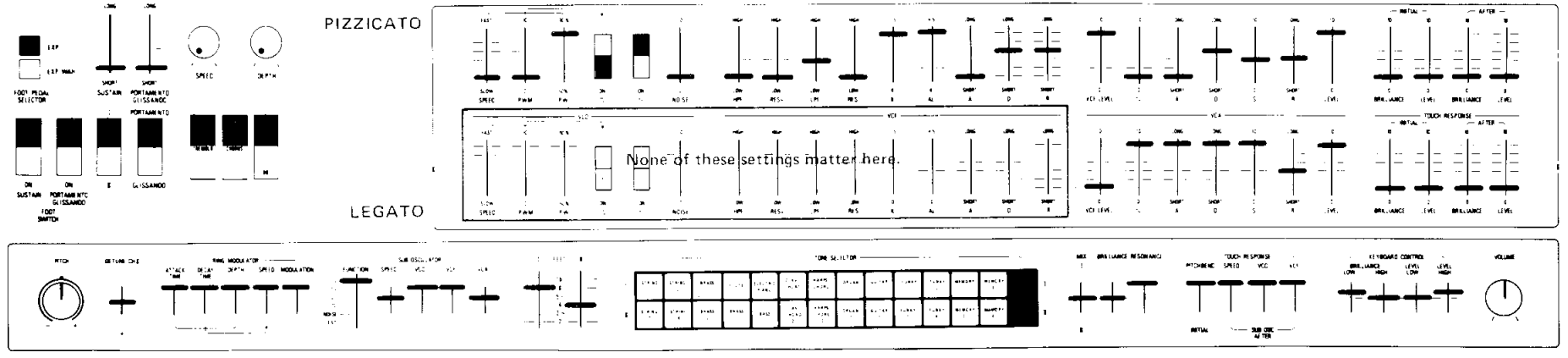
Timpani

Two voices are used at once for this patch (and the next one), so program panels I and II. Panel I is for the initial "mallet" sound. Instead of the waveform used in bells above, turn off square and sawtooth, and use only Noise [25]. The Ring Modulator [16] should also be turned off. HPF and LPF [26 & 28] are set to give a narrower bandpass, and AL [3] is lowered to avoid letting the sound get too thin. The VCF and VCA Release time [34 & 40] are longer, and VCA Sustain level [39] is lowered to simulate the die away of the mallet sound. Panel II is used for the "drum" sound. Sine wave [36], sawtooth [24] and a square wave [23] are used together, and the square wave is set at 75% pulse width [22] with moderate pulse width modulation [21] at a slow speed [20]; the several waveforms give a richer sound, with the sine wave emphasizing the fundamental. Set Feet II [5] at 16' (the Noise in Panel I is not affected by the Feet setting). The filter cutoffs are the same as Panel I, but resonance is added and the VCF envelope is changed. The entire VCA envelope is different, since the head resonates long after the mallet is gone. The addition of sub oscillator VCA modulation [11] to the pulse width modulation on Panel II emulates the reverberant sound of the drum body. This 2-voice effect could be simulated with just one channel.



Pizzicato & Legato

This patch simulates the effect of one instrument playing quickly (pizzicato) using fast attack and decay times, and of a second instrument playing slowly (legato) using slower attack and decay times. The patches can be seen clearly on the diagram. Observe that Panel II uses sine wave [36] and VCA exclusively. Notice when you play that quick key strokes give a "plucked" sound, and holding keys down longer allows a second, completely different voice to develop.



USING THE PROGRAMMABLE PANELS TO DUPLICATE THE PRESET PATCHES

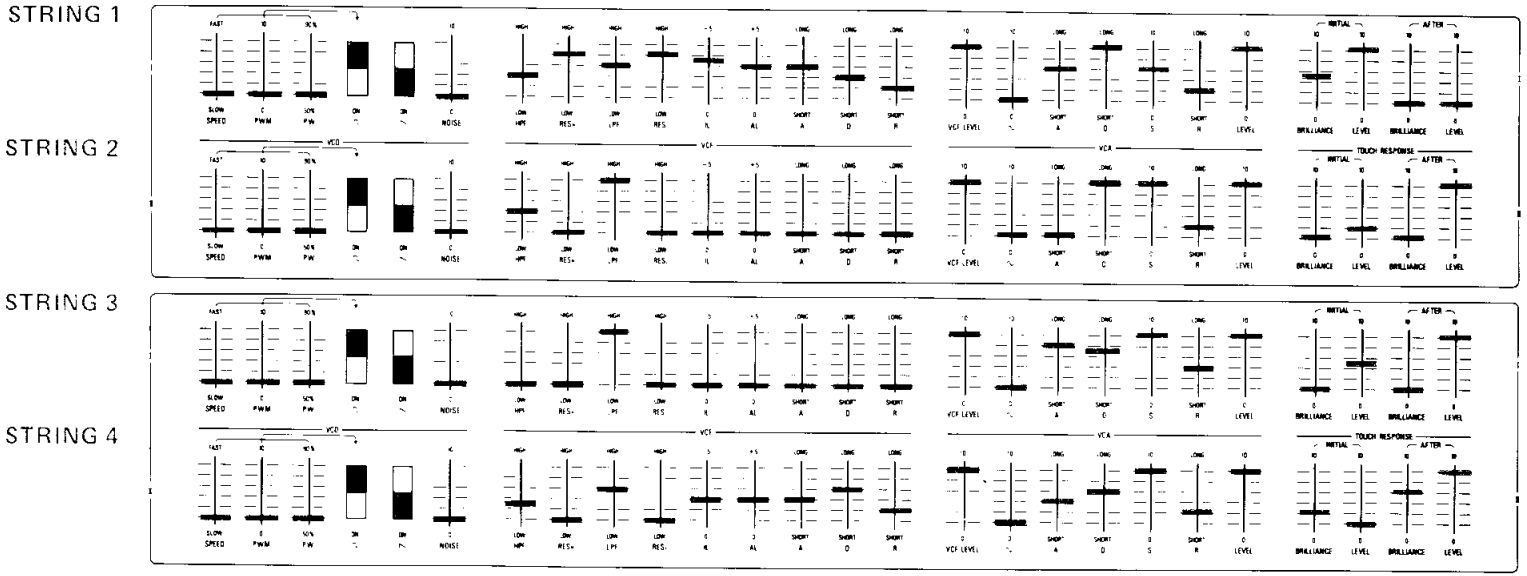
As stated elsewhere in this manual, the preset patches were all derived from settings of the programmable panels. Normally, there would be no need to duplicate the presets by programming the panels. However, setting up the panels to emulate the presets can serve as a good point of departure for developing your own patches.

The following diagrams of programmable panel settings correspond to the 22 preset patches. Some settings are very critical, and a slight change of adjustment can make the difference between a poor match or a perfect match with the equivalent preset's sound. The fine tuning of controls necessary to match the preset is very relevant to making your own entirely unique patches because you experience how to subtly manipulate the controls for specific effects.

Bear in mind that there are several ways to "A-B" compare the presets to the sounds you program. For greatest accuracy, we suggest using the panel which is on the same channel as the preset you wish to duplicate. For instance, if you want to program the Flute, use the Channel I panel; for Bass, use Channel II, etc. This means that the same 8 oscillators, filters and envelope generators will be producing the sound. If you use a Channel I preset with a Channel II panel, or vice-versa, a completely different set of oscillators, filters and envelope generators are creating each sound.

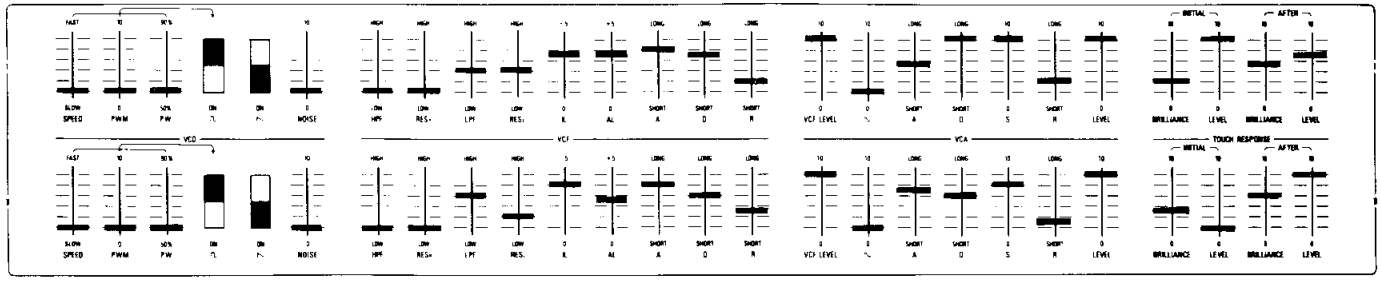
A few patches are more difficult to fine-tune than the others, due to a combination of a critical pulse width adjustment, HPF and LPF settings that yield a bandpass filter, and VCF envelope. The "tricky" patches are: Clavichord 1, Guitar 1 & 2, and Funky 1 & 3; it is probably a good idea to return to these after you have worked through the other patches.

