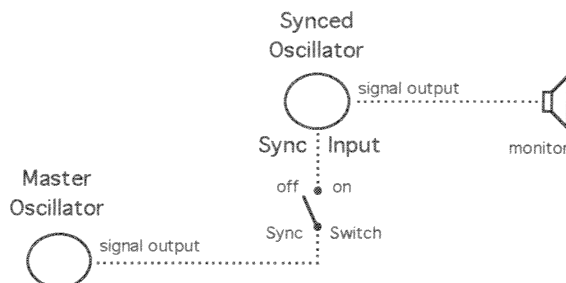
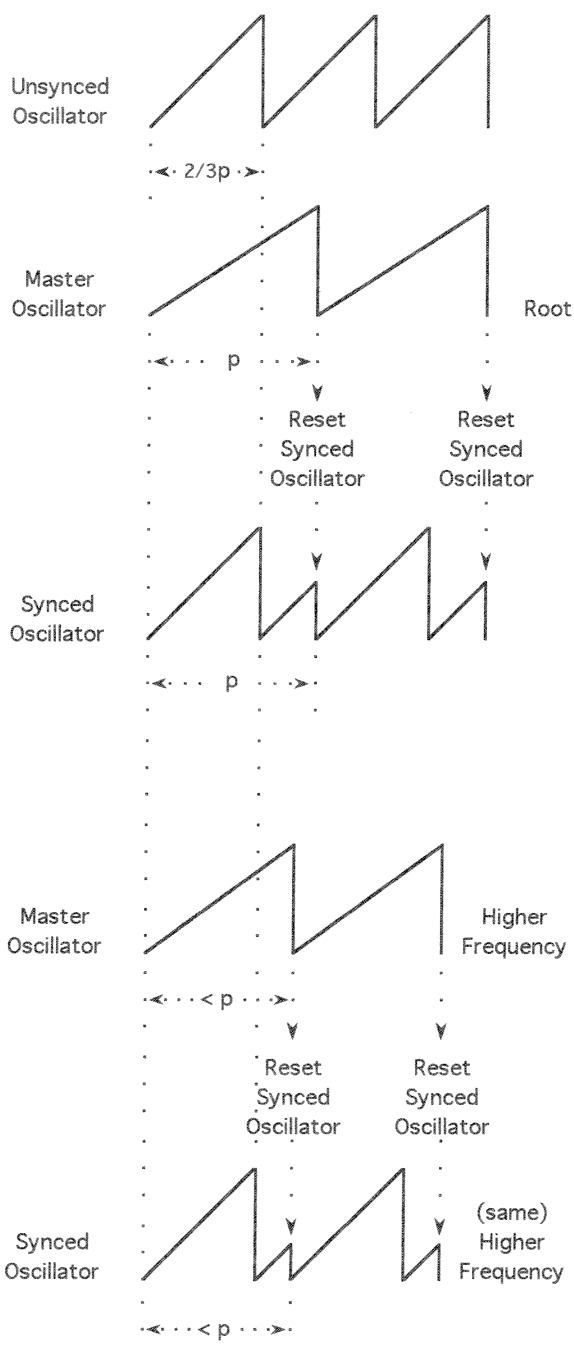


## Oscillator Synchronization

Oscillator synchronization (*synch* or *sync*) forces a "Synced" Oscillator (Osc) to match the frequency of a "Master" Oscillator (Osc) when the signal output of the Master Osc is routed to the *Sync In(put)* of the Synced Osc and/or *osc sync* is enabled (if switchable). The Synced Osc is sometimes called a "slave."



In the graphic(s) opposite, the waveforms of two free-running oscillators designated "Master" and "Unsynced" are tuned to the interval of a perfect fifth (P5). The Master Osc is the *root* of this P5 interval, and its *period*, or time required for one complete waveform cycle is designated "p." The Unsynced Osc is the fifth of the P5 interval, and its period is designated "2/3 p." (The frequency ratio of any perfect fifth is 3/2 that of its root, and the period of any such periodic waveform is the *reciprocal* (inverse) of its frequency.) That is, the *period* of the *higher* note of a P5 interval is 2/3 of the period of the *lower* note, or root.

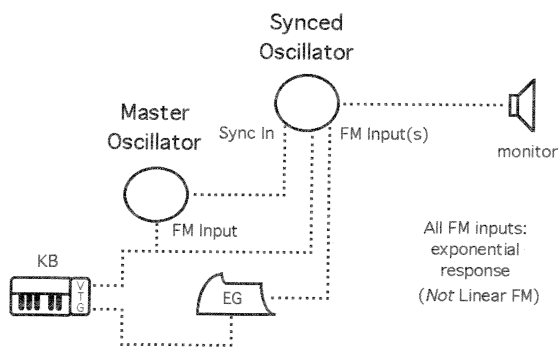


When the sync connection is made as shown above, or when prewired *oscillator sync* is switched *on*, Master Oscillator period, and therefore, *frequency* remains unchanged. But the waveform of the previously Unsynced Oscillator, but (now) *Synced Osc* is forced to *reset* each time the Master Osc waveform resets, and the Synced Osc will therefore produce the *same frequency* as the Master Osc. The Synced Osc produces a *novel waveform* (not a sawtooth in this case), due to being *forced* to reset (to zero) at some mid-point during its *otherwise* free-running cycle (period).

