

ALMØ46 'MCO (mkII)' Operation Manual

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Contents

1	INTRODUCTION	3
2	FEATURES	4
3	TECHNICAL SPECIFICATIONS	4
4	CORE OPERATION	5
4.1	Panel Layout	5
4.2	General Usage	5
4.2.1	Assigning CV, LFO and Envelope Control	7
4.3	Common Voice Parameters and Features	9
4.3.1	Pitch (Global)	9
4.3.2	Chords (Global)	9
4.3.3	Trig in Parameter (Global)	10
4.3.4	Ext Input	11
4.3.5	Presets	11
4.4	Settings	11
4.5	Voice Programs	13
4.5.1	DigiWave - Wavetable Oscillator	13
4.5.2	ToneSum - Additive Synthesis	15
4.5.3	BC8000 - Variable mode digi synth	17
4.5.4	Sylon - Vocoder	19
4.5.5	Virtana - 90s Analog	21
4.5.6	Oomph - Bass synth	23
4.5.7	SID Guts - SID Chip Emulation	25
4.5.8	AEIOU - Vocal Synthesis	27
5	LIMITED WARRANTY	28
6	SUPPORT	29
7	Appendix	30
7.1	I. Firmware update	30
7.2	II. Factory reset	30

7.3	III. AXON expanders	30
7.4	IV. Uploading custom wavetables	30
7.5	V. Uploading/downloading User Presets & configuration	30
7.6	VI. V/OCT calibration	31
7.7	VII. VCV Rack version	32
7.7.1	Keyboard controls:	32
7.7.2	Context menu controls:	32

I INTRODUCTION

The MCO mk II is a highly versatile digital VCO and voice module inspired by 90s/00s digital synths shrunk into just 6HP.

It offers a broad collection of unique, high-quality synth voices, each with extensive, customizable parameters. These parameters can be directly controlled or modulated through assignable internal and external sources. Certain per-voice parameters support audio-rate modulation, including FM, sync, and DSP. Each voice also supports up to four-voice chords, external-triggered envelopes, multiple LFOs, and dual audio outputs for comprehensive desktop like synth functionality.

Voices include a multi dimensional wavetable oscillator based on the original MCO, a complex additive synthesis engine, a multi mode 'JP' type digi-synth, a lush virtual analog implementation, a fully featured vocoder, a bass synth for both kicks and sub sonic tones and finally a rebirth and porting of our discontinued SID GUTs chip voice.

Each voice includes factory presets as well as the ability to store and recall user presets. All states are preserved across power cycles.

The MCO is designed to be familiar, quick and easy to use with a high resolution colour display and a rich visual user interface.

A USB-C connection allows for easy firmware updates, user wavetables upload and device config backup and restore. Axon expander modules are also supported to increase CV control options.

The MCO is also available virtualised for VCV.

2 FEATURES

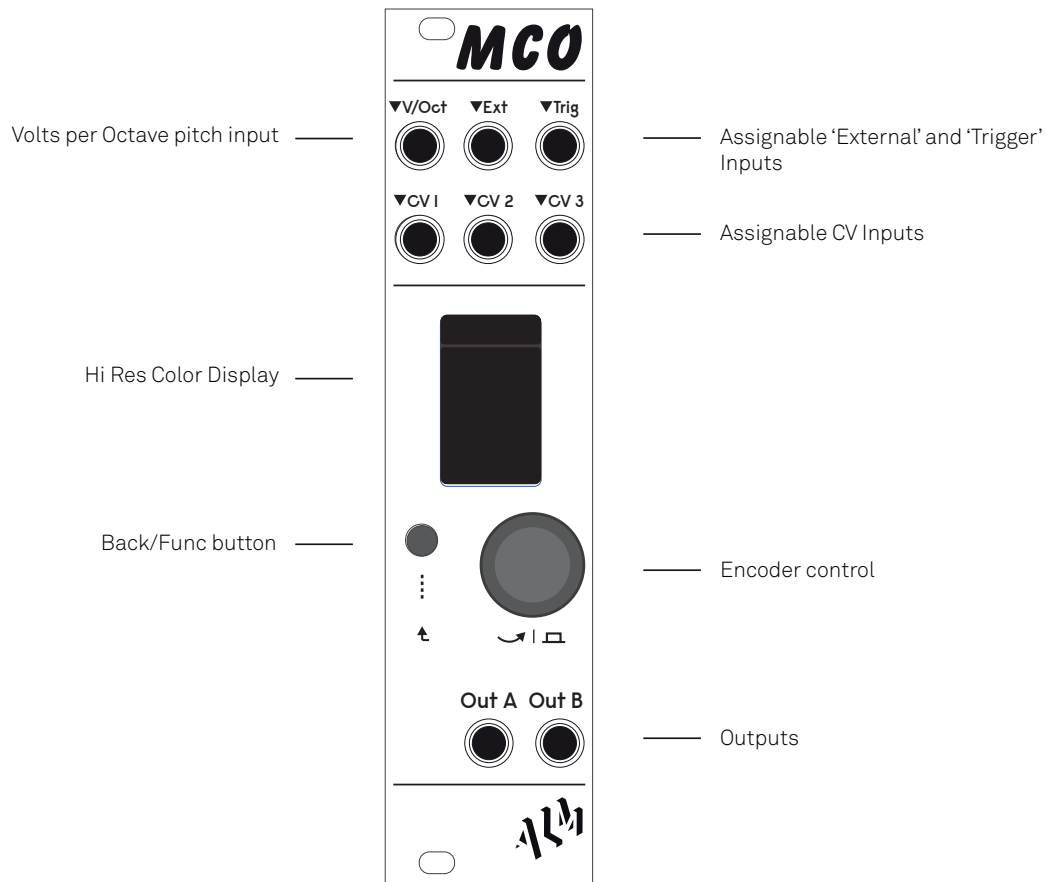
- Great collection of unique, varied, and great sounding synth voices each with numerous parameters.
- All synthesis voices support up to 4 voice chord and dual outputs.
- Built in Envelopes and LFOs for modulation and voice behaviour.
- Factory and user saveable presets per synthesis voice.
- Graphically rich colour and easy to use UI.
- All settings remain between power cycles.
- 4 freely assignable CV inputs.
- Audio rate input for FM, Sync and more.
- Support for Axon expanders for up to 8 assignable CV inputs.
- USB-C for quick and easy 'drag and drop' firmware updates, custom wavetable upload and device backup/restore.
- Also available as a virtualised VCV software module.
- Skiff friendly with reverse power protection.
- 2 Year Warranty.
- Made in England.

