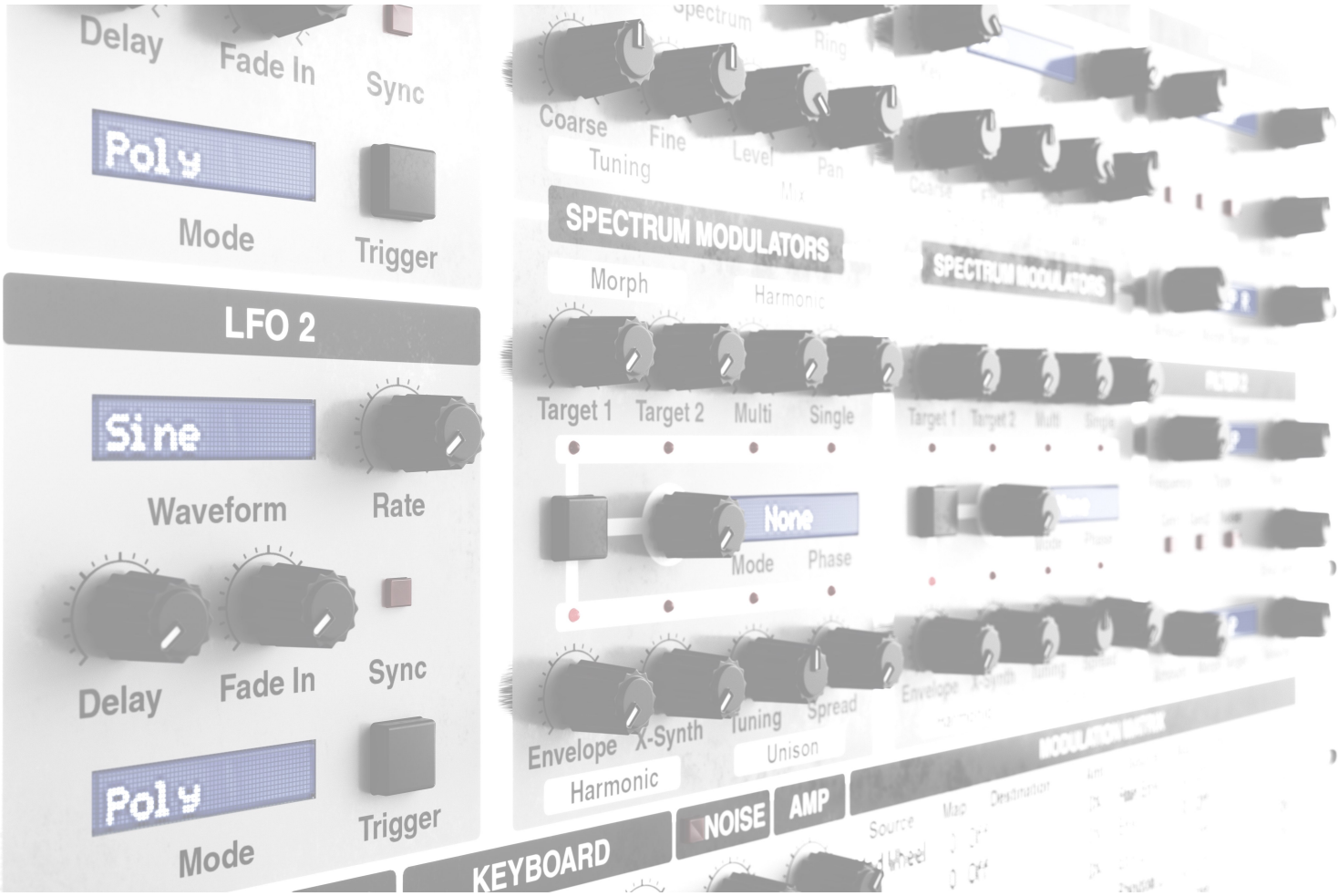
