CONSTRUCTION

Build a Digital Pattern Generator.

by John Blacet

The **Digital Pattern Generator** is a control voltage source capable of producing up to fourteen step sequences. This is accomplished with four level controls, each operating in a separate time division, by multiples of two from each other. This enables the device to produce patterns whose steps do not necessarily have the same duration. When connected to a VCO, the results are quite rythmical.

The **DPG** can be gated, triggered, and run up or down by external control. In addition, the pattern can be made to alternate direction on successive triggers.

The circuit uses as few as five IC's, and operates over a wide power supply range.

About the circuit.

The DPG is based around a four bit binary up/down counter IC, the 4516. Pulses from the variable speed clock formed by two sections of IC 6, enter at pin 15 of IC 1 where they are divided by 2, 4, 8, and 16, and appear at pins 6, 11, 14, and 2. These pulses are buffered by the remaining four sections of IC 6, and activate the four LED's when a high is present. The output of IC 1 is also fed to the four level controls and summed in a diode network. The 741 type OP AMPS buffer the output and provide a glide function. One of each type of buffer is shown and more may be added at the slider of the output level control.

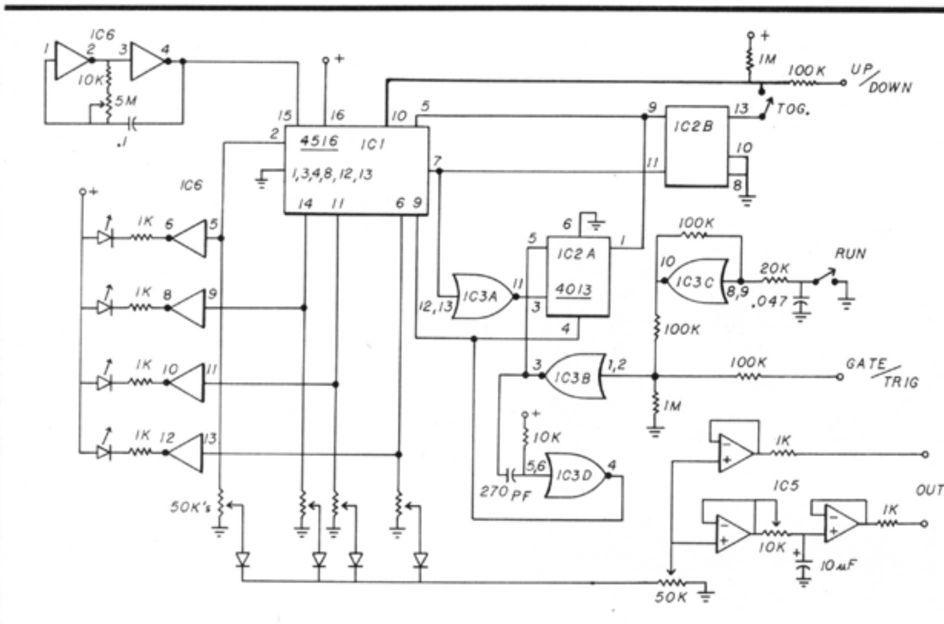


ILLUSTRATION BY JOHN BLACET

Digital Pattern Generator schematic.

The functions of the 4516 are controlled by IC 2 and IC 3. The up/down control (pin 10) is held high by the I M resister to allow up counting when no other input is present. An external signal at this input provides a down count when a ground or low, is applied. When the **up/down toggle** switch is closed, successive triggers will alternate the count direction, provided the pattern has been completed on each occasion.

The unit can be gated or triggered, both at the same input. A positive pulse (trigger) will result in one complete sequence. A positive step (gate) will result in complete sequences until removed. The sequence will complete itself and end. The **run** switch will accomplish the same functions by either a momentary or continuous depression.

The high initiated by any of the above pulls the output of IC 3b low and causes IC 3d to output a positive pulse. This resets both IC 1 and IC 2a and allows the sequence to proceed. IC3c and related components form a schmitt trigger used to debounce the toggle switch.

With no input present at the **trig/gate**, the 1 M resistor to ground pulls the output of IC 3b high and in turn the output of monostable IC 3d low. This low appears at pin 9 of IC 1 and allows a started pattern to run to completion. At this point, the high at the output of IC 3b is clocked through flip-flop IC 2a by the inverted signal from pin 7 IC 1, and appears at the Q output. This high is applied to pin 5 IC 1, stopping the clock and thus the sequence. The output of IC 2a also provides a D input for flip-flop IC 2b which is clocked through by a high from pin 7 IC 1 and, providing the switch on the Q output is closed, sends either a high or low to pin 10 IC 1 to determine sequence direction.