3 TECHNICAL SPECIFICATIONS

- Supply: +12V 70mA / -12V 30mA
- Size: 6HP
- Depth: 32mm

4 CORE OPERATION

4.1 Panel Layout



4.2 General Usage

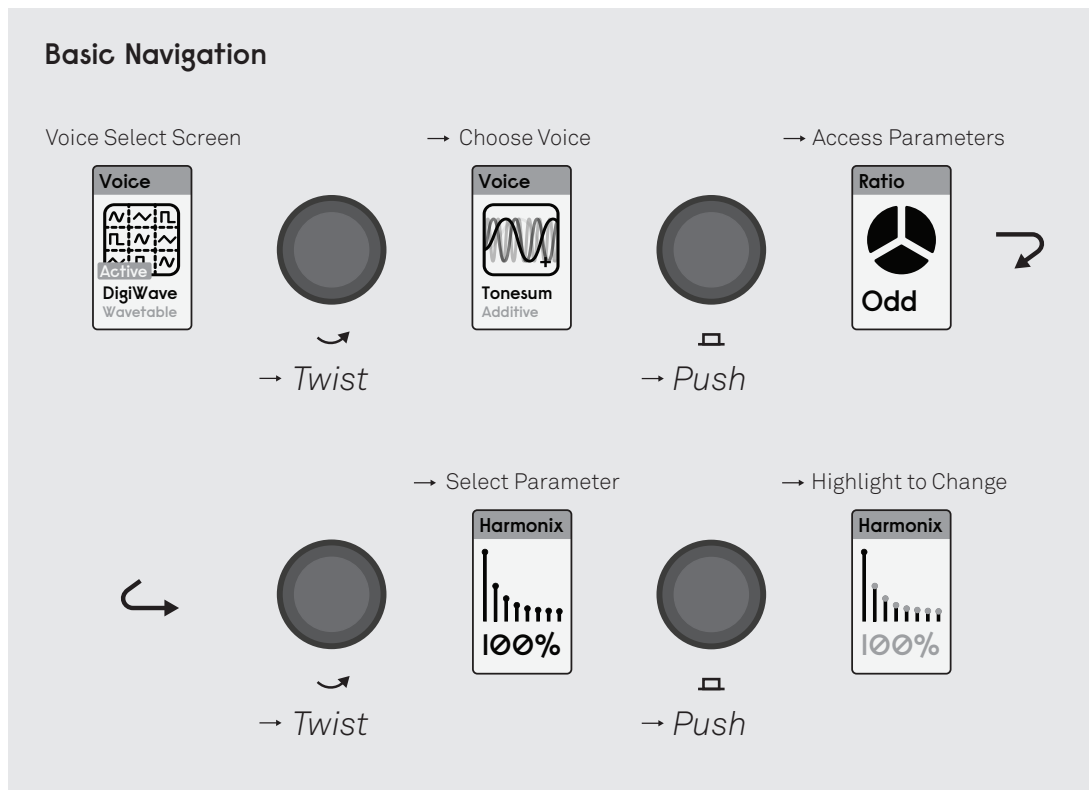
The MCO, at its core, functions like any other Eurorack VCO with a V/Oct input for pitch tracking, parameter control inputs and audio waveform outputs.

Through the display, encoder and button controls the MCOs actual sound generation algorithm or 'synthesis program' can be selected and its various parameters browsed, edited or assigned to modulation sources, such as an internal LFO or an external CV input.

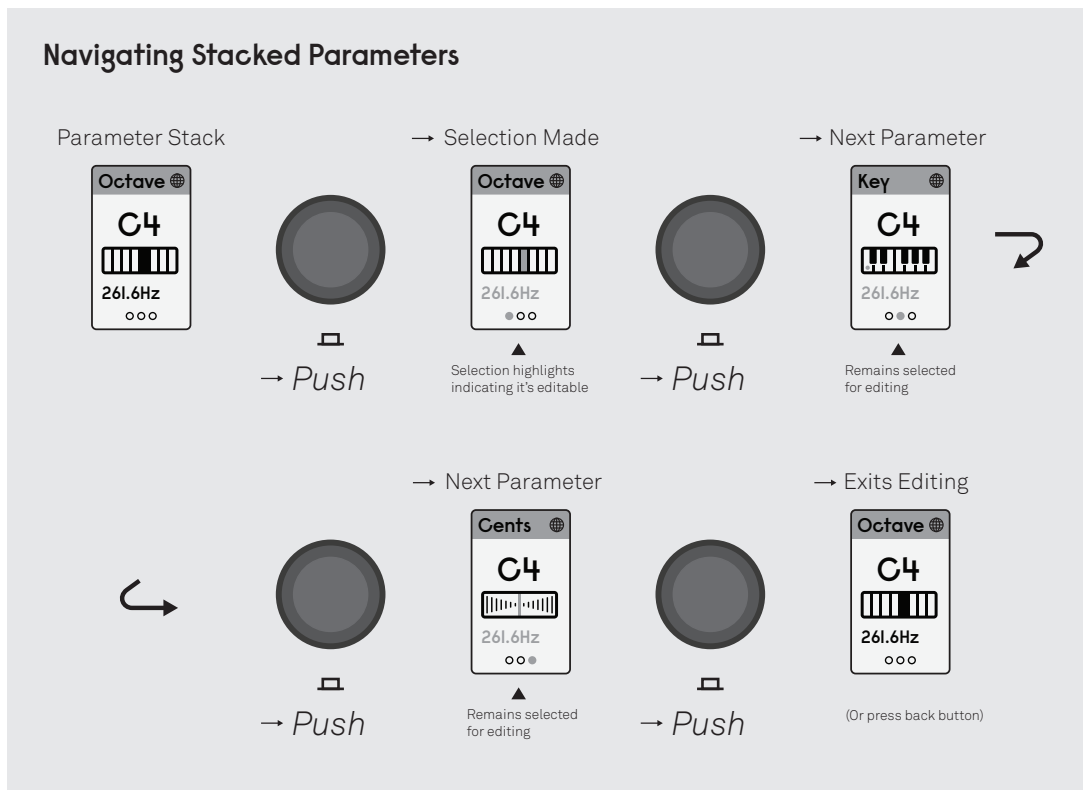
The synthesis programs have a number of common parameters (such as pitch) as well as unique parameters specific to their function. Functionality can also go well beyond a regular VCO with features such as Chord generation and full voice like behaviour with triggered internal envelopes, VCAs and filters. Factory and user presets can also be loaded and saved per synthesis voice.

When initially powered, after a short start up animation, MCO displays the active synthesis voice program. Other available programs (and settings) can be browsed by twisting the program knob and made active by clicking the program knob.

Once a program is made active, its last edited parameter screen is displayed. Parameters can be cycled through by turning the program knob. Clicking the knob will highlight the selected parameter for editing, and turning will then set its value from a range of available values (and CV, envelope & LFO modulation assigns - see next section). Clicking the back button or encoder again will exit. To return to the voice program selection, press the black button.



Some parameters like pitch and envelope settings include a series of related values grouped together or 'stacked' (indicated by small dots beneath the parameter) which can be paged through by clicking the knob between edits. Clicking through the full set of parameters will exit editing or pressing the back button at any time will exit editing the 'stack' immediately.



At any time, the current parameter on screen can be reset to its default value by double clicking the program encoder. Note that, when viewing or editing a stacked parameter, the whole stack will be reset to its default state and not just the one that's currently selected.

The MCO functions as a free running oscillator with audio output from its output jacks and pitch controlled by voltage patched into the V/Oct input but can also behave as a standalone voice with an inbuilt VCA and Envelope. This behaviour is dependent on how the 'Trig In' input is configured and if it is physically patched (a cable is automatically detected when connected). See the 'Trig In Parameter' section below for more info.

There are 3 CV inputs, each of which can be assigned to almost any parameter with independent digital offset and attenuation. The 'Trig In' can also function as an additional fourth assignable CV input if needed. See the next section for more info on CV usage.

