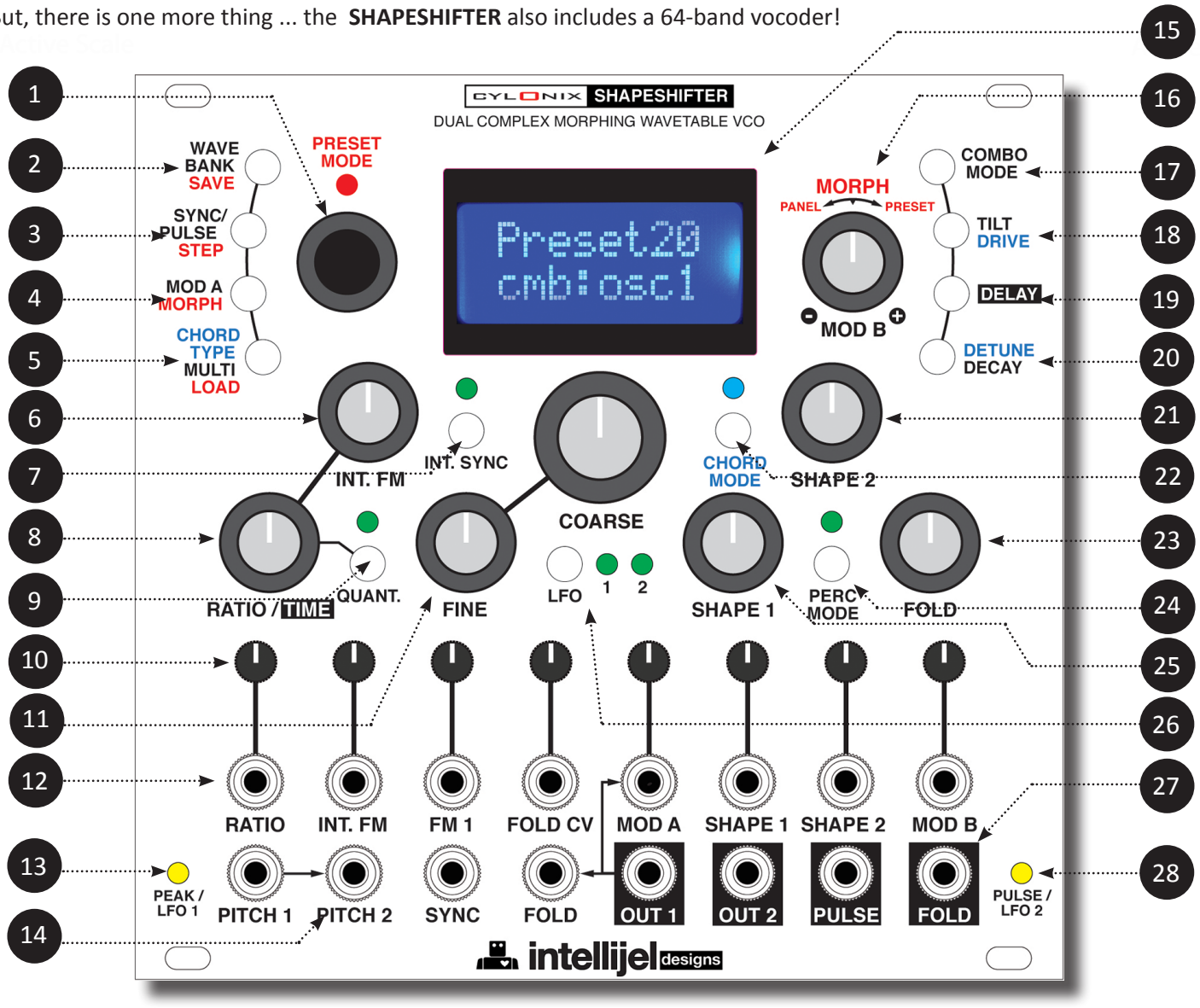
The **SHAPESHIFTER** is a dual digital voltage controlled wavetable-based oscillator in a 26-HP Eurorack format.

The wavetables consists of 128 banks, each with 8 individual 512-sample waveforms, for a total of 1024 waves. The choice of waveform within the currently selected bank is under voltage control. There is smooth interpolation between the waveforms within a bank, allowing a very wide range of different possible waveshapes. Oscillator 1 can be operated in a CHORD mode, which runs 8 copies of the oscillator in parallel with adjustable detuning, leading to very fat, rich waveforms. The oscillators have extensive modulation capabilities including audio rate (98KHz) Frequency and Phase Modulation (FM and PM) via external sources. Nonlinear combination processes allow the outputs of the two oscillators to interact to generate complex timbres and sonic textures. The **SHAPESHIFTER** module also includes the analog wave folder circuitry from the **intellijel** µ**Fold II** module to add analog warmth and metallic rasps to the digital output.

The module includes a sophisticated preset mode where panel settings can be stored. There are 12 user-prgrammable preset slots and another 52 volatile slots that can be used as a scratchpad. These scratchpad slots are initialized to interesting presets on module powerup. The capabilities of the preset mode is not limited to mere passive storage of settings, however. In this mode the user can also ***step*** through, or ***sequence***, the settings, either in order or randomly in response to pulses input to the external sync input. This gives the user the ability to generate complex sequences of sounds. The preset mode also allows the user to ***morph*** between the current panel settings and a preset providing a very powerful real-time performance tool.

But, there is one more thing ... the **SHAPESHIFTER** also includes a 64-band vocoder!



Front Panel Elements (*numbers refer to the diagram on the first page*)

1 **MANUAL DATA INPUT** - this is a rotary encoder which is used to enter data in various operation modes. Pushing on the encoder activates a switch which enters and exits the PRESET mode. The red LED above the encoder indicates whether or not the PRESET mode is active. When the LED is lit the PRESET mode is active.

2 **WAVE BANK/SAVE BUTTON** - this button, when pressed, switches the rotary encoder to entry of the active wave bank for oscillator 1 or 2. Successive presses of the buttons toggles between oscillator 1 and oscillator 2. When bank select is active, the top line of the LCD display will show a descriptive title for the currently selected bank. The waves corresponding to each wave bank are depcited in Appendix A.
When the module is in PRESET mode (indicated by the illumination of the red LED above the rotary encoder) this button has a different function - that of saving the current front panel control state into the currently selected preset.

3 **SYNC/PULSE/STEP BUTTON** - this button, when pressed, switches the rotary encoder to selection of the SYNC mode. A second press of the button switches the rotary encoder to selection of the PULSE output source.
When the module is in PRESET mode (indicated by the illumination of the red LED above the rotary encoder) this button has a different function - that of entering the PRESET STEP mode.

4 **MODA/MORPH BUTTON** - this button, when pressed, switches the rotary encoder to selection of the MODA destination.
When the module is in PRESET mode (indicated by the illumination of the red LED above the rotary encoder) this button has a different function - that of entering the MORPH mode.

5 **CHORD TYPE/MULTI/LOAD BUTTON** - this button, when pressed, switches the rotary encoder to selection of the MULTI setting for oscillator 1. A second press of the button switches the rotary encoder to selection of the MULTI setting for oscillator 1. If CHORD mode is active (as indicated by the illumination of the LED above the CHORD mode button) then a third button press will switch the rotary encoder to selection of the CHORD type.
When the module is in PRESET mode (indicated by the illumination of the red LED above the rotary encoder) this button has a different function - that of loading the control settings from the currently selected PRESET.

6 **INT. FM POTENTIOMETER -** this potentiometer provides an offset that is summed with the external IFM input signal to produce the signal that sets the modulation of oscillator 1's frequency by the output of oscillator 2. The internal FM is computed at the system clock rate of 25 MHz, providing very high-quality aliasing free modulations.

7 INT. **SYNC BUTTON** - this button toggles the internal sync on and off. When on, as indicated by the illumination of the LED above the button, both oscillators 1 and 2 are synchronized at the start of each cycle of an internal synchronization oscillator running at the same frequency as oscillator 1 (except that the synchronization oscillator is not affected by the FM inputs to oscillator 1). The specific response of the oscillators to the synchronization pulses depends on the SYNC mode setting.

Front Panel Elements (*continued...*)

8 **RATIO/TIME POTENTIOMETER -** this potentiometer provides an offset to the oscillator 2 RATIO setting. This is summed with the external RATIO input signal. The pitch of oscillator 2 is shifted by an amount proportional to this sum. Oscillator 2's frequency setting is also used to set the delay time for the echo effect, thus the RATIO/TIME potentiometer can be used to alter the delay time.

9 **QUANT. BUTTON** - this button, when pressed, toggles quantization of the oscillator 2 frequency ratio on and off. When ratio quantization is enabled the pitch of oscillator 2 is tied directly to the pitch of oscillator 1. The external PITCH2 input is ignored in this situation. There are 16 different quantized ratios available: [1/8, 3/16, 1/4, 5/16, 3/8, 1/2, 5/8, 3/4, 1, 5/4, 3/2, 2, 3, 4, 6, 8].

10 **MODULATION INPUT ATTENUATORS** - these mini-potentiometers (without knobs) serve to adjust the level of the modulation inputs (those coming from the second row of jacks from the bottom of the front panel).

11 **FINE and COARSE POTENTIOMETERS -** these two potentiometers provide an offset to the pitch for both oscillators. This offset is summed with the external pitch input signals (PITCH1 and PITCH2), as well as the RATIO signal in the case of oscillator 2, to produce the oscillator pitches.

12 **MODULATION INPUT JACKS** - the top row of jacks are used to input eight different modulation signals. These signals include:

RATIO: adjusts the ratio of the frequency of oscillator 2 as compared to that of oscillator 1.
IFM: sets the level of the internal frequency modulation of oscillator 1 by oscillator 2.
FM 1: audio rate linear frequency modulation of oscillator 1.
FOLD CV: adjusts the amount of waveform folding imposed by the analog wave folder.
MOD A: audio rate modulation input with a number of different modulation targets.
SHAPE 1: modulates the shape of oscillator 1's waveform within the current wavetable bank.
SHAPE 2: modulates the shape of oscillator' 2s waveform within the current wavetable bank.
MOD B: low rate modulation input with a number of different modulation targets.

13 **PEAK/LFO 1 LED -** this LED indicates whether either of the two audio-rate modulation inputs, FM 1 and MOD A, have reached the limits of their range, and hence whether clipping of these signals is occuring. If you see the PEAK LED come on, turn down the attenuator for these inputs. When oscillator 1 is operating in LFO mode, this LED no longer signals the presence of peaks, but instead indicates the sign of output 1 (i.e. the LED is illuminated whenever output 1 is positive).

14 **INPUT JACKS** - the four leftmost jacks in the bottom row are used to input the following signals:

PITCH 1: this input sets the pitch of oscillator 1. It has a 1 volt/octave scale factor.

PITCH 2: this input sets the pitch of oscillator 2. It has a 1 volt/octave scale factor. This jack is normalized to the PITCH 1 jack, which means that if no cable is plugged into the PITCH 2 jack, the PITCH 2 input follows the signal input to the PITCH 1 jack.

SYNC: positive-going pulses input to this jack cause the oscillators to be synchronized, according to the current SYNC mode settings. These pulses are also used to trigger the percussive attacks when the module is in PERC mode, and cause stepping of the presets when preset stepping is activated.

FOLD IN: the signal input to this jack is fed to the input of the analog wavefolder circuitry. It is normalized to the OUT 1 jack, so that if no cable is plugged into the FOLD IN jack, the input to the wavefolder is taken from output 1.

15 **TWO-LINE LCD DISPLAY** - the top row of this display is used, in various modes, to show the waveform banks for the two oscillators, the sync mode, the pulse output source, the MODA destination, the MULTI settings, and the chord type. When PRESET mode is active the top row of the display shows the preset number, the preset step mode parameters, and the morph preset. The bottom row of the display is used to show the various MODB parameter settings: the combination mode, oscillator 1 waveform tilt, echo level, chord mode detuning, chord mode overdrive level, and the percussion mode decay time.

16 **MOD B/MORPH POTENTIOMETER** - this potentiometer provides an offset for the MOD B modulation level. This is summed with the external MOD B input to provide the overall MOD B modulation level. The potentiometer gives a zero value when at the 12 o'clock setting, and negative offsets when rotated counter-clockwise and positive offsets when clockwise. When a parameter (such as the TILT level) is selected to be a MOD B destination, the lower row of the display will show the current value of the modulation level. When the MORPH mode is enabled while in PRESET mode, the MOD B/MORPH control will set the level of morphing from the panel control settings to the currently selected preset values. Full counter-clockwise gives the panel settings while full clockwise gives the preset settings.

17 **COMBO MODE BUTTON** - this button, when pressed, switches the rotary encoder to selection of the nonlinear outputs combination modes. The encoder selected mode is displayed on the bottom row of the LCD display. Subsequent presses of the button toggles the MOD B modulation on and off. When the MOD B modulation is enabled the LCD display will change to show the offset to the selected mode.

18 **TILT/DRIVE BUTTON** - this button, when pressed, switches the rotary encoder to setting of the waveform TILT level for oscillator 1. The TILT parameter setting is displayed on the bottom row of the LCD display. Subsequent presses of the button toggles the MOD B modulation on and off. When the MOD B modulation is enabled the LCD display will change to show the offset to the TILT setting. When CHORD mode is active, the output 1 DRIVE level will be set and displayed instead of the TILT level.

19 **DELAY BUTTON** - this button, when pressed, switches the rotary encoder to setting of the ECHO level. The setting is displayed on the bottom row of the LCD display. Subsequent presses of the button toggles the MOD B modulation on and off. When the MOD B modulation is enabled the LCD display will change to show the offset to the echo level.

20 **DETUNE/DECAY BUTTON -** this button, when pressed, switches the rotary encoder to setting of the detuning for oscillator 1 in CHORD mode. The DETUNE parameter is displayed on the bottom row of the LCD display. Subsequent presses of the button toggles the MOD B modulation on and off. When the MOD B modulation is enabled the LCD display will change to show the offset to the DETUNE parameter. When PERC mode is active, the percussive envelope DECAY time will be set and displayed instead of the DETUNE parameter value.

21 **SHAPE 2 POTENTIOMETER** - this potentiometer selects the waveform for oscillator 2 from the 8 waveforms in the currently selected wave bank. There is a smooth interpolation between the waveforms. This setting is summed with the external SHAPE 2 modulation input to provide the actual selection.

22 **CHORD MODE BUTTON -** this button, when pressed, toggles the CHORD mode on and off. When CHORD mode is active, 8 detuned copies of oscillator 1 are running. These copies are shifted in relative pitch in musical intervals to produce chords. There are 64 different chords that are available. When the CHORD mode is turned on, the upper row of the display will indicated the currently selected chord type. This selection can be changed with the rotary encoder.

23 **FOLD POTENTIOMETER** - this potentiometer sets the amount of folding imposed by the waveform folder. As this control is part of the analog waveform folder circuitry its setting is not shown on the LCD display.

24 **PERC MODE BUTTON** - this button, when pressed, toggles the PERCUSSION mode on and off. When this mode is active output 1 is passed through a digital amplifier whose gain is controlled by a simple envelope. The envelope has a very sharp attack and an exponential decay. The decay rate is determined by the DECAY parameter setting. The envelope is triggered by positive-going pulses received at the external sync input jack.

25 **SHAPE 1 POTENTIOMETERS -** this potentiometer selects the waveform for oscillator 1 from the 8 waveforms in the currently selected wave bank. There is a smooth interpolation between the waveforms. This setting is summed with the external SHAPE 2 modulation input to provide the actual selection.

26 **LFO MODE BUTTON and LFO 1,2 LEDs** - this button, when pressed, cycles through the enabling of LFO mode for oscillators 1 and 2. The first button press turns on LFO mode for oscillator 2 only. The second button press turns on LFO mode for oscillator 1 only, the third button press enables LFO mode for both oscillators, and the fourth button presses turns off LFO mode for both oscillators. In LFO mode the pitch of the oscillator is dropped by 7 octaves (frequency is divided by 128). When LFO mode is enabled for oscillator 2 and quantization is off, the pitch of oscillator 2 is no longer affected by the COARSE and FINE knobs. It is only affected by the PITCH 2 input and the RATIO control and input in this situation.

27 **OUTPUT JACKS -** the four rightmost jacks in the bottom row are used to output the following signals:

OUT1: outputs the oscillator 1 waveform after passing it through the nonlinear combination process and the echo/delay effect. The signal is internally generated at 25MHz but is downsampled to 98KHz before passing through a DIgital to Analog converter.

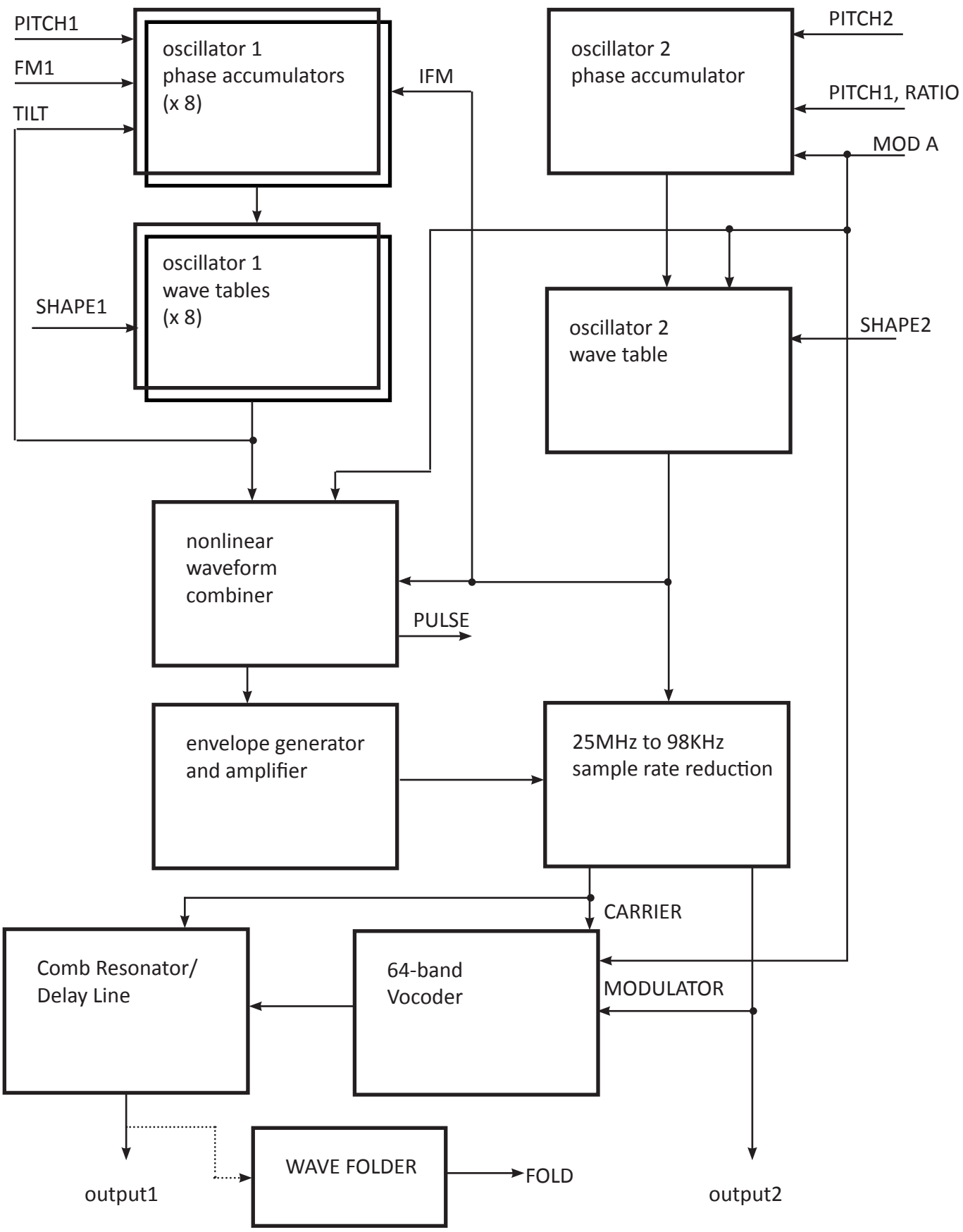
OUT 2: outputs the oscillator 2 waveform. The signal is internally generated at 25MHz but is downsampled to 98KHz before passing through a DIgital to Analog converter.