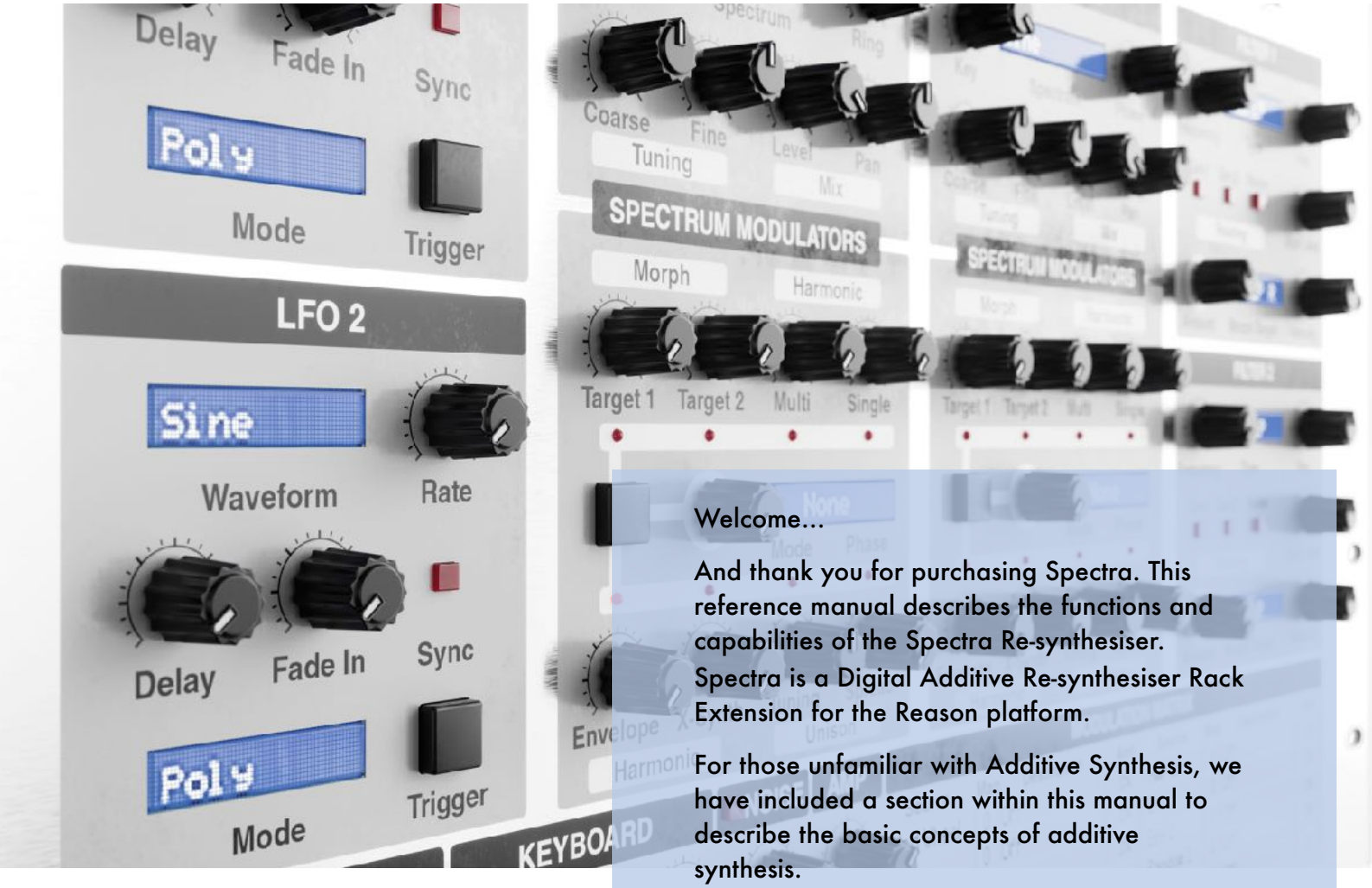
SPECTRA

