E N T I T Y

User's Manual

version 1.01

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SUMMARY OF FEATURES

The Entity is a true stereo six-voice polyphonic synthesizer. Each voice includes a stereo resonant/oscillating/distorting filter based on real analogue circuitry. This filter receives a sub-mix of signals from three individually panned oscillators, a ring modulator, a stereo white noise generator and signals from an external input.

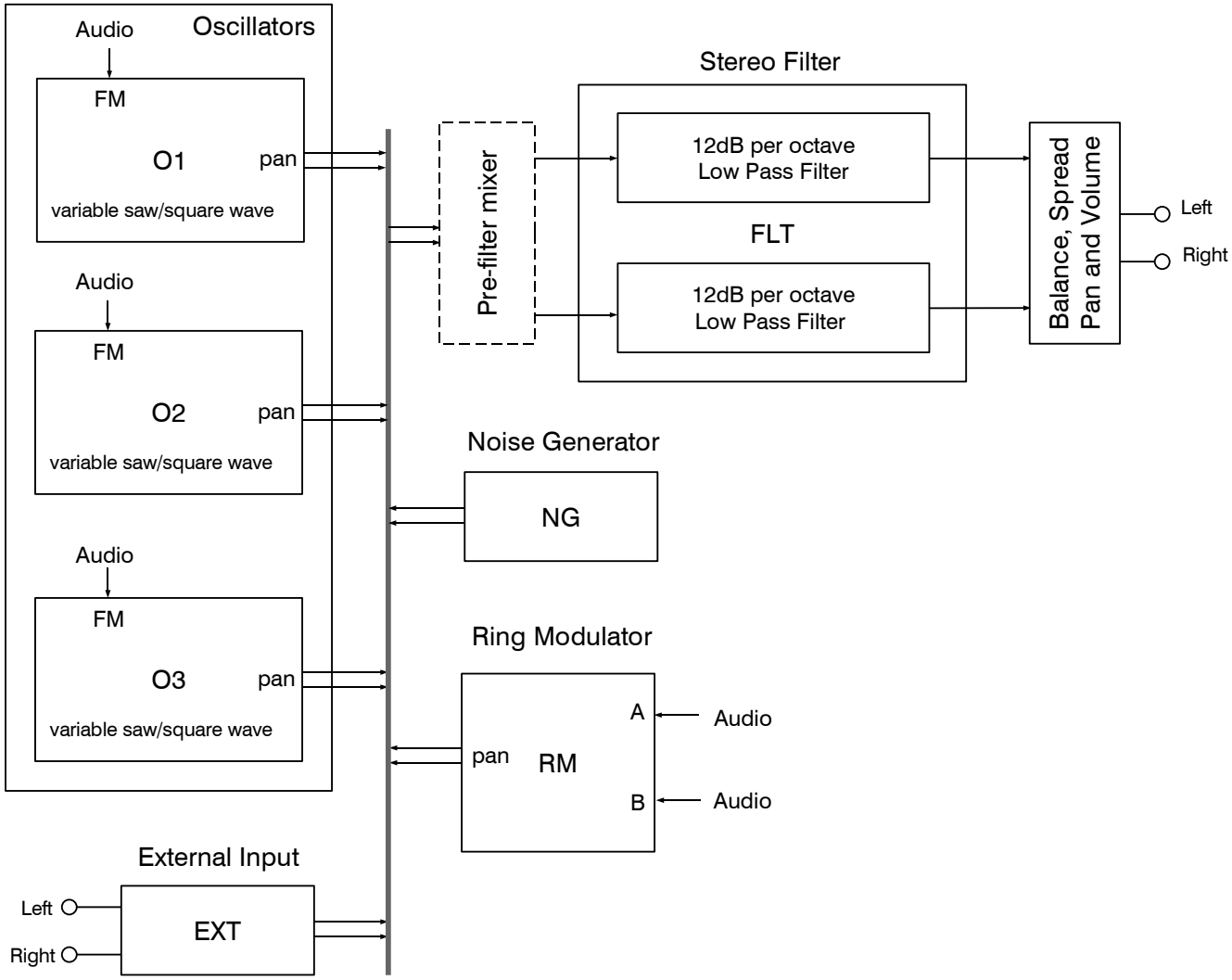


Figure 1. Entity Voice Architecture

Each of these audio components has a set of parameters that define its operating characteristics, all of which can be modulated, in any combination of depths, by sixteen modulation sources. Even switched parameters, like oscillator waveforms, can be modulated. For example, it is possible to switch an oscillator's octave using a continuously variable foot pedal, or an LFO output. The modulations are updated seven hundred and fifty times a second, resulting in extremely smooth parameter variations.

STEREO FILTER

The heart of any analogue synthesizer is its filter. In the analogue world, filters not only remove harmonics from a sound, they *add harmonics* as well. The character of this harmonic distortion very often determines the musical character of a synthesizer.

The Entity filter carefully reproduces the subtle nuances of a *specific* analogue filter circuit. By making direct AB comparisons between this analogue circuit and the digital version, it was found to be possible to recreate, in detail, all the characteristics that are so important to the filter's sound. This includes harmonic phase-locking, resonance reduction and distortion without high harmonics. The Entity filter is a faithful recreation of a real analogue filter in the digital domain.

Entity is open source software (released under the GPL), so anyone who wishes to look at the filter source code can download it at http://www.entitysynth.net.

OSCILLATORS

Three audio oscillators provide waveforms that can vary continuously between sine wave and sawtooth or sinewave and square wave. Beyond these limits, the oscillators can reach instability, distortion and random noise, depending on the requirements of the sound.

Each oscillator can have its waveform further shaped by a phase parameter. In the case of the sawtooth waveform, the phase parameter has the same effect as having two oscillators with a phase offset. By sweeping the phase parameter with an LFO, a chorus effect is produced. For square waveforms, the phase parameter is more subtle. In both cases, the phase parameter can be used to greatly vary the tonal characteristics of an oscillator.

Frequency modulation can also be applied to each oscillator. The FM source can be selected from another oscillator, the noise generator, the external input, the filter, and so on.

Oscillator outputs are individually panned in the submix that supplies the stereo filters.