Any change of Master Oscillator frequency will cause a *different* forced reset point during the Synced Osc's period, and the Synced Osc will continue to reset normally at the *end* of its *own* period as well, (as depicted above). The diagram opposite shows a change of *only* the Master Osc to a higher frequency, and therefore a shorter " $< p$ " period. The reset forced by the Master Osc causes the Synced Osc to produce the *same* " $< p$ " shorter period, and *same* higher frequency. The Synced Oscillator waveform is determined by the relationships of: (1) the (unsynced) tuning, or intervallic relationship of the two oscillators; (2) and the waveform originally selected as the Synced Oscillator output. If *only* the Synced Osc is monitored (see block diagram above), choice of Master Oscillator *waveshape* is not audible.

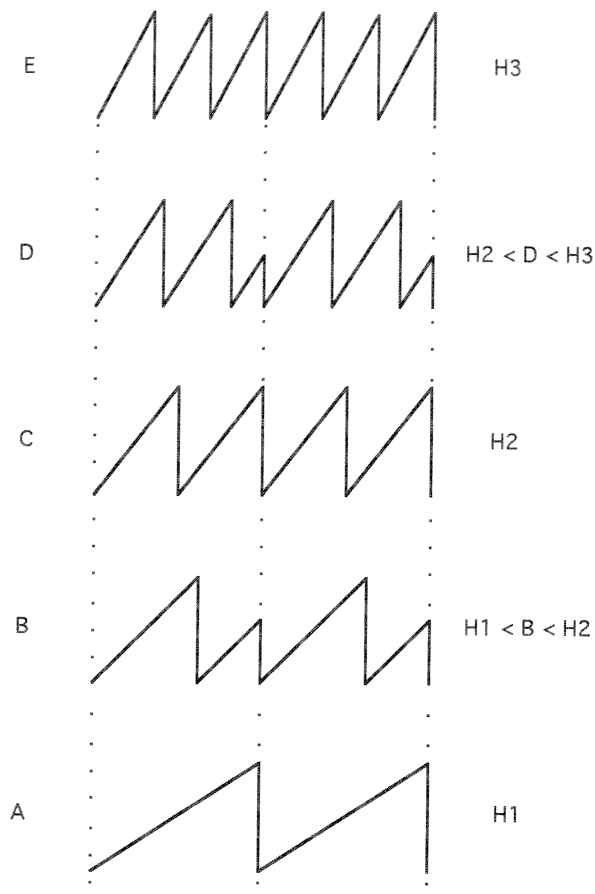
When oscillators are synced, a change of Master Oscillator frequency will force Synced Oscillator frequency to match. The Synced Osc is forced to match the *frequency* of the Master Osc, but the Synced Oscillator will *not* necessarily match the *waveshape* of the Master Oscillator. If Master Oscillator *frequency* is dynamic, then *waveshape* of the Synced Oscillator will also be dynamic. Synced Oscillator *waveshape* will be *dynamic* as a result of being forced to reset to match dynamic Master Oscillator *frequency*. However, such a Synced Oscillator dynamic waveform will also exhibit the dynamic *frequency* changes of the Master Oscillator as well, producing gliding pitch "siren" effects that may not be wanted.

Novel *dynamic waveforms* independent of *change in frequency* can be produced using oscillator synchronization techniques, and this is often musically desirable. When the *intervallic relationship* between two synced oscillators is *altered* dynamically, the waveform(s) output by the Synced Osc may vary dramatically. A change of the *frequency* of the Synced Osc *independent* of the Master Osc frequency can implement this effect. The block diagram below is archetypal:

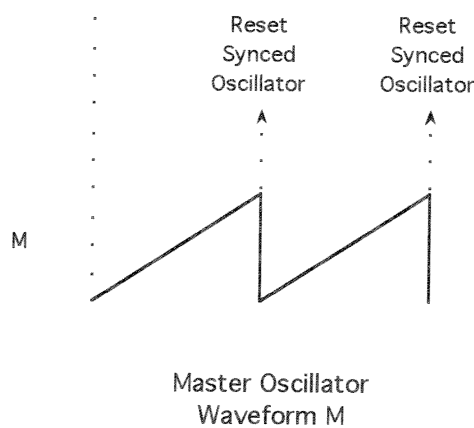


As shown by graphics opposite, when the (EG) Envelope Generator above dynamically alters the Synced Osc frequency independent of Master Osc frequency, waveforms A - E are produced by the Synced Oscillator. In cases A, C, & E, Synced Osc frequency is *harmonic* (H1, H2, & H3) to Master Osc frequency. So, the Synced Oscillator waveform is *not* novel, because the Synced Osc will reset at the end of its own period, without being *forced* to reset by the Master Osc. Choice of Master Osc waveform "M" is not important in most designs. Both oscillators will be controlled by the (KB) keyboard (see block diagram above).

Synced Oscillator Waveforms A - E



Synced Oscillator Waveforms A - E



Master Oscillator Waveform M