The Ext input is a special purpose input for fast audio rate signals which can be used to FM, Sync or ring modulate the voice or as audio input for external signal processing. Its function is dependent on the currently selected voice or a parameter setting within.

4.2.1 Assigning CV, LFO and Envelope Control

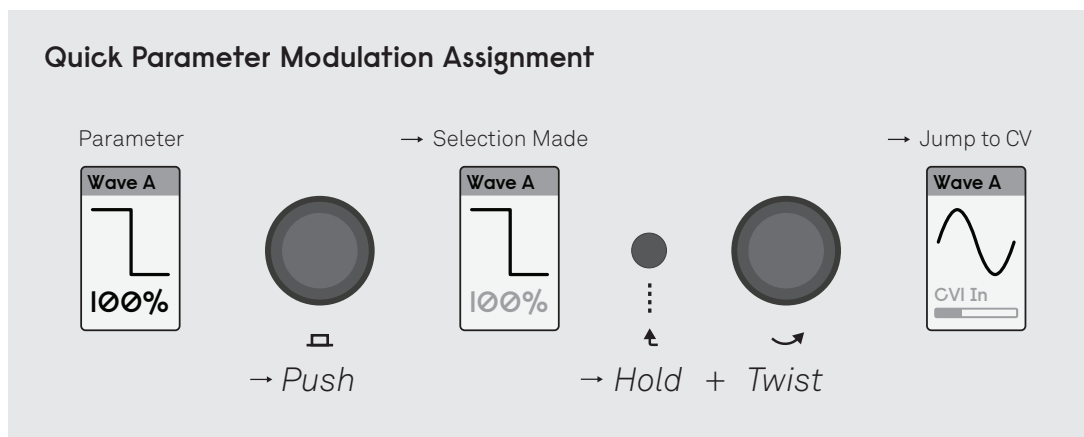
As well as being controlled directly parameters can also be automated via CV or internal modulation.

When editing a parameter, scrolling left past the lowest value will select one of the assignable modulation sources to automate or control that parameter. This includes available CV inputs

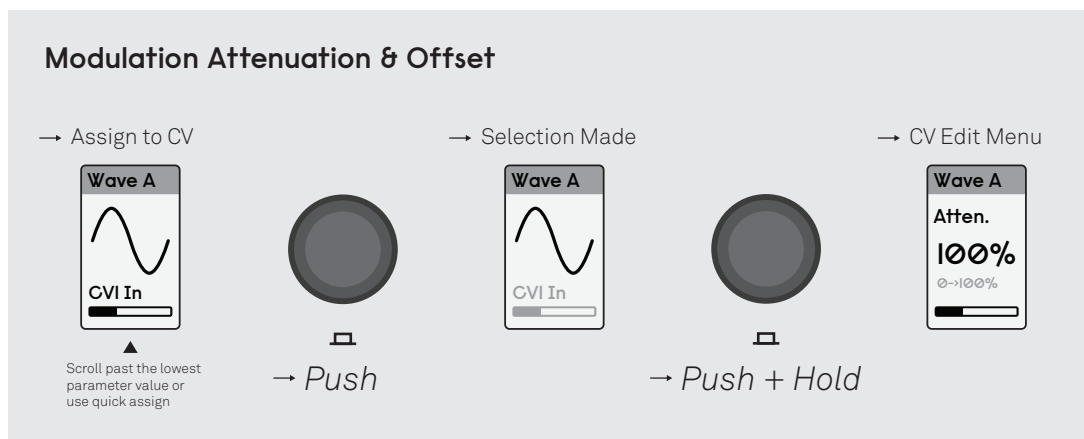
as well as inbuilt global LFOs and triggered envelope.

With a parameter highlighted, a shortcut for assigning modulation, is holding the back button and twisting the program knob to immediately jump to the modulation assign options.

TIP The global 'Mod Sel' setting allows modulation assignment to be accessible only from this 'key combo'.



Each assignment includes its own digital attenuation and offset settings for scaling the incoming modulation per parameter. To adjust this, hold the program encoder for >1 sec. with the assignment selected. (To exit press the back button). When modulation is assigned, a small bar graph will be displayed indicating the CV level (after attenuation and offset).



For external CVs, the expected input voltage range is unipolar 0-5 Volts (Euro voltages outside of this range won't damage the module but will be clipped to within the range).

4.3 Common Voice Parameters and Features

All voice engines share a number of common features and parameters. Some parameters (such as pitch) are global and shared between all engines - this is indicated by the parameter having a small globe icon in the top right hand corner.

4.3.1 Pitch (Global)

The pitch parameter sets the base frequency of the voice with any voltage patched to the V/Oct input added to it. It consists of 4 settings spread across stacked pages for Octave, Semitone and Cents providing increasingly fine control and an additional 'Scale' parameter.

The frequency spans approx. 8 octaves with a minimum frequency of C0 (16.35Hz) and maximum of B7 (3951Hz). Some engines may reach outside of this base range.

The scale parameter sets a scale for the in-built quantizer to follow. This will quantize any incoming V/Oct data to the chosen scale. The Pitch (including any Cents detune) is used as the root for the scale. Note that other frequencies that are produced with an in-built function are not quantized including any detune parameter, pitch modulation or the additional notes of chords. There is space for up to 3 user-definable scales that can be edited by selecting the scale, then holding the encoder for greater than approximately 1 second.

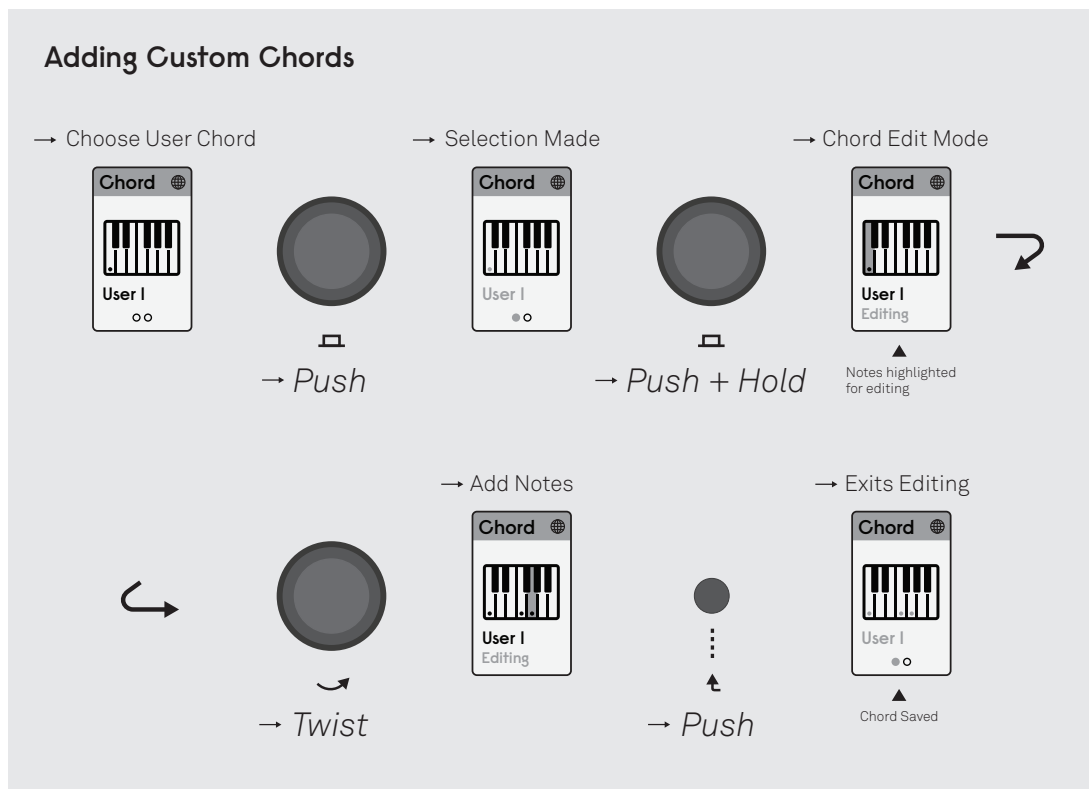
4.3.2 Chords (Global)