NOISE GENERATOR

Stereo white noise carefully simulates noise sources found in analogue circuitry. Specifically, the noise has a Gaussian probability distribution, which is generated by thermal noise in analogue components such as resistors and transistors.

RING MODULATOR

A pair of audio signals (called 'A' and 'B') are processed by the ring modulator. This generates an output signal comprising the harmonic sum and difference of the input signals. The ring modulator output can be panned in the submix supplied to the filter.

EXTERNAL INPUT

Stereo input signals supplied to the Chameleon can be processed by the filters and/or used as audio modulation sources. For example, Entity need not be used only as a synthesizer. The filters can be used simply for processing external sounds.

MODULATION SOURCES

Each voice in the Entity has four LFOs, numbered LFO1 to LFO4. These can be used for applying pitch vibrato or whatever effect is required that should be separately implemented in each voice. Two additional LFOs, LFO5 and LFO6, are common to all voices. These may be used to modify the sound as a whole. For example, if pan position is modulated by LFO5 or 6, the sound as a whole will move from left to right. If LFO1 is used to modulate pan, the effect may become less clear when several notes are played at once, because each voice has a different pan position. Of course, this can be just what's needed for textural depth in a sound.

Each voice has two envelopes, ENV1 and ENV2, using the classic ADSR configuration.

Three real time control modulation sources are provided: CTR1 to CTR3. These are derived from front panel potentiometers on the Chameleon, and also from midi. An additional modulation source, MMOD, is midi only, and is typically derived from the modulation wheel of a keyboard.

The note velocity is provided as a modulation source called KVEL, which can be set to decay from its initial value like an envelope. KFLW provides a “key follower” value, or pitch value, which is usually supplied to control the pitch of the oscillators according to the note played on the keyboard. However, this does not always have to be the case.

Two additional values are provided: VDIF, the “voice difference”, is a value that depends on the voice number. If you want to spread the voices in a chord across the stereo image, you can do this by modulating the pan position by VDIF. Another typical use for VDIF is when it is applied to the rates of LFO1-4, ensuring that each voice's LFOs have slightly different rates.

STDF, “stack difference”, is used when voices are stacked together. For example, if you want to stack two voices per note, then you might use STDF to detune the voices from each other, and also to pan, so that they are positioned at right and left. STDF and VDIF can be used in combination. When two voices are stacked, they are given the same VDIF value but different STDF values. A second note will have another VDIF value applied to its two voices, and so on.

For further details on modulation sources, see page 13.

STACKING

Up to six voices can be stacked onto each note. Any combination of notes can be programmed into the stack, which is, in effect, a list of (up to) five note transposition values that are applied to the note that is being played. Wherever possible, polyphonic playing is provided. For example, a stack of two voices per note, in a six-voice system, will give three note polyphony.

CASCADING

When six voices are not enough, additional Chameleon units can be cascaded to increase the number of voices available. Up to eight Chameleons can be cascaded* in this way. VDIF and STDF values are generated as if all the voices reside on the same synthesizer.

*See page 25 for more details on cascading

BASIC OPERATING INSTRUCTIONS

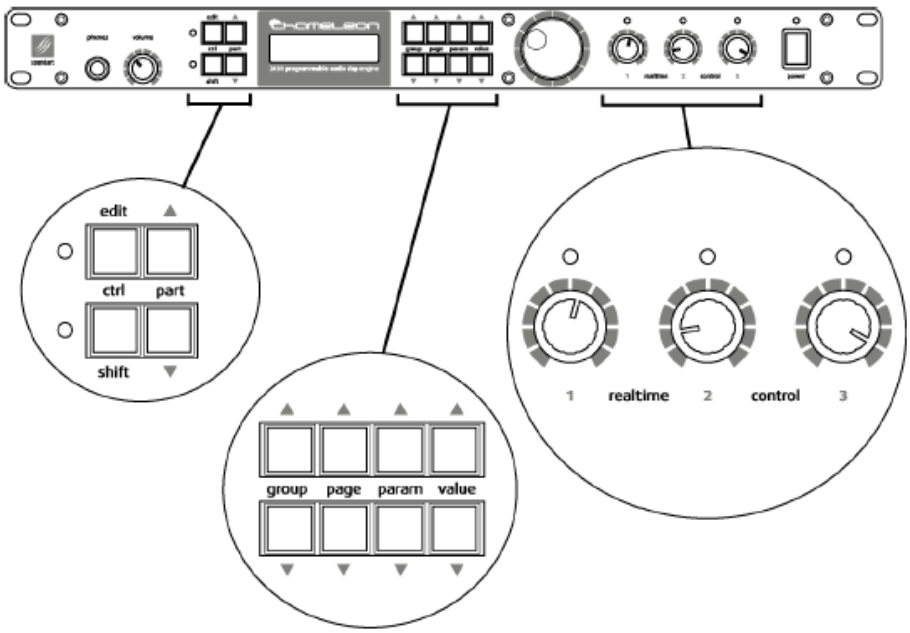


Figure 2. Chameleon Front Panel

SELECTING SOUNDS

Entity powers-up with an interface for selecting different sounds. There are five sound banks A to E in which sounds can be stored, containing up to forty sounds each. An additional bank X contains preset sounds. When Entity is initially installed on a Chameleon, bank A contains a copy of the sounds in bank X.

The sound bank is selected using the PARAM-UP/DOWN keys and sounds are selected using the VALUE-UP/DOWN keys or the rotary encoder. Note that Entity may be configured so the rotary encoder, during sound selection, is used as a modulation source, in which case sounds are selected using the VALUE-UP/DOWN keys only (see page 23 for how to configure the encoder for modulation).

Selected sounds are activated only after the next note is played. This makes it possible to select a sound without jumping through unwanted sounds. It also makes it easier to synchronise sound changes with note events during a live performance.

SAVING SOUNDS

To save a sound, *press and hold the EDIT key for one second.* You can then select the sound number and bank you want to store the sound in (which may be okay as it is). Then press EDIT to name the sound. Press EDIT a third time to save the sound. At any time in this sequence, the SHIFT key cancels saving.

Here is a summary of the key sequence for saving a sound:

Step	Key	Result
1	EDIT-HOLD	After holding down the EDIT key for one second, the EDIT and SHIFT LEDs flash alternately. Select destination sound bank and number (if needed). Press SHIFT to cancel.
2	EDIT	Edit the sound name (if needed). Press SHIFT to cancel.
3	EDIT	The sound is saved.