1. Tune the patches using the middle of the keyboard (FEET selector [5] at 8'). This allows you to hear the fullest spectrum of overtones for more accurate adjustments.
2. If the setting involves adjustment of Pulse Width [22], first adjust that control for the closest sound match.
3. Adjust the filter settings [26-29]: LPF, HPF, RESI and RESh. Press the keys slowly and lightly so that any Touch Response effects do not commence. (NOTE: If VCF envelope [30-34] is in use, also see Step 4 below.) If Touch Response After-Level [44] and After-Brilliance [45] are used, press the keyboard lightly when first setting the filter. Then press the keys harder and set After-Level and After-Brilliance accordingly. It may then be necessary to retouch the filter settings.
4. If VCF envelope (IL and/or AL) is in use, hold down a key until the filter settles to a steady, unchanging cutoff. Then adjust the filter LPF [28] and HPF [26] controls.
5. If VCF AL [31] is used alone without IL, adjust it to produce the brightest sound obtained in that patch; then readjust the LPF [28] and HPF [26] sliders as required.
6. If Initial-Brilliance [42] and Initial-Level [43] are used, strike the keys quickly to determine whether the effects are identical in the preset and programmed patch; adjust as required.
7. If the program and panel patches are the same, then they should react identically to exaggerated settings of the overall Brilliance [7] and Resonance [8] controls. One at a time, set these two controls all the way up, and all the way down, comparing the patches. If differences in sound are observed at extreme settings, adjust the corresponding controls on the Panel to re-match the preset and programmed sounds: RESh and/or RESI at extreme Resonance settings; HPF and/or LPF at extreme Brilliance settings.