Construction.

Almost any method may be used to construct the DPG. Perhaps the simplest is to use a predrilled and etched PC board such as those available at Radio Shack. Use precautions against static electricity when using the CMOS IC's; such as grouding the tip of your soldering iron and not wearing static prone clothing.

The power supply connections and the pin numbers for the op amps are not shown because they differ for various amps. You can use any convenient general purpose device such as a 741, a 5558 dual, or a 4136 quad. The op amps run off dual plus and minus supplies and the CMOS off a positive supply. You should try to use +/- 10 to +/- 15 volts. Fifteen volts is maximum and both supplies should be regulated. Use at least one .05 uf disc and one 1.0 uf electrolytic capacitor on the board for bypassing each supply.

Craig Anderton's book *Electronic Projects For Musicians** offers basic practices for persons unfamiliar with electronic construction and troubleshooting.

A kit consisting of a PC board, all parts, ICs and pots is available from Blacet Music. The address can be found under *Listings*.

Operation.

The DPG may be used much like you would use a conventional sequencer module. The main difference is in the feel of the level controls. One of the first things that can be observed from operating these controls and observing the led's is that each is 2X faster than the previous one. Each control therefore operates in a separate time division as well as determining voltage level. You will also note that, in contrast to a regular analog

Digital Pattern Generator

sequencer, that several leds may be on at once. In this case, the control with the highest level determines the output voltage.

If all leds light, the sequence will be at its end; and if all are unlit, the sequence will be at its beginning. This is a good way to observe sequence direction.

Voltages at the **up/down** and **gate/trig** inputs should be at least 70% of the positive supply voltage, with ground initiating down counting and a positive voltage, a gate or trigger.

When first applying power to the module with the **gate/trig** input connected, the sequence may not start. In this case, briefly disconnect the input.

The **up/down toggle** switch can be used as a direction control when the Pattern Generator is running continuously.

An external voltage controlled clock can be substituted for the built in one by breaking the connection between pin 15 IC 1 and pin 4 IC 6; then applying the external clock through a 10 K resistor. The clock must have fast rise and fall times and have a level of at least 70% of the DPG positive supply voltage.

Coming soon will be a voltage controlled clock which can be used with the DPG or any other sequential device. In the meantime, see (hear) what dimensions of sound are accessible with this project. –⁄\/\/\/–

*Guitar Player Productions: P.O. Box 615, Saratoga, Ca. 95057

Parts list:

IC 1 4516 CMOS up/down counter
IC 2 4013 CMOS flip-flop
IC 3 4001 CMOS quad nor gate
IC 5 741, 5558, or 4136 op amp (see text)
IC 6 4069 CMOS hex inverter

Resistors, 1/4 watt.
6 1K
2 10K
1 20K
4 100K
2 1M

Potentiometers, linear.
1 5M
5 50K
1 10K

Capacitors.
1 .1 uf mylar
1 270 pf polystyrene or ceramic
3 .047 or .05 ceramic
2 1.0 uf electrolytic

Miscellaneous.
4 IN4198 diodes
1 SPST toggle switch
4 1/8" jacks
4 LEDs

THE BEAT GOES ON

Combination tones and temperment.

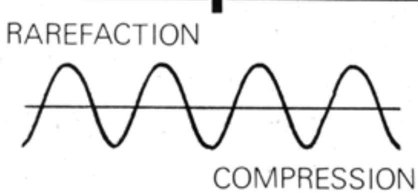
by Jon Dattorro

The synthesizer generates sound by manipulating the very roots of sonic phenomena. Its progression from the present state of the art into the mysterious future depends upon the knowledge the user has assimilated concerning all aspects and idiosyncrasies of his instrument, and the depth of his perception. Although it was originally designed as a musical instrument, the voltage-controlled synthesizer is theoretically capable of reproducing any sound imaginable.

Music is composed of sound, but not all sound is music. The discussion which follows attempts to elucidate some of those "sonic roots" and their relation to music. Hopefully, at the same time, the reader will become aware that a compulsory adherence to any one musical system is now as stifling a limitation as would be the use of the synthesizer for only musical purposes.

When a single sound source such as a flute produces a tone, the air surrounding the flute is made to vibrate in a specific manner such that if our ears are in proximity to this vibrating air, the mechanisms of our ears will be caused to vibrate sympathetically, producing a sense of pitch within our brains. A simple mode of vibration may appear as in Figure I in its symmetrical compression and rarefaction of the air. Some tones in the upper range of the flute very closely resemble the waveform of Figure I which is called a *Sine Wave* (from the Latin *Sinus* meaning "curve" or "hollow"). Figure I then, is just a graphic representation of one way air molecules may be compressed and rarefied with time. Pitch is determined by the frequency of a repetitive waveform: that is, the number of vibrations per second.