Table 1. Key sequence for saving sounds

NAMING SOUNDS

When editing the sound name during the save sequence shown in Table 1, the keys take on the following functions:

Key	Function
PART-UP	Insert space
PART-DOWN	Delete character
GROUP-UP	Set current character to "1"
GROUP-DOWN	Set current character to a space
PAGE-UP	Set current character to "A"
PAGE-DOWN	Set current character to "a"
PARAM-UP	Move cursor right
PARAM-DOWN	Move cursor left
VALUE-UP	Increment character (i.e. "A" -> "B")
VALUE-DOWN	Decrement character (i.e. "3" -> "2")

Table 2. Key functions when naming sounds

SOUND VERSION ACCESS

It is often helpful to be able to access previous versions of a sound, either because a mistake was made when saving over a sound that was still wanted, or because it is helpful to hear how a sound has evolved during an editing session.

Different versions of a sound can be accessed using the PART-UP/-DOWN keys. The versions are arranged as a list, with the most recent or edited version at the top. Not all previous versions are stored (because there is a limit to the amount of flash memory available). Flash memory for 69 previous versions is shared out among the sounds.

Edited sounds appear with a "." in front of the name. Up to two sounds can be edited without the need to save their changes. For example, if you edit sound A2 and then want to listen to sound A4, you can make changes to A4 too, without losing the changes made in edited version of A2. When you go back to A2, you have to press PART-UP to recall the edited version of that sound. Unlike previously saved versions, edited sounds are not stored in flash memory, so they aren't retained after power-off.

EDITING AND SAVING CONFIGURATION SETTINGS

Press SHIFT+EDIT (press and hold SHIFT followed by the EDIT key). This selects configuration parameter editing. The EDIT LED flashes to indicate this. Parameters such as the midi receive channel and device ID can then be selected using the PARAM-UP/-DOWN keys. To save the current configuration, press and hold EDIT, followed by EDIT to confirm, or SHIFT to cancel.

Default parameter values can be selected using SHIFT+VALUE-DOWN. The previous user value can later be restored using SHIFT+VALUE-UP.

Some of the configuration parameters provide access to midi system exclusive save operations (midi save bank, midi save sound etc.). When one of these configuration parameters is selected, press and hold EDIT to initiate the operation. Otherwise, pressing and holding EDIT saves the configuration.

See page 23 for configuration parameter details.

LEVEL METERS

While selecting sounds, you can view input or output levels. Press PAGE-UP to view the output levels. Press PAGE-DOWN to view the externally supplied input levels. Pressing either button again, returns to sound selection.

EDITING

To edit a sound's parameters, press the EDIT key (briefly). To go back to sound selection, press EDIT again. If the sound has been modified, a "." will appear in front of the name.

BASIC EDITING

Sound parameters are arranged in groups and pages, selected using the GROUP, PAGE and PARAM keys, as shown below.

GROUP	PAGES	DESCRIPTION
FILTER	FLT	Main stereo filters
OSCILLATOR	O1 O2 O3	Three variable timbre oscillators, with AM and FM capabilities
NOISE GEN	NG	Stereo white noise generator
RING MOD	RM	Ring modulator
EXTERNAL	EXT	External audio input
LFO	LFO1 LFO2 LFO3 LFO4 LFO5 LFO6	Low frequency oscillators (LFO1 to LFO4 are unique to each voice, LFO5 and LFO6 are common to all voices)
ENV	ENV1 ENV2	Envelopes
[General]		General sound parameters

Table 3. Sound Groups and Pages

Once the group and page and parameter have been selected, the parameter's value can be modified using the rotary encoder or the VALUE-UP/DOWN keys.

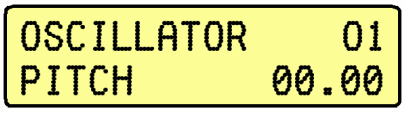
As an alternative to using the GROUP, PAGE and PARAM keys, it is possible to use CTR1 to select the parameter, and CTR2 to select the page and group. This form of editing is far quicker than using the keys to select parameters. Further details on fast editing are given on page 14. Fast editing is possible when the LEDs above CTR1 and CTR2 are lit. It can be switched off or back on again by pressing and holding EDIT followed briefly by the SHIFT key.

Sometimes it is useful to set a value quickly to zero. This can be done by pressing SHIFT+VALUE-DOWN. A parameter whose value has been zeroed in this way can be returned to its original value by pressing SHIFT+VALUE-UP.

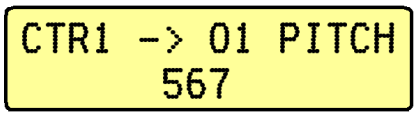
MODULATION ROUTING

Any parameter, with two exceptions*, can be modulated by any of the sixteen modulation sources. Any combination of modulation sources can be used to affect, in differing amounts, the same destination parameter.

Here is an example of setting up CTR1 to control the pitch of Oscillator 1. Use the GROUP, PAGE and PARAM keys to select Oscillator 1 pitch. Oscillator 1 Pitch is displayed in the following way:



Press PART-UP or PART-DOWN to define a modulation for Oscillator 1:



Press PART-UP/-DOWN to select the source as one of CTR1, CTR2, CTR3, MMOD, KFLW, KVEL, VDIF, STDF, LFO1-6, ENV1 or ENV2. Adjust the modulation depth using the rotary encoder or VALUE-UP/-DOWN keys. When fast editing is activated, the volume control can also be used to select the source, making it possible to define modulations very quickly. Any number of modulation depths can be defined. The destination parameter can be selected using the GROUP, PAGE and PARAM keys, and of course CTR1 and CTR2, if fast editing is active.

The modulation depth can be negative or positive, and has a range of -8000 to +7999, although values are usually set in the range -1000 to +1000.

Once the modulation routing has been set-up, press EDIT to go back to ordinary parameter editing.

MODULATION ROUTING NAVIGATION

With so many modulation possibilities, it is impossible to remember exactly how a sound is constructed. It is helpful to be able to tell, very quickly, which modulation sources are affecting a particular parameter. Also, it is helpful to be able to list the parameters that are being affected by a particular modulation source. Both these functions are provided.