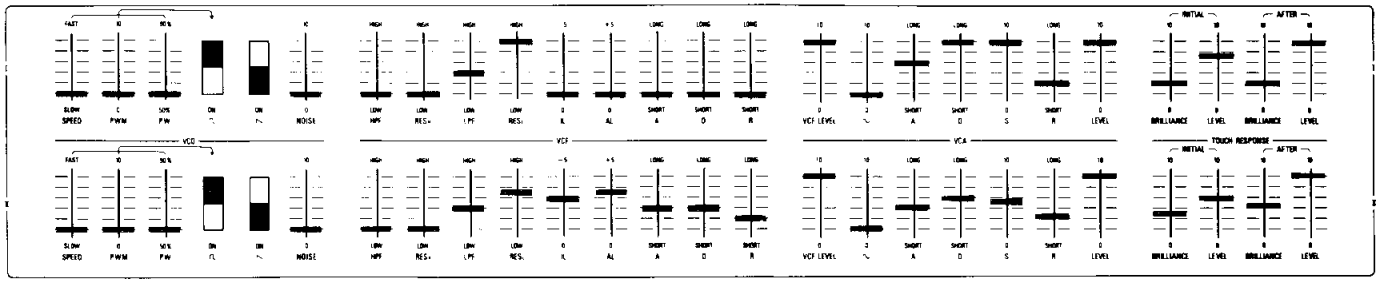
BRASS 1

BRASS 2



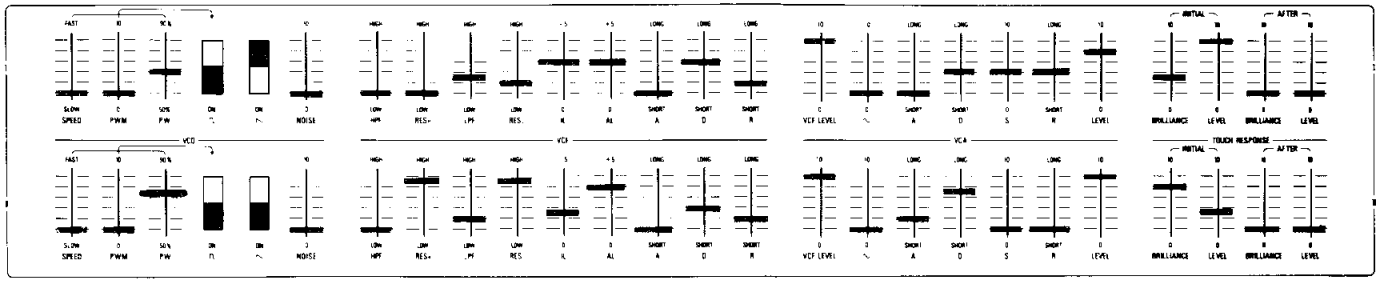
FLUTE

BRASS 3



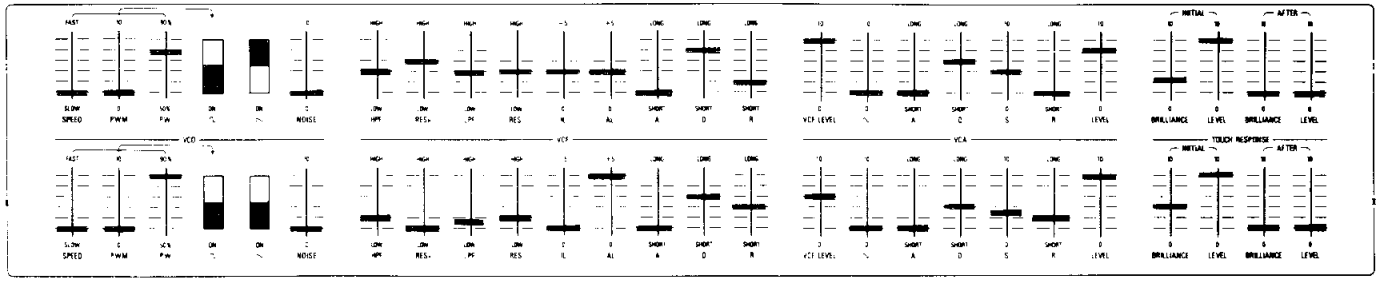
ELECTRIC PIANO

BASS



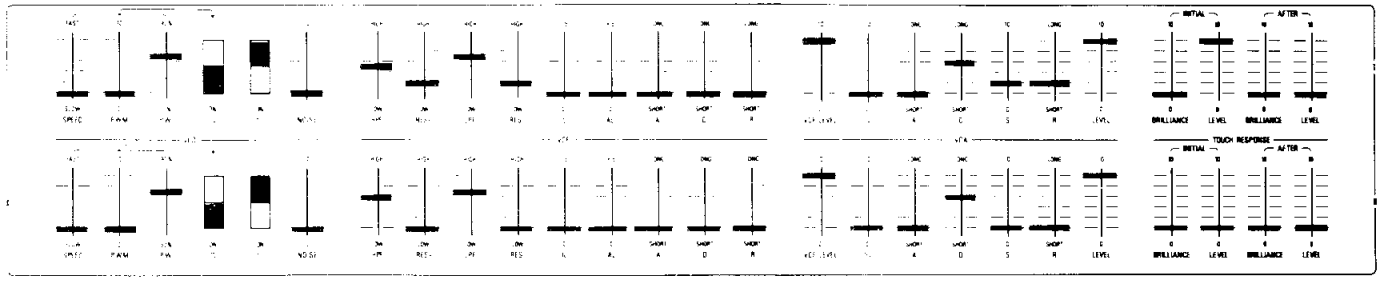
CLAVICHORD 1

CLAVICHORD 2



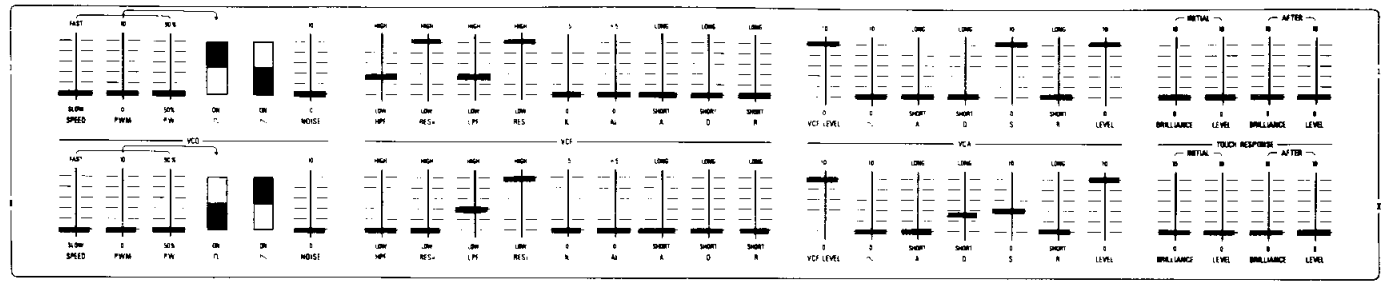
HARPSICHORD 1

HARPSICHORD 2



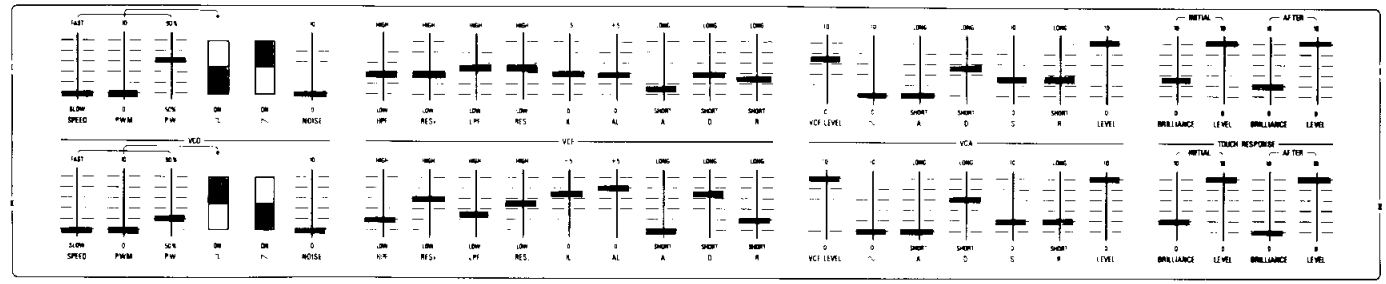
ORGAN 1

ORGAN 2



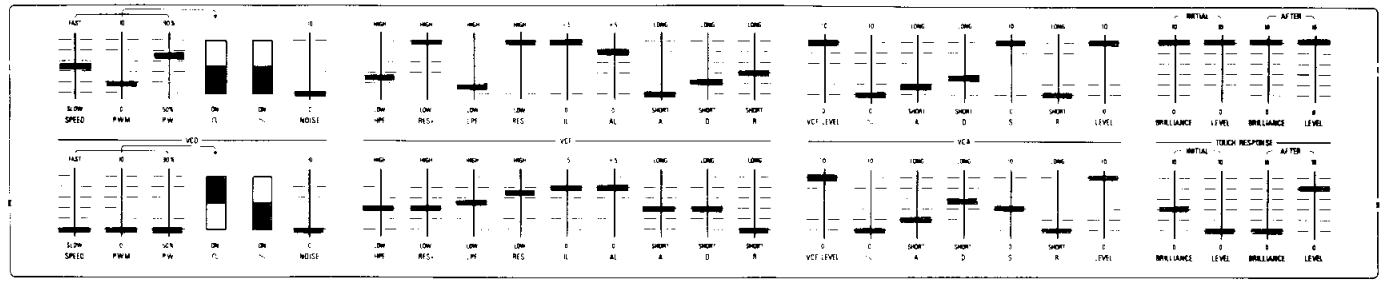
GUITAR 1

GUITAR 2



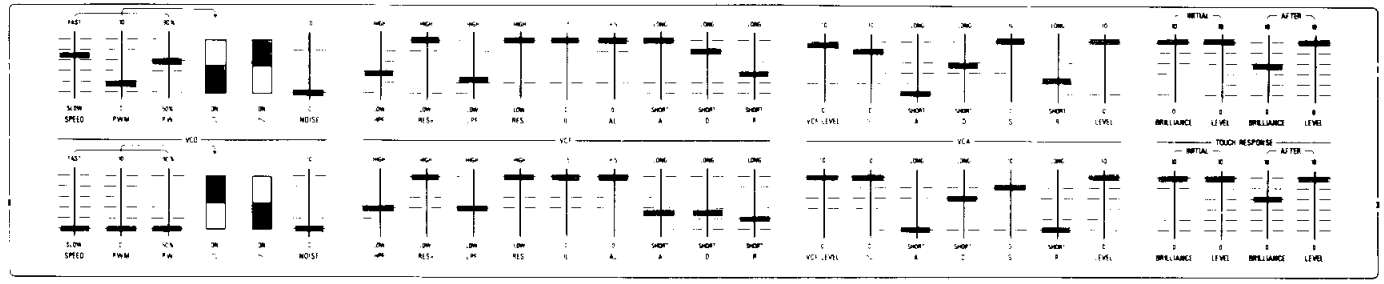
FUNKY 1

FUNKY 2



FUNKY 3

FUNKY 4



Sections II & III provide adequate information to understand all CS-80 controls and functions. You need not read this section to know how to play your synthesizer. However, Section IV does offer alternative and more comprehensive explanations for the benefit of experienced synthesists.

Overall Picture

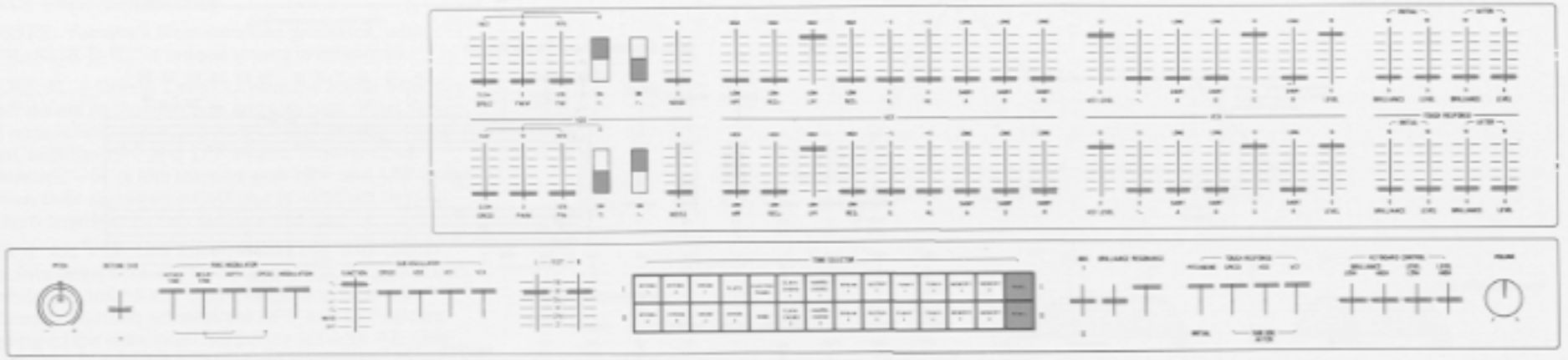
The CS-80 is an eight note polyphonic synthesizer. However, there are really 16 main oscillators divided into two ranks (two channels), both of which are operated simultaneously by the keyboard. When you play one key, two voices are always generated, and a mix control then lets you select any blend of the two voices to feed the mono (General) output. A phasing-type tremolo/chorus circuit splits the General output and feeds it to two different jacks, Left and Right, for rotary speaker effects. Each channel contains eleven factory preset patches, one programmable panel and two miniature versions of the panel that serve as memories for additional voices you wish to store. Thus, when you have programmed the panels and memories, you can select from 28 basically different sounds at the touch of a finger.

The keyboard, and all controls other than the programmable panels and memories, affect both channels simultaneously.

The Programmable Panels

Since PANEL I and PANEL II [20-45] are identical, we use both in the following examples. By moving the MIX lever [4] between I to II, you can quickly hear the differences in similar patches programmed on PANEL I and II. If you wish to hear what the PANEL controls do as you read about them, set the MIX control [4] at the I or II (depending on which PANEL you are using), press the PANEL buttons on the Tone Selector [3], turn up the VOLUME [2], and be sure the FOOT CONTROLLER is flat (maximum volume).

NOTE: Before starting, it is advisable to set all other controls at their nominal positions, as shown, because many controls and functions are interrelated.



VCO (Voltage Controlled Oscillator)

[20] **SPEED** – Adjusts the rate of pulse width modulation of the square wave, provided the PWM lever is moved away from its "0" position.

[21] **PWM** – Adjusts the depth of Pulse Width Modulation (the deviation in square wave duty cycle). A "0" setting yields no modulation.

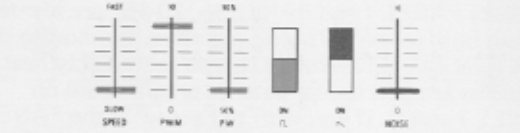
[22] **PW** – Sets the basic duty cycle of the square wave from a symmetrical wave (50%) to a narrow pulse (90%).