Every one of the MCO's voice programs is capable of up to 4 voice chords. The module comes with an array of standard 12-tone chord shapes, as well as 4 unison detune options. A chord Inversion setting is also stacked with the Chord parameter, both settings can be assigned control from external CV or internal modulation sources.

When external CV is assigned to chord or inversion, the voltages at which each will change are as follows:

CV (boundary)	Chord	CV (boundary)	Chord	CV (boundary)	Inversion
0.000	Mono	2.499	Minor	0.00	None
0.227	Octave	2.726	Dim	0.90	1st
0.055	Fifths	2.954	Sus 4	2.55	2nd
0.682	Major	3.181	Detune A	4.20	3rd
0.909	Dom. 7	3.408	Detune B		
1.136	Major 7	3.635	Detune C		
1.363	Major 9	3.862	Castle		
1.590	Minor 9	4.090	User 1		
1.818	Minor 7	4.317	User 2		
2.045	Minor 6	4.544	User 3		
2.272	Minor 4	4.771	User 4		

There is space for up to 4 user-definable chords that can be edited by selecting the chord, then holding the encoder for greater than approximately 1 second.



4.3.3 Trig in Parameter (Global)

The Trig input can be assigned to a number of different functions. Its primary setting is to be used as a gate or trigger input that triggers an internal ADSR or AD envelope respectively. The envelope is then applied directly to the internal VCA and available as an optional assignable modulation source. This makes the MCO function as a standalone voice rather than a free running oscillator.

For external CV control, the Trig input can be reassigned to act as a direct CV input for the VCA level (i.e. for an external envelope) or as a general assignable CV input for parameters (disabling the internal VCA). These secondary modes disable and hide the internal envelope parameter when selected.

The Trig input is able to automatically detect when a patch cable is inserted (a red X will appear if no cable is detected). The actual envelope and VCA will not have any effect until a cable is patched (i.e. the MCO acts as a free running oscillator unless trig in is patched and its parameter set to an envelope).

In VCA mode, an offset parameter will appear stacked next to the global level parameter to act as a simple internal offset to the incoming voltage at the Trig input.

In CV mode, the MCO is entirely free running with the internal VCA disabled.

4.3.4 Ext Input

The External input is a special additional input for fast audio rate signals such as FM, hard sync, ring mod or external audio input processing such as vocoding. Its function is dependent on the currently selected voice or setting within a voice program. For specifics on how the External input is used in each voice program, see the Voice Engines section (4.5) below.

4.3.5 Presets

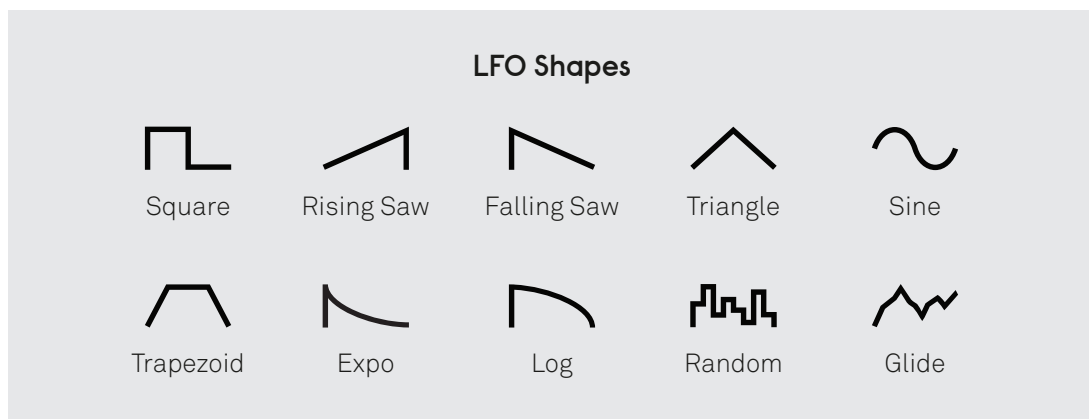
All voice programs have a number of internal factory presets as well as user store-able ones. There are a total of 32 user preset save slots which are shared globally between all voice programs.

Selecting '+Create' from a Presets page will save the current engine settings to the next available user preset slot. Upon saving a user preset, a text entry window appears allowing for a specific name to be entered in. Names can have a maximum length of up to 7 characters. Once saved a user preset can be loaded, overwritten or deleted via a pop up menu that appears when clicking on the selected user preset.

4.4 Settings

The settings menu is accessed from the voice selection page, providing various settings for global configuration.

LFO Mode, Rate and Shape - 3 internal LFOs are available and can be freely assigned to parameters just like external CV and the built in envelope. Parameters for controlling the rate, shape and mode of each of the internal global LFOs are changed from the settings menu. Each LFO can be set as Free running or to be Reset by a rising edge at the Trig input (NOTE: LFO reset only functions when the Trig in parameter is set to either Trig or Gate input). Both Retrig and One-Shot will restart with a trigger, but Retrig will cycle indefinitely.



Mod Select - Sets how parameter modulation sources are displayed/accessed from within a parameter. Options are:

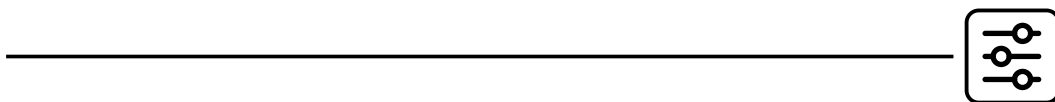
Simple - displays the assignable modulation sources when scrolling left past the lowest value

of a parameter AND via a quick selection by holding the back button + twisting the program knob.

Button - hides the assignable modulation sources from parameter values when browsing. They are now only accessible by holding the back button + twisting the program knob. This option is useful for live performance etc where you dont want to accidentally assign a parameter to a modulation.

Theme - Changes the global colour scheme of the module's UI between Dark and Light modes.

Presets - A simple global preset manager for the 32 user preset slots. Here, all the current user presets across voices can be browsed, loaded, edited and deleted. Loading a preset from this page will load the selected preset in the background, remaining within settings. This is useful for quickly auditioning saved user presets or during live performance when parameters don't need to be adjusted. Selecting 'View' from this page loads the preset and jumps to the voice program screen which can then be entered into for further editing. Finally, presets can be deleted from the global preset manager, eliminating the need to enter each voice program to do so. If a slot is empty, it will display 'Blank' instead of the related engine (blank presets cannot be selected or loaded).