With modulation editing selected, choose a modulation source by repeated pressing of the PART-UP/DOWN keys (hint: most keys auto-repeat if you hold them down). Then, to list destinations affected by the current modulation source, press SHIFT+PART-UP. Press and hold these two buttons to have the display automatically increment through the list. If there are no destinations with a non-zero modulation depth, the display will not change.

To find out which sources are affecting a particular destination, select the destination during modulation editing, and then use SHIFT_PART-DOWN to list the sources that affect it.

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*The two exceptions are the “Stack” and “Polyphony” parameters described on page 22.

Name	Summary
CTR1*	Realtime control 1
CTR2*	Realtime control 2
CTR3*	Realtime control 3
MMOD*	Midi modulation wheel (or other assignable controller)
KFLW	Key follower
KVEL	Key velocity
VDIF	Voice Difference: a modulation source whose value is different for voices assigned to different notes
STDF	Stack Difference: a modulation source whose value is different for voices assigned to the same note
LFO1	Each voice has its own unique set of LFOs 1 to 4
LFO2	
LFO3	
LFO4	
LFO5**	LFO5 and LFO6 are shared by all voices in a sound
LFO6**	They may be synchronised to a midi clock
ENV1	Envelope 1
ENV2	Envelope 2

Table 4. Modulation Sources

STACKING

Several voices can be stacked onto each note. The stack parameter switches this facility on and off. To define a new stack, firstly select the “Stack” parameter (see page 22), then press PART-UP or PART-DOWN. The notes that are subsequently played are recorded and used to define the stack. The first note clears any existing stack. The second and subsequent notes (up to a total of six), define the transposition for each of the stacked voices. Once enough stacked voices have been defined, press EDIT to go back to ordinary editing. Subsequent notes are played according to the stack transpositions that have been defined.

PLAYING MONOPHONICALLY

Entity does not have to play polyphonically. The “Polyphony” parameter (see page 22) may be set to on or off. As well as being useful for synthesizer sounds, the monophonic setting is useful for when Entity is being used as a filter for external signals. Also, monophonic playing is automatically selected when the amount of stacking reduces the number of notes that can be played to one.

A particular feature of monophonic playing style, is the ability to revert to a previously held note

* These modulation sources have the same values in each voice.

** LFO5 and LFO6 are shared by all voices, but their output levels can be different in each voice.

when a currently held note is released. On some synthesizers, something similar is implemented by giving the lowest note played priority, or the highest note played. In Entity, the most recently played note always takes priority, but if any notes are still played when the most recent note is released, the pitch reverts to the most recent of *those* notes without the sound being released. This continues until all notes have been released.

PORTAMENTO

The “Portamento” parameter (see also page 22), is straightforward when applied to a monophonic sound. However, polyphonic portamento is implemented whenever the base (i.e. unmodulated) value of the portamento parameter is one hundred or greater. Polyphonic portamento is a modified voice assignment algorithm, in which the most recently released voices are assigned to newly played notes, resulting in appropriate portamento pitch changes, and the possibility to move entire chords in pitch, if a careful playing style is adopted.

FAST EDITING

Pressing GROUP, PAGE and PARAM keys to select parameters is an extremely awkward way of editing sounds (although this type of interface is common in rack-based synths). A much faster, though initially counter-intuitive, interface is provided so that sounds can be edited at high speed. In practice, this is many times faster than using navigation keys.

Fast editing is indicated by the LEDs above CTR1 and CTR2 being lit. To select fast editing, press EDIT+SHIFT. CTR1 selects the parameter and CTR2 selects the page. Parameters and pages are selected by CTR1 and CTR2 in a logical way. For example, setting CTR2 fully anti-clockwise selects the filter. CTR1 then selects the parameter in the filter. If CTR1 is rotated fully anti-clockwise, filter cutoff is selected. This is the first most common parameter for editing, and is achieved by the turning CTR1 and CTR2 fully anti-clockwise. Parameter mapping to CTR1 and CTR2 has been chosen with speed in mind. Another frequently accessed parameter is sound volume. This is accessed by turning CTR1 and CTR2 both fully clockwise. After a while, this interface can be extremely quick to use, as parameters and pages become associated with physical rotation of CTR1 and CTR2.

When setting up modulations using fast editing, the volume control is used to select a modulation source. This is the most counter-intuitive aspect of this interface. However, it pays off in terms of speed.

For the ultimate in editing speed, toggle the SHIFT key to activate shifted keys. Now the VALUE-DOWN key zeroes the parameter value, and VALUE-UP restores it (many parameters can be zeroed and restored with their values stored internally until the sound is saved). The PART-UP and PART-DOWN keys scan and find the non-zero modulation destinations and sources, making it easy to identify the structure of a sound, and change or remove modulations as required.

If the synthesizer configuration is saved (see "Setting Midi Channel And Other Configuration Parameters" on page 6) with high speed editing activated, then this will automatically be selected the next time Entity is switched on. With high speed editing activated, configuration parameters are also selected using CTR1, during configuration editing (see page 10).

See the Entity quick reference chart on page 16 for a summary of key actions.

TIPS AND TRICKS

A keyboard isn't necessary to use Entity! When selecting sounds, GROUP-DOWN will generate a low E, and GROUP-UP will generate A=440. This may be useful when using Entity for effects, for which a keyboard may be unnecessary.

Entity can be used as a filter for processing analogue signals supplied to the Chameleon's external inputs. When selecting a sound configured for filtering, you need to play a note to activate the sound. GROUP-UP or GROUP-DOWN will do this. This enables you to use Entity as a stand-alone filter and processor without the need for a keyboard.

The GROUP-UP and GROUP-DOWN keys also generate an all-notes-off signal when they are released, which may be useful for clearing notes.

Resonating filters can be used in a variety of ways. At high levels of resonance, individual harmonics can be picked out of a tone. Melodies can even be played in this way. However, this requires extremely precise control of the filter's cutoff frequency, which may not be possible using CTR1 or a midi controller. The rotary encoder can be used as a fine control for CTR1, by setting the “Encoder -> CTR1” parameter to ON (see page 23).

Sounds must then be selected using the VALUE-UP/-DOWN keys for sound selection. The encoder works as usual when editing sounds.