[23] **SQUARE WAVE** – Turns ON the square wave generating circuits when the switch is rocked forward.

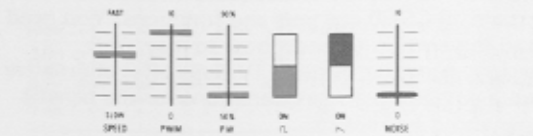
[24] **SAWTOOTH WAVE** – Turns ON the sawtooth wave generating circuits when the switch is rocked forward.

[25] **NOISE** – Introduces white noise into the VCO output as the slider is moved up (#10 is maximum noise).

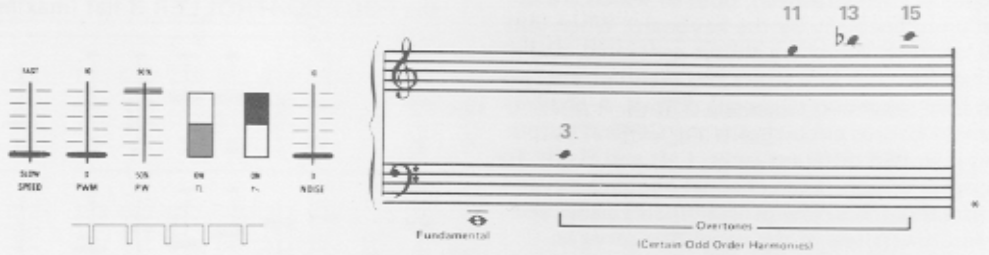
NOTE: The numbers above the notation to the right indicate the overtone number. All notes (except pure sine wave notes) have overtones which are not heard separately, but which give the note its tonal character. The first overtone is the second harmonic of the fundamental (i.e., twice its frequency), etc. To hear the individual overtones, set RES_H [27], RES_L [29] and RESONANCE [8] at maximum, and gradually move LPF [28] down.



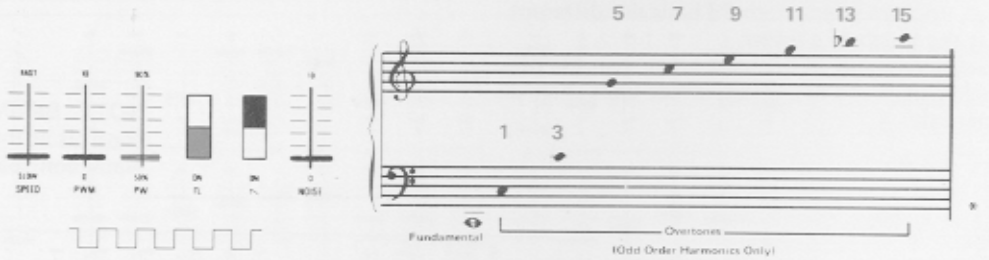
Slow Pulse Width Modulation



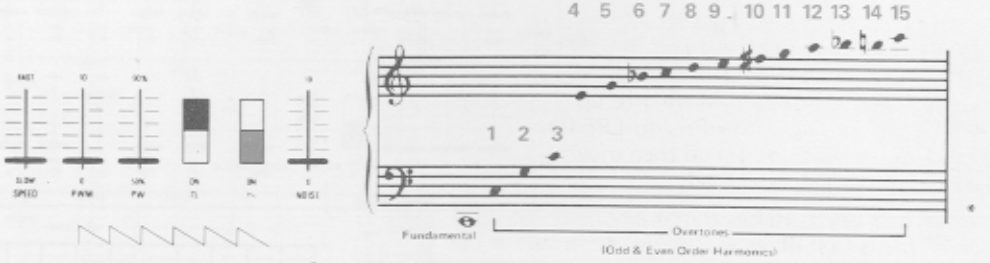
Fast Pulse Width Modulation



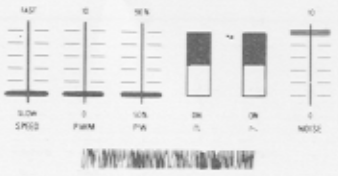
90% Square Wave Pulse Width



50% Square Wave Pulse Width



Sawtooth Wave



Noise

*NOTE: The fundamental (C) is the note played, and the smaller notation to the right suggest the harmonics (overtones) of that note, all of which are simultaneously generated by the VCO.

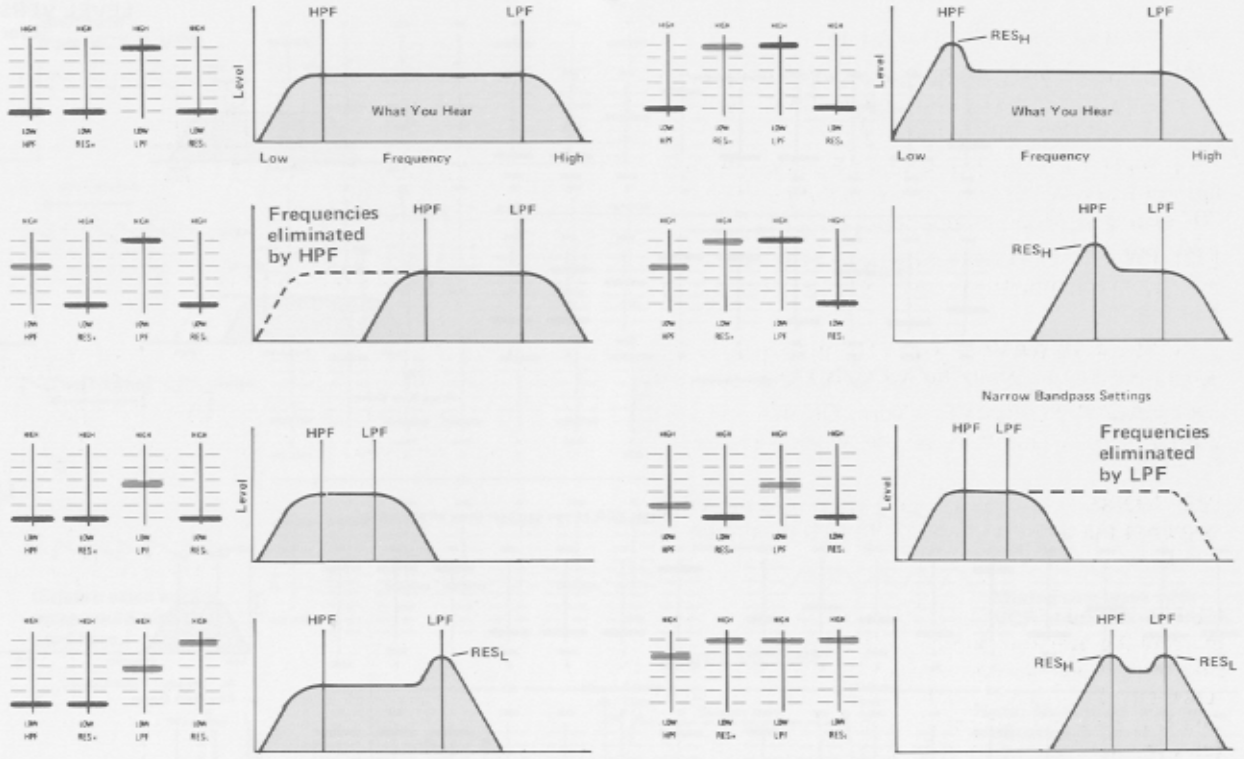
VCF (Voltage Controlled Filter)

[26] **HPF** – Sets the cutoff point of the High Pass Filter (low cut filter). With the slider at LOW, the cutoff frequency is lowest (filter wide open), and at HIGH the cutoff frequency is highest (filter closed).

[27] **RES_H** – Sets the Resonance (Q) at the cutoff point of the High Pass Filter. The HIGH setting gives maximum resonance.

[28] **LPF** – Sets the cutoff point of the LOW Pass Filter (high cut filter). With the slider at LOW, the cutoff frequency is lowest (filter closed), and at HIGH the cutoff frequency is highest (filter wide open).

[29] **RES_L** – Sets the Resonance (Q) at the cutoff point of the Low Pass Filter. The HIGH setting gives maximum resonance.