PULSE: outputs a two-level signal (0-5V) derived from the oscillator 1 or oscillator 2 waveforms (the specific output depends on the particular PULSE mode selected).

FOLD: this is the output of the analog wavefolder.

28 **PULSE/LFO 2 LED** - this LED indicates whether the PULSE output is high (5 volts) or low (0 volts). When oscillator 2 is operating in LFO mode, this LED no longer displays the PULSE output value, but instead indicates the sign of output 2 (i.e. the LED is illuminated whenever output 2 is positive).

SIMPLIFIED SIGNAL FLOW DIAGRAM



Nonlinear Waveform Combination Modes

The outputs of the two oscillators are sent through a nonlinear combination process before going to the echo/delay effect and then onto output 1. The combination process allows the generation of complex timbres and interactions between the two oscillators, as shown in the figures on the next two pages.

Press the COMBO MODE button to activate the rotary encoder for selection of the combination mode. The selected combination mode will be shown in the bottom row of the LCD display. The COMBO MODE parameter can also be modulated by the MOD B input, which is activated with a second press of the COMBO MODE button. When MOD B modulation is active the lower row of the LCD display will change to show both the nominal setting and the offset provided by the MOD B modulation.

There are 8 different combination modes that can be selected:

cmb:osc1 - in this mode there is no nonlinear combination. The output of oscillator 1 is taken as is.

cmb:ring - in this mode the outputs of oscillator 1 and oscillator 2 are multiplied, equivalent to the well-known *ring modulation* effect.

cmb: min - in this mode either the output of oscillator 1 or the output of oscillator 2 is chosen, depending on which one has the lower value.

cmb:pong - in this mode the output of oscillator 1 is chosen if it has a positive value, otherwise the output of oscillator 2 is chosen if it has a negative value. If neither of these conditions holds, then the output is set to 0.

cmb:inlv - in this mode the digital bits representing the two oscillator waveforms are interleaved to provide the output of the combination process. The most significant bit of oscillator 1 is used as the most significant bit of the output, the 2nd most significant bit of oscillator 2 is used as the 2nd most significant bit of the output, and so forth, alternating between taking bits from oscillator 1 and 2.

cmb: and - in this mode the digital bits representing the two oscillator waveforms are combined using the logical AND operation (the AND operation produces a 1 bit when both the input bits are 1, otherwise it produces a 0 result).

cmb: xor - in this mode the digital bits representing the two oscillator waveforms are combined using the logical XOR operation (the XOR operation produces a 0 bit when the input bits have the same value, otherwise when the bits have different values it produces a 1 result).

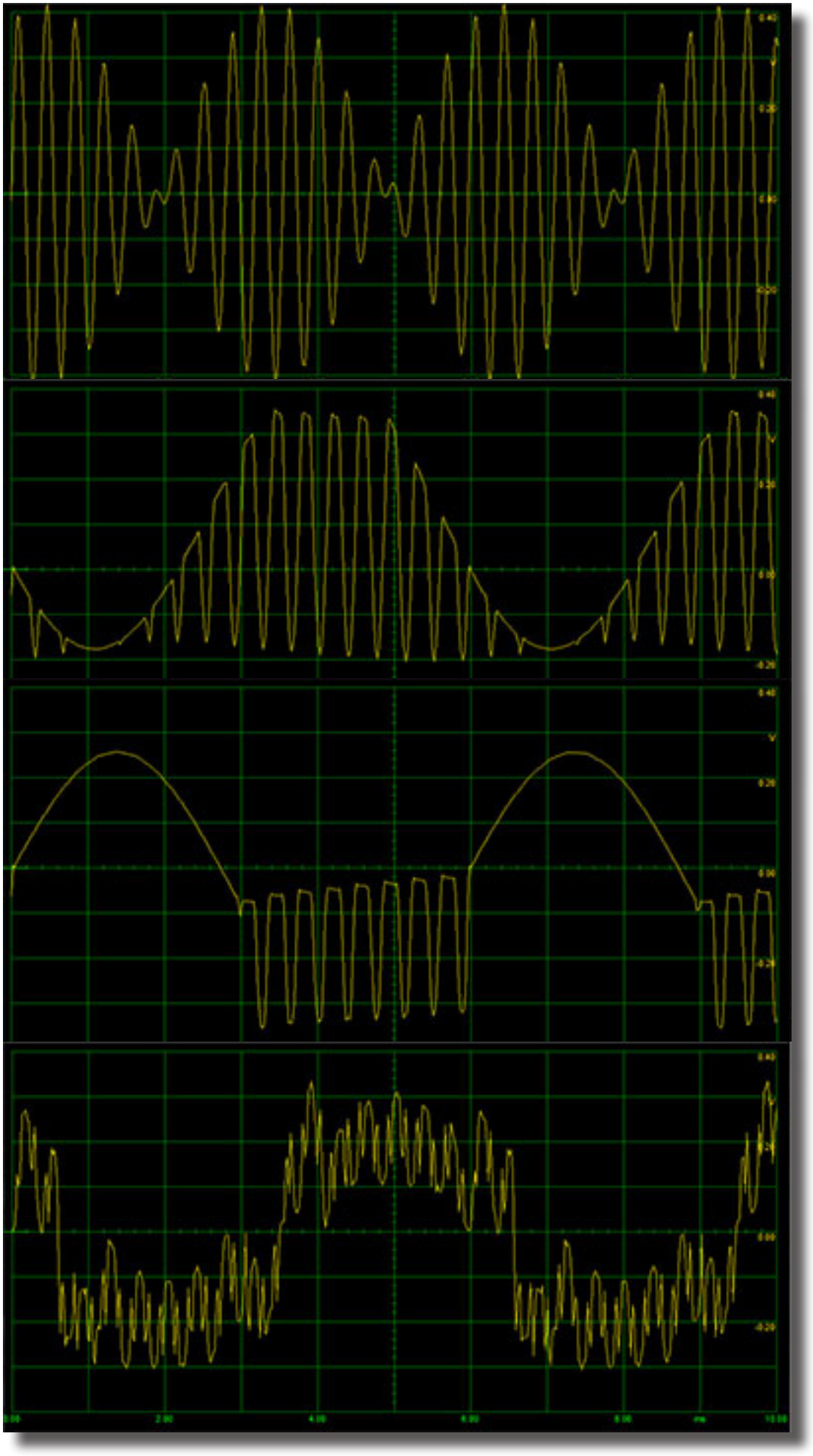
cmb:gLcH - in this mode each bit of the output of the combination process is set to 1 whenever the respective bits of oscillator 1 and 2 both become 1, and is set to 0 whenever the respective bits of oscillator 1 and 2 both become 0. Otherwise the bits hold their value constant. Whenever the 2nd most significant bit of the combination goes from 0 to 1, the phase of oscillator 1 is 'bumped', or offset, by a step of 1/4 cycle (or 90 degrees of phase) and the phase of oscillator 2 is bumped by a step of 1/8 cycle (or 45 degrees of phase). The overall effect of this rather complicated combination is to provide a noisy and glitchy sound.

RING

MIN

PONG

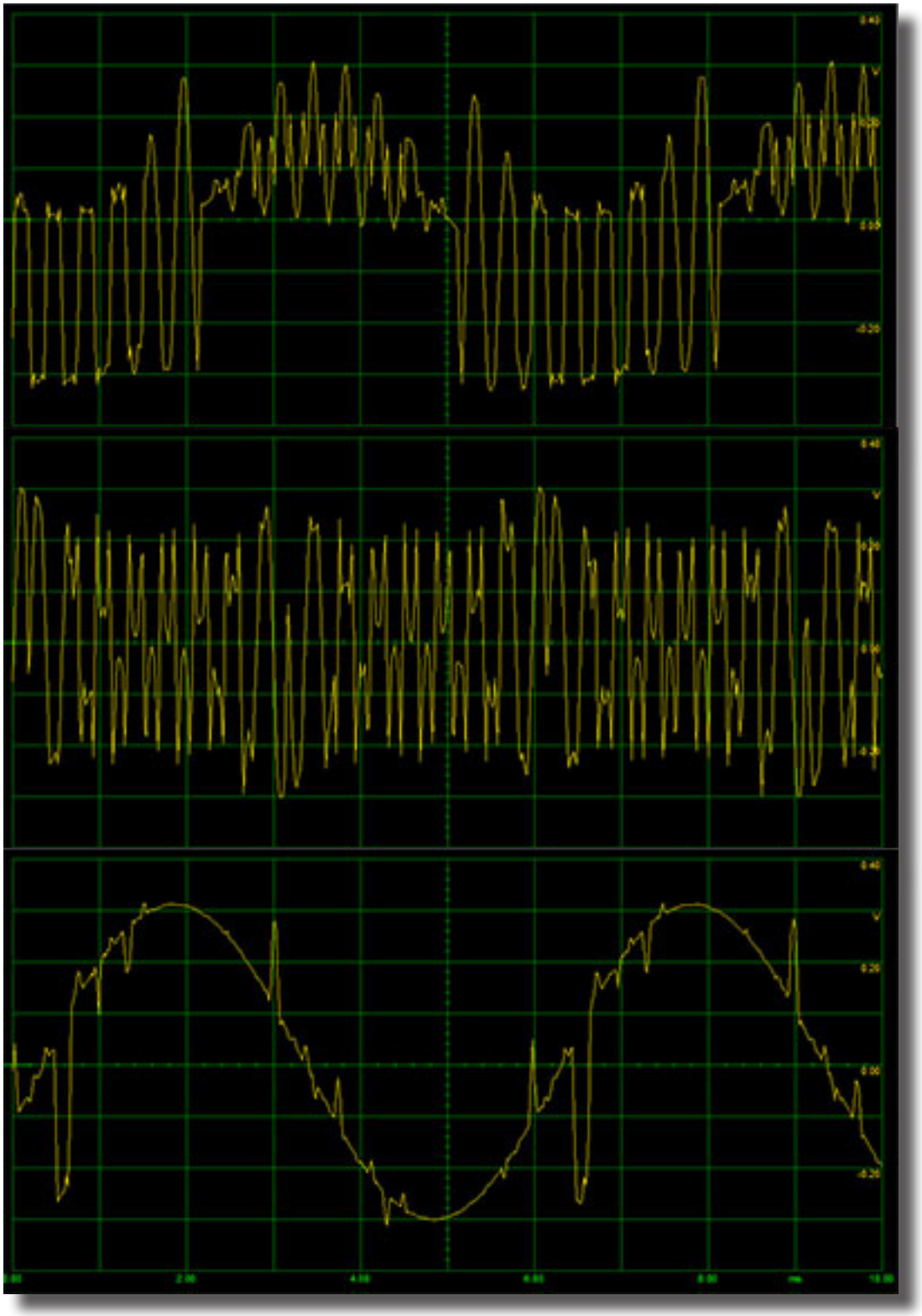
INLV



AND

XOR

gLcH



Examples of the output of the nonlinear waveform combination process in the different waveform combination modes (the osc1 mode is not shown). The oscillator 1 and oscillator 2 waveforms are both sine waves, with the frequency of oscillator 2 set to about 16 times that of oscillator 1.

Oscillator SYNC Modes

The oscillators can be reset, or synchronized, whenever a synchronization event occurs. A synchronization event happens whenever the voltage at the SYNC input jack rises above about 0.2 volts, and also whenever the phase of the internal synchronization oscillator passes zero when the INT. SYNC mode is enabled. The synchronization oscillator runs at the same nominal frequency as oscillator 1 (except that it is not affected by frequency modulation or detuning). The specific behaviour of the oscillators in response to a synchronization event depends on the currently selected SYNC mode, as described below and shown in the figure on the next pages.

Press the SYNC/PULSE/STEP button to activate the rotary encoder for selection of the SYNC mode. The selected SYNC mode will be shown in the upper row of the LCD display.

There are 8 different SYNC modes that can be selected:

HardSync - in this mode the phases of both oscillators 1 and 2 are reset to zero when a synchronization event occurs. This is most common type of synchronization effect found in other oscillator modules.

SoftSync - in this mode the phases of both oscillators 1 and 2 are reset to zero when a synchronization event occurs but only when the oscillator waveform is in the first quarter of its cycle (i.e. where the phase is between 0 and 90 degrees). Thus the oscillators might not be reset on every synchronization event. This gives a somewhat noisier and more erratic sound than hardsync.

Rev Sync - in this mode the *direction* of the waveform is reversed when a synchronization event occurs. For example, a rising sawtooth waveform will become a falling sawtooth waveform. This tends to provide a rather smooth sound, useful for basses, especially when INT SYNC is enabled.

Hold/1sh - in this mode the output of oscillator 1 switches between being held constant (freeze effect) or running free on each synchronization event. This is useful to provide choppy gating effects with low frequency SYNC inputs. Oscillator 2 will go through one complete cycle on each synchronization event.

BumpSync - in this mode the phase of oscillator 1 is 'bumped', or offset, by 1/4th of a cycle (90 degrees) and the phase of oscillator 2 is bumped by 1/8th of a cycle (45 degrees) whenever a synchronization event occurs.

2=1 Sync - this mode operates in the same way as HardSync mode, except that whenever the output of oscillator 1 is equal to the output of oscillator 2 an additional synchronization event is created that is sent to oscillator 2 only. The typical result is to create 'chirps' in oscillator 2 where its waveform chases that of oscillator 1, being repeatedly reset with shorter and shorter time intervals until it catches up.

1=2 Sync - this mode is similar to 2=1 Synch mode except that the additional synchronization event is sent to oscillator 1 only. In this mode the 'chirps' are created in oscillator 1.

Sync Off - in this mode the synchronization events have no effect on the oscillators. It can be useful when the SYNC input is used to step the presets in PRESET STEP mode to avoid the transient that might otherwise occur, and also in CHORD mode to prevent the phase alignment of the 8 oscillators (unless you want that effect!).

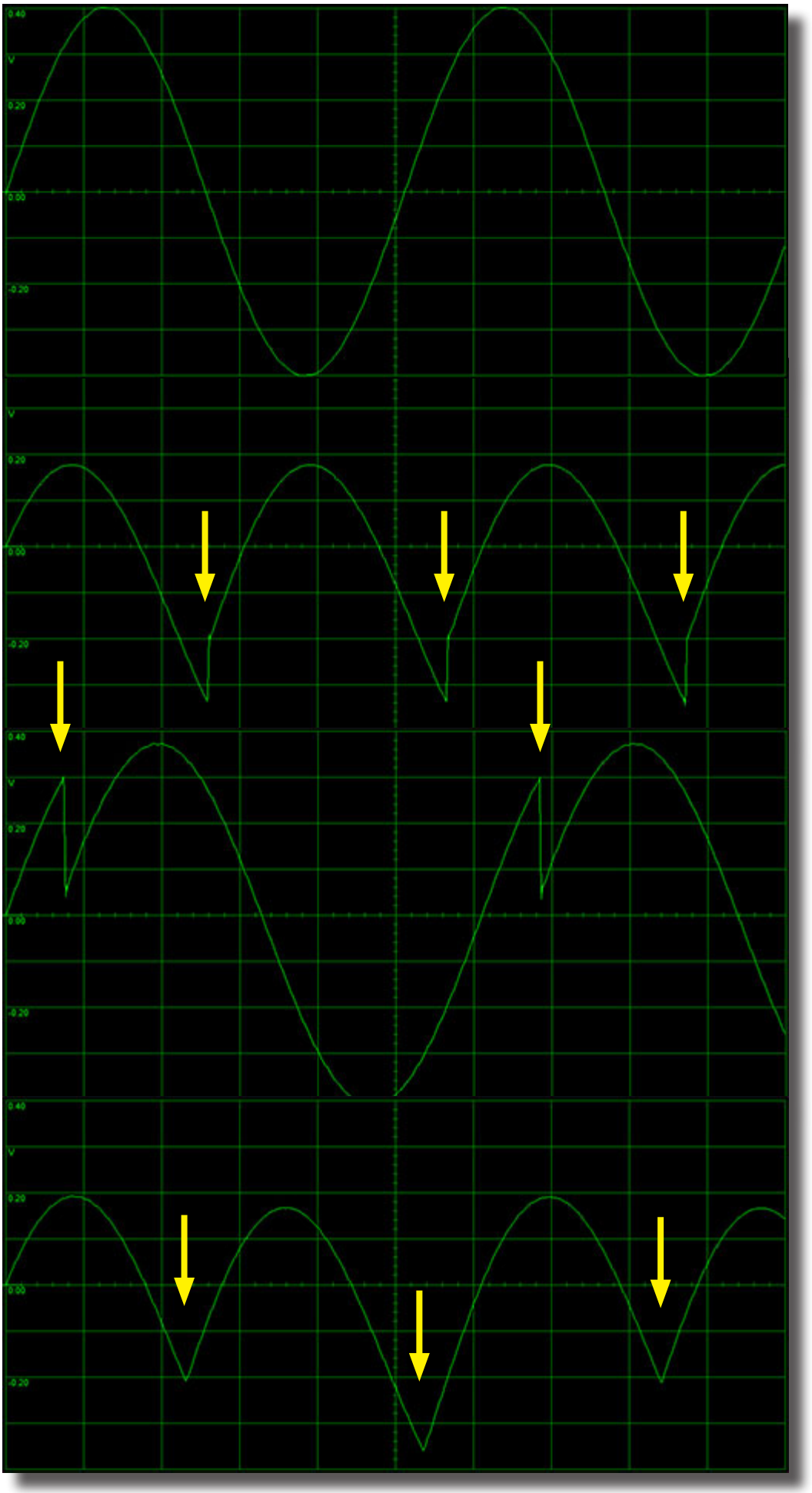
Examples of the response of oscillator 2 to synchronization events in each sync mode is shown in the next two pages. The yellow arrows indicate the time of occurence of synchronization events.

Sync Off

Hard Sync

Soft Sync

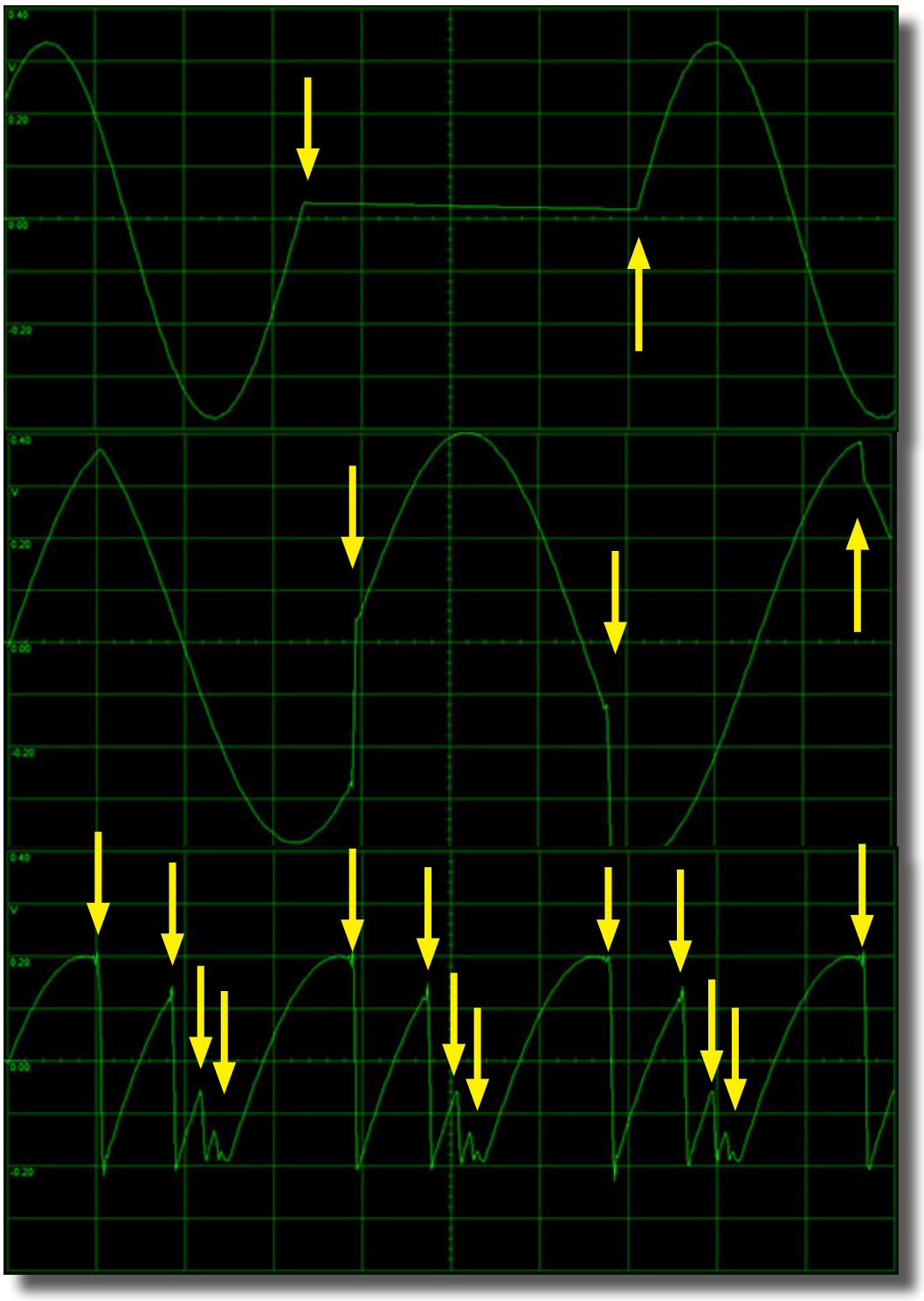
Reverse Sync



Hold/1sh

Bump Sync

2=1 Sync



Examples of the oscillator 2 output in the different sync modes, with int. sync turned on. Oscillator 2 is set to sine wave. In the 1=2 Sync mode (not shown) the output of oscillator 2 would look the same as in the Hard Sync mode, but the output of oscillator 1 in this case would look similar to the output shown for oscillator 2 in the 2=1 Sync mode. The yellow arrows indicate the occurence of synchronization events (which can come from either the external SYNC input or from the internal sync).