ENTITY QUICK REFERENCE

KEY	SOUND SELECTION	EDITING		CONFIGURATION
		Parameter	Modulation	
EDIT	*Switch to editing*	*Switch to sound selection*	*Switch to editing parameter*	*Exit configuration*
EDIT-HOLD*	*Save sound*	*Save sound*		*Save config or save-to-midi***
SHIFT-EDIT	*Switch to configuration*	*Switch to configuration*		
EDIT-SHIFT		*High speed editing on/off*		*High speed editing on/off*
SHIFT		*Shift key on/off*		
PART-UP	*Select more recent/edited version*	*Switch to editing modulation or stack*	*Select source*	
SHIFT-PART-UP			*Find destinations*	
PART-DOWN	*Select previous version*	*Switch to editing modulation or stack*	*Select source*	
SHIFT-PART-DOWN			*Find sources*	
GROUP-UP/DOWN		*Select group*		
PAGE-UP/DOWN	*Monitor input/output levels*	*Select page in current group*		
PARAM-UP/DOWN	*Select sound bank*	*Select parameter in current page*		*Select configuration parameter*
VALUE-UP	*Sound up*	*Increment value*		*Increment value*
SHIFT-VALUE-UP		*Restore previous non-zero value*		*Restore user value*
VALUE-DOWN	*Sound down*	*Decrement value*		*Decrement value*
SHIFT-VALUE-DOWN		*Set value to zero (can be restored later)*		*Set value to default*

* Press EDIT key for one second

** Save-to-midi occurs instead of save config when one of the save to midi sysex parameters is selected

PARAMETER SPECIFICATIONS

Parameter	Description
Cutoff	Filter cutoff frequency, in semitones, 60.0 = middle C, 69.0 = A440
Resonance	Filter resonance. Values over 700 cause self-oscillation.
Overdrive	Filter overdrive. Affects the way that filter input signals combine with resonance and the level of filter distortion. 0 = no input signal, 1000 = maximum distortion.

Table 6. FILTER parameters

Name	Description
Brightness	0 = sine wave, 1000 = noise, around 300-400 is full spectrum waveform. Unstable between 400 and 1000.
Phase	For a sawtooth waveform, this adjusts the phase offset between two waveforms of the same shape that are combined to form the oscillator output. Smooth changes result in a chorus effect. For a square waveform, the results are more subtle.
Wavtype	Waveform type. Sawtooth or square, with variable brightness.
Octave	Selects octave. -10 = sub-audio.
Pitch	Defines pitch in semitones. Used to tune or detune oscillators. Normally modulated by KFLW to a depth of 1000, to provide an equal tempered semitone keyboard tuning.
Offset	Offset frequency in hertz. Very small values can be used for phasing effects between oscillators.
FM source	FM modulation source. See table of audio sources on page 18.
FM	Frequency modulation. The degree to which the oscillator is frequency modulated (strictly speaking, phase modulated) by an FM source.
Phase sync	If ON, staccato playing causes the oscillator phase to reset at the start of a new note.
Pan	Stereo position of oscillator output
Level	Level of oscillator supplied to filter.

Table 7. OSCILLATOR parameters

Name	Description
Level	Level of noise supplied to the filter

Table 8. NOISE GEN, NG parameters

Name	Description
Level	Level of external signal supplied to the filter

Table 9. EXTERNAL, EXT parameters

To see how much external signal is being supplied to the input, press PAGE-DOWN when selecting sounds.

Name	Description
Source A	Select the source for the first input to the ring modulator. See Table 11. Audio Sources.
Source B	Select the source for the second input to the ring modulator. See Table 11. Audio Sources.
Pan	Position in sub-mix supplied to stereo filter.
Level	Level of ring modulator supplied to the stereo filter.

Table 10. RING MOD, RM, parameters

Mnemonic	Description
O1	Oscillator 1
O2	Oscillator 2
O3	Oscillator 3
NG	Noise generator (a monophonic noise source uncorrelated with the main stereo noise generator output)
RM	Ring modulator
FLTL	Filter output (left)
FLTR	Filter output (right)
EXTL	External input (left)
EXTR	External input (right)

Table 11. Audio Sources

Name	Description
Rate	Frequency of LFO. This has a normal range of 0 - 1000. Values below zero provide midi clock synchronisation rates for LFO5 and 6. See Table 14.
Wavform	(See Table 13 for LFO waveforms)
Sync	(See Table 15 for LFO synchronisations)
Delay	Delay after new note before LFO level reaches maximum
Level	Output level of LFO. This enables the depth of LFO modulation of a destination parameter to be varied.

Table 12. Low Frequency Oscillator parameters

Although LFO5 and LFO6 are not independently generated in each voice, their delay and level characteristics are. So, for example, it is possible to use LFO6 to apply volume vibrato (synchronously) across all voices, although each individual voice can vary the onset of vibrato, by use of the LFO6 delay parameter.

When the Rate, Waveform or Sync of LFO5 or LFO6 is modulated by a voice-specific modulation source, such as KFLW or LFO1, the modulation source's value is taken from the most recently assigned voice.

Name	Description
Triangle	Standard triangle waveform
Sawtooth	Standard sawtooth waveform
Saw-exp	Exponential sawtooth
Square	Standard square waveform
Pulse	Very short rectangular pulse waveform
Random	A new random value is selected on each new LFO cycle
Gaussian	A new Gaussian random value is selected on each new LFO cycle
Pink	A new pink noise random value is selected on each new LFO cycle
Rand-sm	A new random value is selected on each new LFO cycle, and the waveform is generated by smooth transition between successive values
Gauss-sm	Smooth transitions between Gaussian values
Pink-sm	Smooth transitions between pink noise values

Table 13. LFO waveforms

Value	Description
0 -1000	LFO not synchronised to midi
Sync 32/1	1 LFO cycle per 32 whole notes (32 bars of 4/4)
Sync 24/1	
Sync 16/1	
Sync 12/1	
Sync 9/1	
Sync 8/1	1 LFO cycle per 8 whole notes
Sync 7/1	
Sync 6/1	
Sync 5/1	
Sync 4/1	
Sync 3/1	
Sync 2/1	
Sync 1/1	1 LFO cycle per whole note (1 bar of 4/4)
Sync 1/2	
Sync 1/3	
Sync 1/4	1 LFO cycle per quarter note
Sync 1/6	3 LFO cycles per half note
Sync 1/8	
Sync 1/12	3 LFO cycles per quarter note (triplets)
Sync 1/16	
Sync 1/24	
Sync 1/32	
Sync 1/48	
Sync 1/96	1 LFO cycle per midi clock message

Table 14. LFO5 and LFO6 Midi Synchronisation Rates

LFO SYNC PHASE

An LFO synchronised to midi will stay locked to the midi clock without any drift in phase. However, it may be necessary to define a starting phase for the LFO, either at the start of a piece of music, or at one or several points throughout its duration.

