A SAMPLE/HOLD PATCH THAT SWINGS.

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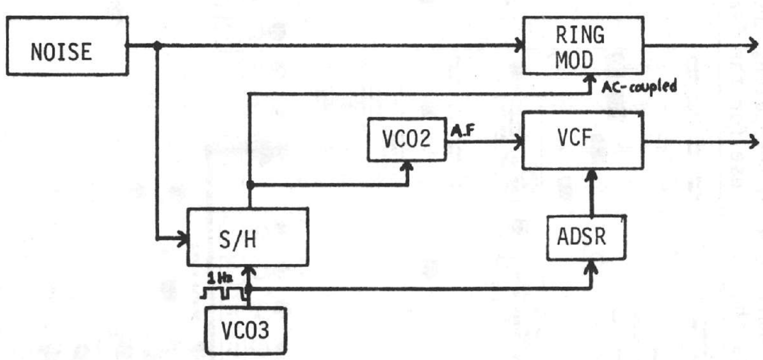
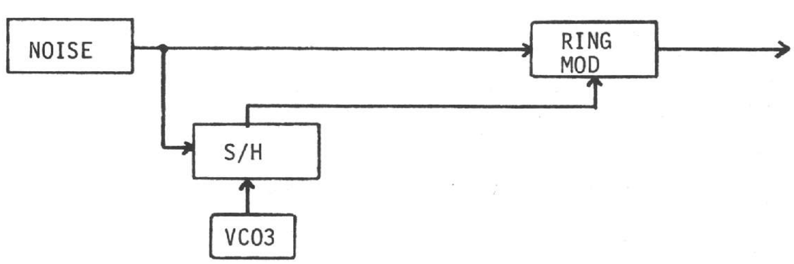
1. BLOCK DIAGRAM.



2. On the following page is a panel patch chart for realizing the patch on an Arp 2600. At the end of the article we will give suggestions for realizing the patch on other synthesizers.

3. Little in this patch is critical. It divides neatly into two simpler patches, both controlled in important respects by the same S/H control signal. One part of the patch produces the percussion sequence, the other produces the melodic accompaniment (or lead, depending on which is louder).

4. First let's take a look at the percussion section. A reduced block diagram of just that much looks like this:

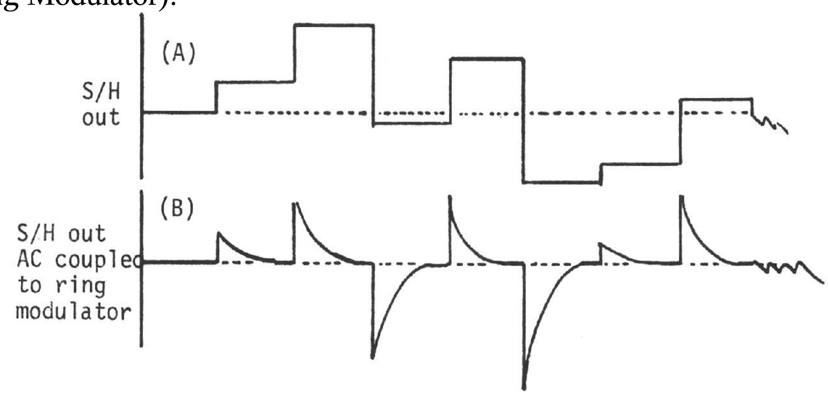


...which you should at first simplify even more by omitting VC03 and using the normalled triggering input signal from the Internal Clock.