PULSE Source Modes

The lower row of jacks on the front panel includes a PULSE output. This output is a two-level signal, either at 0 volts or 5 volts. This signal is derived from the outputs of oscillators 1 and 2 in various ways.

Press the SYNC/PULSE/STEP button two times to activate the rotary encoder for selection of the PULSE source. The selected PULSE source will be shown in the upper row of the LCD display.

There are 8 different PULSE source modes that can be selected:

+o1 : in this mode the PULSE output is high (5 volts) when oscillator 1's output is positive. Otherwise it is low (0 volts).

EOC : in this mode the PULSE output goes high when the output 1 envelope is high. During normal operation this will always be high. During PERC mode, this output will be low during the decay phase of the percussive envelope and will go high at the end of the envelope cycle. This could be used to trigger other events in a modular system.

+o2 : in this mode the PULSE output is high (5 volts) when oscillator 2's output is positive. Otherwise it is low (0 volts). This mode can be useful as a trigger or gate when oscillator 2 is running in LFO mode.

-o2 : in this mode the PULSE output is high (5 volts) when oscillator 2's output is negative. Otherwise it is low (0 volts).

OR : in this mode the PULSE output is high when either oscillator 1's output is positive or oscillator 2's output is positive.

AND : in this mode the PULSE output is high when both oscillator 1's output is positive and oscillator 2's output is positive.

XOR : in this mode the PULSE output is low when oscillator 1's and oscillator 2's outputs are both positive or both negative. Otherwise the output is high.

gLcH : in this mode the PULSE output is equal to the sign of the output of the nonlinear waveform combination process as when running in gLcH mode. This mode is available even when the combination mode is set to something other than gLcH. This mode can be useful in generating noisy and glitchy triggers.

MOD A Destinations

The MOD A input located in the top row of jacks is converted to digital form at a high sampling rate (98 KHz). This digitized signal can be inserted into the system at a number of points, providing different capabilities for the module. This input is AC-coupled, meaning that it is not sensitive to DC (or very low frequency) values.

Press the MOD A/MORPH button to activate the rotary encoder for specifying the destination of the MOD A signal. The selected destination will be shown in the upper row of the LCD display.

There are eight different destinations for the MOD A input that can be selected:

Phase2 - in this mode the MOD A signal is used to modulate the PHASE of oscillator 2.

Combo 2 - in this mode the MOD A signal is fed into the nonlinear combination process in place of the oscillator 2 output. This allows an external signal to be combined with oscillator 1's output (for example, one could do RING MODULATION or XOR-ing of oscillator 1's waveform with the audio signal from another module).

Shape 2 - in this mode the MOD A signal is used to address the wavetable for oscillator 2. In this situation the PITCH 2 and RATIO signals have no effect, since the phase accumulator for oscillator 2 is disconnected from the circuit. Instead, the MOD A signal is driving the wave table addressing. If one feeds in a sawtooth waveform from another oscillator module, the results would be similar to using the internal oscillator 2, except that the pitch is now being controlled by the external source. But one can feed in waveforms other than sawtooths, in which case the effect will be similar to a waveshaper. This could be used for distortion effects, for example.

Voc MOD - in this mode the MOD A signal is used as the MODULATION signal for the 64-band vocoder. The output of the nonlinear waveform combiner is used as the vocoder's CARRIER signal. The vocoder consists of two banks of 64 narrow bandpass filters that covers the frequency spectrum from roughly 15Hz to 15,000Hz. One filter bank is used to measure the energy in the MODULATION signal in each of the 64 frequency channels, while the other is used to filter the CARRIER signal. The individual energy levels of each channel for the MODULATION signal are multiplied by the individual channel outputs of the CARRIER signal filter bank. These 64 products are summed together to produce the single vocoder output signal. The effect is to map the frequency spectrum of the MODULATOR signal onto that of the CARRIER signal. This can produce 'robotic' vocal sounds when the carrier frequency is held constant or melodic singing sounds when the CARRIER pitch is varied. For best results, the CARRIER signal should use harmonic-rich waveforms such as sawtooth or pulse waves.

Phase1 - in this mode the MOD A signal is used to modulate the PHASE of oscillator 1.

Combo 1 - in this mode the MOD A signal is fed into the nonlinear combination process in place of the oscillator 1 output.

Shape 1 - in this mode the MOD A signal is used to address the wavetable for oscillator 1. In CHORD mode the MOD A signal only affects the root oscillator. The other seven are unaffected.

Voc CARR - in this mode the MOD A signal is used as the CARRIER signal for the vocoder.

CHORD MODE

When CHORD MODE is activated, by pressing the CHORD MODE button, the LED above the button will light up. More importantly, when CHORD MODE is active, oscillator 1 will be split into 8 separate oscillators, each outputing the same waveform, but with different frequencies. This allows chords to be played when the frequencies are chosen to be at musical intervals, and provides a deep, rich, sound when the frequencies are chosen to be the same (i.e. a UNISON chord), but with slight variations in tuning between them.

The amount of detuning between the 8 oscillators can be adjusted by pressing the DETUNE/DECAY button (as long as PERC. MODE is not active). When this is done, the lower line of the LCD display will show the current detuning value, expressed as a number from 0 to 99. This value can be changed with the rotary encoder. A larger number means a greater detuning. The detuning is an offset to the oscillator frequencies rather than a scaling, meaning that the effect for a given detuning is less at higher pitches. So you may want to increase the detuning amount when playing mainly high notes and lower it when playing mainly low notes. The detuning parameter can also be modulated by the MOD B input, which is activated with a second press of the DETUNE/DECAY button. When MOD B modulation is active the lower row of the LCD display will change to show both the nominal setting and the offset provided by the MOD B modulation.

When CHORD MODE is first activated, the top line of the LCD display will change to showing the currently selected chord type. This can be selected using the rotary encoder. There are 64 different chord types that can be chosen. The following table shows the label for each type shown in the LCD display, along with the interval in semitones assigned to each of the 8 oscillators (0 is the root note). Negative numbers indicate suboctave intervals (pitches below the root note).

CH:uniso	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**(unison)**
CH: m2nd	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**(minor 2nd interval)**
CH: M2nd	**0**	**0**	**0**	**0**	**2**	**2**	**2**	**2**	**(major 2nd interval)**
CH: m3rd	**0**	**0**	**0**	**0**	**3**	**3**	**3**	**3**	**(minor 3rd interval)**
CH: M3rd	**0**	**0**	**0**	**0**	**4**	**4**	**4**	**4**	**(major 3rd interval)**
CH: 4th	**0**	**0**	**0**	**0**	**5**	**5**	**5**	**5**	**(4th interval)**
CH:trito	**0**	**0**	**0**	**0**	**6**	**6**	**6**	**6**	**(tritone interval)**
CH: 5th	**0**	**0**	**0**	**0**	**7**	**7**	**7**	**7**	**(5th interval)**
CH:aug5	**0**	**0**	**0**	**0**	**8**	**8**	**8**	**8**	**(augmented 5th interval)**
CH: 6th	**0**	**0**	**0**	**0**	**9**	**9**	**9**	**9**	**(6th interval)**
CH: m7th	**0**	**0**	**0**	**0**	**10**	**10**	**10**	**10**	**(minor 7th interval)**
CH: M7th	**0**	**0**	**0**	**0**	**11**	**11**	**11**	**11**	**(major 7th interval)**
CH:octav	**0**	**0**	**0**	**0**	**12**	**12**	**12**	**12**	**(octave interval)**
CH:suboc	**0**	**0**	**0**	**0**	**-12**	**-12**	**12**	**12**	**(suboctave + octave)**
CH: 2oct	**0**	**12**	**24**	**0**	**12**	**24**	**12**	**24**	**(octave + 2octave)**
CH: min	**0**	**3**	**7**	**0**	**3**	**7**	**0**	**3**	**(minor triad)**
CH:minI1	**12**	**3**	**7**	**12**	**3**	**7**	**12**	**3**	**(minor triad 1st inversion)**
CH:minI2	**12**	**15**	**7**	**12**	**15**	**7**	**12**	**15**	**(minor triad 2nd inversion)**
CH: maj	**0**	**4**	**7**	**0**	**4**	**7**	**0**	**4**	**(major triad)**
CH:majI1	**12**	**4**	**7**	**12**	**4**	**7**	**12**	**4**	**(major triad 1st inversion)**
CH:majI2	**12**	**16**	**7**	**12**	**16**	**7**	**12**	**16**	**(major triad 2nd inversion)**
CH: sus	**0**	**5**	**7**	**0**	**5**	**7**	**5**	**7**	**(suspended triad)**
CH: aug	**0**	**4**	**8**	**0**	**4**	**8**	**0**	**8**	**(augmented triad)**
CH: dim	**0**	**3**	**6**	**0**	**3**	**6**	**0**	**6**	**(diminished triad)**

CH: maj6	**0 4 7 9 0 4 7 9**	**(major 6th)**
CH: maj7	**0 4 7 11 0 4 7 11**	**(major 7th)**
CH:7M1st	**12 4 7 11 12 4 7 11**	**(major 7th 1st inversion)**
CH:7M2nd	**12 16 7 11 12 16 7 11**	**(major 7th 2nd inversion)**
CH:7M3rd	**12 16 19 11 12 16 19 11**	**(major 7th 3rd inversion)**
CH: dom	**0 4 7 10 0 4 7 10**	**(dominant 7th)**
CH:7D1st	**12 4 7 10 12 4 7 10**	**(dominant 7th 1st inversion)**
CH:7D2nd	**12 16 7 10 12 16 7 10**	**(dominant 7th 2nd inversion)**
CH:7D3rd	**12 16 19 10 12 16 19 10**	**(dominant 7th 3rd inversion)**
CH: min7	**0 3 7 10 0 3 7 10**	**(minor 7th)**
CH:7m1st	**12 3 7 10 12 3 7 10**	**(minor 7th 1st inversion)**
CH:7m2nd	**12 15 7 10 12 15 7 10**	**(minor 7th 2nd inversion)**
CH:7m3rd	**12 15 19 10 12 15 19 10**	**(minor 7th 3rd inversion)**
CH:hdim7	**0 3 6 10 0 3 6 10**	**(half diminished 7th)**
CH:7h1st	**12 3 6 10 12 3 6 10**	**(half diminished 7th 1st inversion)**
CH:7h2nd	**12 15 6 10 12 15 6 10**	**(half diminished 7th 2nd inversion)**
CH:7h3rd	**12 15 18 10 12 15 18 10**	**(half diminished 7th 3rd inversion)**
CH: dim7	**0 3 6 9 0 3 6 9**	**(diminished 7th)**
CH:7d1st	**12 3 6 9 12 3 6 9**	**(diminished 7th 1st inversion)**
CH:7d2nd	**12 15 6 9 12 15 6 9**	**(diminished 7th 2nd inversion)**
CH:7d3rd	**12 15 18 9 12 15 18 9**	**(diminished 7th 3rd inversion)**
CH: 7sus	**0 5 7 10 0 5 7 10**	**(suspended 7th)**
CH:7s1st	**12 5 7 10 12 5 7 10**	**(suspended 7th 1st inversion)**
CH:7s2nd	**12 17 7 10 12 17 7 10**	**(suspended 7th 2nd inversion)**
CH:7s3rd	**12 17 19 10 12 17 19 10**	**(suspended 7th 3rd inversion)**
CH:D9th	**0 4 7 10 14 14 7 10**	**(dominant 9th)**
CH:9D2nd	**12 16 7 10 14 14 7 10**	**(dominant 9th 2nd inversion)**
CH:Dm9th	**0 4 7 10 13 13 7 10**	**(dominant minor 9th)**
CH:Dm9-2	**12 16 7 10 13 13 7 10**	**(dominant minor 9th 2nd inversion)**
CH: maj9	**0 4 7 11 14 14 7 11**	**(major 9th)**
CH:9M2nd	**12 16 7 11 14 14 7 11**	**(major 9th 2nd inversion)**
CH: min9	**0 3 7 10 14 14 7 10**	**(minor 9th)**
CH:9m2nd	**12 15 7 10 14 14 7 10**	**(minor 9th 2nd inversion)**
CH: M6/9	**0 4 7 9 14 4 7 9**	**(major 6/9)**
CH: m6/9	**0 4 7 9 14 4 7 9**	**(minor 6/9)**
CH: 9b5	**0 4 6 10 14 14 6 10**	**(9th flat 5th)**
CH: 9#5	**0 4 8 10 14 14 8 10**	**(9th sharp 5th)**
CH:D11th	**0 0 7 10 14 18 7 18**	**(dominant 11th)**
CH:m11th	**0 3 7 10 14 17 14 17**	**(minor 11th)**
CH: wide	**0 12 14 17 7 24 -12 7**	**(octave, 9th, 11th, fifth, 2octave, suboctave, fifth)**

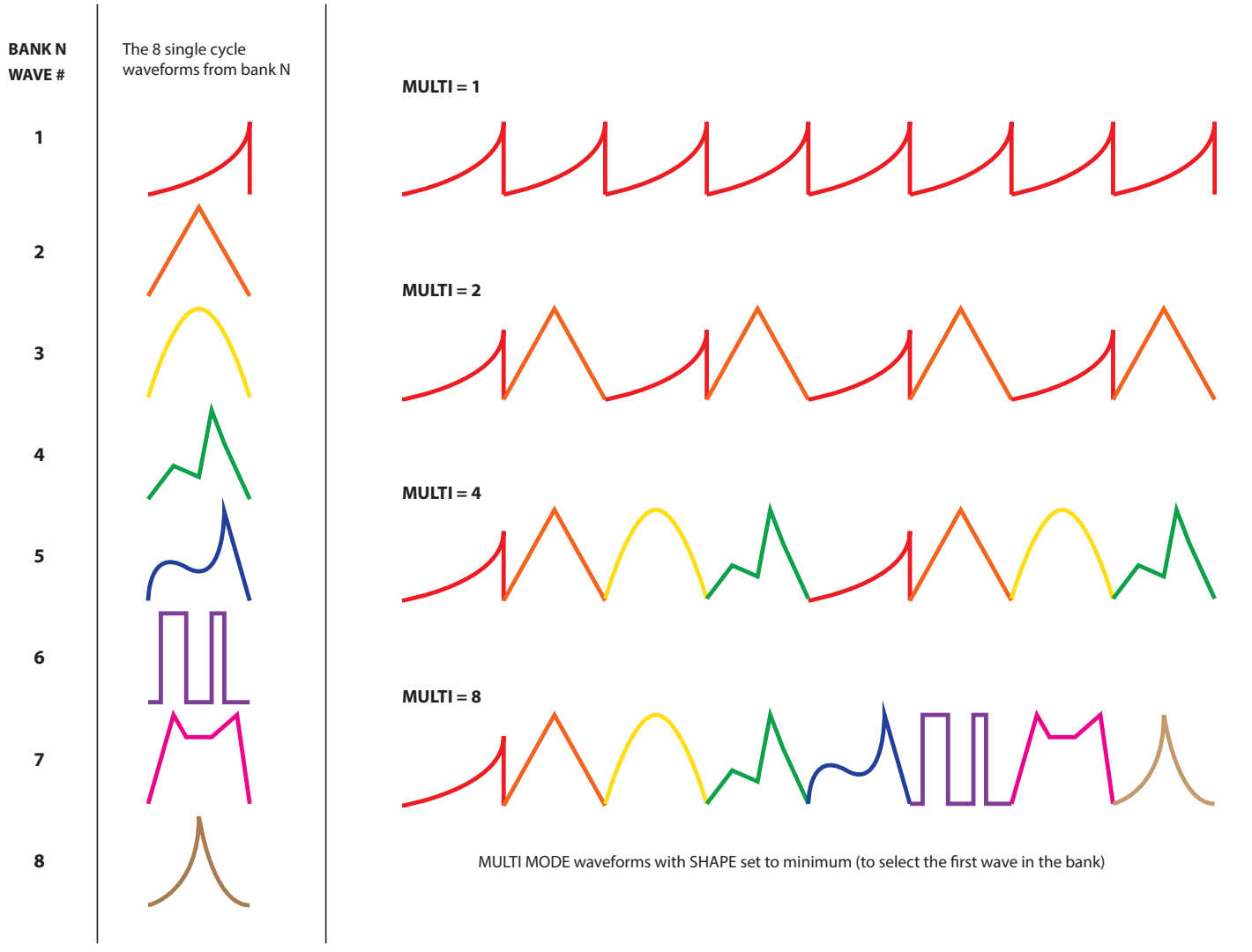
The tuning of the chords can be switched between ***Just Intonation*** and ***Equal Temperament***. This is accessed by pressing the Chord Type/Multi/Load button while Chord Mode is active. Use the rotary encoder to switch between the two tuning methods.

MULTI SETTINGS

The MULTI setting modifies the way in which the wavetables are read. Normally the wavetables are read in 512 sample chunks, called ‘waves’. These waves are shown in Appendix A. In the MULTI modes successive waves are strung together to provide more complex waveforms. There are four different MULTI modes, corresponding to 1 wave (normal operation with 512-sample waveforms), 2 waves strung together (1024-sample waveforms), 4 waves strung together (2048-sample waveforms), and 8 waves strung together (4096-sample waveforms).

To adjust the MULTI settings for oscillator 1, press the CHORD TYPE/MULTI/LOAD button. If CHORD mode is off the LCD display will show “Multi1: N”, where N is the current multi setting for oscillator 1. The setting can then be adjusted with the rotary encoder to a value of 1, 2, 4, or 8. The number (1,2,4,8) indicates how many waves are strung together. To change the multi setting for oscillator 2, press the CHORD TYPE/MULTI/LOAD button once more. The LCD display will now show “Multi2: N”, where N is the current multi setting for oscillator 1. If CHORD mode is off pressing the button again will take you back to setting for oscillator 1, otherwise it will take you to setting of the CHORD TYPE.

The figure below illustrates how the waves in a bank are strung together to create the waveforms produced by the four different MULTI settings.