This is achieved using Midi continuous controller 89 (undefined in the Midi Standard). This continuous controller is called LFO Sync Phase. If the data value of LFO Sync Phase is zero, all LFOs that are synchronised to midi will start at the beginning of their cycle. If the data value is 64, the LFOs start halfway through their cycle. LFO Sync Phase only affects midi synchronised LFOs.

LFO Sync Phase can be used to set the reset the phase at the start of a section of music. Alternatively, it can be used repeatedly to carefully adjust the rhythm.

If the LFO is set to restart on each note (using the LFO sync parameter), then LFO Sync Phase may be unnecessary, because the LFO restarts its cycle at the start of each note anyway.

LFO SYNC SUSTAIN

A piece of music having a variable tempo may require an LFO to synchronise to the midi clock throughout its duration. However, it may be useful to be able to sustain a previously synchronised LFO rate during a section having a different tempo.

This is achieved using Midi continuous controller 90 (undefined in the Midi Standard). This continuous controller is called LFO Sync Sustain. If the data value of LFO Sync Sustain is greater than 63, then midi synchronised LFO rates are sustained at their current values regardless of subsequent changes in the midi clock rate.

LFO Sync Sustain is released by sending an LFO Sync Sustain event with a data value of 63 or less. After this, midi synchronised LFOs return to tracking the midi clock rate as usual.

Name	Description
Off	LFO is free running
Note	Restart at the beginning of each note*
LFOx Anti	Lock LFO in antiphase with LFOx**
LFOx Quad	Lock LFO in quadrature with LFOx**
LFOx S&H	Sample and hold LFO when LFOx restarts its cycle
LFOx NSH	Note sample and hold: Restart LFO at the beginning of each note, then sample and hold LFO when LFOx restarts its cycle*
Note S&H	Sample and hold LFO at the beginning of each note

Table 15. LFO internal synchronisations

* LFO5 and LFO6 don't support this synchronisation

** LFO5 and LFO6 cannot phase lock to LFO1-4

Name	Description
Attack	Attack time (the time it takes for the envelope to reach maximum after the start of a new note)
Decay	Decay time (the time it takes for the envelope to decay to the sustain level after the attack phase has completed)
Sustain	Sustain level (the level sustained after the decay phase for the remainder of the duration of the note)
Release	Release time (the time it takes for the envelope to decay to zero after the note is released)

Table 16. ENV parameters

The operation of envelopes depends on playing style. If the next note is played before the previous one is released, that is considered legato playing. In this case, envelopes start the attack phase at whatever level had previously been reached. If the Portamento parameter (described below) is non-zero, then legato playing is always assumed. Otherwise the envelope is set to zero at the start of the attack phase.

Name	Description
Octave	Octave of keyboard. This affects KFLW, so if KFLW is not used to affect oscillator pitch, this parameter will have no effect (whereas oscillator octave settings always have an effect).
Stack	Switches stacked voices on or off. The number and transpositions of stacked voices are defined during stack edit, described on page 13.
Polyphony	When off, the synth is monophonic, although voices can still be stacked.
Portamento	The time taken to change pitch between successive notes. If this is non-zero, then legato playing is assumed, and envelopes are not reset to zero at the start of the attack phase. Also, oscillator phase sync will not occur. See also page 14.
KVEL decay	The time taken for the KVEL parameter to decay from the keyboard velocity value of a new note down to zero.
Balance	Relative levels of left and right filter outputs.
Spread	Width of stereo field. 0 = left and right both panned centrally, 1000 = left and right both panned left and right. -1000 = left and right panned right and left.
Pan	Location of centre of stereo field
Volume	Output level of sound.

Table 17. General sound parameters

CONFIGURATION PARAMETERS

Name	Description
MIDI RX CHANNEL	Define midi receive channel. There is an additional setting of ALL, so that data on any midi channel or intended for any Entity synthesizer will be recognised.
MIDI TX CHANNEL	Define midi transmit channel.
MIDI DEVICE ID	Define midi system exclusive device ID used during transmission and reception of system exclusive data.
MIDI THRU	Switch on or off echoing of midi events from midi input to midi output on back panel.
MIDI PITCH BEND	Select number of semitones for midi pitch bend range
MIDI NRPN DATA	Select transmission and/or reception of parameter changes using Non-registered parameter numbers (page 27)
MIDI VOLUME	Select transmission and or reception of midi volume (from the front panel Volume control)
MIDI PROG CHANGE	Select transmission and or reception of midi program change information. Sound bank changes are included with this data.
MIDI CONTROLLERS	Select whether midi controller events will be off, sent, received or sent and received.
MIDI CTR1 RTC	Select which midi controller number CTR1 modulation events will be sent and received on.
MIDI CTR2 RTC	CTR2 midi controller number (as above)
MIDI CTR3 RTC	CTR3 midi controller number (as above)
MIDI MMOD RTC	Select which midi controller number midi modulation events will be sent on(modulation source MMOD).
ENCODER −> CTR1	During sound selection, the rotary encoder can be used as a fine control for CTR1. This parameter selects that function. This is very useful for precise filter frequency adjustment, and exploring harmonic series.
MIDI CASCADE	Two or more Chameleons can be cascaded to increase the number of voices available. For two Chameleons, the first must have this parameter set to “1/2” and the second must have this parameter set to “2/2”.