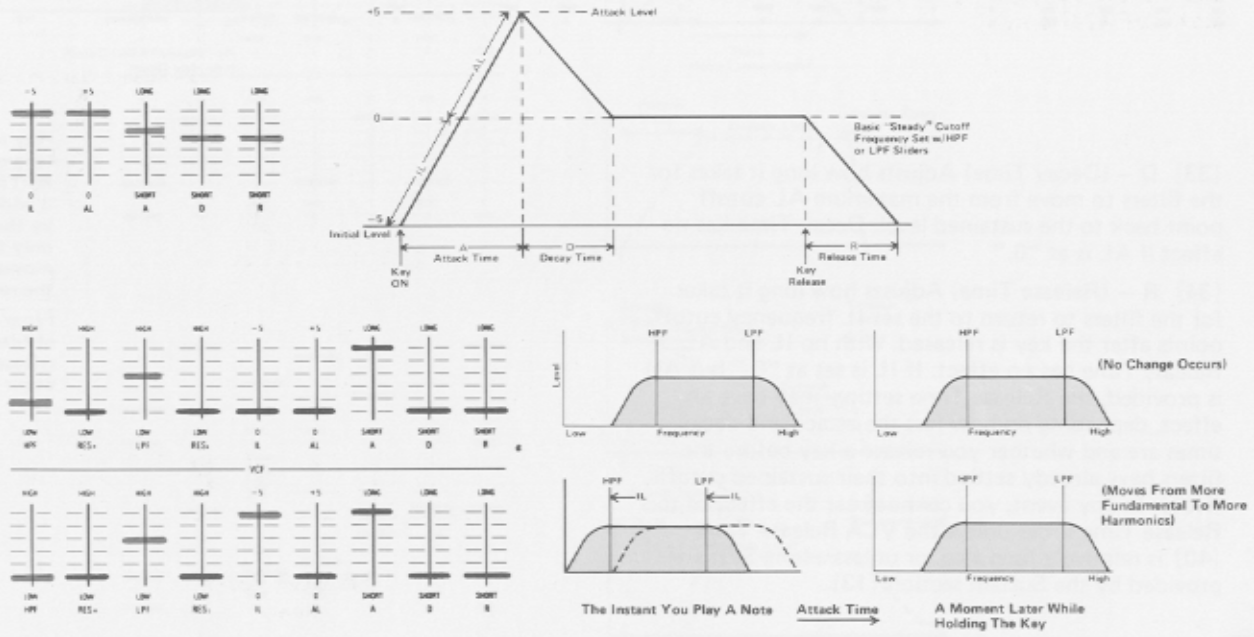
VCF Envelope Generator

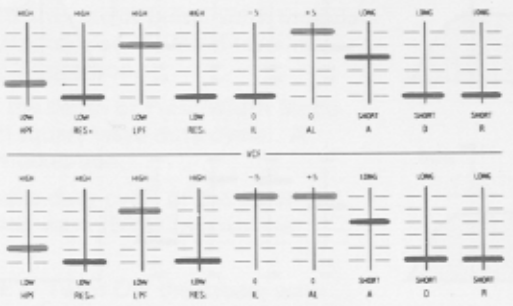
NOTE: Yamaha's filter envelope generator, with "IL-AL-A-D-R," is unique among synthesizers.

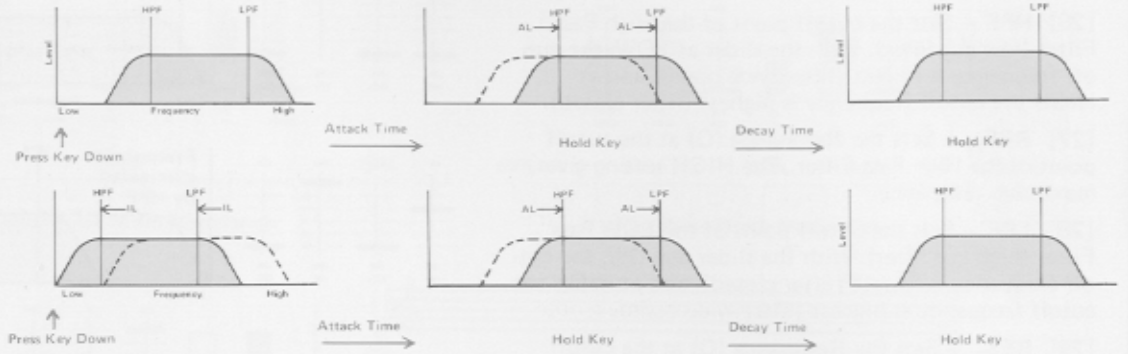
[30] **IL** – (Initial Level) Lowers the initial filter cutoff points of the high pass and low pass filters (when a note is first played) relative to the "steady" levels set with the HPF and LPF sliders. Moving IL up toward "–5" is like starting with HPF and LPF lower than their sustained cutoff points and then moving them together to their sustained levels.

[31] **AL** – (Attack Level) Raises the filter cutoff points when a note is first played. The AL rise occurs while you hold a key down, beginning from the "steady" cutoffs set with the HPF and LPF sliders, going to the maximum frequency set with AL slider, and then returning to the "steady" cutoffs.

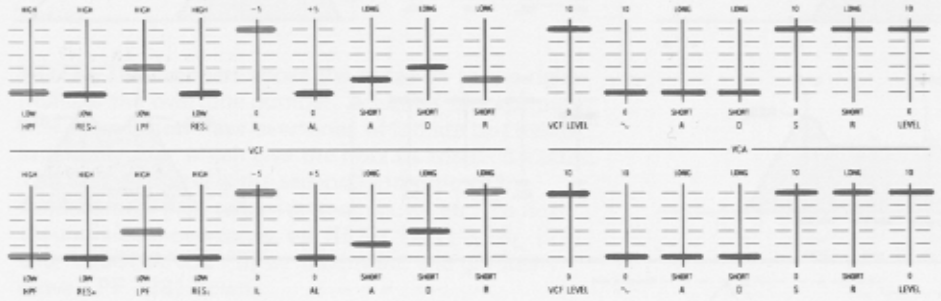
[32] **A** – (Attack Time) Adjusts how long it takes for the filters to move from the minimum IL to the maximum AL cutoff frequencies when either or both of these sliders is moved up from "0". Attack Time has no effect if IL and AL are both at "0".

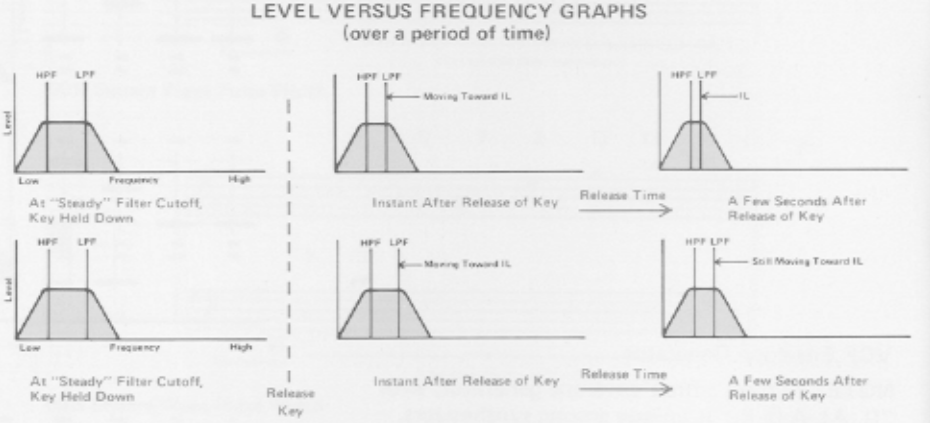






Reset VCA so you can hear these effects better.





[33] **D** – (Decay Time) Adjusts how long it takes for the filters to move from the maximum AL cutoff point back to the sustained level. Decay Time has no effect if AL is at "0."

[34] **R** – (Release Time) Adjusts how long it takes for the filters to return to the set IL frequency cutoff points after the key is released. With no IL and AL, Release Time has no effect. If IL is set at "0," but AL is provided, the Release Time setting may have an effect, depending on how fast the attack and decay times are and whether you release a key before the filters have already settled into their sustained cutoffs. (Note: In any event, you cannot hear the effect of this Release Time slider unless the VCA Release Time [40] is relatively long also, or unless a long Sustain is provided by the Sustain section [13].

Play a series of rapid staccato notes and several long chords for each of these patches.
NOTE: In the lower illustrations, the HPF slider is wide open, so the lower filter cutoff (shown by the HPF lines) cannot move any lower. Therefore, only the upper cutoff (shown by the LPF lines) moves, the rate of motion being determined by the release time.

From left to right the graphs are only a few samples of filter characteristics at specific times; relative to release of the key. The filter changes actually occur gradually.

VCA (Voltage Controlled Amplifier)

[35] **VCF LEVEL** – Adjusts the amount of input to the the VCA provided by the VCO's square wave, sawtooth wave and/or noise generators and filtered by the VCF.