1

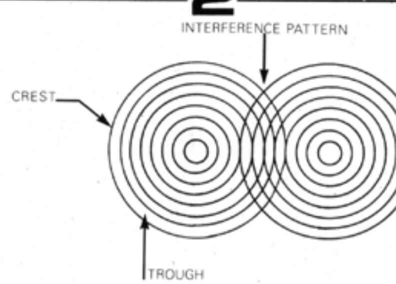


More complex tones than those of the flute are heard frequently in the sounds of the other orchestral instruments. For example, playing a tone on the violin produces a wave form which is a composite of many sine waves of varying intensities and at multiple frequencies of the perceived pitch; thus, the violin possesses a timbre uniquely its own as the result of its particular composite. Using sine waves as building blocks then, we can see that it becomes possible to create an infinite variety of timbres by combining any number of them in almost any way.

A description of the way in which the individual component-sine waves of a tone are combined is called the *Spectrum* of that timbre. The frequency of the lowest component-sine wave (fundamental) of a particular spectrum usually, but not necessarily, determines the frequency of the perceived pitch of that sound spectrum, even in the case of tones produced by conventional orchestral instruments. The reason for this is that the way in which the entire spectrum of a sound interacts in the air becomes more important to our ears than just the lowest (or relatively loudest) single frequency component present.

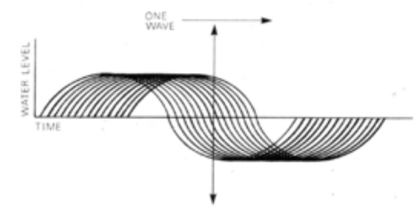
The internal modulation of a spectrum with time as well as resonance of vibrating bodies are also factors which determine timbre, but it is still first a function of the pitch components within a spectrum. It should be clear then, that a thorough discussion of timbre involves all parameters of sound.

2



When any number of tones are sounded together, interesting wave patterns are created in the medium surrounding the sources, such as air, through which they travel. These resultant patterns are called *Interference Patterns* and can be observed directly by simultaneously dropping two pebbles a certain distance apart, into a calm pool of water (Fig. 2) and noting the pattern caused by the meeting of the crests and troughs of the water waves as they attempt to propagate through the water unhindered as if no obstacles or other wavefronts were present. These waves in the water surprisingly enough produce almost no current; that is, the only movement of *water* that takes place is up and down not across. The waves themselves, however, do appear to be moving across the water in this case and indeed they do. The reason for this is that the up and down movement of the water does not happen simultaneously at all points but happens sequentially across the entire surface of the water thus causing the waves' transverse movement. (Fig. 3) A wave generated at one side of a pond then, will undoubtedly reach the other side in a certain amount of time.

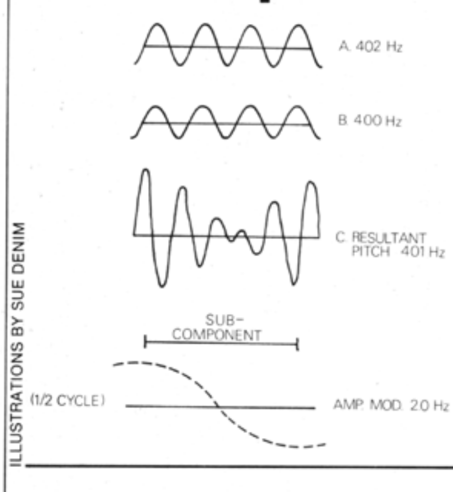
3



Air waves interact in a similar fashion except that sound waves as in the case of the flute, tend to propagate spherically as opposed to the two dimensional circular propagation of the waves on the water's surface. This accounts for the fact that we are able to hear the flute even if we are standing in back of the player. Of course, if both listener and player are in the same room there will be multiple reflections of the sound waves off the walls making the flute louder than it would be outside in an open field.

Providing that two or more tones are sufficiently present relative to each other and they occupy the same space, and given that their pitch-frequencies are slightly different, the phenomenon known as *Beats* will occur. Beating occurs as a result of the *Interference Pattern* produced by the combination of closely related waveforms (Fig.4).

4



ILLUSTRATIONS BY SUE DENIM

The addition of the two waveforms A and B in Figure 4, results in the new waveform C. Since the height of the waveforms in Figure 4 represents their amplitude, it can be seen that