Name	Description
MASTER TUNING	Define the frequency for A above middle C. Usually this is 440 Hz. The frequency can be set to a high precision, but the internal quartz clock may not be as accurate as the parameter's precision suggests.
MIDI SAVE CONFIG	Save configuration data to midi. The resulting system exclusive stream, when replayed to the Entity, will modify the current configuration, but not save it.
MIDI SAVE ALL	Save all sounds and configuration data to midi. The resulting system exclusive stream, when replayed to the Entity, will write all the sounds and configuration data to flash.
MIDI SAVE BANK	Save current bank to midi. The resulting system exclusive stream, when replayed to the Entity, will save all the sounds to flash. If this is done in error, however, the previous versions should still be accessible.
MIDI SAVE SOUND	Save sound to midi (hold EDIT to save). The resulting system exclusive stream, when replayed to the Entity, will modify the current sound, but not save to flash.

Table 18. Configuration parameters

CASCADING

If you're lucky enough to have more than one Chameleon, it's possible to use this to increase the number of voices available in Entity. Up to eight Chameleons can be cascaded, giving a total of 48 voices. Although this seems like more than would ever be necessary for polyphony, consider how these might be used for stacked voices.

For two cascaded Chameleons, set the “Midi Cascade” parameter (see page 23) to “1/2” and “2/2” respectively. The second Chameleon receives midi from the first. It must receive the same note data, so the “Midi Thru” parameter (see page 23) must be ON. Furthermore, both Chameleons must have the same sounds selected at the same time. NRPN editing will work, but editing the stack may cause the units to desynchronise from each other. In this case, transmit the sound data from the first Chameleon to the second using “Midi Save Sound” or “Midi Save Bank” (see page 24). Voice assignment always resets itself on the first note after a new sound is selected, so this should solve any problems.

For more than two or three cascaded Chameleons, the optimal configuration is to supply the midi output from the first to a midi multi-way splitter. This minimises midi time delays. The splitter duplicates and supplies midi from the first Chameleon to the others, which must have their cascade parameters set accordingly, for example, “2/4”, “3/4” and “4/4”.

MICROTONALITY

No interface is provided for microtunings. Instead, a tuning may be downloaded to the Entity as a Midi Tuning Standard system exclusive message. The tuning then becomes part of the current sound, and the sound will be marked as being changed.

If the sound is subsequently saved, the tuning is stored as part of the sound. From then on, that sound will have the tuning that was downloaded into it.

A simple alternative to the Midi Tuning Standard is to set the KFLW to oscillator pitch modulation depth to something other than 1000. A value of 500 will generate quartertones. A value of 387 will generate (approximately) a 31-note equal tempered scale.

The following book is recommended reading on the subject of microtonality:

“Tuning In - Microtonality In Electronic Music” by Scott R. Wilkinson, ISBN 0-88188-633-5

MIDI IMPLEMENTATION CHART

Model: Entity 1.00 Date: 27 November 2005

Function		Transmitted	Recognized	Remarks
Basic Channel		1 to 16	1 to 16	
Default Channel		1	1	
Mode	Default	X	X	No Modes supported
	Messages	X	X	
	Altered	X	X	
Note Number		0 to 127	0 to 127	Oscillator octaves have greater range
True Voice			0 to 127	
Velocity	Note ON	X	O	
	Note OFF	X	X	
Aftertouch	Keys	X	O	Assignable as CTR1-3 or MMOD source
	Channel	X	O	
Pitch Bend		X	O	
Control Change		O	O	See notes
Prog		0-39	0-39	Displayed as 1-40
Change	True #	0-39	0-39	
System Exclusive		O	O	
System Common		X	X	
System Real Time		X	X	
Aux Messages	All Notes Off	O	O	
	All Sound Off	X	O	
	Reset Controllers	X	O	
	Active Sense	X	X	
Notes: CTR1-3 and MMOD can be assigned any controller from 1-95. Controllers recognised and transmitted are: 0 Sound Bank, 6 Data Entry, 7 Volume, 10 Pan, 11 Expression, 98 and 99 NRPN fine and coarse. Controllers recognised but not transmitted are: 11 Expression, 64 Hold, 89 LFO Sync Phase*, 90 LFO Sync Sustain*, 96 and 97 Data increment and decrement (*not part of midi standard).				

O = Yes X = No

APPENDIX B - NRPN Editing

The Entity responds to Non-Registered Parameter Number (NRPN) midi messages. A sound parameter is selected by sending midi controller 99 and midi controller 98 messages. These correspond to the coarse and fine parameter numbers. The Entity has 89 base parameters. Midi controller 98 defines the base parameter, and midi controller 99 is used to define the modulation source.

After the parameter is defined, its value can be modified using Data Button Increment or Decrement control messages (midi controllers 96 and 97). Alternatively, data entry can be used, using midi controllers 6 (coarse) and 7 (fine).

DYNAMIC DATA RANGING

Most Entity parameters have a wide range (typically 0 to 7999, or -8000 to 7999), enabling extreme settings to be made, and at high precision. However, useful values are typically in a smaller part of this range. Controlling a parameter using NRPN edits from a 128-step device (such as a potentiometer or a foot pedal) requires an appropriate range of Entity parameter values be assigned to the 128 possible potentiometer values. This will ensure that potentiometer adjustments made during performance are appropriate for the kind of effects a musician would like to achieve.

However, it is also desirable to be able to change parameters at a fine level of detail, and over the whole range of possible values. This is usually required when editing a sound from software running on a computer.

Dynamic data ranging makes both these kinds of operation possible. If the Data Entry fine data value (midi controller 38) is received without a preceding coarse data value (midi controller 6), then it is assumed that the transmitting device is a potentiometer or other limited-resolution device. The fine data entry values are translated automatically to cover a range suitable for the currently selected parameter. For example, filter cutoff will cover values from 25.0 to 130.0. Oscillator FM routing will switch between the nine different audio sources over the range of the potentiometer.

For precise editing, data entry values are sent as a pair, with the coarse/MSB followed by the fine/LSB data values. In other words, midi controller 6 followed by midi controller 38. It is not necessary for these to be combined as part of a running status sequence.

When data increment and decrement controllers are used, the parameter is always modified according to its highest level of resolution.

Entity Non-Registered Parameter Numbers are detailed on the following pages.