[36] **SINE WAVE LEVEL** – Adjusts the amount of input to the VCA provided by the VCO's sine wave generator. Since the sine wave does not go through the VCF, it may be mixed in any proportion with the VCF-processed signals as it enters the VCA.

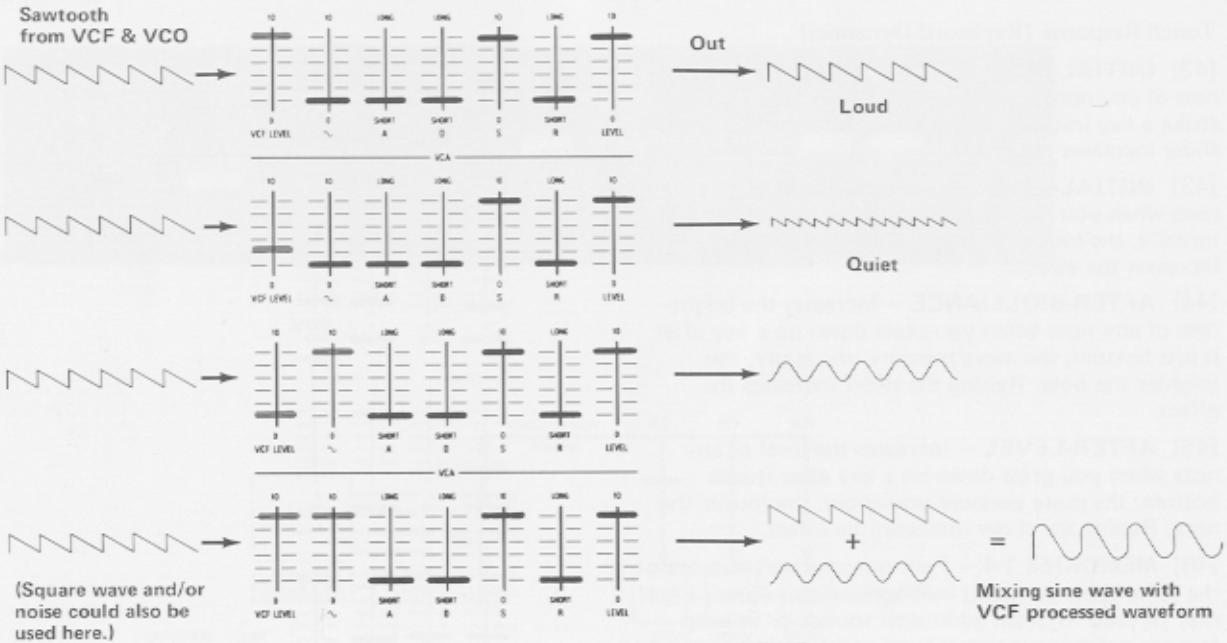
[37] **A** – (Attack Time) adjusts how long it takes for the level to increase to a maximum each time a note is played.

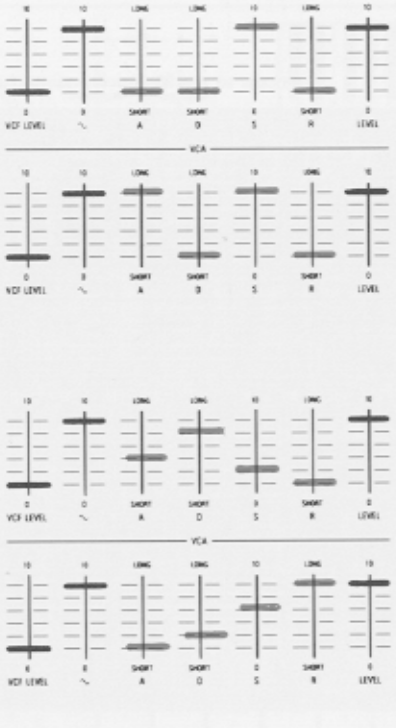
[38] **D** – (Decay Time) Adjusts how long it takes for the level to decrease from a maximum to a steady (sustained) level each time a note is played.

[39] **S** – (Sustain Level) Adjusts the fixed level of a note that is steady (after attack and decay) so long as a key is held down.

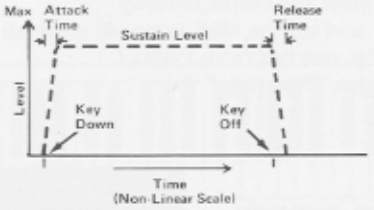
[40] **R** – (Release Time) Adjusts how long it takes for the level to die to silence after you release a key. The effect is like the sustain time provided by the controls in [13].

[41] **LEVEL** – (VCA Level) Sets the highest level attained by the VCA, thus affecting the sustain level and the maximum attack level. If VCF LEVEL [35] and SINE WAVE LEVEL [36] are thought of as input mixing controls, then this slider serves as the VCA's master output control.

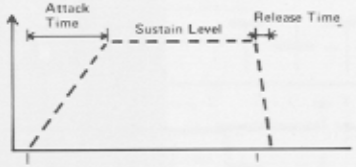


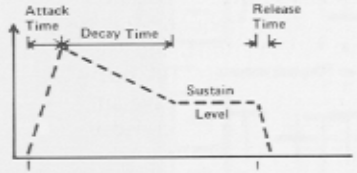


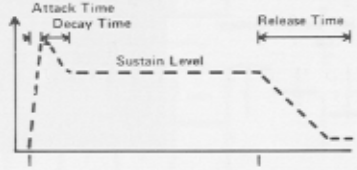
LEVEL VS TIME



Note: Maximum level set by Sustain & Level







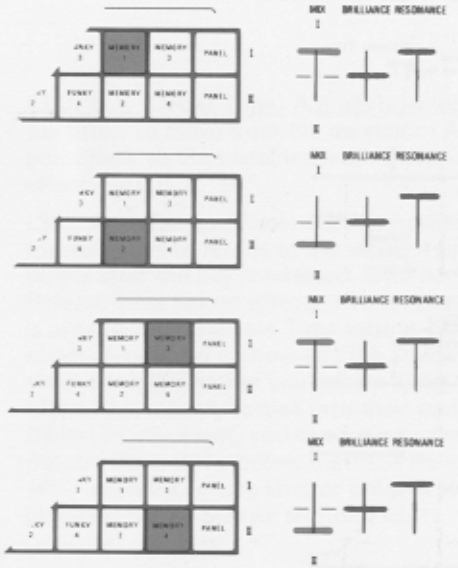
[42] **INITIAL-BRILLIANCE** – Increases the brightness of any note when you play harder; the faster you strike a key initially, the brighter the note. Raising the slider increases the effect.

[43] **INITIAL-LEVEL** – Increases the level of any note when you play harder; the faster you strike a key initially, the louder the note. Raising the slider increases the effect.

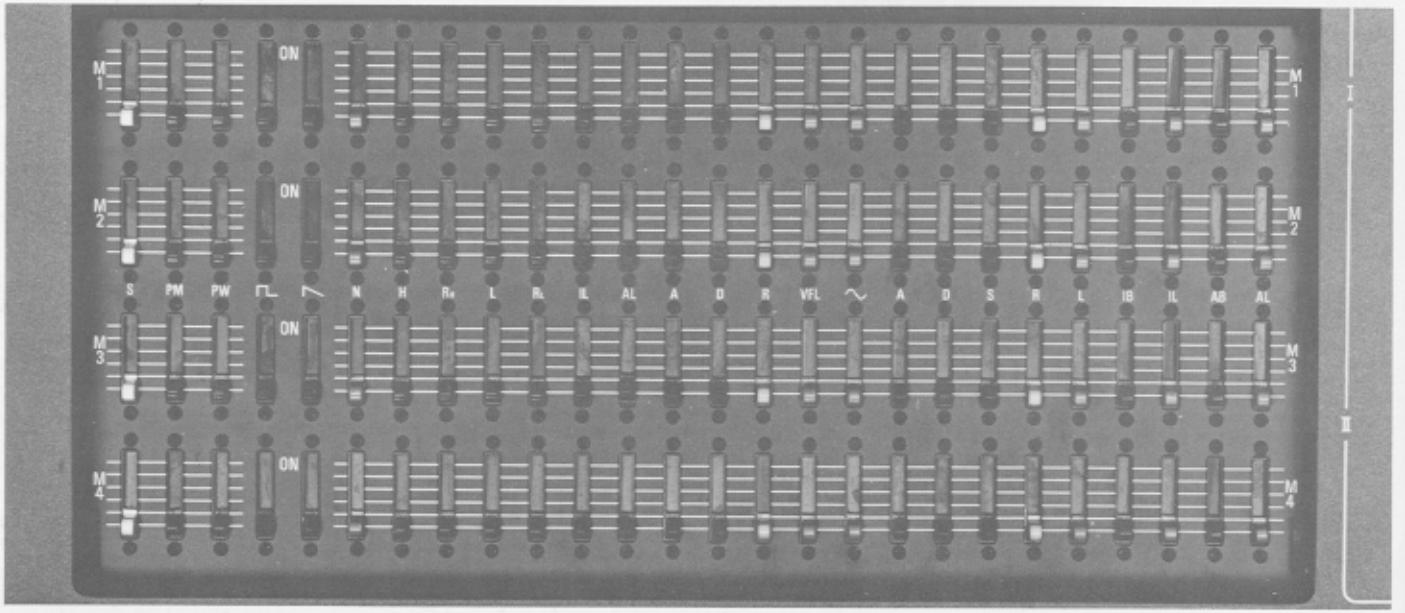
[44] **AFTER-BRILLIANCE** – Increases the brightness of any note when you press down on a key after it hits bottom; the more pressure you apply, the brighter the note. Raising the slider increases the effect.