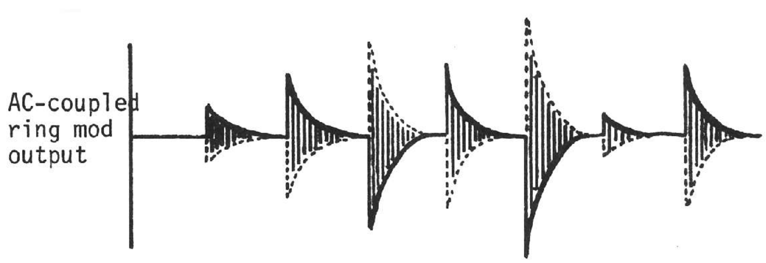
5. Everything that is interesting about the sequence of percussive envelopes you are hearing derives from the fact that the S/H is AC-coupled to the Ring Modulator, (i.e. the switch labelled "AUDIO – DC" in the Ring Modulator panel is set to "AUDIO". See the description of the Ring Modulator in chapter four of the 2600 Owner's Manual.) To verify this, switch the RM coupling to "DC". You hear only a series of changing noise amplitudes; loud when the S/H output voltage goes high (positive or negative doesn't matter), and soft when the S/H output voltage happens to hit a value closer to zero.

6. If you didn't know it before, this is the time to learn that THE "AUDIO -- DC" SWITCH IN THE RING MODULATOR PANEL DOES NOT CHANGE THE RING MODULATOR'S BEHAVIOR. What it does change is the nature of the signal going into the Ring Modulator. As always, the signal output from the Ring Modulator depends on nothing but the nature of the two signal inputs. If switching from DC to AC coupling changes the signals in some way, then of course it will change the nature of the output signal too.

7. So here is a diagram showing (a) a typical series of output voltages from the S/H circuit, and (b) how the same series of voltages might look when AC-coupled to another device (e.g. the Ring Modulator):



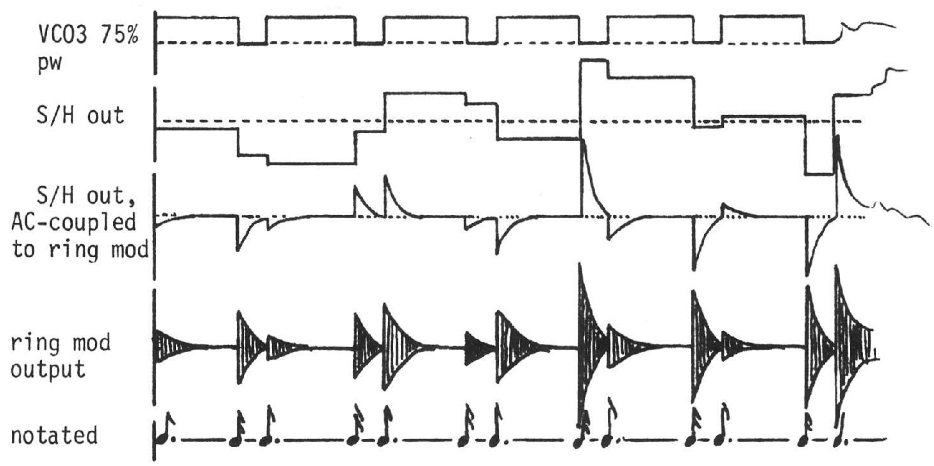
8. If the other signal input to the Ring Modulator carries an audio-frequency signal, that signal will be modulated by the voltage fluctuations of 7b above to produce a series of "events":



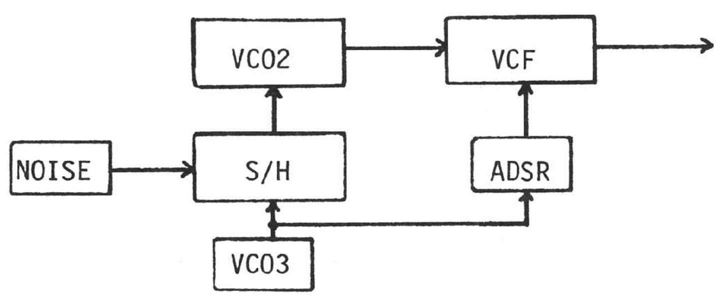
9. Now substitute the pulse output of VC03 for the Internal-Clock triggering of the S/H

circuit. On most 2600's the Sample/Hold circuit will trigger on both the leading and trailing edges of the pulse train; thus with a pulse-width of perhaps 75% the percussive events produced from the Ring Modulator will be grouped in pairs. The percussion sequence begins to "swing":

A Sample/Hold patch that swings



10. Now let's take a look at the other part of the complete patch, the melodic one. This is a perfectly straightforward S/H sequence except for the fact that the S/H circuit is being triggered from the VC03 pulse wave:



Thus the sequence of pitches from the audio oscillator (in this case VC01) will be grouped in pairs just as are the percussion-events from the Ring Modulator.