4.5 Voice Programs

4.5.1 DigiWave - Wavetable Oscillator

The DigiWave is a wavetable based voice that produces two simultaneous morphing waveforms from a factory or user uploaded wavetable bank. The waves can be combined in multiple different ways with pulse width modulation available across all shapes. A secondary one octave down sub oscillator output is simultaneously available with four possible wave shapes. This flexible voice expands on the original MCO's sound and unique feature set with the same wavetable and sub options.

- **JACK ASSIGNMENTS**

Ext In - Selectable between Hard Sync or FM input.

Out A - Main wavetable voice.

Out B - Sub oscillator with selectable shape.

- **PARAMETERS**

Table - Choose between Factory (MCO wavetable without the noise wave) and User definable waves (See appendix II for upload info). User tables are split into 4 groups of 16 waves and further divided in half, with the first half to Wave A and second half to Wave B.

Wave A - The primary wave shape.

Wave B - The secondary wave shape combined with A via Mix Modes.

Invert B - Inverts the phase of Wave B.

Mix Mode - 5 algorithms that are used to morph or combine Wave A and Wave B.

- *Morph* - Mixes between Wave A and Wave B with a standard morphing algorithm like the Wave controls.
- *Splice* - Overlays then splices Waves A and B together at a specific point in the 2 wave cycles. Produces more complex PWM style sounds.
- *Multiply* - Mixes between Wave A and the multiplied result of Waves A and B ($A \times B$).
- *Min* - Mixes between Wave A and whichever of Waves A and B, is closer to 0.
- *Max* - Mixes between Wave A and whichever of Waves A and B, is further from 0.

AB Mix - Controls the Morph, Splice or Mix amount setting depending on which Mix Mode is selected.

PWM (Pulse Width Modulation) - Replaces the last X% of the output waveform cycle with silence to produce a Pulse Width Modulation effect.

Out B - Select between the standard Stereo output or a Sub output inspired by the original MCO. Further settings control the shape of the 1 octave down sub oscillator.

Ext Mode - Selects between Hard Sync or FM (frequency modulation) at the External input.

- **FACTORY DIGIWAVE PRESETS**

Digit - A sine based sound with mellow harmonics for a vintage wavetable character.

Voice - The original MCO formant wave, intended to be used with a gate to trigger the slow ADSR envelope.

Sqrsaw - Equal parts square and saw wave, sounds best when patched through a filter.

Warm Bz - A warm yet buzzy square based sound, works great for creating chords that stand out but aren't too bright.

Digisi - An 'aliased' sine wave, produces authentic mellow vintage video game tones, sounds best when used with a trig to trigger the short AD envelope.

GBpulse - A Gameboy inspired double pulse wave sound with hollow and plasticity tone.

TZ PWM - A special modulated pulse wave sound with 'thru-zero' PWM controlled by LFO1 assigned to wave AB Mix.

SAW PWM - Pulse width modulation done to a saw wave! Modulated by LFO1 assigned to PWM, sounds great with one of the 'Detune' chords.

- **USAGE TIPS**

Try uploading your own custom wavetables for even further exploration with this.

Each of the Mix Modes have a distinct sound. Demo each one to see what might work best in different situations.

Out B is a Sub output but it follows the same amplitude envelope and V/Oct input. You can use external envelopes to trigger each output individually.



4.5.2 ToneSum - Additive Synthesis

The ToneSum is an additive based voice that produces a range of physical and organic sounding tones entirely from twelve combined sine waves. It allows complex and nuanced tones to be shaped intuitively from familiar EQ and filter style spectrum controls as well as other unique options such as harmonic distribution and detuning. This distinct voice can produce anything from bright, glassy sounds to woody plucks or eerie inharmonic sweeps.

- **JACK ASSIGNMENTS**

Ext In - FM input.

Outs A & B - Stereo output (effect controlled via Spread parameter).

- **PARAMETERS**

Complex/Harmonics - Controls the levels of all added harmonics. Morphs from 0 to $1/n$ where n is the 'harmonic number'.

Ratios - Ratio of the frequencies between each of the harmonics

- Odd: Every odd harmonic. (1, 3, 5, 7, etc.)
- Even: Every even harmonic + the fundamental. (1, 2, 4, 6, etc.)
- All: Every harmonic. (1, 2, 3, 4, etc.)

Fauxpass - Turns down the level of each harmonic by a further $1/n$. Acts like a high cut or lowpass-like effect in practice, rounding out shapes.

Notch/Freq - Directly affects the level of each of the harmonics, morphing the frequency response into a notch-like or bandpass-like shape that can be swept across the range of the harmonics with the Freq parameter. Similar to a parametric EQ band in practice.

Flip - Multiplies the level of every other harmonic by $2(X-50)\%$. In practice reduces the level of every other harmonic as Flip is increased until crossing 50%, where the level is then increased with an inverted phase.

Detune - Changes the ratio between each harmonic so they are no longer whole multiples. Produces an inharmonic hollow sound similar to resonating materials like metal or tuned percussion instruments.

Spread - Adds stereo spread between outs A and B by panning each harmonic to the left and right based on its distance from the fundamental.

- **FACTORY TONESUM PRESETS**

Warm 1 - An ultra warm emotional tone, intended to be used with a gate to trigger the slow ADSR envelope for instant warm SNES like melodies.

Warm 2 - A second ultra warm emotional tone, intended to be used with a gate to trigger the slow ADSR envelope for instant warm SNES like melodies.

Vibes - A classic vibraphone emulation, intended to be used with a gate to trigger the percussive ADSR envelope. Sounds the most authentic between octaves 3 - 6.

OctPluk - An analog sounding octave up pluck, intended to be used with a gate to trigger the percussive ADSR envelope. Sounds great with chords.

Inharmonic - A hollow, otherworldly 'inharmonic' tone. Selecting one of the 'Detune' chords takes this sound even further towards simulated tubular bells.

Wind - A more subtle, sweeping variation on the 'inharmonic' preset, greatly elevated by selecting one of the 'Detune' chords.

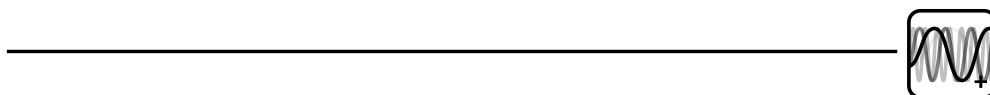
Glknspl - A classic glockenspiel emulation, intended to be used with a gate to trigger the short percussive ADSR envelope. Sounds the most authentic between octaves 5 - 7.

- **USAGE TIPS**

Try assigning envelope modulation to parameters like Fauxpass or Notch for more realistic tuned percussion sounds.

Classic Additive bell-like sounds can be made by adding some detune.

The different ratios correspond to different waveforms. Sawtooth waves contain every harmonic but square waves only contain odd harmonics.



4.5.3 BC8000 - Variable mode digi synth

The BC8000 is a multimode synthesiser voice inspired by the specialty oscillator types available in the classic JP8000 synthesiser. It can produce an array of different textures and sounds from its Supersaw, Triangle Mod, Noise and Feedback oscillator modes. A built in resonant multimode filter and dedicated pitch-mod LFO make this voice the likely choice for organic and expressive sounds.

- **JACK ASSIGNMENTS**

Ext In - Ring-modulation input.