[45] **AFTER-LEVEL** – Increases the level of any note when you press down on a key after it hits bottom; the more pressure you apply, the louder the note. Raising the slider increases the effect.

[46] **MEMORIES 1-4** – Four miniaturized versions of the same controls found in Programmable Panels I & II may be used to patch additional sounds or to keep favorite patches protected from accidental lever movements. To hear a Memory, press the corresponding Memory Tone Selector [3] and set the MIX lever [4] accordingly. You can transfer patches from PANEL to MEMORY by eye, and then "fine tune" the memory by ear.



Access to the Memories using the Tone Selector Buttons and the Mix Lever



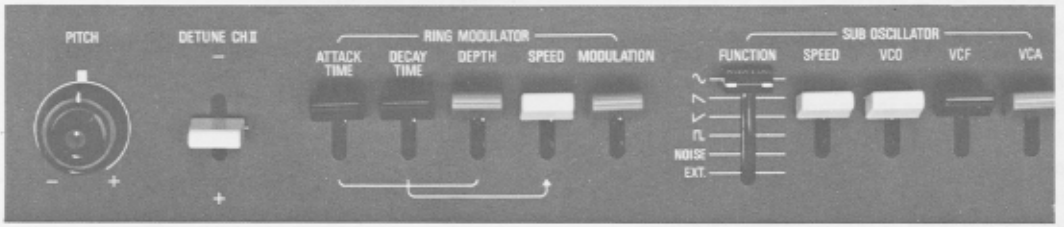
Other Selectors & Sound Modifiers
(from Left to Right)

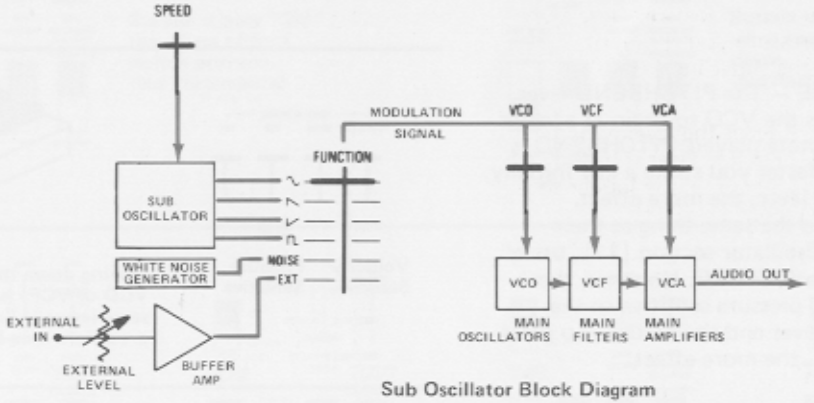
[18] **PITCH** – Tunes the entire keyboard. The outer ring is a coarse adjustment, the inner ring a fine adjustment. Center both controls for "normal" pitch.

[6] **DETUNE CH II** – Detunes channel II sharp or flat with respect to channel I.

[16] **RING MODULATOR** – Processes both channels I and II. MODULATION is a depth of effect control, SPEED sets the modulation rate. ATTACK TIME & DECAY TIME serve as an attack-release envelope for the ring modulation speed; DEPTH sets the amount of envelope effect.

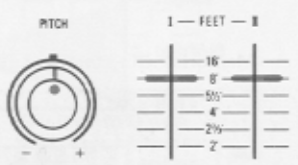
[11] **SUB OSCILLATOR** – Processes both channels I and II. FUNCTION selects a waveform: sine, sawtooth, inverted sawtooth, square wave, white noise, or an external input. (A line level signal connected to the Ext In jack on the rear panel will modulate the Sub Oscillator in EXT mode). SPEED sets the frequency of the sine, sawtooth or square wave. VCO, VCF and VCA are modulation depth controls that apply the selected signal to the control inputs of their respective voltage controlled circuits (oscillator, filter and/or amplifier).



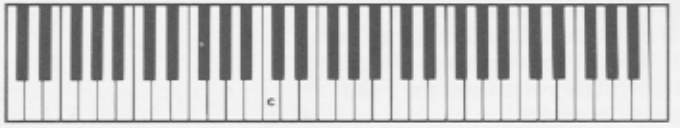


Sub Oscillator Block Diagram

[5] **I – FEET – II** – Two slide switches set the keyboard range for their respective channels, row I and II of the Tone Selectors [3]. Feet refers to equivalent organ footages, where 8' is normal pitch, 16' an octave below, 5-1/3' a perfect fifth above, etc.



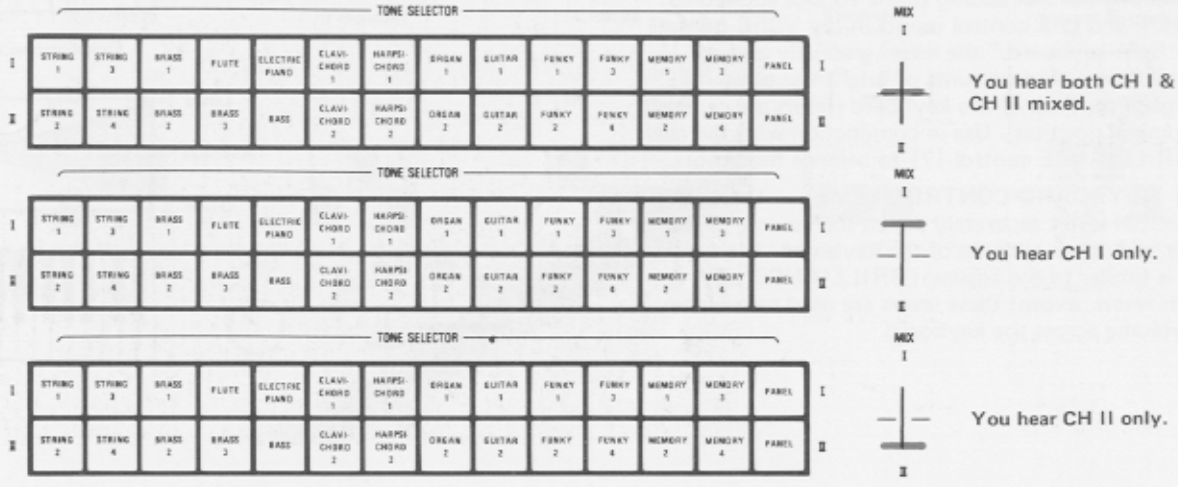
Set PITCH & FEET
as shown for true middle "C".



Middle C
16' = 1 octave below Middle C
8' = Middle C
4' = 1 octave above Middle C etc.

[3] **TONE SELECTOR** – Two rows of momentary pushbutton switches select two voices that sound simultaneously when you play any key (the MIX control [4] sets the balance between the two voices). Preset patches, memory-programmed patches or panel-programmed patches may be selected. The buttons light up to show which voices have been selected; only one voice per row at any one time. (Preset sound quality depends largely on the setting of the BRILLIANCE lever [7].)

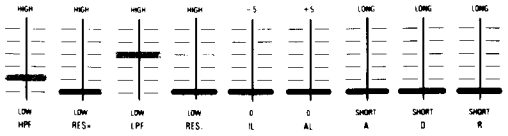
[4] **I – MIX – II** – Assigns tones selected in channel I, II or a combination of the two, to the synthesizer output: a balance or blend control.



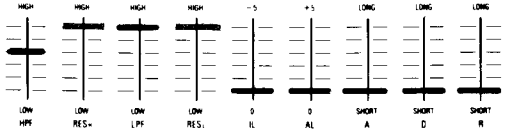
[7] **BRILLIANCE** – Adds voltage to the VCF's high pass and low pass control inputs, thus shifting up the cutoff frequencies and brightening the sound as the lever is pulled down. Nominal setting is centered, but there is a considerable change in sound when you adjust this for different patches.