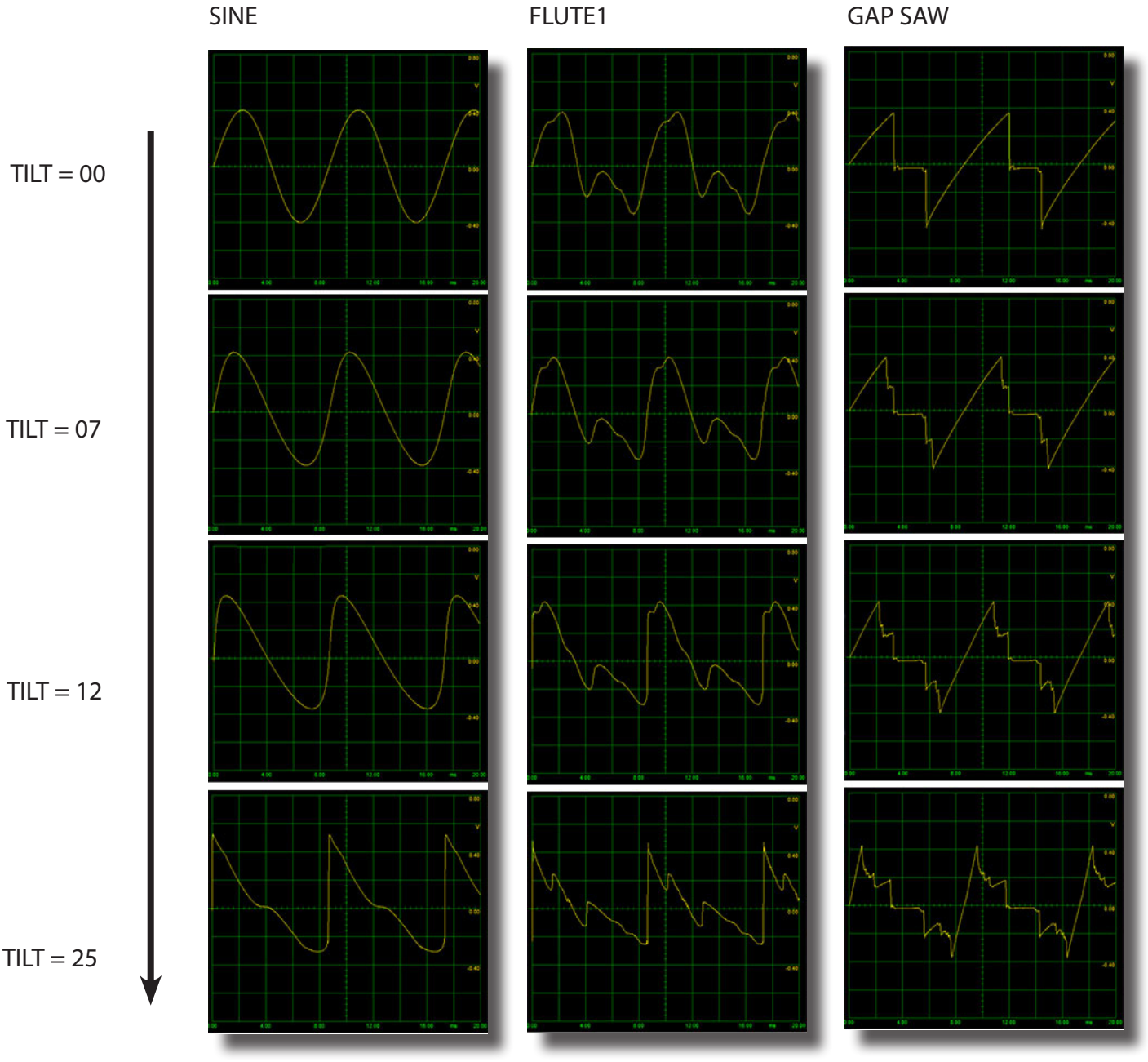
MULTI MODE waveforms with SHAPE set to minimum (to select the first wave in the bank)

TILT FUNCTION

The TILT function phase modulates oscillator 1 with its own output. This results in a self-feedback loop which has the effect of 'tilting' the waveform, as shown in the diagram below. The amount of feedback, and hence the amount of tilting, is set by the TILT parameter. At large values of the TILT parameter the waveform may start to become distorted, and even chaotic.

To set the nominal value of the TILT parameter, press the TILT/DRIVE button. The TILT parameter value can then be adjusted with the rotary encoder and will be shown in the bottom row of the LCD display.

The TILT parameter can also be modulated by the MOD B input, which is activated with a second press of the TILT/DRIVE button. When MOD B modulation is active the lower row of the LCD display will change to show both the nominal setting and the offset provided by the MOD B modulation.



DRIVE FUNCTION

The DRIVE function is operational only when CHORD MODE is active. It applies a variable amount of gain (between 1 and 3) to output1, followed by a cubic saturation process. The purpose of this function is to compensate somewhat for the loss of amplitude experienced due to phase cancellation of the multiple waveforms when in CHORD MODE. The saturation keeps the peak amplitude within limits, and provides a nice soft rolloff of the peaks for most waveforms. In some cases the result may sound distorted at high DRIVE levels.

To set the nominal value of the DRIVE parameter, press the TILT/DRIVE button. If CHORD MODE is active, the DRIVE parameter value can then be adjusted with the rotary encoder and will be shown in the bottom row of the LCD display. The DRIVE parameter can also be modulated by the MOD B input, which is activated with a second press of the TILT/DRIVE button. When MOD B modulation is active the lower row of the LCD display will change to show both the nominal setting and the offset provided by the MOD B modulation.

DELAY FUNCTION

The output of the nonlinear waveform combiner, after going through the envelope amplifier, is passed through a simple comb resonator/delay line. For short delay times this acts as a resonator, and at long delay times it provides an echo effect. The DELAY parameter sets the amount of feedback from the output of the delay line back to its input, and also sets the wet/dry mix of the input and delayed signals. As the DELAY parameter increases, the resonator depth, or the echo regeneration increases. At the same time the wet/dry ratio increases. This is needed to prevent saturation or clipping at higher feedback levels, and means that the level of the input signal gets lower and lower as the DELAY parameter increases. At the maximum DELAY setting the feedback is 100% and the input is 0% and the delayed signal will be infinitely repeated (a hold or freeze effect). This can be used in performances to provide overdubbing or looping effects. To do this one quickly changes the DELAY parameter (using the MOD B knob as described in the next paragraph) to 0, plays some material, then quickly changes the DELAY parameter to 99 to hold and repeat the material just played.

To set the nominal value of the DELAY parameter, press the DELAY button. The DELAY parameter value can then be adjusted with the rotary encoder and will be shown in the bottom row of the LCD display (on the display it is labeled as *echo* rather than delay). The DELAY parameter can also be modulated by the MOD B input, which is activated with a second press of the DELAY button. When MOD B modulation is active the lower row of the LCD display will change to show both the nominal setting and the offset provided by the MOD B modulation.

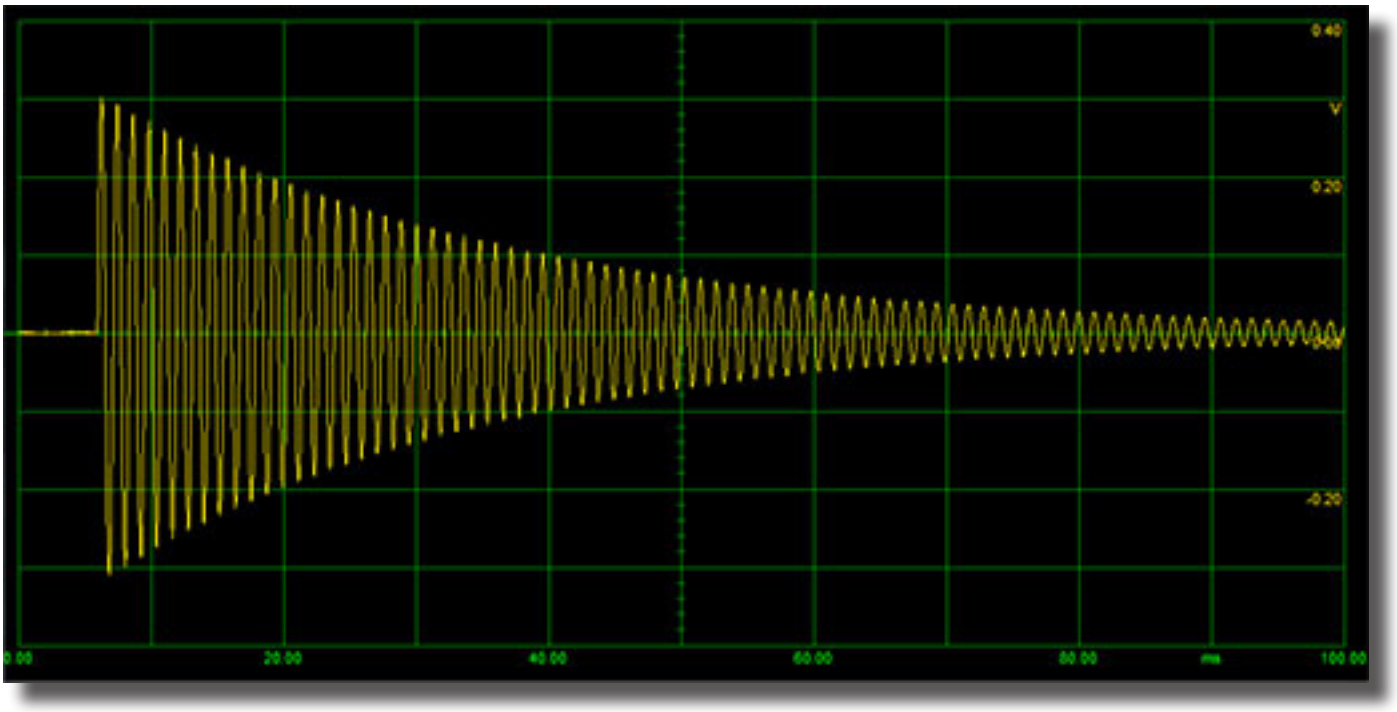
The DELAY parameter does not specify the delay time, however. The delay time is set by the period of oscillator 2. This permits synchronized LFO echo effects when oscillator 2 is in LFO mode, and produces pitch synchronous resonator effects when oscillator 2's pitch follows that of oscillator 1 (as when QUANT is turned on). The signal tracking the period of oscillator 2 is passed through a slew-rate limiter (low pass filter or smoother) before using it to compute the delay time. This causes a pitch shifting when the pitch of oscillator 2 changes. At long delay times (oscillator 2 in LFO mode) this produces long gliding pitch shifts, while at short delay times (resonator effect) this slew produces flanging effects.

PERCUSSION MODE

Percussion Mode is turned on and off by pressing the PERC. MODE button. When Percussion Mode is active, as indicated by the illumination of the LED directly above the PERC. MODE button, the output of the nonlinear wave combiner is passed through an amplifier whose gain is modulated by an exponential envelope. This envelope is triggered by a positive-going pulse on the SYNC input jack. The attack phase of the envelope is very fast (less than 1 msec), and there is no sustain phase. The exponential decay begins immediately with a time constant that is set by the DECAY TIME parameter. When Percussion Mode is active, pressing the DETUNE/DECAY button will allow the DECAY TIME parameter to be set with the rotary encoder and its value will be shown in the bottom row of the LCD display. The DECAY TIME parameter can also be modulated by the MOD B input, which is activated with a second press of the DETUNE/DECAY button. When MOD B modulation is active the lower row of the LCD display will change to show both the nominal setting and the offset provided by the MOD B modulation.

The minimum decay time is about 2msec (to half peak amplitude) and the maximum is about 3 seconds. The mapping of the DECAY TIME parameter to actual decay times is split into three distinct non-overlapping time ranges. From 0-24 the decay times range from about 2msec to 3 msec, 25-49 ranges from about 20-30 msec, 50-99 ranges from about 50 msec to 3 seconds.

When the PERC. MODE button is pressed a second time, the system will activate GATE mode. In this mode the SYNC input acts as a gate for the envelope. When the SYNC input goes high the envelope will jump immediately to its maximum value, and will remain there as long as the SYNC input is high. When the SYNC input goes low the envelope will begin to decay at the rate set by the DECAY TIME parameter.

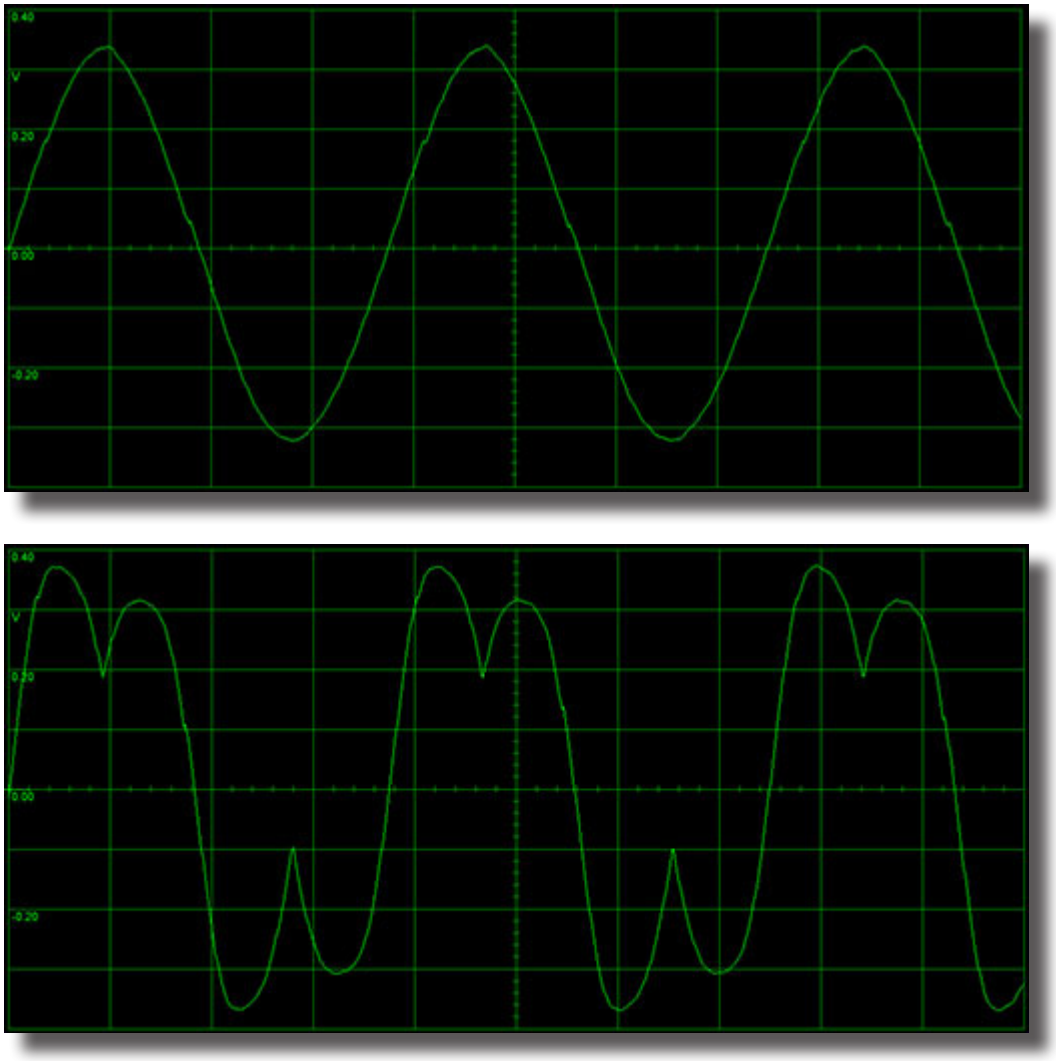


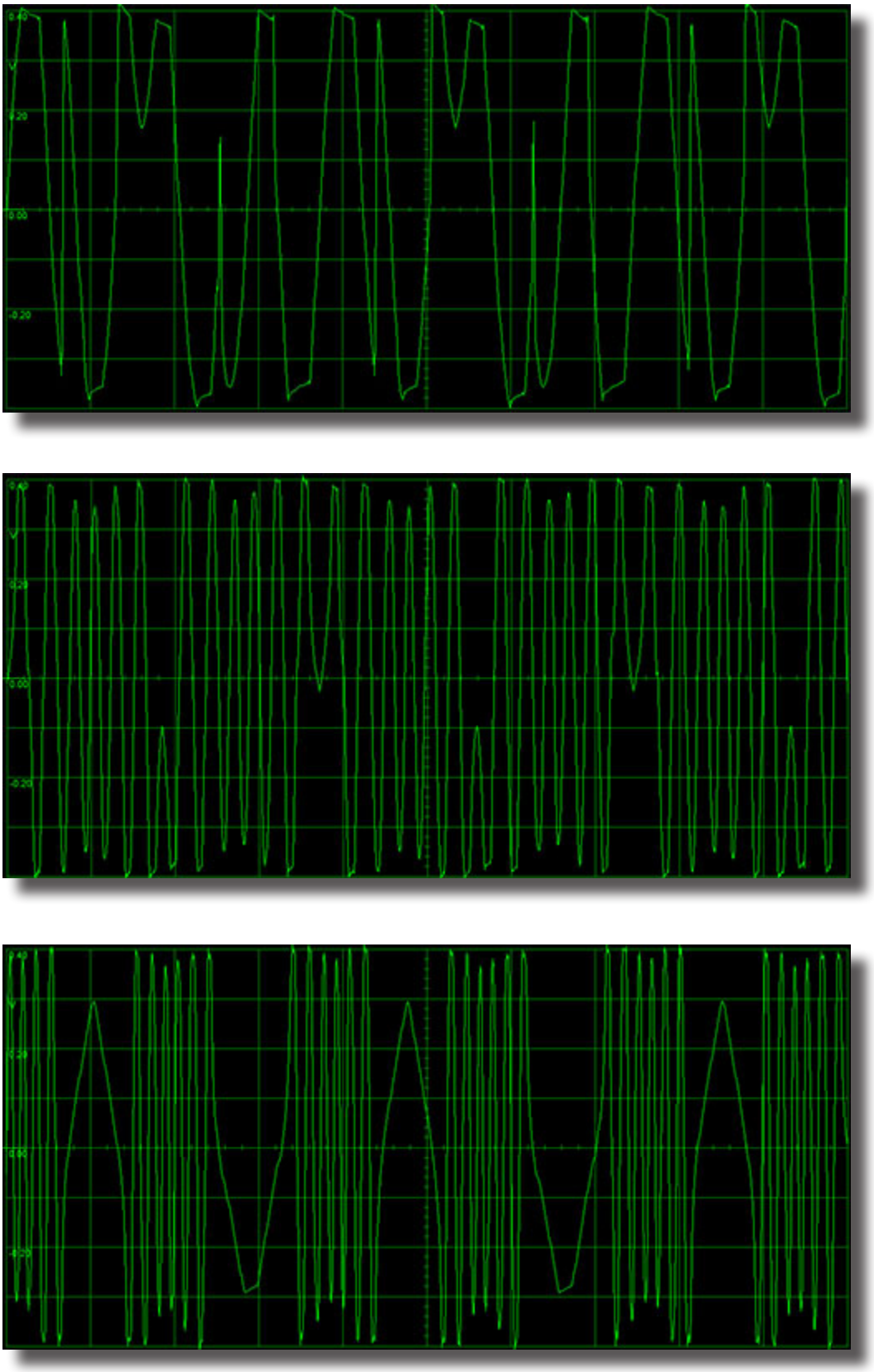
The output in PERC. MODE when the DECAY TIME parameter is set to 30, acting on a 1KHz sine wave. The time axis shows a period of 100msec.

WAVE FOLDER

The SHAPESHIFTER module includes a fully analog wave folding circuit. This circuit is based on the one used in the ***intellijel*** μ**Fold II** module. Its input comes from the FOLD jack on the bottom row of the front panel. This jack is *normalled* to the OUT 1 jack meaning that when there is no cable plugged into the FOLD jack, the signal at OUT 1 is fed into the wave folder's input. Inserting a cable into the FOLD jack will break this normalized connection and the wave folder input will be taken from whatever is connected to the cable. This allows an external signal to be acted on by the wave folder.

The action of the wave folder circuit is to *bend* or *fold* the input waveform back on itself. This generates harmonics brightening the sound. The amount of folding is set by the position of the FOLD knob and by the level of the FOLD CV input. At low levels the FOLD controls acts like a simple amplifier. When the FOLD amount is zero the output will also be zero. As the FOLD level increases the amplitude of the output will increase until the maximum output level is reached at which point the folding will begin to take effect. The figure below shows the effect of the wave folder on a triangle wave for various settings of the FOLD control.





The wave folder output for a triangle wave input. From top to bottom the FOLD level is increasing.