Outs A & B - Stereo output (basic widening effect).

- **PARAMETERS**

Waveform - Waveforms inspired by the unique shapes on the JP8000 and JP8080. With 2 controls per waveform.

- **Supersaw** - A classic supersaw algorithm. 7 saw waves summed.

- ✧ *Detune*: Detunes the saw components.

- ✧ *Mix*: Level of additional saw waves.

- **TriMod/Triangle mod** - A triangle wave, scaled up so it 'wraps' around. Wraps any point that would be above 100%.

- ✧ *Offset*: Adds an offset that puts the top of the triangle wave closer to the wrapping point.

- ✧ *Mod Depth*: Level (and speed) of an internal LFO added to the offset.

- **Noise** - Digital noise running into a tuned filter.

- ✧ *Cutoff*: Cutoff of the filter. 50% is tuned to the MCO's base pitch.

- ✧ *Resonance*: Filter resonance. 100% overpowers the noise and produces a pure sine wave.

- **Feedback** - An oscillator fed into a short delay line.

- ✧ *Harmonics*: Length of the delay line, bringing out/emphasising different frequencies (acts like a comb filter).

- ✧ *Feedback*: Feedback amount that increases or decreases the effect of the comb filter.

Mod Rate & Mod Depth - Level and speed of an internal vibrato LFO that affects the base pitch.

State Variable Filter Additional controls for a state variable filter available in all modes.

- *Filter* - Selects between low-pass, high-pass, band-pass and notch filter types.
- *Cutoff* - Sets the cutoff frequency of the filter.
- *Rez* - Sets the resonant peak of the filter (narrows the width of the Notch filter).

• **FACTORY BC8000 PRESETS**

Super - A classic Supersaw lead with a huge sound great into a filter and delay. Select a chord for an even bigger sound.

Saw LP - A simple Saw Wave going into a low pass filter, intended to be used with a gate to trigger the ADSR envelope set to modulate the filter.

Vowel - A lo-fi vocal like sound from a folded triangle wave processed by the built in resonant band pass filter.

Unstable - A plucky and airy tonal noise sound. Sounds best at higher octaves.

Ambient - An unstable highly resonant feedback tone. - try increasing the Mod Depth, Rate and Feedback amount for even further instability.

Tube - A tubular feedback patch with Harmonics modulated by LFO1, works best with LFO1 set to a slow freely sweeping triangle wave.

Ocean - A tonal sweeping ocean wave noise sound produced by modulating the Notch filter with LFO1, works best with LFO1 set to a slow freely sweeping triangle wave.

BusyBee - A thin buzzy saw voice with fast fluttery vibrato.

CheapKB - A cheap 80s keyboard that is running out of batteries.

DynaSaw - A dynamic supersaw. Intended to be used with a gate to trigger the ASDR envelope to modulate the Super Mix level.

• **USAGE TIPS**

Try assigning an LFO or other modulation to the notch filter for a sweeping phaser like effect.

The BC8000's Noise mode is the best source of white noise in the MCO.

Add some pitch modulation with the Mod Dep and Mod Rate parameters to get a variety Lo-Fi sounds.



4.5.4 Sylon - Vocoder

The Sylon is a feature packed vocoder and FFT-based-reconstruction voice that produces rich robotic and harmonic sounds based on any source patched to the MCO's External input. Similar to the ToneSum, it includes simple EQ and filter style controls for intuitively designing exciting, dynamic vocoder or FFT sounds. The additional Crush and Slew parameters introduce digital character and dynamics control respectively for further uses such as a unique percussion processor or spatial effect.

- **JACK ASSIGNMENTS**

Ext In - Vocoder 'modulator' audio input.

Outs A & B - Stereo output (basic widening effect).

- **PARAMETERS**

Mode - Classic (vocoder/filters) mode or Spectral (reconstruction with sine waves) mode.

Formant - Amount of formant shifting up or down. Causes frequencies to hit higher or lower FFT bins.

(Classic) Slope - Adds a slope to the level of the filter array to make higher or lower harmonics more pronounced.

(Classic) Notch/Frequency - Directly affects the level of the filter array with a notch-like or bandpass-like shape that can be swept across the range of the harmonics with the Freq parameter. Similar to a parametric EQ band in practice.

Slew - Update speed of the vocoder or reconstructor. Slows down the changes in level for each band.

Crush - Amount of bit crushing to be applied to the encoded signal.

Crush Mix - Amount of bit crushed signal to be mixed in with the output.

Pre-Gain - Input gain stage for setting the External input signal level before processing.

Ext. Mix - Amount of direct unprocessed External input signal to be mixed into the output.

(Classic) Noise - Amount of noise to mix with the saw wave carrier.

(Classic) Quality - Fixed amount of filter bands placed accross the frequency spectrum. Decreasing the amount of bands decreases the clarity of the vocoder for a more vintage style sound.

- **FACTORY SYLON PRESETS**

Voco - A simple straightforward vocoder sound, set the amount of dry signal with the Ext.

Mix parameter. Try selecting a chord for a more musical sound.

Vintage - A lower fidelity gritty vintage vocoder sound. Try lowering the quality further for even more vintage buzz.

Reverb - Mimics the sound of a short reverb tail. Change the pitch of the vocoder to vary the 'reverb' fidelity.

Lo-Fi - A digital aliased blur great for adding a halo to rhythms. Set the amount of dry signal with the Ext. Mix parameter.

Spectre - Shiny spectral FFT vocoding. Works best with a chord selected.

Drums 1 - Noisy vocoder processing intended for percussive sounds. Remember the built in envelope can still be used in the Sylon for further rhythmic emphasis.

Shift - Dynamic vocoding with continuously shifting Formant and Notch settings modulated by LFOs 1 and 2, works best with LFOs set to a slow freely sweeping triangle or glide waves.

Resobit - Resonator style spectral tails with crunchy aliasing. Works best with a chord selected.

Voltage - Warm, broken, gritty, noisy vocoding. Try modulating the Noise amount for varied clarity.

Waves - Digital ocean waves with Notch frequency modulation from LFO1. Works best at higher octaves with LFO1 set to a slow freely sweeping triangle wave.

- **USAGE TIPS**

For a reverb like effect, try increasing the Slew and the amount of noise.

The Spectral mode works best with transient inputs like drum breaks or one-shots.

To use with a microphone, its best to disconnect the Trig input or repurpose it as an additional CV input.



4.5.5 Virtana - 90s Analog

The Virtana is a 90s style dual oscillator 'virtual-analog' synthesiser voice great for producing classic subtractive sounds with bright digital clarity. Along with controls for oscillator wave shapes, tuning and mix, it also includes a resonant low pass filter and special Drift control for adding subtle vintage style pitch instability.

The Virtana naturally excels at thick detuned bass, dual oscillator chords, stirring PWM sounds and bright leads.

- **JACK ASSIGNMENTS**

Ext In - Hard sync input.

Outs A & B - Stereo output (basic widening effect).

- **PARAMETERS**

Oscillator Shape - Fixed shape setting per oscillator: Triangle, Ramp and Pulse.

(Pulse shape) PWM - Sets the pulse width of the pulse wave per oscillator.

Osc Mix - Mix between oscillator A and oscillator B.

B Detune - Detune (in semitones) of oscillator B from oscillator A.