FLT	cutoff	0
	resonance	1
	overdrive	2
O1	brightness	3
	phase	4
	wavetype	5
	octave	6
	pitch	7
	offset	8
	FM source	9
	FM	10
	phase sync	11
	pan	12
	level	13
O2	brightness	14
	phase	15
	wavetype	16
	octave	17
	pitch	18
	offset	19
	FM source	20
	FM	21
	phase sync	22
	pan	23
	level	24
O3	brightness	25
	phase	26
	wavetype	27
	octave	28
	pitch	29
	offset	30
	FM source	31
	FM	32
	phase sync	33
	pan	34
	level	35
NG	level	36
EXT	level	37
RM	source A	38
	source B	39
	pan	40
	level	41
LFO1	rate	42
	waveform	43
	sync	44
	delay	45
	level	46
LFO2	rate	47
	waveform	48
	sync	49
	delay	50
	level	51
LFO3	rate	52
	waveform	53
	sync	54
	delay	55
	level	56
LFO4	rate	57
	waveform	58
	sync	59
	delay	60
	level	61
LFO5	rate	62
	waveform	63
	sync	64
	delay	65
	level	66
LFO6	rate	67
	waveform	68
	sync	69
	delay	70
	level	71
ENV1	attack	72
	decay	73
	sustain	74
	release	75
ENV2	attack	76
	decay	77
	sustain	78
	release	79
(General sound parameters)		
	octave	80
	stack	81
	polyphony	82
	portamento	83
	KVEL decay	84
	balance	85
	spread	86
	pan	87
	volume	88

Table 20. Entity Non-Registered Parameter Numbers

MODULATION PARAMETER NRPNS

When the NRPN coarse/MSB is set to zero, parameter numbers 0-88 are selected, as shown in Table 15. For non-zero coarse/MSB values in the range 1-16, modulation sources are selected in combination with a destination defined by the fine/LSB of the NRPN:

Modulation Source	NRPN Coarse/MSB	NRPN numerical range
CTR1	1	128 - 216
CTR2	2	256 - 344
CTR3	3	384 - 472
MMOD	4	512 - 600
KFLW	5	640 - 728
KVEL	6	768 - 856
VDIF	7	896 - 984
STDF	8	1024 - 1112
LFO1	9	1152 - 1240
LFO2	10	1280 - 1368
LFO3	11	1408 - 1496
LFO4	12	1536 - 1624
LFO5	13	1664 - 1752
LFO6	14	1792 - 1880
ENV1	15	1920 - 2008
ENV2	16	2048 - 2136

Table 21. Non-Registered Parameter Numbers (Modulations)

For example, the CTR1 modulation depths have NRPNs of 128-216:

```
CTR1 -> FLT cutoff        NRPN = 128
CTR1 -> FLT resonance     NRPN = 129
CTR1 -> FLT overdrive     NRPN = 130
...
```

CTR2 modulation depths have NRPNs of 256-344:

```
CTR2 -> FLT cutoff        NRPN = 256
CTR2 -> FLT resonance     NRPN = 257
...
```

and so on.

EXCEPTIONS

Two parameters don't use modulation depths in the usual way. These are “Stack” and “Polyphony”, base parameter numbers 81 and 82 respectively. NRPN messages for their modulation depths should not be transmitted. Their base parameters should work fine.

RECEIVING AND TRANSMITTING HIGH RESOLUTION NRPN DATA

Entity internal parameter data is 14 bit. A user value of zero corresponds to a high resolution data entry value of 8192. Continuous parameters typically have user values of zero or -8000 to +7999, corresponding to NRPN data values of 192 to 16191. Switched parameters (like octaves) take values as in the following example:

8191 (octave = -1)
8192 (octave = 0)
8193 (octave = 1)
8194 (octave = 2)
...

High resolution NRPNs can be used for modifying sounds remotely (without the need to use system exclusive). High resolution NRPNs are transmitted from the Entity when MIDI NRPN DATA transmission is enabled (see configuration parameters, page 4).

High resolution events are distinguished in a midi stream by having the Data Entry MSB immediately followed by the Data Entry LSB (running status is not necessary).

APPENDIX C

```
ENTITY System Exclusive Encoding
--------------------------------

0xF0        Start of Sysex
0x00 0x20 0x45    SoundArt MIDI ID
0x01        Product ID (Chameleon = 0x01)
xxxx        Device ID (0x00..0x0F, 0x7F = broadcast)
0x01 0x01   Application ID (0x01 0x01 = Entity Polyphonic)
xxxx        Message ID
....        Data (size variable)
xxxx        Checksum (XOR of all data bytes truncated to 7 bits, 0x7F is
            always valid)
0xF7        End of Sysex

Stored Sound Dump (when sent to synth, sound is saved automatically)
--------------------------------------------------------------------

0x00        Message ID (0x00 = Stored Sound Dump)
xxxx        Sound Bank
yyyy        User sound number
....        Dump data (compressed sound data, variable length)

Edited Sound Dump (when sent to synth, sound is updated but not saved)
----------------------------------------------------------------------

0x01        Message ID (0x01 = Edited Sound Dump)
xxxx        Sound Bank
yyyy        User sound number
....        Dump data (compressed sound data, variable length)

Stored Global Dump (new global settings saved automatically)
------------------------------------------------------------

0x02        Message ID (0x02 = Stored Sound Dump)
....        Dump data (global parameters)

Edited Global Dump (global settings updated but not saved)
----------------------------------------------------------

0x03        Message ID (0x03 = Edited Sound Dump)
....        Dump data (global parameters)

Stored Sound Request
--------------------

0x04        Message ID (0x04 = Stored Sound Request)
xxxx        Sound bank
yyyy        User sound number

Edited Sound Request
--------------------

0x05        Message ID (0x05 = Edited Sound Request)
xxxx        Sound bank
yyyy        User sound number
```

```
Stored Active Sound Request
---------------------------

0x06        Message ID (0x06 = Stored Active Sound Request)

Edited Active Sound Request
---------------------------

0x07        Message ID (0x07 = Edited Active Sound Request)

Stored Global Request
---------------------

0x08        Message ID (0x08 = Stored Global Request)

Edited Global Request
---------------------

0x09        Message ID (0x09 = Edited Global Request)

Sound Bank Request
------------------

0x0A        Message ID (0x0A = Sound Bank Request)
xxxx        Sound bank

All Sounds Request
------------------

0x0B        Message ID (0x0B = All Sounds Request)

All Sounds & Global Request
---------------------------

0x0C        Message ID (0x0C = All Sounds and Global Request)
```

APPENDIX D

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