[8] **RESONANCE** – Adds voltage to the VCF's resonance control inputs, thus increasing the resonance and adding twang as the lever is pulled down. Nominal setting is always with the lever up for minimum additional resonance.

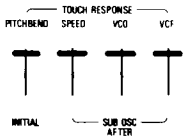
Moving Brilliance Up (minimum) is like moving HPF & LPF Down (& vice-versa) for preset or programmed patches.



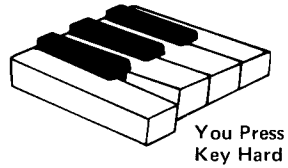
Moving Resonance Down (maximum) is like moving RES_H & RES_L Up for preset or programmed patches.



[12] **TOUCH RESPONSE** – The PITCHBEND lever, when pulled down, causes the VCO to begin at a lower pitch and slide up to the note played. PITCHBEND is velocity sensitive, so the faster you strike a key **initially**, and the farther down the lever, the more effect. SPEED, VCO and VCF do the same thing as their counterparts in the Sub Oscillator section [11], using its set FUNCTION and basic SPEED. However, these levers make the keyboard pressure sensitive so the farther down you pull a lever and the harder you press a key **after** it hits bottom, the more effect.

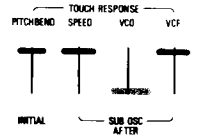


Velocity Sensitive Pressure Sensitive



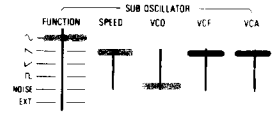
You Press Key Hard

+



Moving down the "after" levers (Speed, VCO or VCF) is like moving down the same levers in Sub oscillator when you press hard on a key.

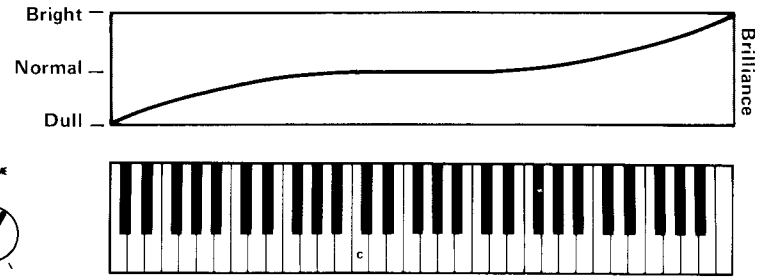
=



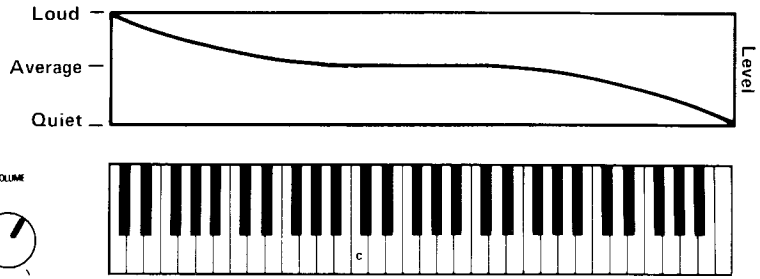
[2] **VOLUME** – This is the main volume control that sets the level of all three CS-80 outputs (Left, Right & General). Overall volume is also affected by the rear-panel HIGH/LOW switch and the FOOT PEDAL (Expression Controller).

[9] **KEYBOARD CONTROL-BRILLIANCE** – The LOW and HIGH levers separately adjust the brilliance of the lower and upper sections of the keyboard (by subtracting from or adding to the voltage applied to the HPF and LPF control inputs in the VCF). Instead of a "split keyboard," the levers gradually add or subtract increasing amounts of brightness as you approach the ends of the keyboard (levers are centered at nominal position). Use in conjunction with the overall BRILLIANCE control [7] to balance the timbre.

[10] **KEYBOARD CONTROL-LEVEL** – The LOW and HIGH levers separately adjust the volume of the lower and upper sections of the keyboard. The function is similar to the adjacent BRILLIANCE LOW & HIGH levers, except these levers are used to balance the volume across the keyboard.



Color shows adjustment range, solid line shows actual setting.



[17] **FOOT PEDAL SELECTOR** – Pushbuttons select what function the foot pedal (controller) will play. EXP makes it an expression pedal that adjusts the volume. EXP/WAH makes it an expression/wah-wah pedal that simultaneously adjusts the volume and sweeps the HPF & LPF cutoff points while adding resonance.

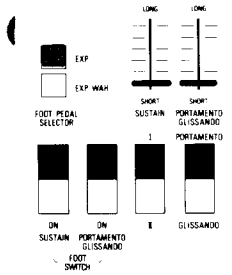
[13] **SUSTAIN SECTION** – The SUSTAIN slider adjusts the die-away of a note after you release a key (maximum of about 10 seconds). The SUSTAIN FOOT SWITCH assigner, rocked forward (ON), enables you to turn sustain ON & OFF with the Foot Switch; rocked back sustain is always ON. (If the Foot Switch is not plugged in, sustain is always ON regardless of the assigner switch setting). SUSTAIN I-II selects the type of sustain and **has no relationship to channels I & II;** I sustains each note individually and II ends the sustain of previous notes each time a new note or chord is played.

[14] **PORTAMENTO/GLISSANDO SECTION** – The PORTAMENTO/GLISSANDO (P/G) slider adjusts length of time it takes to change pitch from the previously played note or chord to the next. The P/G FOOT SWITCH assigner, rocked forward (ON), enables you to turn the effect ON & OFF with the Foot Switch; rocked back P/G is always ON. (If the Foot Switch is not plugged in, P/G is always ON regardless of the assigner switch setting). PORTAMENTO/GLISSANDO changes the way the frequency moves between notes; PORTAMENTO is a continuous slide, whereas GLISSANDO is a series of discrete, half-step notes (like a chromatic scale). GLISSANDO stops when you let go of a key unless you have selected SUSTAIN II mode, in which case the effect continues until the note dies away.

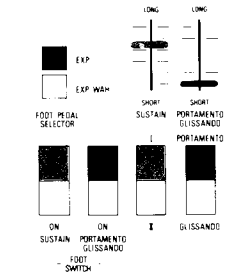
[15] **TREMOLO SECTION** – The ON/OFF switch activates whatever effect is preset with the two adjacent switches; CHORUS is a slower version of TREMOLO. Either effect may be varied in rate using the SPEED control, or in amount of modulation using the DEPTH control. There is a phasing as well as an amplitude modulation which, when used with the CS-80's LEFT and RIGHT outputs, is similar to a "rotary speaker" effect. (The CS-80 output level drops slightly when you turn ON this section.)

THE KEYBOARD – Is pressure and velocity sensitive, depending on the nature of the preset patch selected, and on the setting of the TOUCH RESPONSE sections [12] and [42-44].

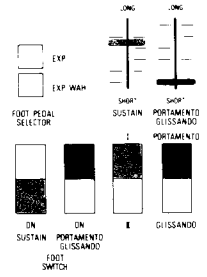
[1] **POWER** – Switches the AC power. A red light in the switch is illuminated when power is ON.



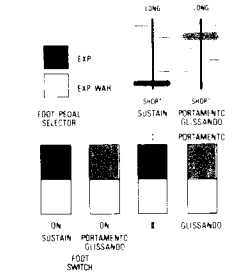
Foot controller is now an EXPression pedal.



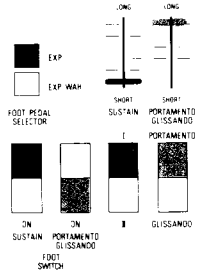
Sustain is now "ON" regardless of foot switch position. (No Portamento)



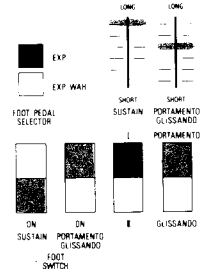
Sustain is "ON" only when foot switch is down. (No Portamento)



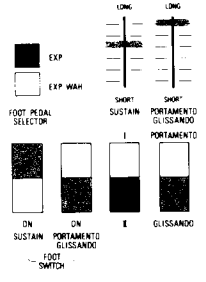
Portamento is now "ON" regardless of foot switch position. (No Sustain)



Portamento is now "ON" only when foot switch is down. (No Sustain)



Sustain now turns "ON" when foot switch is down, while Portamento remains "ON".



Glissando now turns "ON" when foot switch is down, while Sustain remains "ON". (NOTE: In II Mode, with Sustain, Glissando continues after you release the key.)