Drift - Analog style random pitch drift amount.

Cutoff - Sets the cutoff frequency of the low pass filter.

Rez - Sets the resonant peak of the low pass filter.

Chorus - Sets the mix of the chorus effect.

- *Depth* - The maximum detune of the chorus effect.

- *Rate* - The speed the chorus effect.

- **FACTORY VIRTANA PRESETS**

Detune 1 - A thick, detuned dual square wave. Select a chord for an even bigger sound.

Detune 2 - A sharp, detuned dual ramp wave with slight instability. Increasing the AB Mix makes the detune more apparent.

Mega5th - A rich sound with oscillator B tuned up a 5th.

VT-303 - A 303 style synth voice emulation. Intended to be used with a gate to trigger the ADSR envelope set to modulate the filter. Try creating a 303 accent by assigning CV to level and envelope stages.

VT-101 - A 101 style synth voice. Intended to be used with a gate to trigger the ADSR

envelope set to modulate the filter.

Tape-Fi - A warm wobbly 'cassette tape' style triangle tone. Intended to be used with the a gate to trigger the ADSR envelope set to modulate the oscillator mix.

Ovrtone - A filtered square tone with subtle 5th overtone and filter modulation from LFO1.

Anim8ted - An aggressive animated lead. Intended to be used with a gate to trigger the ADSR envelope set to modulate the filter.

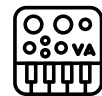
Vocal - A droning vocal style tone. Sounds best at mid to higher octave settings.

- **USAGE TIPS**

Try detuning the 2 oscillators then selecting one of the 'detune' chord shapes for a classic VA unison sound.

The Virtana is the only way to get 8 distinct voices at once on the MCO! Detune oscillator B by a fifth (7 semitones) and select the Octaves chord shape to get a thick Fifths stack.

Assigning a different internal LFO or CV control to each PWM control can give simple motion to a square lead or bass without the need for detune.



4.5.6 Oomph - Bass synth

The Oomph is a one of a kind kick drum and bass synthesiser voice designed to produce powerful modern kicks, basses and tonal percussion sounds. It can operate both as a free running bass oscillator or as a drum voice when a 'Trig In' is assigned to an envelope and a trigger is patched (revealing extra parameters).

It includes a specialised percussive pitch envelope with 'Click' and 'Thump' settings for sculpting transients followed by a 'Sub' setting that produces a natural pitch droop over time as the sound decays. In addition, on board FM and numerous distortion modes take sounds further into experimental territory.

- **JACK ASSIGNMENTS**

Ext In - Selectable between Hard Sync or FM input.

Outs A & B - Stereo output (basic widening effect).

- **PARAMETERS**

(Trig/Gate) Click - Increases the start frequency of the pitch envelope as a multiple of the base frequency. Produces an increasingly sharper click transient.

(Trig/Gate) Thump - Time it takes to drop from the starting click and base frequencies.

Sub - Frequency that the base pitch will droop down to. Once reaching this frequency, the voice will remain there until retriggered.

(Trig/Gate) Sub Len - The time it will take to droop to the Sub frequency.

FM Ratio - Frequency ratio of the internal FM modulation operator.

FM Depth - Sets the amount of internal FM.

Dist type - Type of distortion: Soft, Saturate, Hard, Wavefold, Crush.

Drive - Amount of distortion.

Bias - Asymmetrical bias (positive DC-offset) that causes the positive half of the wave cycle to distort sooner.

Ext Mode - Selects between Hard Sync or FM (frequency modulation) at the External input.

- **FACTORY OOMPH PRESETS**

Mdrn K - A punchy digital sounding kick with medium decay.

Future - An futuristic sounding kick with a pronounced grit and medium decay.

808 BD - Warm and sub-y, a classic 808 style kick. Set to Pitch near G3 for authentic

sound.

909 BD - Warm and punchy, a classic 909 style kick. Set to Pitch near G3 for authentic sound.

BitKick - A distorted and bit reduced kick with short decay.

Driven - A hyper punchy tonal kick with medium decay.

OPLBass - A classic 2 operator FM OPL chip style bass tone. Intended to be sequenced with trigger and V/Oct CV.

VocBass - A vowel bass tone with modulation over FM depth from LFO1. Intended to be sequenced with trigger and V/Oct CV.

SlpBass - A cold GM slap bass emulation reminiscent of your favourite sitcom. Lowering the FM Depth reduces brightness.

Punch - A warm punchy aliased kick with short decay.

- **USAGE TIPS**

Try patching an external envelope to the V/Oct or Ext in (in FM mode) to add even sharper transients to sounds.

Remember the engine can be used for making great bass lines too not just Bass drums.



4.5.7 SID Guts - SID Chip Emulation

The SID GUTS voice is a C64 style SID chip emulation based on our (now out of production) SID GUTS and SID GUTS DELUXE modules. This classic voice offers distinct lo-fi digital charm with aliased waves, pitched digital noise, ring mod and a slower update rate that produces idiosyncratic imperfections in the sound for tones reminiscent of classic 80s computer game music.

- **JACK ASSIGNMENTS**

Ext In - Dependent on 'Mod Source' setting - (INT) V*Oct CV or (EXT) audio input.

Outs A & B - Stereo output (basic widening effect).

- **PARAMETERS**

Shape - Choice from classic SID Guts waveform shapes (square, ramps, triangle and pitched noise).

(Square) PWM - Sets the pulse width of the Square wave.

Mod Type - SID-inspired modulation options that use either an internal triangle wave oscillator or external input (depending on the mod source setting).

- *Off* - No modulation.
- *Mod* - SID-style ring modulation.
- *Sync* - SID-style Hard sync.

(Mod/Sync) Source - Selects between the internal mod oscillator (INT) or external audio rate modulation source (EXT) to be used for ring mod or sync. When set to INT, the External input functions as a V/Oct input to control the frequency of the internal mod oscillator.

State Variable Filter Additional controls for a state variable filter.

- *Filter* - Selects between low-pass, high-pass, band-pass and notch filter types.
- *Cutoff* - Sets the cutoff frequency of the filter.
- *Rez* - Sets the resonant peak of the filter (narrows the width of the Notch filter).

- **FACTORY SID GUTS PRESETS**

Clash - A classic atonal SID ring mod sound. Patch V/Oct signals to both the V/Oct and External ins to control the carrier and mod oscillators respectively.

SG-PWM - A SID pulse wave with basic pulse width modulation from LFO1.

Bright - A basic bright saw wave tone. Sounds great with chords.

Flute - A sweet mellow lead sound with 80s warmth and aliasing. Intended to be used with a gate to trigger the slow ADSR envelope.

NylonSt - A mellow 80s style nylon string guitar emulation.

Liftoff - A rocket blast from your favourite 80s game. Sounds most authentic with an LFO or envelope patched to the V/Oct input.

SidSpeak - Lo-Fi vowel sync tones. Requires pitch modulation patched to the V/Oct input to achieve the expected vowel tones.

Blade - A classic sharp ring modulated saw tone. Patch V/Oct signals to both the V/Oct and External ins to control the carrier and mod oscillators respectively.

Hello - A brittle old skool vocal imitation. Try subtly modulating the filter Cutoff for vowel movement.

Laugh - A laugh, but completely computer generated. Sounds most authentic around C2 and with the built in envelope triggered.