PRESET MODE

The SHAPESHIFTER module contains a 64-slot memory for storing parameter settings (called presets). All 64 of these preset slots can be written to by the user to save interesting settings. However, only 12 of these preset slots are in non-volatile memory (i.e. they persist after turning the power off) and the other 52 slots are in volatile memory (i.e. they disappear once the power is turned off). The 12 non-volatile presets can be used to store your favorite settings for future use and are very useful in setting up the module for performances. The 52 volatile presets can be used as a scratchpad for testing out new ideas (which can then be copied to a non-volatile preset if desired) or to set up sequences for use in the PRESET STEP mode. The contents of the 52 volatile presets are initialized to interesting settings upon powerup of the module (these are described in Appendix B). Users may find these useful as examples showing how to apply various aspects of the module, or they can just use the sounds as is in their performances. Of course, these volatile presets can be modified and overwritten as needed.

The user interacts with the preset memories while the module is in PRESET MODE. This mode is entered by ***pushing*** on the rotary encoder. The red LED above the rotary encoder will illuminate indicating that the module is now in PRESET MODE. Pushing the encoder a second time will leave PRESET MODE.

Once in preset mode the buttons to the left of the rotary encoder change their function to allow the user to interact with the preset memories. There are four primary operations that can be done: SAVE, STEP, MORPH, and LOAD.

When PRESET MODE is first entered, the LCD display shows the currently selected preset. If this is preset 1 through 12 (one of the non-volatile memory slots) the display will read “UserPrNN” (where NN is a number from 1 to 12). If one of the volatile presets is selected the display will read “PresetNN” (where NN is a number from 13 to 64). The selected preset can be changed by turning the rotary encoder.

SAVE: While in preset mode the current parameter settings can be stored to the currently selected preset memory slot. To do this, first get into the state where the LCD display is showing the currently selected preset number (i.e. “PresetNN” or “UserPrNN”). If the module is in STEP or MORPH mode this state can be reached just by pressing either the WAVE BANK/SAVE or the CHORD TYPE/MULTI/LOAD buttons. Once the preset number is being displayed, use the rotary encoder to change the preset number to the slot in which you want to save. Then press the WAVE BANK/SAVE button (top button to the left of the encoder). The LCD display will change to show “Save? NO”. If you do not actually want to save to this preset (because, for example, you pressed the button by accident or you changed your mind) just press the WAVE BANK/SAVE button again and nothing will happen. If you really do want to save to the preset, then turn the rotary encoder. The LCD display will now show “Save?YES”. Press the WAVE BANK/SAVE button to save to the preset memory.

LOAD: When the LCD display is showing the preset number (i.e. showing “PresetNN” or “UserPrNN”) pressing the CHORD TYPE/MULTI/LOAD button (bottom button to the left of the encoder) will cause the contents of the currently selected preset to be read and the module’s parameters updated with these stored values. Immediately after a preset is loaded, the panel controls will be set to ***soft pickup***. This means that turning the knobs on the panels will not have any effect until the position of the knob is equivalent to the value of the loaded preset. This may take some getting used to, as it may appear at first that the module is broken since the knobs no longer seem to work. But there is a good reason for doing things this way. It allows the sound made by the module upon loading of a preset to accurately represent the state of the module when the preset was saved, even though the panel controls may be in different positions. Otherwise the presets may sound different when loaded, depending on how the panel controls are set. When the PRESET MODE is exited, however, the soft pickup is turned off, and all parameter values immediately jump to the current panel settings (***hard pickup***).

PRESET MODE (continued...)

MORPH: The SHAPESHIFTER module allows you to morph between the current panel parameter settings and the settings stored in the currently selected preset. To activate this ability, press the MOD A/MORPH button (second from bottom button to the left of the rotary encoder). The LCD display will now show “Morph NN” (where NN is the currently selected preset number) and “PnL->Pst” (or “Pnl<-PsT”). The currently selected preset number can be changed by turning the rotary encoder. The parameter values actually used by the module in this situation will be a blending of the current panel settings and the parameters stored in the currently selected preset. The relative blending is controlled by the MOD B control (and MOD B input). When the MOD B control is fully counter clock-wise the actual parameters will be the same as the panel settings, whereas if the MOD B control is fully clock=wise then the actual parameters will be those from the currently selected preset. When the MOD B control is somewhere in between, the actual parameters will be a blending of the two. There are two exceptions to this blending: the INT. SYNC and PERC. MODE settings are always set to the panel configuration. The preset values for this buttons are ignored. Note that the currently selected preset can be changed on the fly using the rotary encoder, allowing the sounds to be rapidly changed during a performance. With the MOD B knob turned all the way clock-wise (so that the blending is completely to the preset values) this allows a quick way to audition the presets before loading them.

STEP: The SHAPESHIFTER module also has the capability of stepping through the presets in response to triggers sent to the SYNC input. To activate this ability press the SYNC/PULSE/STEP button (second button from the top to the left of the rotary encoder). The stepping is done on presets in a user-definable range of preset numbers (the Begin and End presets). The STEP mode has seven different settings, accessed by turning the rotary encoder. These are described below:

Fwd : NN when this is selected, press the SYNC/PULSE/STEP button to turn on the stepping action. Each trigger received by the SYNC input will step the preset to the next highest number. The LCD display will change to show “Fwd *NN”. The * indicates that stepping is live. To disable the stepping press the SYNC/PULSE/STEP button again.

Rev : NN this is the same as the Fwd setting except that each trigger will step to the next lower preset.

Fw/Rv: NN in this mode the stepping will first increase the preset number until the end preset number is reached, and then step downwards until the beginning preset number is reached, and the cycle repeats.

Rand : NN in this mode a random preset number in the range is selected on each trigger.

MOD B: NN in this mode the preset number selected on each trigger is set by the position of the MOD B knob (and by the MOD B input). This allows an external input to select or sequence the presets on each trigger.

Begin: NN when this is selected, press the SYNC/PULSE/STEP button. The LCD display will change to show “Begin? NN”. In this state you can turn the rotary encoder to select the starting preset number for the stepping sequence. Once you have chosen the desired starting preset number, press the SYNC/PULSE/STEP button again and use the rotary encoder to select one of the other settings.

End : NN in a manner similar to the Begin setting, this allows you to select the endng preset number for the stepping sequence.

Div: N in a manner similar to the Begin setting, this mode sets the number of SYNC pulses per step. It is used when you want to repeat a preset for a number of sync pulses before stepping to the next one. N can range from 1 to 8. When set to 1, the preset will step on every sync pulse.

Technical Details

The digital portion of the SHAPESHIFTER module is implemented in an Altera Cyclone IV Field Programmable Gate Array (FPGA). The use of Gate Array technology rather than a general purpose programmable microcontroller or DSP chip allows highly efficient implementation of fast parallel operations.

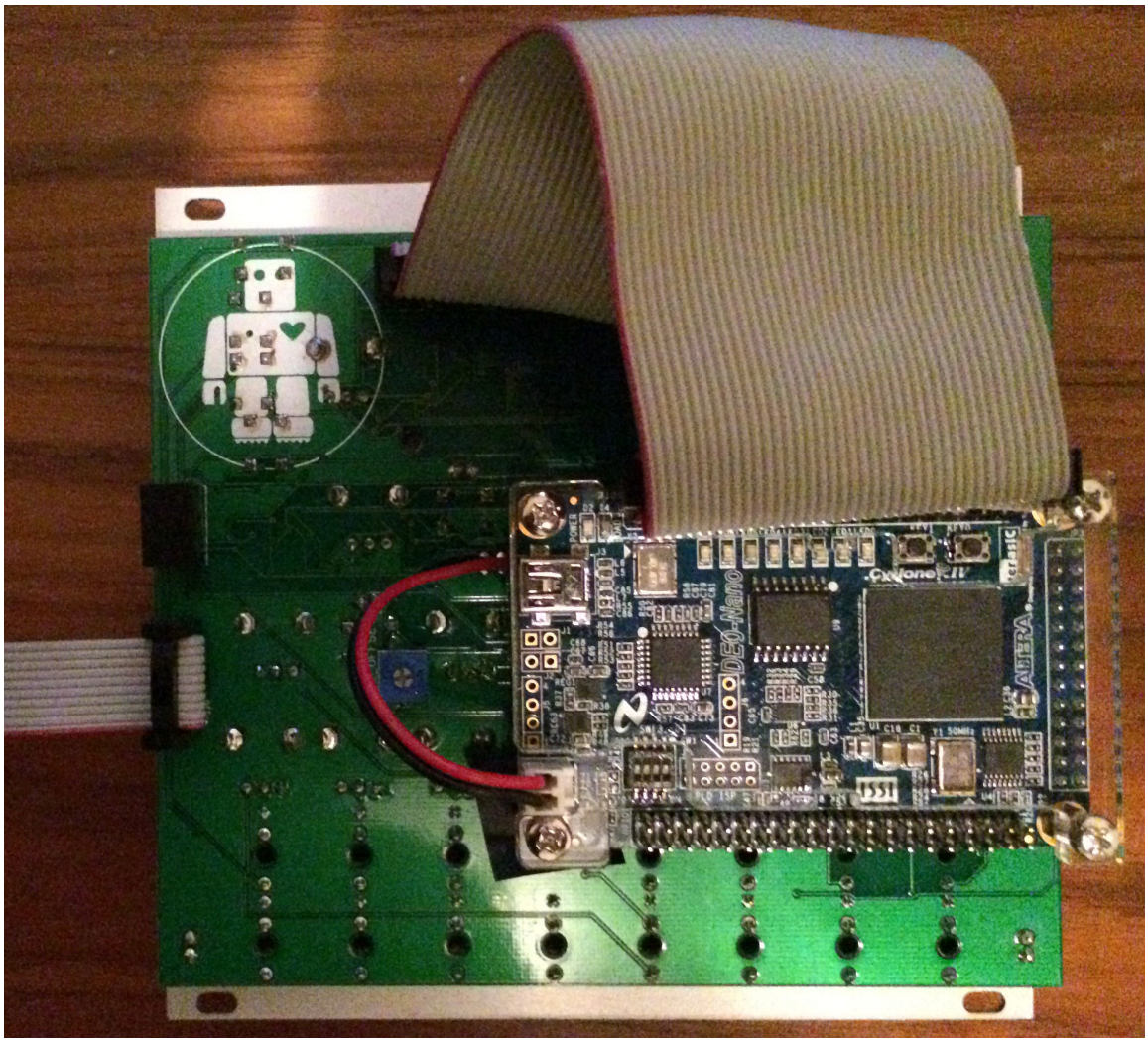
The primary logic blocks are clocked at a rate of 25MHz. The phase accumulators of the 9 oscillators are updated at this rate, as well as the nonlinear combination operations. This results in very low aliasing noise for the nonlinear operations and for the frequency and phase modulations. The phase accumulators are 55-bits in width, allowing for very low frequency operation and high quality frequency and phase modulation.

The contents of the relatively slow wavetable EPROM are copied to fast SDRAM memory when the module is first powered up. The SDRAM is then clocked at a rate of 100MHz. This results in a fast read rate of the wavetables - when CHORD mode is off the wavetables for each oscilllator are read at a sampling rate of 3MHz. When chord mode is on the wavetable read rates drop to 700KHz per oscillator, which is still high enough to minimize aliasing noise. Linear interpolation is performed between successive samples, providing smooth waveforms even at low frequencies. Each wavetable sample is digitally represented with 16 bits, and each waveform in the wavetable consists of 512 samples. There are 1024 different waveforms stored in the wavetable.

Most of the signal processing in the module is done at a 25MHz sampling rate. The signals are then filtered and down-sampled to 98KHz (25Mhz/256) before being output by the Digital to Analog Converters. Some of the signal processing (the delay line and the vocoder filter banks) is done at the lower output sampling rate. The PULSE output is sent at the primary 25MHz sample rate, although it is passed through an analog buffer which rolls off the high frequencies.

The input signals MOD A and FM1 are converted to digital form by 24-bit Analog-to-Digital Converters running at a sampling rate of 98KHz. The input signals PITCH1, PITCH2, INT. FM, RATIO, SHAPE1, SHAPE2 and MOD B are converted to digital form with 12-bit Analog-to-DIgital Converters running at 25KHz sampling rates. The SYNC input signal is sampled at 25MHz and converted directly to a 1-bit digital representation. The FOLD and

Rear View of the Module



If your module is acting erratically, or not working at all, make sure that all cables on the back are securely connected. The top 40-pin cable connects the front panel board to the FPGA board. The left-hand 10-pin cable connects the module to the Doepfer format power supply. The -12V pin of the cable (usually the one marked in red) must be oriented towards the bottom of the module. The two-wire (red-black in the photo above) provides the +5V power to the FPGA board. If it is correctly connected you will see a blue LED light up on the FPGA board.

The silver connector directly above the +5V power connector on the FPGA board is a mini-B USB connector, which is used to update the firmware on the FPGA (see appendix C for details).

Version

This manual is for version 1.04 of the module's firmware.

To determine the firmware version, press the QUANT., INT.SYNC., LFO (twice), CHORD MODE, and PERC. MODE buttons, so that their (six) corresponding LEDs light up (note that you want to have both of the LFO 1 and 2 LEDs light up). When this is accomplished, the LCD screen will alternate between displaying "shapshft/ver 1.03", some Japanese characters, and "CYLONIX/intllijel". If there is no "shapshft/ver 1.03" (or other version display) then your module has the original (ver 1.00) firmware. Note that a display of "ver 1.1" actually indicates version 1.01.

Please refer to Appendix C of this manual for instructions on updating the module's firmware.

Changelog

Version 1.04

- Added: pressing the Perc button twice activates GATE mode, where the SYNC input acts as a gate for Out1. When the SYNC input goes high the Out1 envelope immediately goes high. When the SYNC input goes low the Out1 envelope decays at a rate set by the DECAY parameter.
- Fixed: The logic of the Pulse mode was inverted.

Version 1.03

- Added: 4 new MODA destinations, swapping Osc2 by Osc1 in the Phase, Combo, and Shape destinations, and swapping the Carrier and Modulator in the vocoder.
- Changed: The modulation range for the Phase modulation (by MODA) and the Tilt function (internal self-phase modulation of Osc1) has been increased 4-fold.
- Fixed: In version 1.01 and version 1.02 the Shape1 and Shape2 parameters were coarsely quantized when Morphing between panel and preset settings in Preset Morph mode. The Shape parameters now smoothly morph between settings.
- Fixed: The pitch of oscillator 2 increased when changing the Multi mode with QUANT turned on. The pitch now remains constant over all multi modes.

Version 1.02

- Added: Users can now choose between just intonation or equal temperament tunings in chord mode.
- Added: Holdsync mode has been changed to do holdsync for osc1 and oneshot for osc2.
- Added: A confirmation message is now displayed when a preset is loaded.

Version 1.01

- Added: The version number of the firmware is now displayed when entering the SplashScreen display.
- Fixed: In version 1.00 there were small discontinuities in the waveforms when the Shape1 and Shape2 parameters were rapidly modulated. These have been eliminated.

Technical Specifications

Inputs:

PITCH1, PITCH2: -5 to +7V (1V/Oct scaling)

All other inputs: -5V to +5V

Outputs:

OUT1, OUT2: 12 Vp-p
FOLD: 10Vp-p (occasional peaks to 16Vp-p)
PULSE: 0 to +5V

Max Current Draw:

+195 mA in normal operation (from +12V supply, with occasional peaks to +220 mA)
-50 mA (from -12V supply)

Module Dimensions:

Width: 26HP
Depth: 40mm

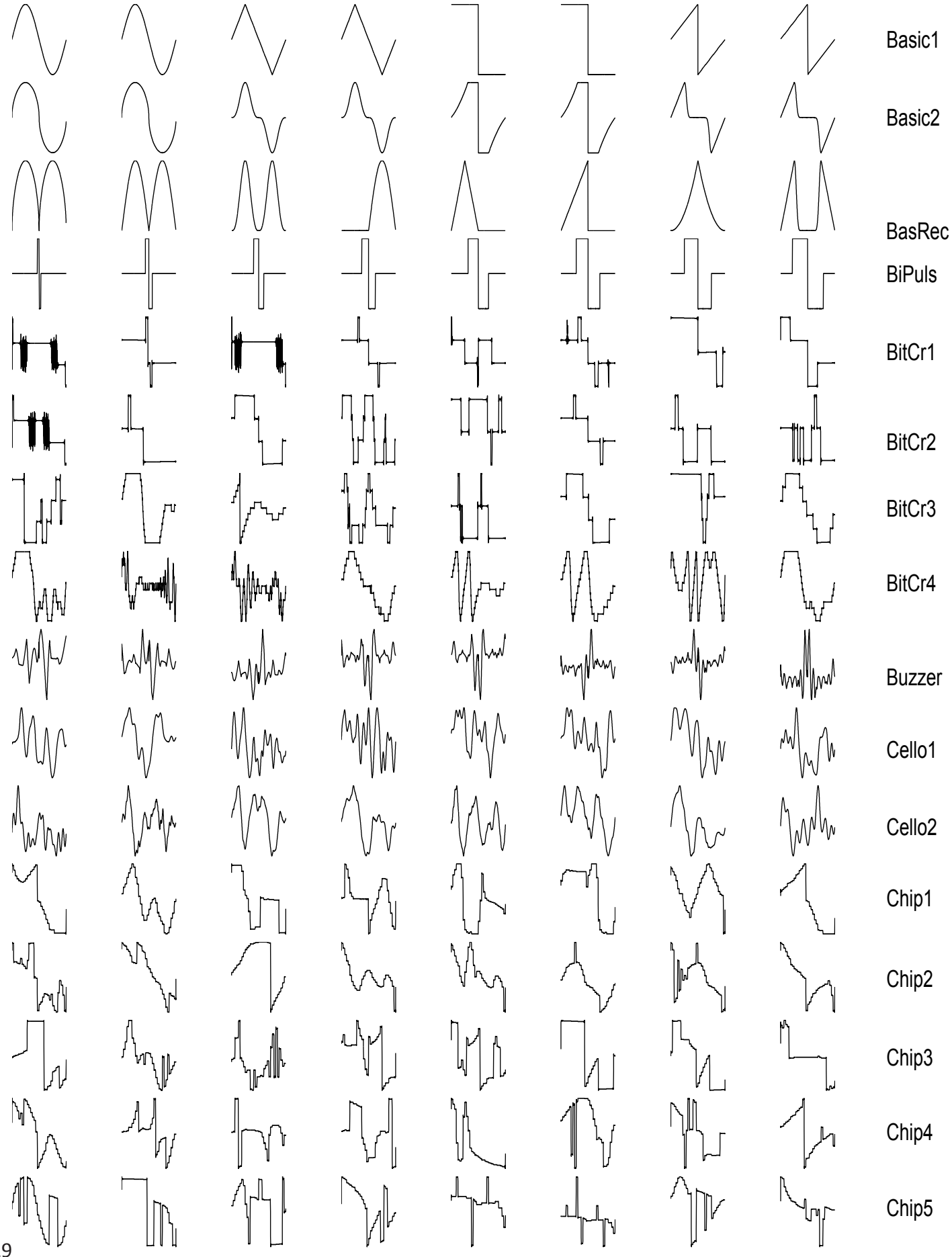
Warranty

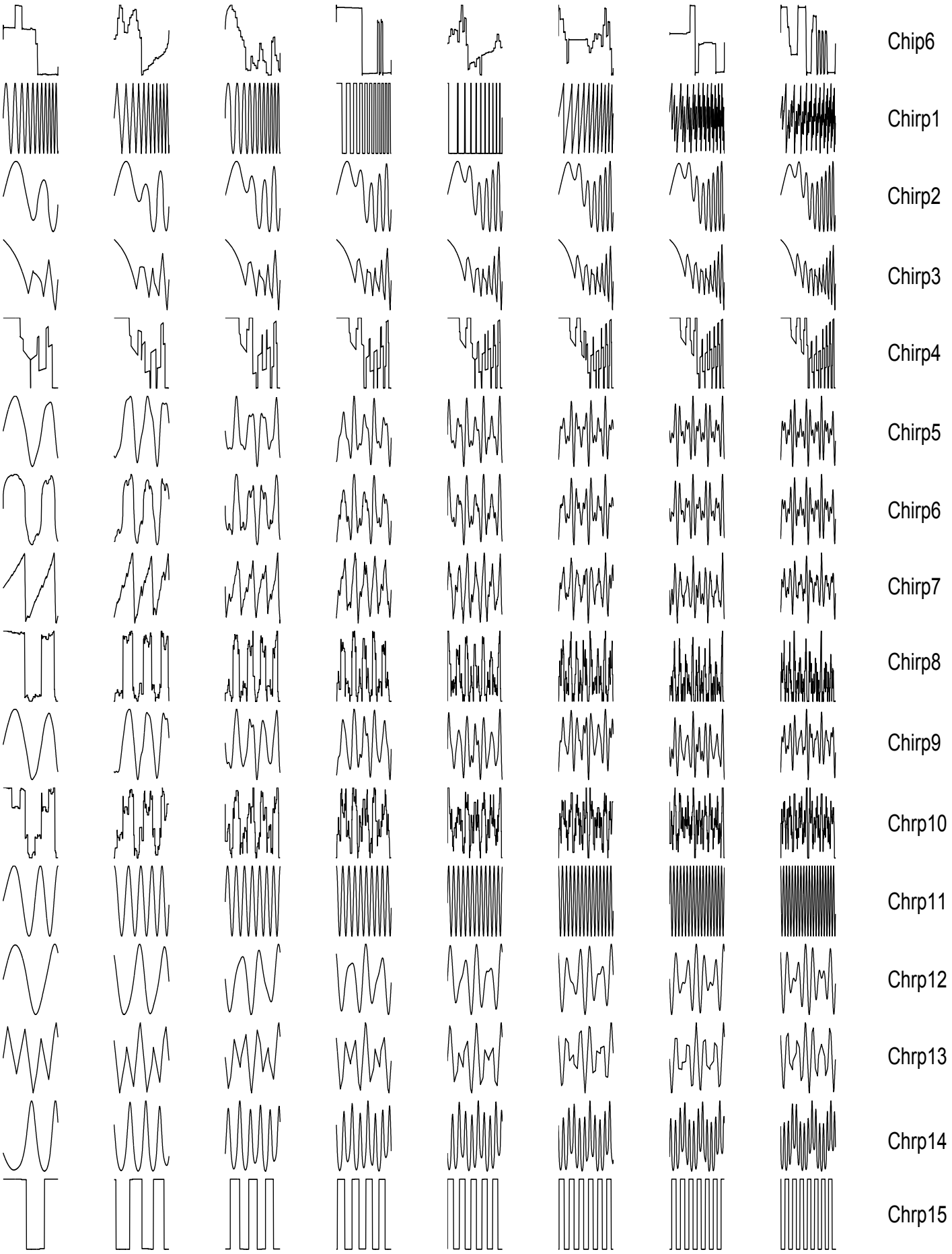
Intellijel Designs Inc. warrants this hardware product against defects in materials and workmanship when used normally in accordance with Intellijel's published guidelines for a period of TWO (2) YEARS from the date of original retail purchase by the end-user purchaser ("Warranty Period").

