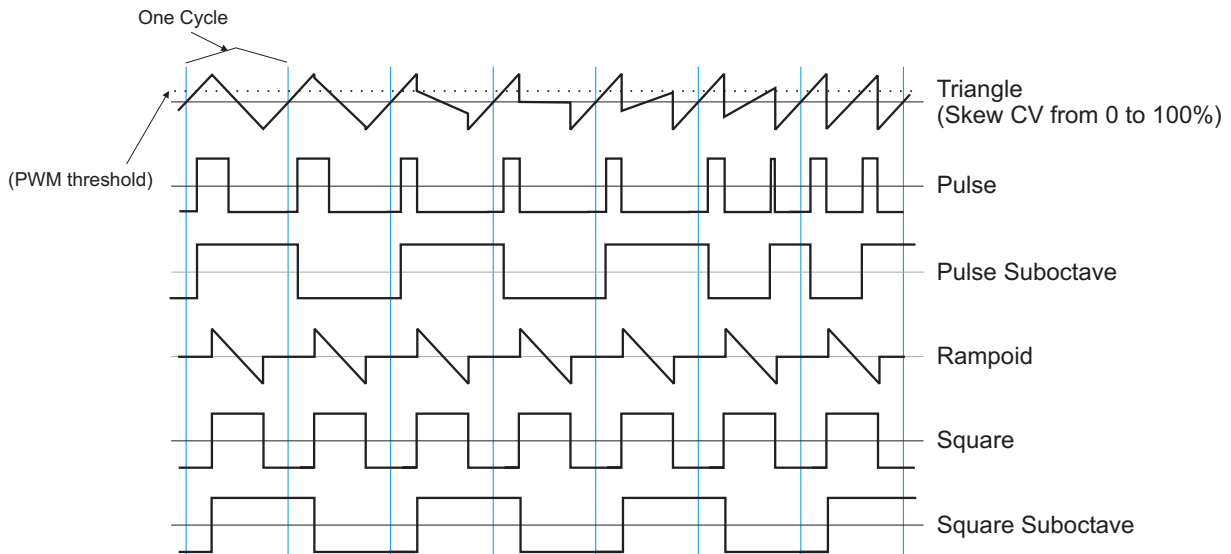# Magic Smoke Electronics

CIRCUIT CHANGES

Although the core of the VCO remains the same as the original Thomas Henry design, a few additional features were added. These features are highlighted on the schematic (enclosed in a double blue line) and include:

1) Added "Rampoid" waveform. This waveform is tapped off the timing capacitor, and is buffered by IC5a. The Rampoid sounds much like a traditional Sawtooth wave.
2) Added variable-width Pulse waveform. The Pulse wave is derived from the Tri / Sine wave, and will shift octaves just like the Tri / Sine wave does (although the octave shift will happen at different points, depending on where the PWM threshold is set). See the waveform graphics below for an illustration of how this happens as the Skew control voltage goes from 0 to 100%.
3) Added Sub-octave derived from the Pulse waveform. This waveform does not track the changing pulse width of the pulse wave, but it will shift octaves as the Tri / Sine wave skews from a triangle to a 2x Saw.
4) Added Sub-octave derived from Square waveform.
5) Added Hi / Low switch to change timing capacitors. The TH-102 has a range of roughly 33,000:1, so these two settings will cover a very wide range of frequencies.

Rev 01 circuit boards require two jumpers (see "Rev 01 Rework" document for details), but are otherwise identical to Rev 02 boards.

WAVEFORMS

The most unusual feature of the TH-102 is the waveform "Skew" modulation feature. As the Skew CV is increased, the negative-going slope of the Triangle wave will gradually be inverted around 0 Volts. This allows you to slowly shift the waveform from a Triangle to a Sawtooth under voltage control. As shown below, the Sawtooth wave is a two times the frequency of the original Triangle wave. A similar waveform modulation happens if the Sine wave is selected, except the skewed waveform resembles a Sawtooth wave with curved "S-shape" segments. The harmonics are slightly different with the Sine wave, resulting in a slightly more mellow "muted" tone.

One Cycle

(PWM threshold)

Triangle (Skew CV from 0 to 100%)

Pulse

Pulse Suboctave

Rampoid

Square

Square Suboctave

MAGIC SMOKE ELECTRONICS

CALIBRATION / TUNING

The first setting to adjust would be the Tri / Sine Offset (R24). Set the TH-102 to a medium frequency, select the Triangle wave and adjust the waveform to be centered around 0 Volts. After this is done, select the Sine wave and adjust the Sine Round (R3) and Sine Symmetry (R22). You will need to work back and forth between the two adjustments a few times to get the best appearing Sine wave. You can change the value of R21 to 22k or even 24k if you notice that the Sine wave is significantly lower in amplitude than the Triangle. Some XR-2206s show more difference than others between the two waveforms. The Offset may need to be readjusted after the Sine shape is set. The Rampoid, Pulse, Square, and Suboctave waves do not require any trimming. The only other remaining adjustments are the Volts per Octave trim (R1) and the High Frequency (HF) Tracking (R42). The Volts per Octave trim is best adjusted with the TH-102 in the low to mid audio range, while the HF trim will only affect the tracking in the higher octaves. Start with the HF trim set all the way up to 1M Ohm, and do not adjust it until the TH-102 is up around 6 or 7KHz.

USING THE TH-102

Some very dramatic effects can be realized by using separate modulation sources for the Skew and Pulse Width control voltages. The appearance of the "octave shift" is more subtle and gradual with the Sine and Triangle waves, while the octave shift on the Pulse wave is more sudden and depends partially on the Pulse Width CV. The hysteresis compensation normally used to speed up a pulse width comparator was actually left off of the TH-102 to avoid a 'pop' when the octave shift occurred in the Pulse wave.

The Sync input is a standard synchronization function that acts to reset the timing capacitor. This input expects a Saw, Square, or Pulse wave with a sharp rising edge. Sync will reset the timing caps regardless of the current level of the output waveforms, and is often referred to as "Hard Sync."

Because the Pulse wave is derived from the Tri / Sine wave, it will also shift octaves as that wave is skewed. The exact timing of the shift will change depending on the pulse width control voltage, and can be modulated separately from the Skew function. Setting the Skew and Pulse Width controls fairly high (above 65% or so) will actually allow you to get three octaves of tones from the TH-102:

1) Tri / Sine wave and Pulse wave at one octave above "fundamental."
2) Rampoid, Square, and Pulse Suboctave at fundamental.
3) Square Suboctave at one octave below fundamental.