Reference Manual



Welcome



Welcome…

And thank you for purchasing Spectra. This reference manual describes the functions and capabilities of the Spectra Re-synthesiser. Spectra is a Digital Additive Re-synthesiser Rack Extension for the Reason platform.

For those unfamiliar with Additive Synthesis, we have included a section within this manual to describe the basic concepts of additive synthesis.

Re-synthesis is also a capability that is not commonly encountered so there is also a dedicated section(s) on Re-synthesis which describes in some detail what Re-synthesis is as well as its capabilities within Spectra.

I sincerely hope you enjoy using Spectra as much as I enjoyed making it.

James Williams

jameswilliams@synthetechsound.com.au

Contacting Us

Support

For questions regarding the use of your Spectra Re-synthesiser not covered in this manual or any online resources please contact us via the following address.

support@synthetechsound.com.au

Note that we are a small Australian company and therefore you may not receive an immediate response due to time differences and/or current workload. We will, however endeavour to respond as quickly as possible to support enquiries.

Defects

Should you experience an issue you believe is a defect while using Spectra or if you would like to recommend changes to this manual we encourage you to notify us via the following address.

defects@synthetechsound.com.au

Note that it is extremely difficult to chase down some obscure problems so when making a defect submission we would appreciate any and/or all of the following information.

1. A General Description or Summary of the issue
2. A Description of the issue. Keep in mind, the goal of this description is to enable a software developer to reproduce the issue. Information we would consider important are:
    a. OS Platform and version
    b. CPU Speed and RAM size of the machine where the error occurred
    c. The version of Reason you are using
    d. The version of Spectra you are using
    e. The steps required to reproduce the issue and the patch where you discovered the issue.

    If the issue is difficult to identify we may request the song file and/or patch in use when the defect is presented.

General Enquiries

For any queries not related to support or defects, please contact us on the address below.

info@synthetechsound.com.au

Special Thanks To

It is impossible to communicate the gratitude and appreciation to those who contributed to the release of Spectra in a single page. Synthetech Sound would like to sincerely thank the following people who contributed their time, passion, creativity, knowledge, insights, sounds, songs, expertise, templates, spectra and support to the release of Spectra.

NaviRetlav (Navi Retlav Studios) - Sound Designer/Preset Developer

Benedict - Sound Designer/Preset Developer

Nirude - Developed Extraordinary 3D Renders (Thanks Nirude)

odarmonix -Beta Tester (Thanks for talking me into making the harmonic changes)

midiguru - Beta Tester

Buddaka - Demo Song Developer

reflectionjack - Demo Song Developer

VHS - Demo Song Developer

Advanced Suite - Demo Song Developer

Arsenic - Beta Tester

dhruan - Beta Tester

Laser Rot - Beta Tester

Action Kid Waveforms (AKWF) - Single Cycle Waveforms (for the internal Spectra)

Noel G. (Reasonistas) - Combinator Skin Developer

Propellerhead Support (Thanks Gustav, John, Joakim for answering all of my dumb questions and for the awesome support during the project)

Using This Manual

Additive Synthesis is sometimes described as "hard". I get this, but the possibilities of sound design using Additive Synthesis are absolutely staggering. With this in mind I started developing Spectra and adopted a design goal of making an Additive Synth that could be simple if you wanted to just preset surf and/or to let you get your hands dirty directly editing spectral harmonics if you wanted to. My hope in setting this goal was to support the basic principle that **the synth should be as easy or as complex as the user wants it to be.** For me this also supported my basic philosophy that synthesisers should be fun, no matter how you define fun.

To this end I really felt it was equally important to have a manual which supported these principles and design goals. Spectra can be very simple synth, or it can be a very complex synth. I knew a good manual was going to be required in order to assist you through Spectra's complexities. I hope you find this manual helpful in the unlocking of the possibilities within the Spectra synthesiser.

Important Information

Important additional information relevant to the current section is displayed in a grey box with an information icon like this:

Important additional information is sometimes displayed in a shaded box like this.

Version

This manual is current as at version 1.0.0 of the software.

Updated

This manual was last updated on 12, February 2018.

Copyright

Definitions

The following terms are used within this manual. For each term we have either derived, or used a direct quote segment of a definition from Wikipedia. All definitions are credited to Wikipedia.

Term	Wikipedia Definition
Fourier Series	a way to represent a (wave-like) function as the sum of simple sine waves. More formally, it decomposes any periodic function or periodic signal into the sum of a (possibly infinite) set of simple oscillating functions, namely sines and cosines
Fundamental	The fundamental frequency, often referred to as simply as the fundamental, is defined as the lowest frequency of a periodic waveform. In music, the fundamental is the musical pitch of a note that is perceived as the lowest partial present.
Harmonic	The term harmonic in its strictest sense describes any member of the harmonic series. A harmonic of a periodic wave is a wave with a frequency that is a positive integer multiple of the frequency of the original wave, known as the fundamental frequency.
Harmonic Envelope	Used to apply a contour for each harmonic in a spectrum.
Histogram	A way of representing a spectrum in visual form. The Spectrum, Harmonic Envelope and Filter editors all utilise a histogram for representing values within their appropriate spectra.
Inharmonic	In music, inharmonicity is the degree to which the frequencies of overtones (also known as partials or partial tones) depart from whole multiples of the fundamental frequency (harmonic series).
Magnitude	A measure of the power of a harmonic. Very similar to level.
Overtones	see Harmonic
Partial	see Harmonic
Periodic	to repeat a functions values in regular intervals or periods. For example a sine wave is periodic whereas speech may not be.
Polyphony	A number of notes. In this manual polyphony is often used to describe the maximum polyphony or maximum number of notes which can be played at one time.
Spectra	The plural form of 'Spectrum'
Spectrum	sounds usually have many different frequencies mixed. A musical tone's timbre is characterised by its harmonic spectrum or mixture of frequencies within the sound.