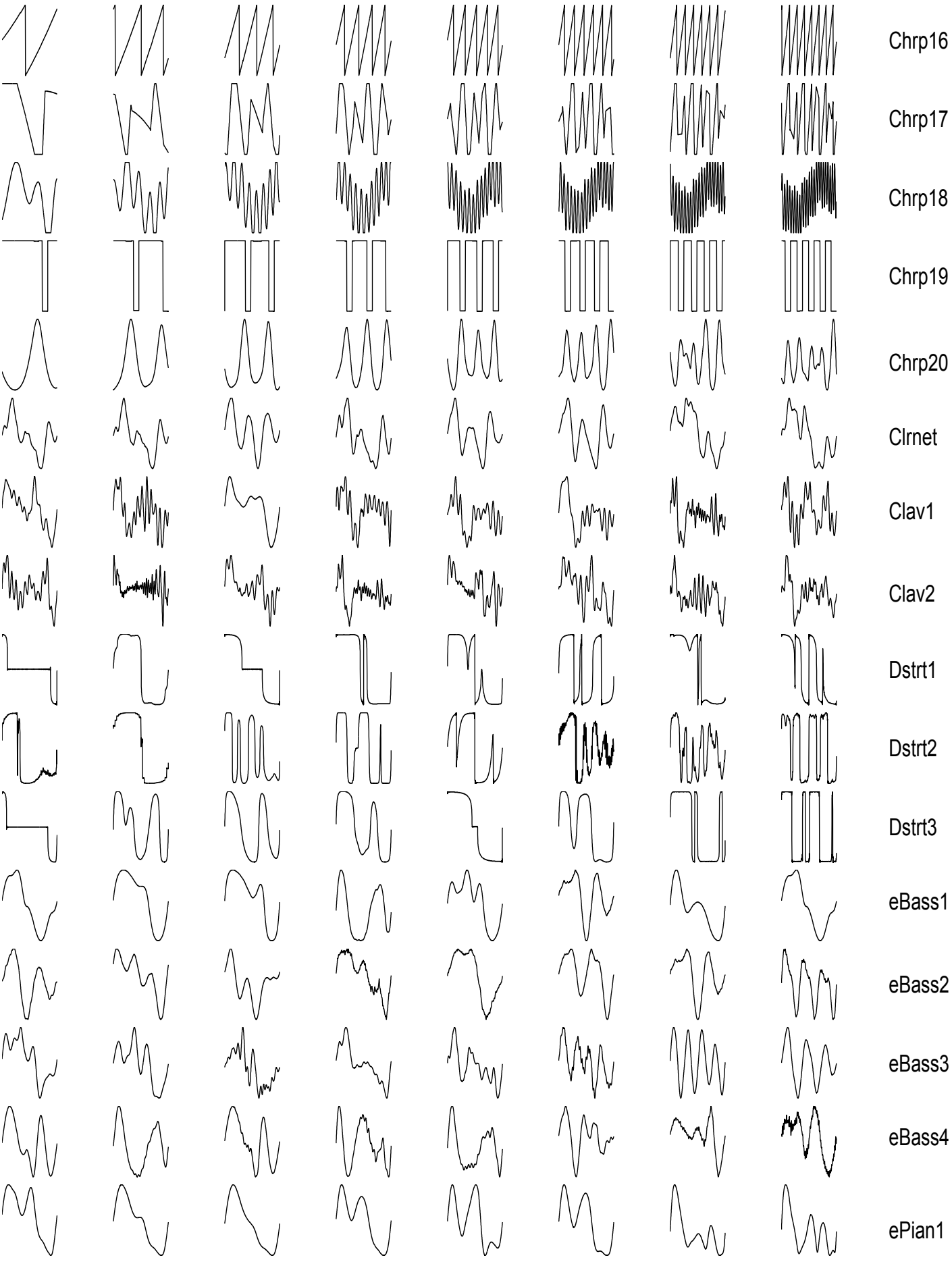
This warranty does not cover any damage or malfunction caused by incorrect use – such as, but not limited to, power cables connected backwards/incorrectly, connection of excessive voltage levels, or exposure to extreme temperature and/or moisture levels.

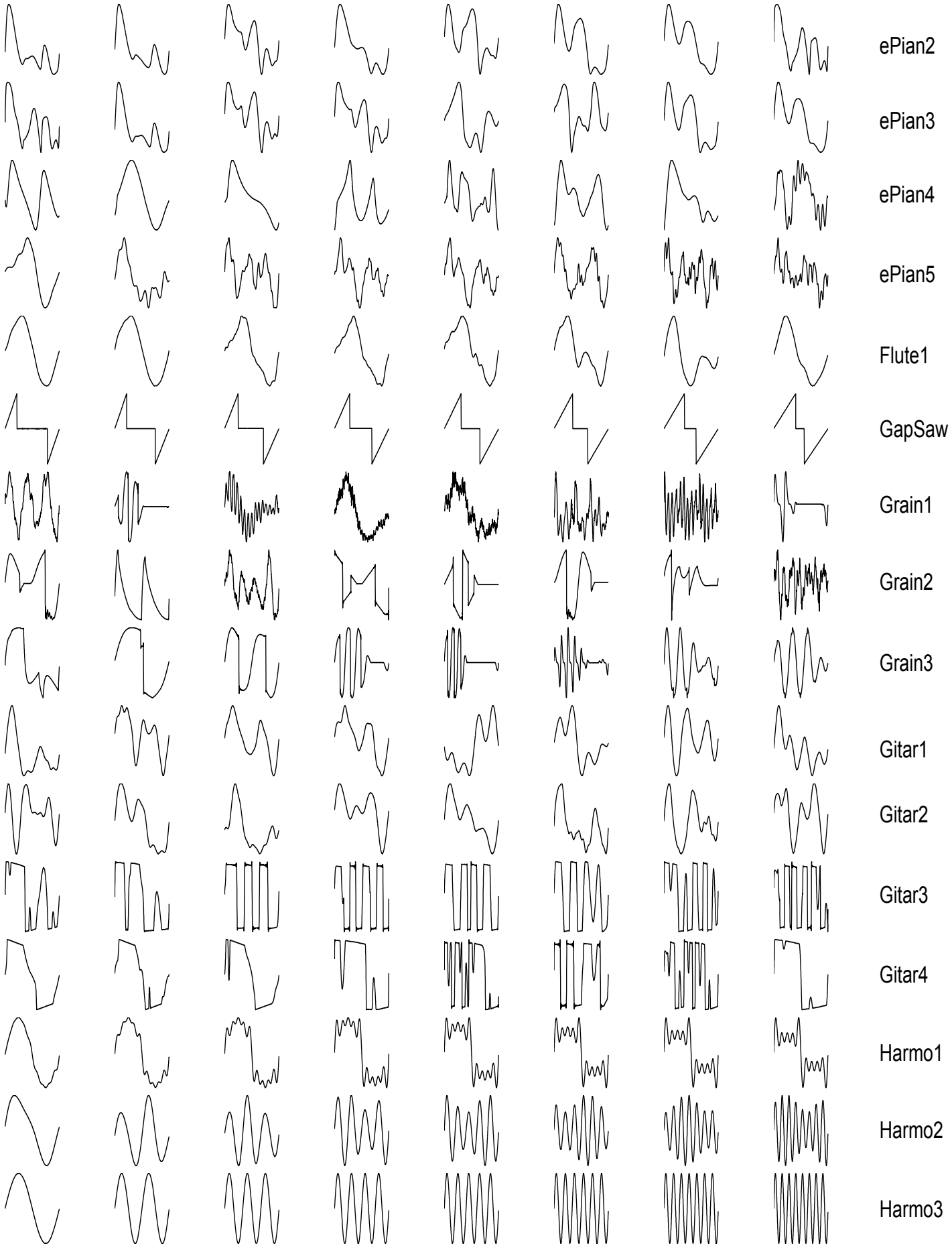
The warranty covers replacement or repair, as decided by Intellijel Designs Inc.. Please contact our customer service (support@intellijel.com) for a return authorization before sending the module. The freight cost of sending a module back for servicing is the responsibility of the customer.
Intellijel implies and accepts no responsibility for harm to person or apparatus caused through operation of this product.

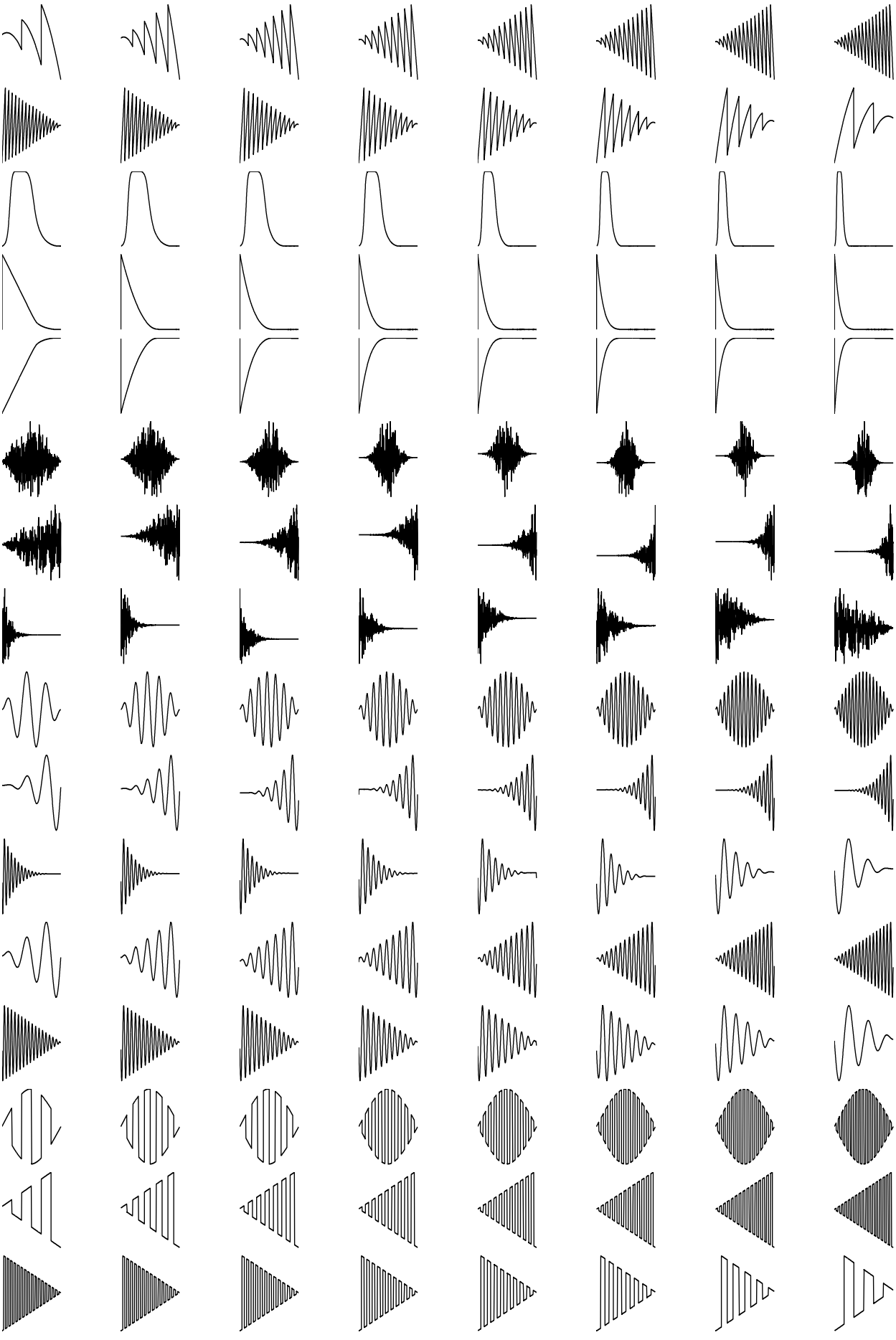
APPENDIX A - BANK BY BANK GRAPHICAL WAVETABLE DISPLAY

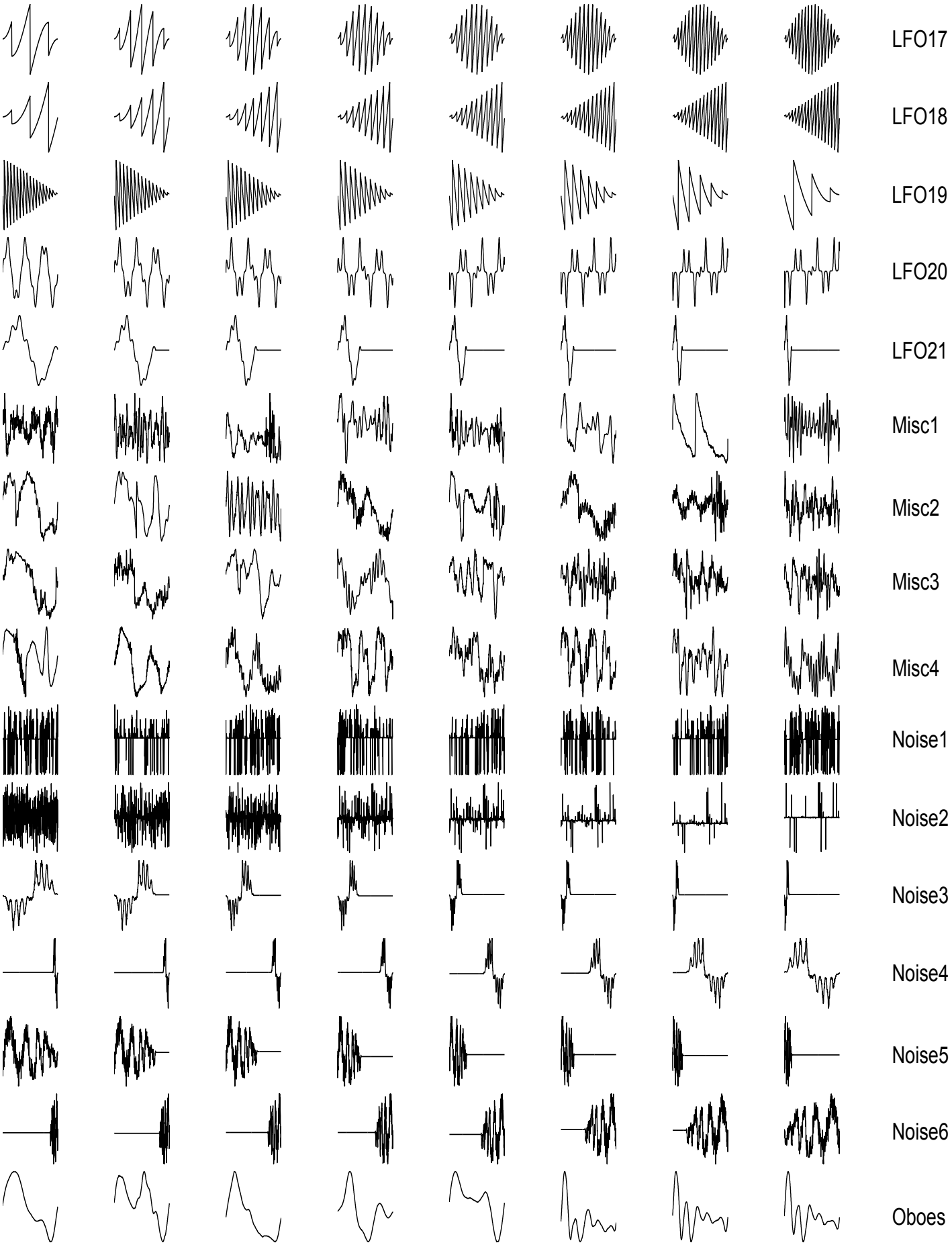


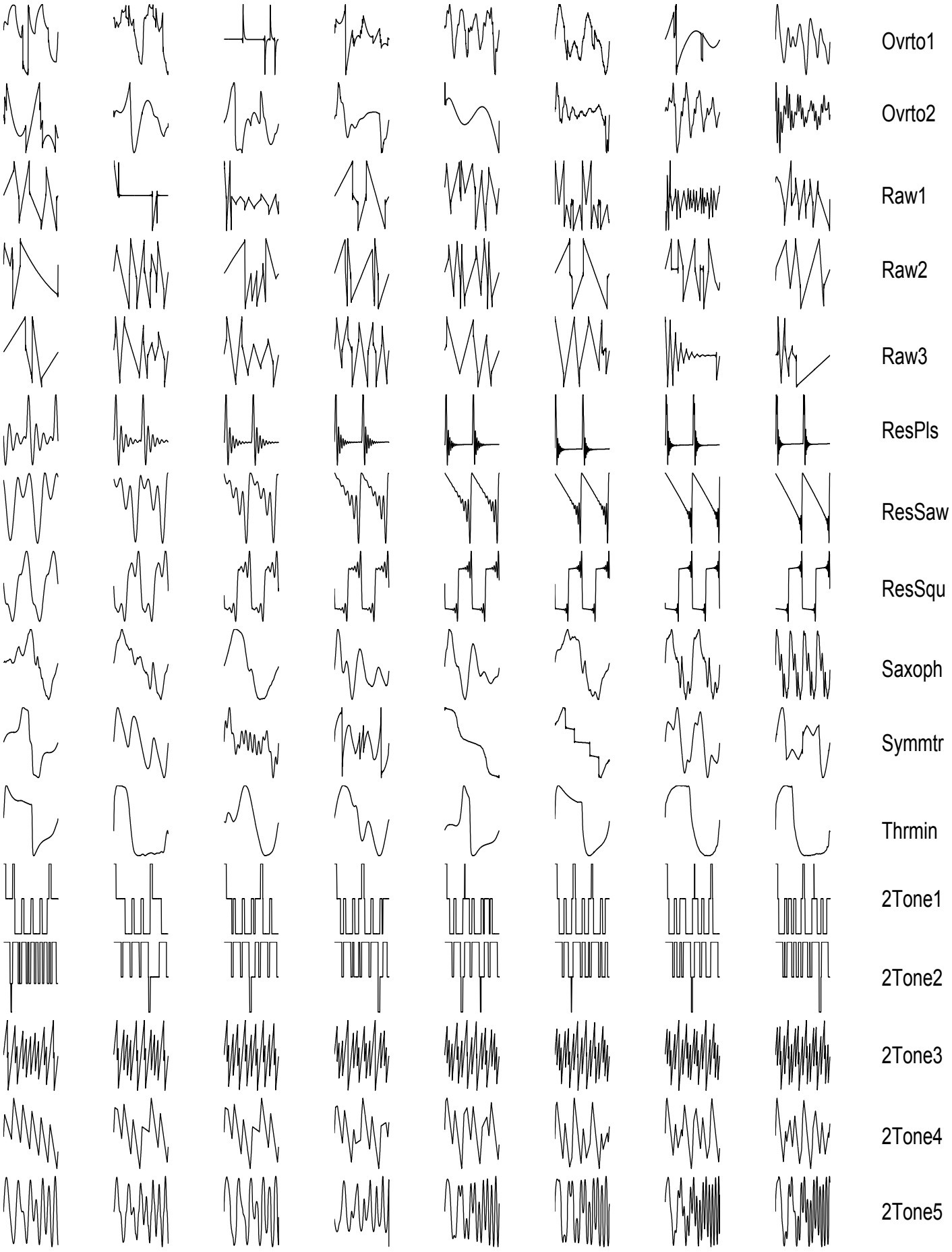

Chip6
Chirp1
Chirp2
Chirp3
Chirp4
Chirp5
Chirp6
Chirp7
Chirp8
Chirp9
Chrp10
Chrp11
Chrp12
Chrp13
Chrp14
Chrp15