11. Now use either a Y-connector or the "Multiple" on the left-hand side of the 2600 to feed the VC03 pulse wave to the envelope gate input as well as the S/H triggering input. Set up any standard percussive envelope on the ADSR generator, set the VCF cutoff frequency subsonic, and open the control input to the VCF from the ADSR generator all the way. NOTE THAT YOU ARE GETTING TWO PITCHES IN EACH EVENT:

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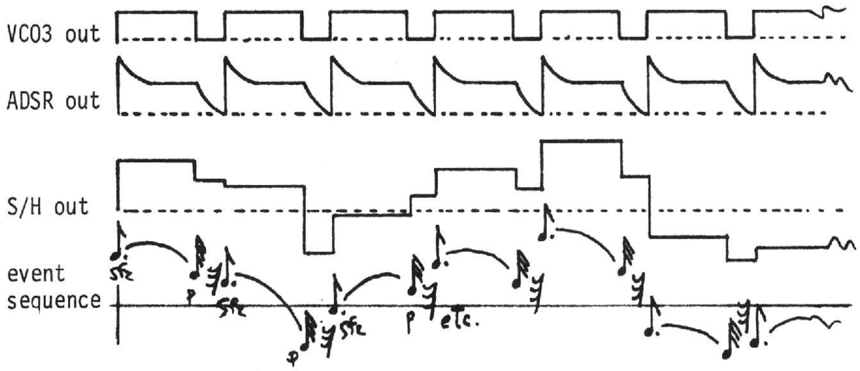


The diagram should make clear why this is happening. Changing the pulse-width now will change the rhythmic "feel" of the pitch-sequence. The second pitch in each envelope can be made to "disappear" by shortening the final decay (i.e. "release") time or by shortening the pulse-width to minimum. (There is at least one other way of doing this; figure it out and send us a note about it.)

12. The patch is now complete. You will adjust the relative level of the percussion and "lead" melody with the input attenuators to the Mixer. A number of additions to the patch are possible; we have not, for example, talked about using keyboard control anywhere in the patch. Nor have we discussed the results in such a patch as this one of sampling a periodic waveform rather than a random-noise signal. We would like to hear from any of our readers who follow out some of these expansions.

13. THE CRUCIAL POINT on which the patch depends is the fact that the 2600 S/H circuit triggers on both the leading and trailing edges of a pulse input. Ironically and curiously enough, it's not really supposed to do this. It was designed, strictly speaking, to trigger only on the leading edge (cf. the description in chapter four of the owner's manual); but when this "fault" leads to such interesting results, who would want it changed? We invite our readers to think about what they would have to do to achieve the same asymmetry (i.e. pairing) of trigger pulses if the S/H circuit did not have this "fault" and triggered only on steeply rising wavefronts. (We expect more than one solution.)

14. Synthesis systems which do not include a sampling circuit would obviously not be capable of duplicating the "no-hands" character of the patch we have given. This would appear to rule out, for example, any attempt to realize the patch on the smaller Synthi/EMS units. Their Ring Modulator, however, _i^ AC-coupled, and the pulse-width on their oscillators two and three is manually controllable. With a noise signal going into one of the Ring Modulator inputs, and a low-frequency pulse wave of suitable width into the other, you might try simulating the random-voltage output levels of a sampling circuit by adding the keyboard control voltage to the same input that carries the pulse train. The small sequencer in the Synthi AKS model can be put to good use here as a substitute for the keyboard. The two-notes-per-envelope element in our patch would have to be simulated by keyboard technique: press two keys and release the upper one just before the lower one.

15. We haven't yet been able to confront one of the new ElectroComp Model 101's with this patch. They do include a sampling circuit, however, and their Ring Modulator is AC-

coupled; so something very similar to if not identical with our patch should be possible on the 101.