Blast - A retro blast swept by triggering the built in envelope. Try changing octaves to produce different blasts.

- **USAGE TIPS**

Try patching fast modulation sources to the V/Oct input for classic bubbly 8bit video game effects.

Fast Arpeggio's can mimic the class chiptune chord effect.

Pitching the noise as well as the amplitude with an envelope can make interesting drum sounds.



4.5.8 AEIOU - Vocal Synthesis

The AEIOU voice is a vocal synthesis engine that uses band pass filters to mimic the formants of a human voice for a range of phonemes. Morphing between the two phoneme parameters using LFOs, the built in envelope or external modulation can produce any sound from robotic whisper textures, to background chatter, to simple pronounced words.

- **JACK ASSIGNMENTS**

Ext In - Selectable between Hard Sync or FM input.

Outs A & B - Stereo output (basic widening effect).

- **PARAMETERS**

Vox A - The primary phoneme.

Vox B - The secondary phoneme.

Mix (A/B) - Crossfade between Vox A and Vox B.

Vox Tone - Blend between different voice types.

Vibrato - Pitch modulation to simulate a shaky voice or a controlled vibrato.

- *Vibrato* - Depth of the pitch modulation.
- *Rate Hz* - Rate of the pitch modulation.
- *Shape* - Wave shape for the pitch modulation.

Gruffness - Simulates a gravelly voice.

Whisper - Simulates a whispering voice.

Ext Mode - Use an external audio source to modulate the vocal synthesis engine.

- *Sync* - The vocal engine hard syncs to the Ext in signal.
- *FM* - The Ext in signal frequency modulates the vocal engine.

- **FACTORY AEIOU PRESETS**

Nasal - High pitched humanoid voice.

Yeah - Morphs between phonemes to say the word 'yeah' when a trigger is sent to the Trig input.

Cough - A crude cough sound when triggered. Try adjusting the envelope decay time to morph the cough into a sneeze.

Chatty - A continuous morphing between phonemes to create background chatter. Try

sending in more complex modulation to let the chatter change over time.

Autoton - An unmodulated robotic voice that sounds more like traditional old-school vocal synthesis than a real human voice.

Whisper - A constant whispery breath. Try sending a trigger to the Trig input to create a haunting whispered sentence.

Operatic - A singing opera voice with wavy vibrato and a noisy tone reminiscent of singing on an old radio.

Bubble - Morph between all phonemes on trigger for a very characterful percussive effect.

Ha - A slightly gruff 'Ha'. Try sending repeated triggers to make a full laugh.

Sad - A modulated moan. Try triggering intermittently to produce cries of pain.

- **USAGE TIPS** To start synthesising basic words, try setting Vox A and Vox B to different phonemes and then assigning the Mix (A/B) parameter to the internal envelope and sending a trigger to the Trig input.



5 LIMITED WARRANTY

From the date of manufacture this device is guaranteed for a period of 2 years against any manufacturing or material defects. Any such defects will be repaired or replaced at the discretion of ALM. This does not apply to;

- Physical damage arising from mistreatment (i.e. dropping, submerging etc).
- Damage caused by incorrect power connections.
- Overexposure to heat or direct sunlight.
- Damage caused by inappropriate or mis-use including physical 'modding'.
- Use of incorrect or non official firmware

No responsibility is implied or accepted for harm to person or apparatus caused through operation of this product. By using this product you agree to these terms.

6 SUPPORT

For the latest news, additional info, downloads and firmware updates please visit the ALM website at <http://busycircuits.com> and follow @busycircuits on twitter and instagram.

Any questions? Please visit <http://busycircuits.com/support>.

7 Appendix

7.1 I. Firmware update

With the unit unpowered, connect a USB cable from the port at the right side of the PCB to a computer. The module will appear as a standard removable storage device. Copy a valid firmware file to the root directory to update. When complete, the module will automatically eject once the update completed and is ready to use powered normally (any 'unmount' errors from the computer can be safely ignored - if the MCO screen reports a successful update, then it is!).

7.2 II. Factory reset

Whilst powering, hold down the program knob and wait for the bar to fill. This will clear all saved data back to factory state but not the custom wavetable.

7.3 III. AXON expanders

Both of the AXON expanders are supported by the MCO. They plug into the small horizontal 6 pin connector marked 'AXON' on the rear of the module. This will add 4 extra CV inputs. Only a single connected AXON (1 or 2) is supported at once. The AXON-2's extra A and B buttons are mapped to 'Jump to Voice select' and 'Reset parameter' respectively.

7.4 IV. Uploading custom wavetables

A custom user wavetable can be uploaded to the module for use in the DigiWave voice. With the unit unpowered, connect a USB cable from the port at the right side of the PCB to a computer. The module will appear as a standard removable storage device. Copy a Wavetable file in the WaveEdit format (this will be a .wav file with each waveshape spliced sequentially). Wavetables are 44.1khz 16bit wav files with 256 samples per waveform and 64 waveforms total.

See <https://synthtech.com/wavedit/> for information on generating your own wavetables and <https://smpldsnds.github.io/wavedit-online/> for an assortment of public domain wavetables.

7.5 V. Uploading/downloading User Presets & configuration

With the unit unpowered and connected to your computer via USB (see firmware update section), the 'PRESETS.BAK' file can be copied from/to your computer as to back up / restore all stored user presets and settings on the MCO.

7.6 VI. V/OCT calibration

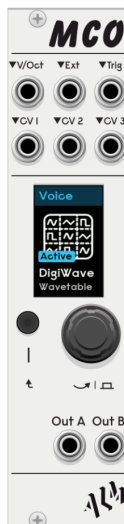
All MCO IIs are shipped with the V/Oct expertly calibrated at the factory. If you wish to recalibrate, please follow instructions.

- With the module powered off, disconnect all jacks.
- Power on the module with the back button pressed down. Hold until the bar has completed. The screen should display '1V' now.
- Patch 1V into both the V/Oct input and Ext. input. Click the program encoder. The screen should display '3V' now.
- Patch 3V into both the V/Oct input and Ext. input. Click the program encoder. If calibration was successful, the module will automatically reboot, showing the short startup animation.
- If calibration fails, the module will go back to displaying 1V. When this happens, try again, but double check the voltages going in are the correct levels.

The ALM002 Beast's Chalkboard is recommended to be used to generate required precise voltage offsets (1V & 3V) for calibration. Alternatively, Pamela's NEW or PRO Workout can also be used by setting an output's level parameter to 0% and then its offset parameter to 20% (1V) and 60% (3V).

7.7 VII. VCV Rack version

'VCV Rack' is an open-source cross-platform software based virtual modular environment. A fully featured emulation of the MCO II will be available for purchase via the VCV Rack store: <https://library.vcvrack.com/ALM046/>



The emulation runs identical core code and has the same user interface as the physical module. It does additionally have a context menu for quicker menu diving.

7.7.1 Keyboard controls:

The following keys can be used to control the MCO. (Note the cursor must be hovering over the module).

Key	Function
[	Left encoder turn
]	Right encoder turn
=	Encoder click
-	Back button click

7.7.2 Context menu controls:

Accessed by right-clicking module, the context menu allows for quick and immediate access to multiple internal functions. The standard VCV menu function initialise behaves as expected. The input range of the CV inputs can be switched between 10V and 5V.