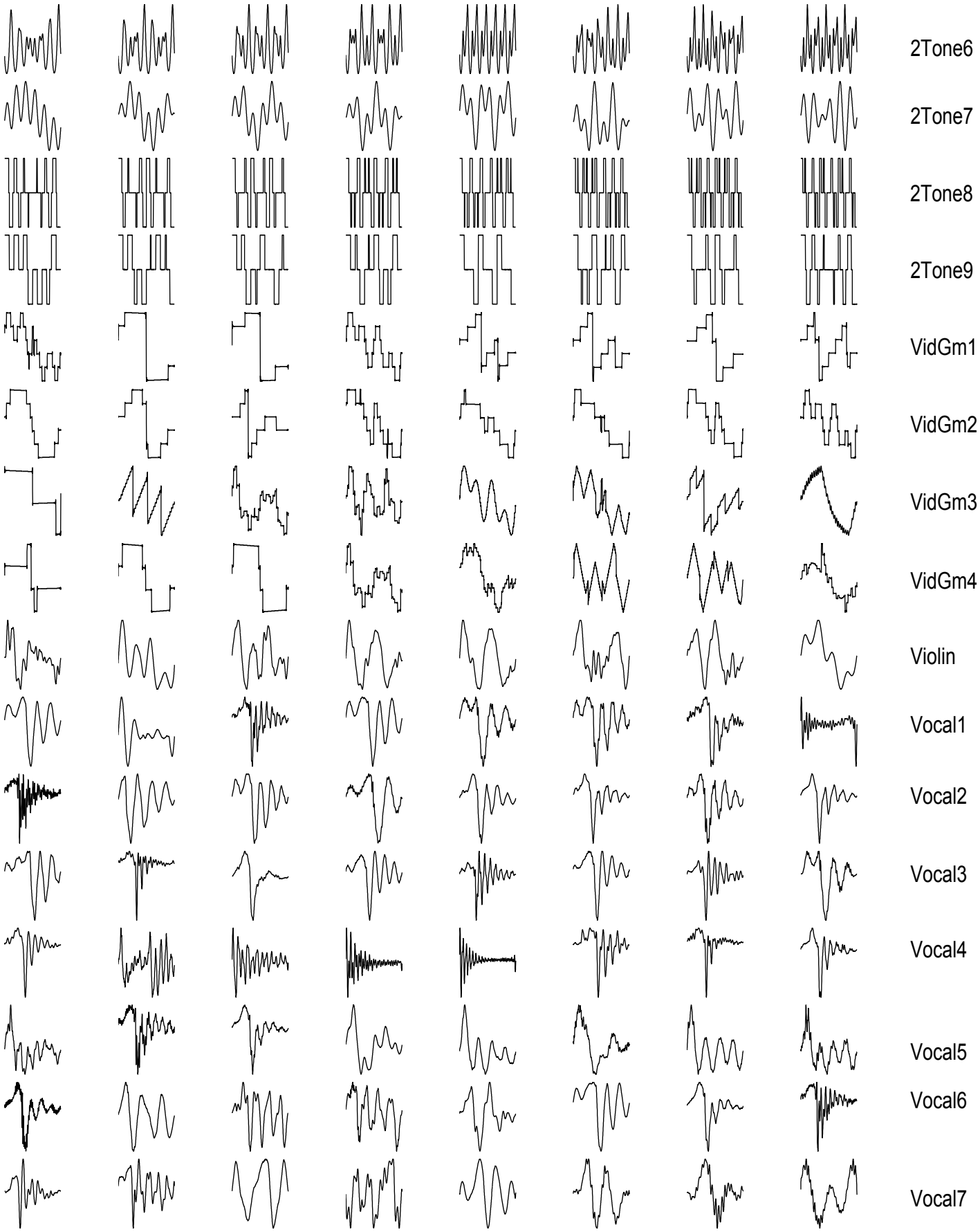

Chrp16
Chrp17
Chrp18
Chrp19
Chrp20
Clrnet
Clav1
Clav2
Dstrt1
Dstrt2
Dstrt3
eBass1
eBass2
eBass3
eBass4
ePian1


ePian2
ePian3
ePian4
ePian5
Flute1
GapSaw
Grain1
Grain2
Grain3
Gitar1
Gitar2
Gitar3
Gitar4
Harmo1
Harmo2
Harmo3


LFO1
LFO2
LFO3
LFO4
LFO5
LFO6
LFO7
LFO8
LFO9
LFO10
LFO11
LFO12
LFO13
LFO14
LFO15
LFO16


LFO17
LFO18
LFO19
LFO20
LFO21
Misc1
Misc2
Misc3
Misc4
Noise1
Noise2
Noise3
Noise4
Noise5
Noise6
Oboes


Ovrto1
Ovrto2
Raw1
Raw2
Raw3
ResPls
ResSaw
ResSqu
Saxoph
Symmtr
Thrmin
2Tone1
2Tone2
2Tone3
2Tone4
2Tone5


2Tone6
2Tone7
2Tone8
2Tone9
VidGm1
VidGm2
VidGm3
VidGm4
Violin
Vocal1
Vocal2
Vocal3
Vocal4
Vocal5
Vocal6
Vocal7

APPENDIX B - FACTORY PRESETS

The SHAPESHIFTER powers up with presets 13 through 64 presets initialized to values read from a ROM. The user can overwrite these during operation, but any changes will be lost once the power is turned off. On the next power up these presets will be re-initialized. These presets are intended to serve as examples and starting points that the user can modify. The preset slots can be overwritten during operation, for example to set up a series of related patches for sequencing in preset step mode.

The lower 12 presets are stored in EPROM so that user changes will be retained when the power is turned off.

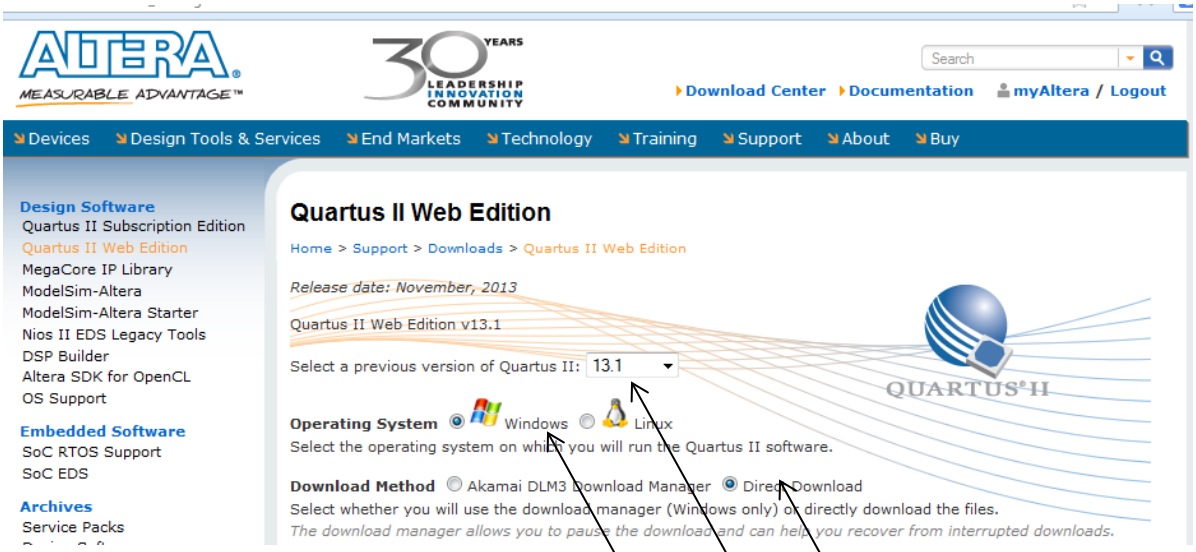
Brief descriptions of the factory presets (13 through 64):

13 - supersaw
14 - supersquare
15 - percussive supersquare
16 - quantized FM
17 - unquantized FM
18 - unquantized FM sync
19 - unquantized FM rev sync
20 - unquantized FM rev sync
21 - tibetan throat singers
22 - harsh chorale
23 - multi minimum
24 - multi minimum rev sync
25 - multi minimum hold sync
26 - resonant saws
27 - resonant squares
28 - 2 tone
29 - multi 2 tone
30 - multi res wet
31 - multi res square
32 - multi res square chord
33 - multi chirp rev sync
34 - multi chirp hold sync
35 - harmonics interleave
36 - multi harmonics chord xor
37 - harmonics rev sync
38 - 2 tone xor
39 - 2 tone xor2
40 - bipulse rev sync and
41 - ringmode osc2 lfo gating
42 - xor pitched noise (out1 only)
43 - lfo xor glitch monster walk
44 - multi interleave chord perc
45 - multi interleave perc
46 - super mario pinball
47 - dual noise
48 - intermittent glitch
49 - 2=1 sync ripper
50 - 1=2 (out2 only)
51 - cinematic ringmod
52 - laughing decay (out1 only)
53 - xor noise pulse clav
54 - tilt mod fm
55 - cinematic echo (put empty plug in pitch2 input)
56 - percussive echos
57 - flanged percussion
58 - minor harmony
59 - minor harmony 2nd inversion
60 - major 7th harmony 1st inversion
61 - minor 7th harmony 2nd inversion
62 - dim7 harmony
63 - dom9th harmony 2nd inversion
64 - minor 11th sharp harmony

APPENDIX C - UPGRADING THE MODULE'S FIRMWARE

To update the Shapeshifter module's firmware, it is simplest (although not simple) to use the **Altera Quartus II Standalone programmer** software. This software is available for Windows or Linux. The Windows program can be run on a Mac using Parallels. The following is the instructions for Windows 7.

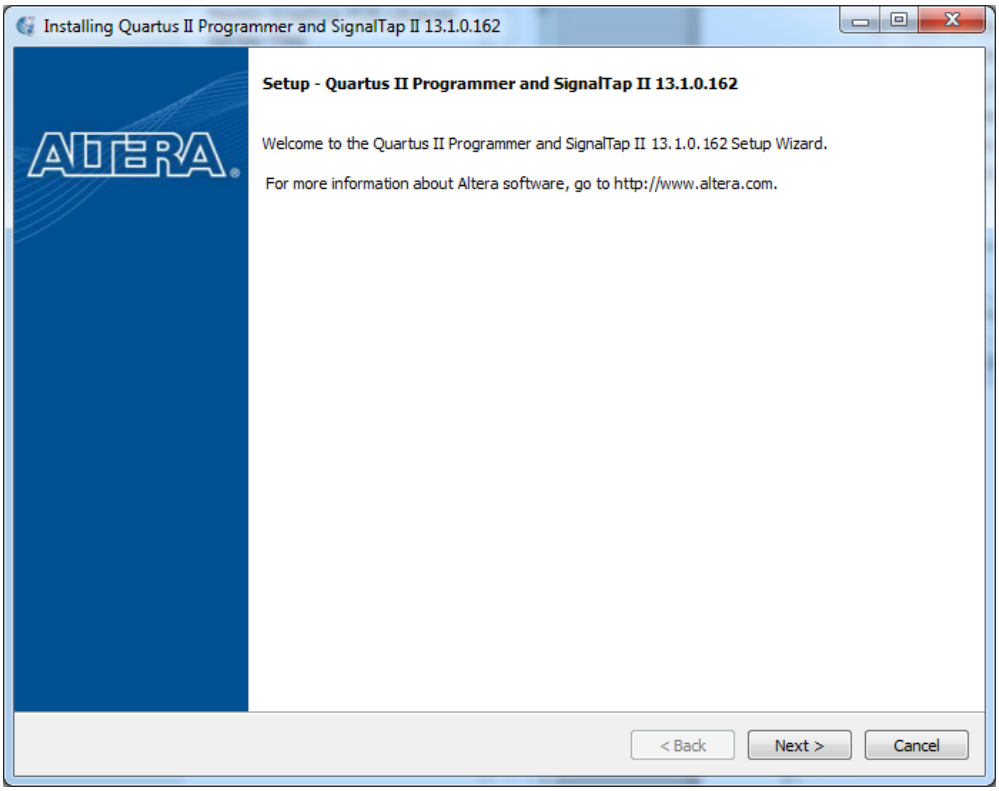
1. Go to the Altera.com web site to download the Standalone programmer software. http://dl.altera.com/?edition=web



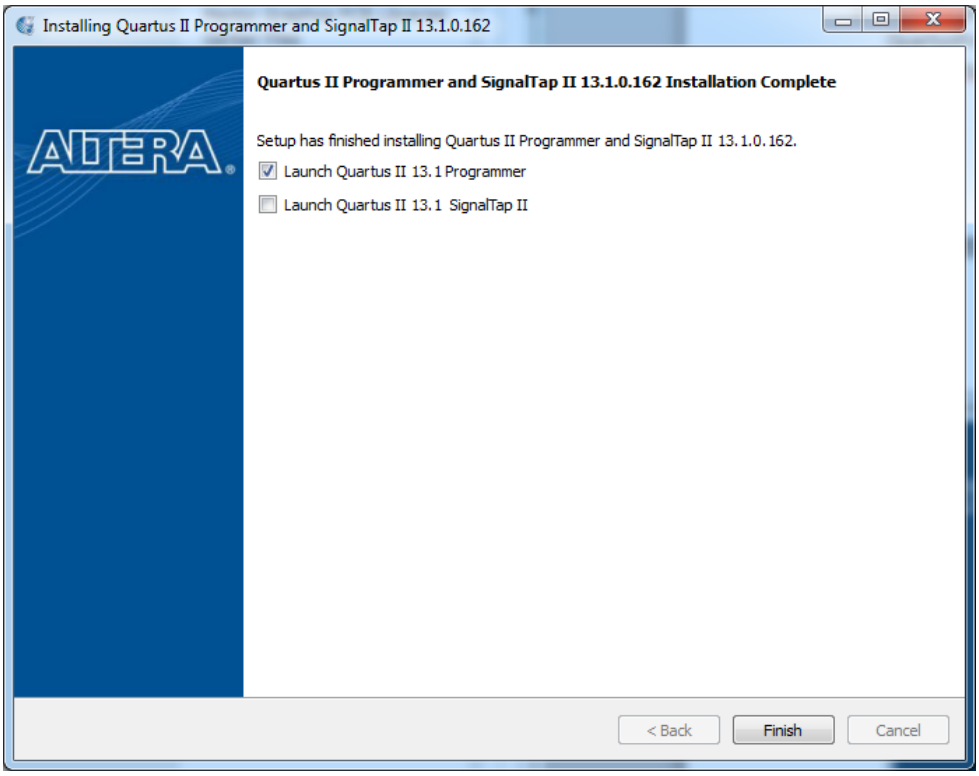
2. Select the most recent version of Quartus II (v13.1 as of this writing).
3. Select which operating system you want to work with (either Windows or Linux)
4. Select "Direct Download". If you have trouble downloading you could try to use the Akamai download manager, but this requires additional annoying steps.
5. Click on the "Additional Software" tab.
6. Click on the big blue/white downward arrow to the right of the "Quartus II programmer and SignalTap II" box. (you won't be needing the SignalTap II software but it gets installed anyway). You will be taken to a page requesting you to sign in. If you don't already have an account on the Altera site, you will have to create one. It is free. Once logged in, you may have to click on the download arrow again to begin the download.



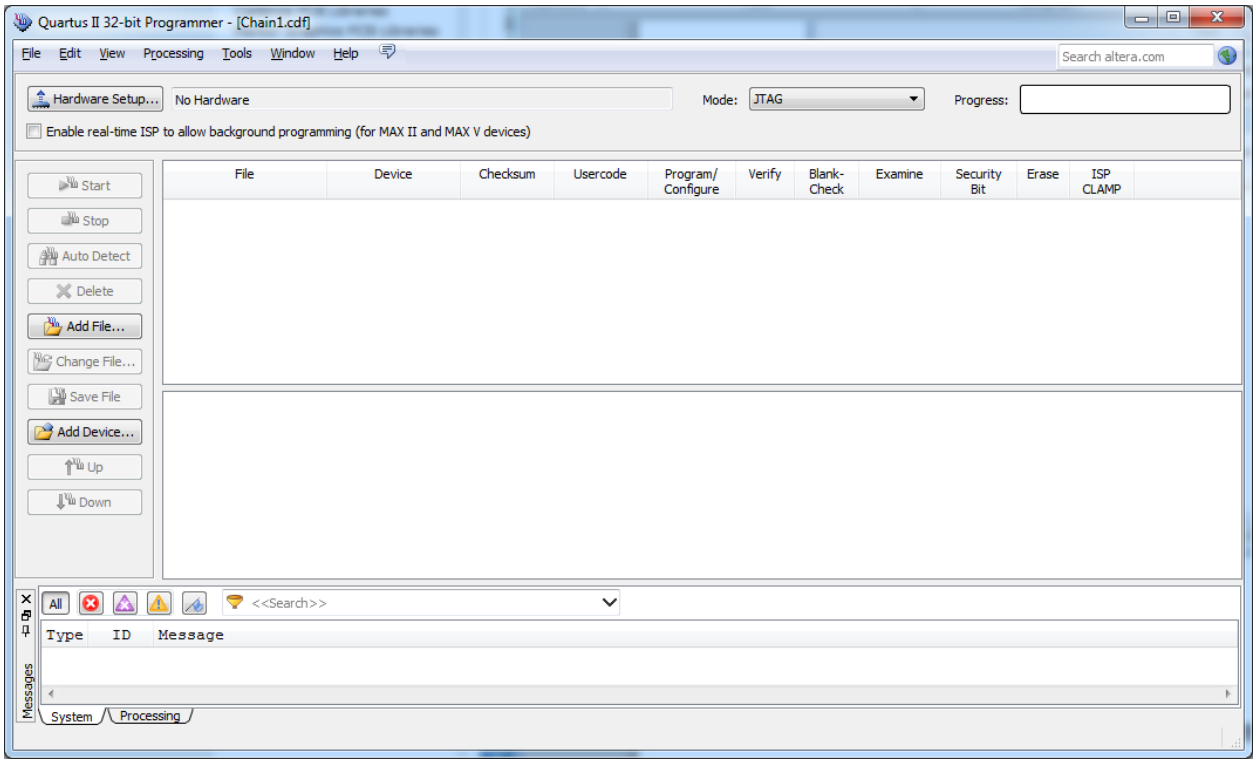
7. Find the program that was downloaded (it will be named something like QuartusProgrammerSetup-13.1.0.162.exe) and run it.
8. The Quartus II Programmer and SignalTap II installation window will appear.