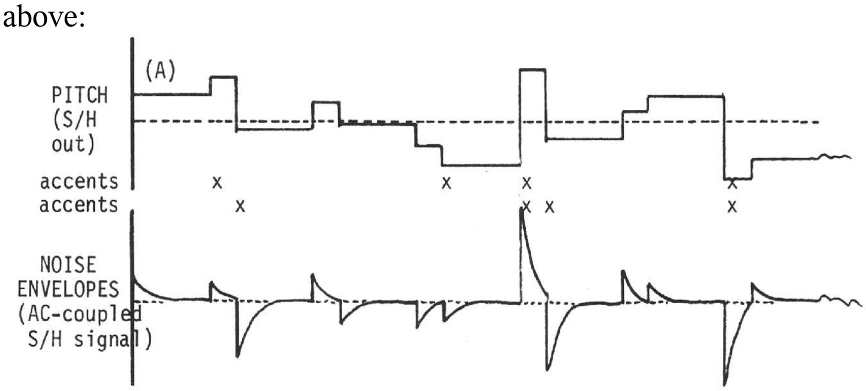
PSYCHOACOUSTICAL ELEMENTS INVOLVED IN THE PATCH.

16. If you own a 2600 and have set up the patch by this time, you have discovered what we found so fascinating about it: the uncanny resemblance of the percussion signal to complex, super-syncopated, offbeat jazz drumming. Careful listening will reveal another surprise; although both the melodic and the percussion signals are derived from control by one and the same S/H output, the apparent accents in the two do_ not by_ any means coincide.

17. It might perhaps be tempting for a novice to look for some element in the patch that was responsible for this syncopation. But that would be a mistake; there is no such element. AS LONG AS THE S/H CIRCUIT IS SAMPLING A RANDOM-NOISE SIGNAL, THE VOLUME OF SUCCESSIVE EVENTS IN THE RING MODULATOR OUTPUT WILL BE COMPLETELY RANDOM. Therefore the occurrence of "loud" (i.e. accented) beats will also be randomized in time. The only contribution of the synthesizer lies in the pairing of beats according to the width of the timing pulses from VC03; EVERYTHING ELSE IS CONTRIBUTED BY THE STRUCTURE OF YOUR PERCEPTION. Given the pairing of beats, your own mind perceives the randomized accents within that structure as complex syncopations, anticipations, etc., of some basic rhythm.

18. One way to prove this is to count out a four-beat rhythm along with the percussion signal; then a three/four, then 6/8, then 2/4, and so on. The percussion signal is perfectly compatible with any of these rhythms. Why? Because the accented beats occur at random intervals, they are not really part of any particular rhythmic pattern at all. "A noise signal consists of all frequencies," and, we add, all rhythms as well.

19. As for the non-coincidence of melodic and percussive accents originating in the same S/H output voltage, which was the second point we mentioned in #16 above, that is not entirely a matter of psychoacoustics. It begins with the fact that the S/H output voltage, AC-coupled to the Ring Modulator, does not directly set the output volume of the percussion events produced at the Ring Modulator output. Consider again the diagram given in #7 above:



Note that the points of maximum amplitude in (b), the voltage which governs the Ring Modulator output volume, do not necessarily coincide with points of maximum amplitude in (a), which governs the pitch of the melodic sequence. The b_ voltage corresponds much more nearly to the distance between successive voltage steps in waveform a. than it does to the absolute amplitude of any individual step. In mathematical terms, it is an approximation of the first derivative of waveform a.

20. Other things being equal, you will tend to hear relatively high or low pitches in the melodic sequence as more heavily accented than intermediate pitches; thus for determining where accents in the melodic sequence will fall, we must look for relatively high positive or low negative voltages in waveform a_; but the dynamic accents in the percussion signal will occur when the change from one voltage level to the next in waveform a is greatest.

21. Basically the patch is just simply fun to listen to; we hope you find it so. But it's also enormously instructive; we hope our readers find it as stimulating to their imagination as it has been to ours.