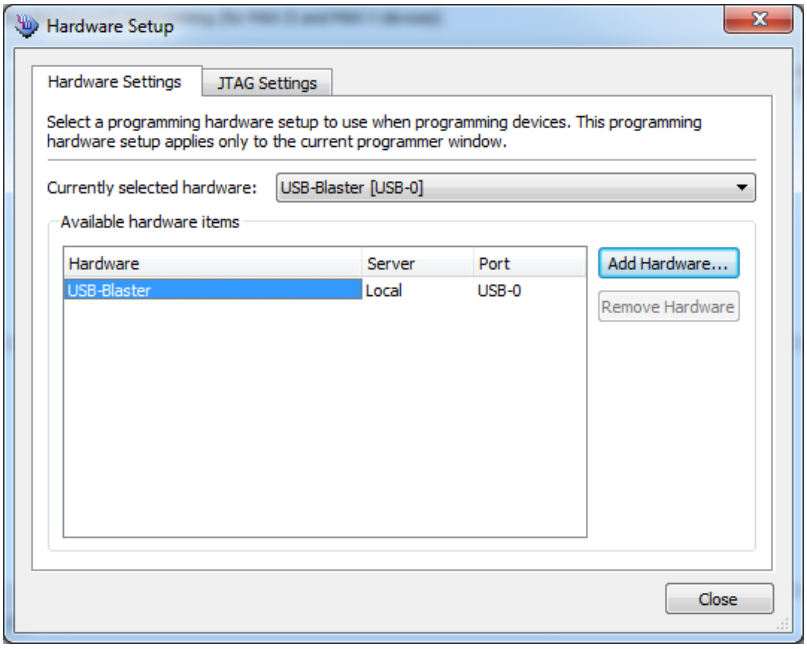
9. Go through all of the installation steps, specifying the install directory and so forth.



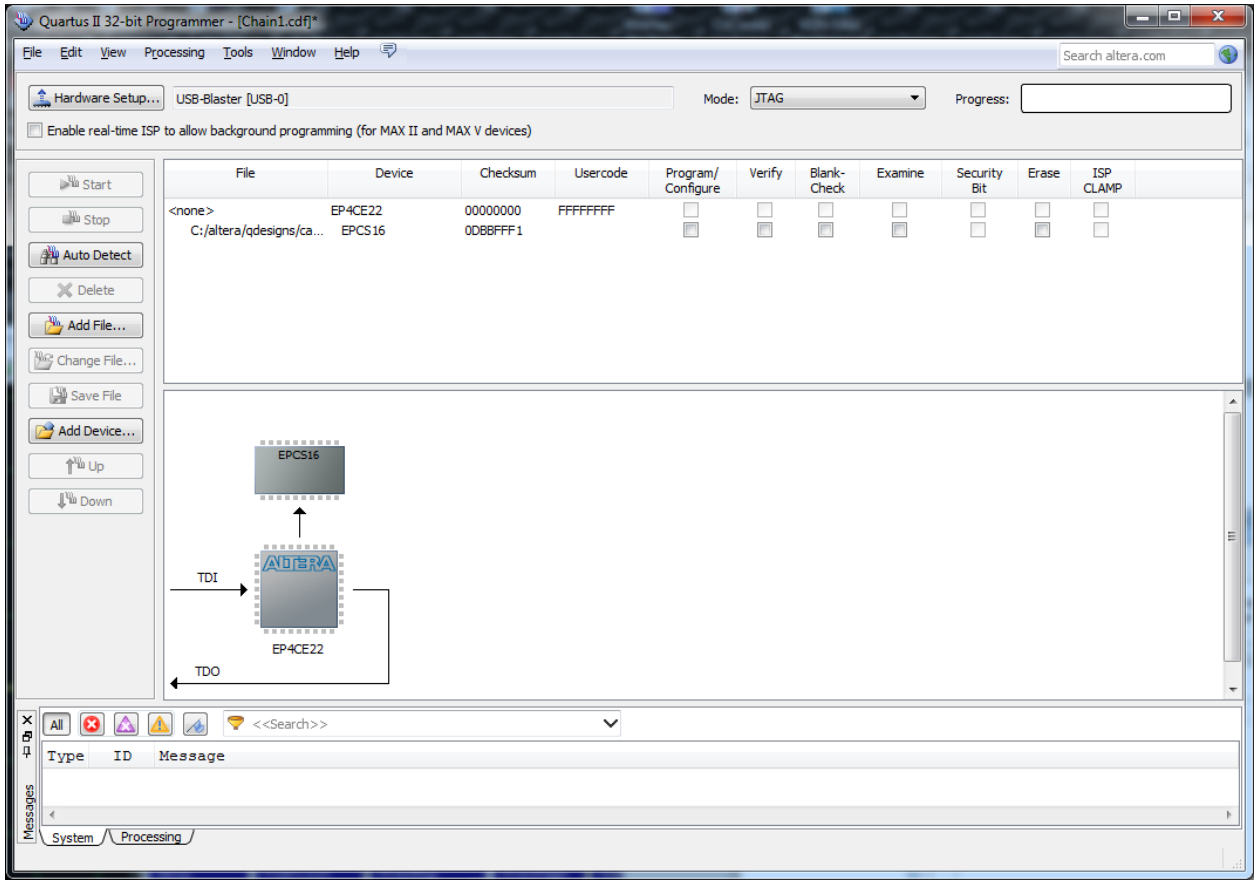
10. Next, you may need to manually install the driver for the USB-Blaster device. This is the driver for the USB connection to the Shapeshifter module.
11. Connect a USB cable between your computer and the small board (Terasic DE0-Nano board) on the rear of the Shapeshifter module. Note that the board on the Shapeshifter takes in a MINI-B plug. You will need a USB cable with this type of connector. Once the USB connection has been made, the blue LED on the back of the Shapeshifter module should light up. Some of the LEDs on the front panel may light up as well.
12. If Windows indicates that it can't find the driver for the USB device, then do the following (on Windows 7):
    a. Press the **Start** button and go to **Devices and Printers**
    b. **Right click USB-Blaster** and select **Properties**
    c. Select the **Hardware-tab** and again, select **Properties**
    d. Select **Change Settings** go to the **Driver-tab** and select **Update Driver**
    e. In the pop-up window, select **Browse my computer for driver software**
    f. Under **Search for driver software in this location** copy/paste C:\altera\13.1\qprogrammer\drivers\usb-blaster (Note that **C:\altera is the default install location and directory number will change if you install a different version.**)
    g. Click **Next**
13. Once the program and the drivers are all installed, run the standalone programmer. The Quartus II 32-bit Programmer window will appear.



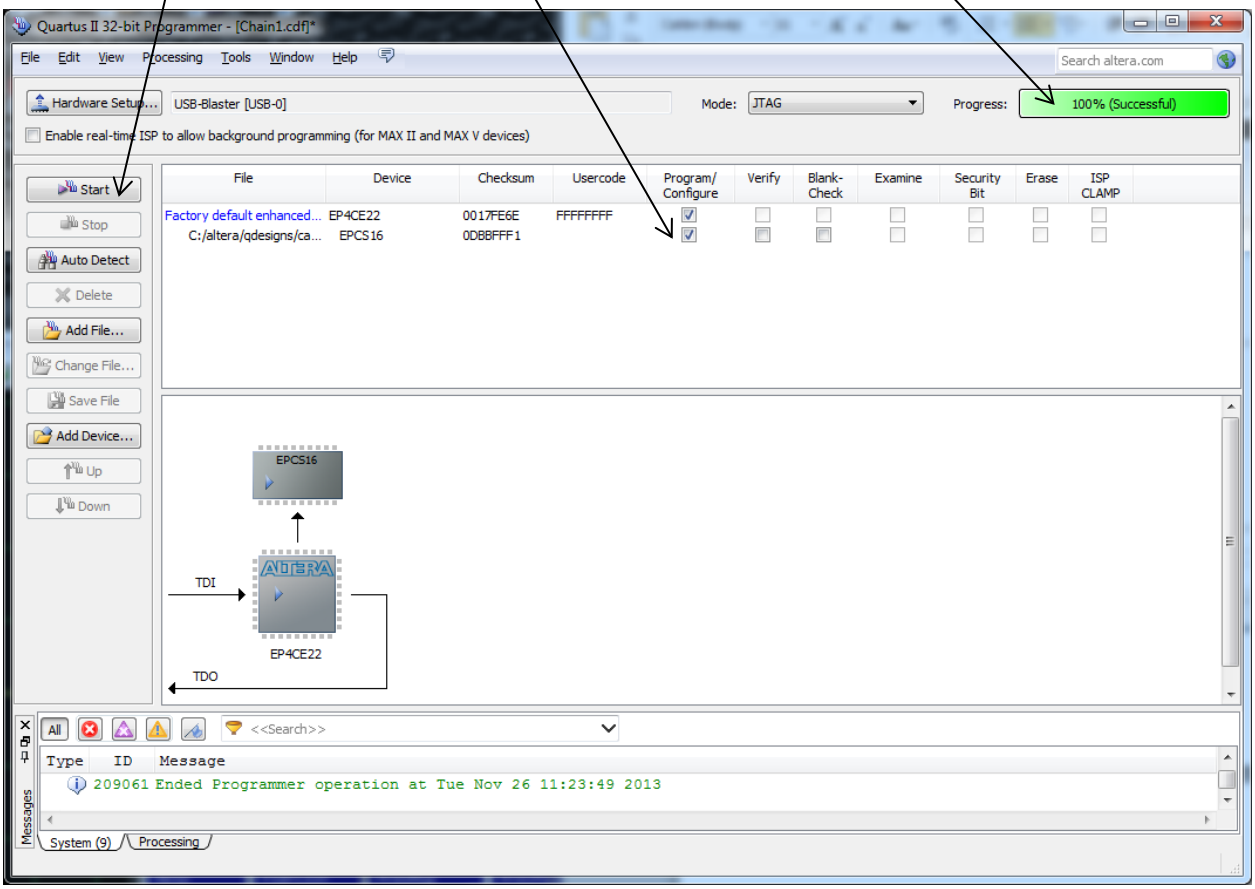
14. Make sure that the "Mode" tab in the top line of the Programmer window is set to "JTAG". Click on "Hardware Setup". The "Hardware Setup" window will appear. Under "Available hardware items" a line listing "USB-Blaster" should be present. Double-click on this line. The item "Currently selected hardware:" should change to say "USB-Blaster. Close this window.



15. Back in the Programmer window, click on “Add File”. In the directory dialog window that appears, select the Shapeshifter configuration update file (the .jic file, not the .bin file) that you wish to install. This file can be obtained from the Intellijel website. The programmer window will change and look something like the following:



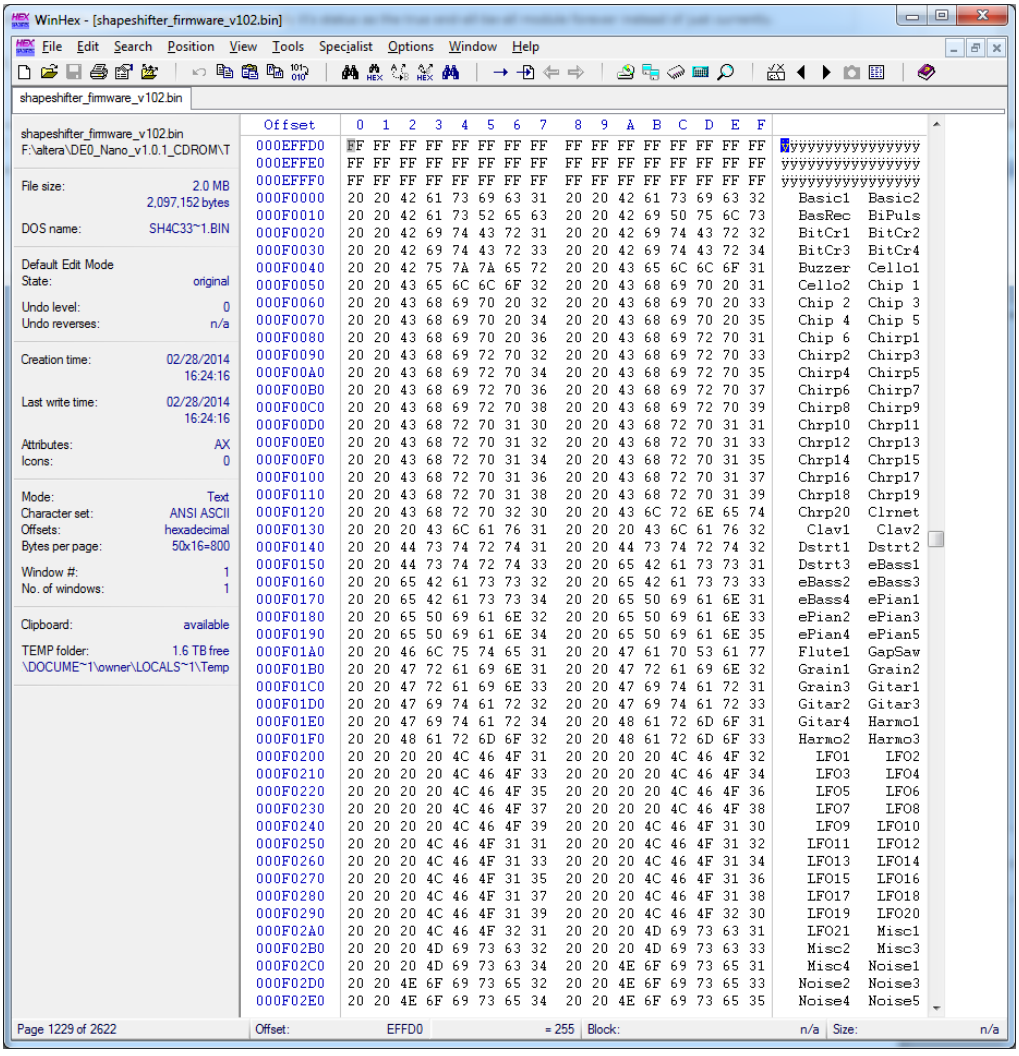
16. Click on the check-box in the ***second*** row under the Program/Configure column. The “Start” button should no longer be grayed-out.
17. Click on the “Start” button to begin the download of the configuration file to the Shapeshifter board. The download process will take about 20 seconds. The Progress bar will show the progress of the downloading and when complete will read “100% (Successful)”.
18. The Shapeshifter board will now be updated and ready to go!



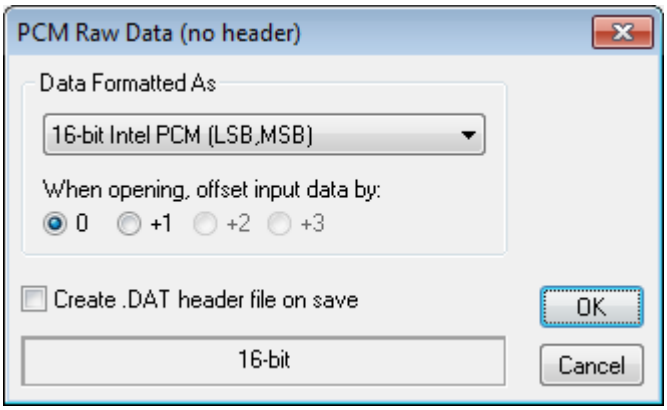
APPENDIX D - CHANGING THE WAVETABLE SAMPLES

How to load your own samples into the Wavetable EPROM.

1. You can load your own waves into the Wavetable EPROM using the Terasic Control Panel program. This program is also useful for testing out parts of the Shapeshifter board, such as the ADC channels.
2. The wave data for the Shapeshifter module is stored in the same 2MByte EEPROM as the module's FPGA configuration. The EEPROM is not directly accessible, but can be programmed using the Terasic Control Panel program. It requires that the entire EEPROM be erased and reloaded whenever changes are made. So, changing the wavetable data requires editing the firmware data, erasing the Shapeshifter EEPROM, and loading the edited data back into the EEPROM.
3. Editing the firmware file can be done with any capable binary editing software. A suitable program is the WinHEX program from X-Ways (http://www.x-ways.net/winhex/index-m.html).
4. Download the current version of the Shapeshifter firmware from the Intellijel web site and load this into the binary editor program (the screenshot below is from the WinHEX program):



5. The wavebank names are also stored in the firmware file. These are stored beginning at address 0F000 (hex). See the screenshot above for the names in the factory firmware. Each name is stored in 8 consecutive bytes, and encoded in ASCII. The name for bank 1 starts at 0F0000, that for bank 2 at 0F0008, and so on through all 128 banks. You can use the binary editor to overwrite the memory with the names you want for your waves. For best results, limit the names to 6 characters, setting the first 2 characters to spaces.
6. The wavetable waves are stored in the firmware memory starting at address 100000 (hex). Each wave consists of 512 two-byte (16-bit) signed (2's-complement) samples. The first wave starts at address 100000, the second at address 100400, the third at address 100800 and so on. There are 1024 waves in the wavetable memory. You can change some or all of them. Note that each 2-byte sample is stored in little-endian (Intel) format, where the first byte is the least-significant byte and the second is the most-significant.
7. It is most convenient to produce banks of 8 waves at a time in a sample editing program (e.g. Adobe Audition). Such a sound file would then have 4096 16-bit samples, split into 8 different segments of 512 bytes, each corresponding to one of the waves in the bank. Save the wave bank in the sample editing program as a 16-bit Intel PCM RAW format file. For example, in using Adobe Audition you would set the file save options as follows:

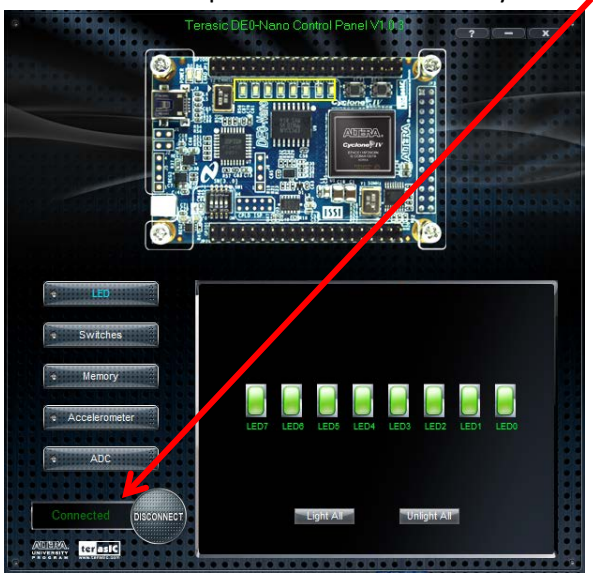


8. Once you have a new wave load it into the binary editor and overwrite the desired wave bank in the Shapeshifter firmware file using the cut and paste operations of the binary editor.
9. Once all of the new waves have been written into the firmware file, save the file, giving it a different name than the original firmware file (e.g. something like ***shapeshifter_firmware_modified.bin***).
10. If you haven't already, download and install the Altera Quartus Standalone Programmer. The Terasic Control Panel makes use of some of the components of the Altera program.

11. Go to the ***Terasic*** Company's download site (http://www.terasic.com/downloads/cd-rom/de0-nano/) and download the zip file or rar file for the ControlPanel software.



12. Unzip the file into some directory.
13. Connect a USB cable between your computer and the small board (Terasic DE0-Nano board) on the rear of the Shapeshifter module. Note that the board on the Shapeshifter takes in a MINI-B plug. You will need a USB cable with this type of connector. Once the USB connection has been made, the blue LED on the back of the Shapeshifter module should light up. Some of the LEDs on the front panel may light up as well.
14. Run the *DE0_Nano_ControlPanel.exe* program. The program will try to connect to the DE0-Nano board on the Shapeshifter module and say "Connected" if successful.



15. Click on the “Memory” tab on the left hand side. In the “Memory Type” menu on the right hand side, choose “EPCS (100000h WORDS, 2MB)”. This will select the configuration EPROM on the Shapeshifter board.
16. Because of the way in which the EPROM is written, you first have to erase the entire EPROM. Once you do this, your Shapeshifter board will no longer be functional, so take a deep breath, and then press the “Chip Erase (30 sec.)” button. The erasing process actually takes about 2 minutes, not 30 seconds.
17. In the “Sequential Write” section click on the box “File Length” and then click on “Write a File to Memory”. Select the ***shapeshifter_firmware_modified.bin*** file.
18. A progress window will appear. The writing process will take about **16 minutes** (!). Do not disconnect the board from the computer during this process; otherwise you will have to restart the writing process. Once the writing has been completed your Shapeshifter board will be updated and ready to go!