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Overview

Introducing Spectra

Spectra is an additive re-synthesiser. Why do we call it a re-synthesiser? Spectra has the ability to analyse any periodic sound down to its fundamental elements capturing its harmonic spectrum and therefore its timbre or tone colour. This is referred to as "Fourier Analysis". This means that Spectra can analyse a sound in order to determine how the sound is made then rebuild or re-synthesise the sound based on this analysis.

The Spectra Front Panel

Figure 1 - Spectra Front Panel

Front Panel Control Layout

Spectra's front panel layout is designed to make Spectra look as familiar as possible to synth enthusiasts.

2 LFO's

The 2 LFO's have multiple internal Waveforms and a Sample and Hold Function and also enable you to define your own drawable Shapes. The User Definable Shapes enable the LFO's to simulate an Envelope. Each LFO has its own Delay and Fade In Controls and can be synced to tempo. The LFO's also can run in Free, Mono, Poly, OneShot, Triggered and Trig Held Modes.

3 Spectral Generators

Spectra has 2 Generators and 1 Spectral Noise Generator. Each Generator contains up to 256 Sine wave oscillators. There are a number of built in spectra and additionally 10 user spectra which can be freely edited.

2 Spectrum Modulators

Each Generator has its own dedicated set of spectrum modulators. The spectrum modulators enable you to morph two spectra (x2), modulate a group of harmonics (multi), a single harmonic, route the Generator spectrum to a Harmonic Envelope, cross synthesise two spectra, and apply a unison effect to each Generator. Note that spectrum morphing can also be sequenced via the editor.

2 Spectral Filters

The Filters are spectral filters enabling you to draw a filter response. Each Filter can be freely assigned to any combination of Generator 1, Generator 2 and the Noise Generator. Each Filter has the ability to morph with any of the inbuilt or user-defined filter responses and morphing can also be sequenced with up to 10 morph transitions.

Performance Controls

Spectra includes standard Pitch bend, Modulation Wheel and portamento controls. The Pitch bend amount can be defined for both up and down directions. Spectra also supports multiple Keyboard Modes including Poly, Legato and Mono.

Modulation Matrix

The modulation matrix enables you to route any modulation source to any destination by a specified amount. Modulation Maps enable you to scale the Modulation source using a user definable value.

The Editor

Spectra's editor enables easy editing of all the Spectrum harmonics for each of the 10 User Definable Spectra. The Modulators section of the Editor enables you to define 'Multis' for use in the Spectrum Modulators section and to draw LFO Shapes for use in the LFO's. The Maps section enables you to draw a transfer function for scaling any of the Modulators. The Editor also enables you to freely edit any of the 10 User Definable Spectral Filters via drawing the individual harmonics or to develop a Filter impulse using the Filter Designer. The Envelopes sections enable editing of any of the 5 built in Envelopes. Note that Spectra has 2 Harmonic Envelopes, and 3 MSEG's of up to 16 stages (2 Modulation Envelopes and 1 Amplitude Envelope). The Harmonic Envelopes are an array of envelopes aimed at modulation of each individual harmonic within a Generators spectrum (prior to the sine waves being added together). This means that Spectra effectively has 515 envelopes. The Editor also enables you to specify a spectral morph sequence or filter morph sequence. The built in analyser enables you to analyse sounds either internally via Generator 1, Generator 2, Generator 1 and 2 mixed, a drawn waveform or via an imported sample. The analysed spectrum can then be used within a Generator. Finally the XY Controllers offer additional modulation options.

Figure 2 - Spectra Front Panel Layout

The Back Panel

The Back Panel of Spectra offers several features Reason users have come to expect including 6 CV inputs, Note and Gate CV Inputs for enabling play by the Matrix, RPG-8 or other appropriate Utility devices.

Spectra also has CV outputs from its internal XY controllers.

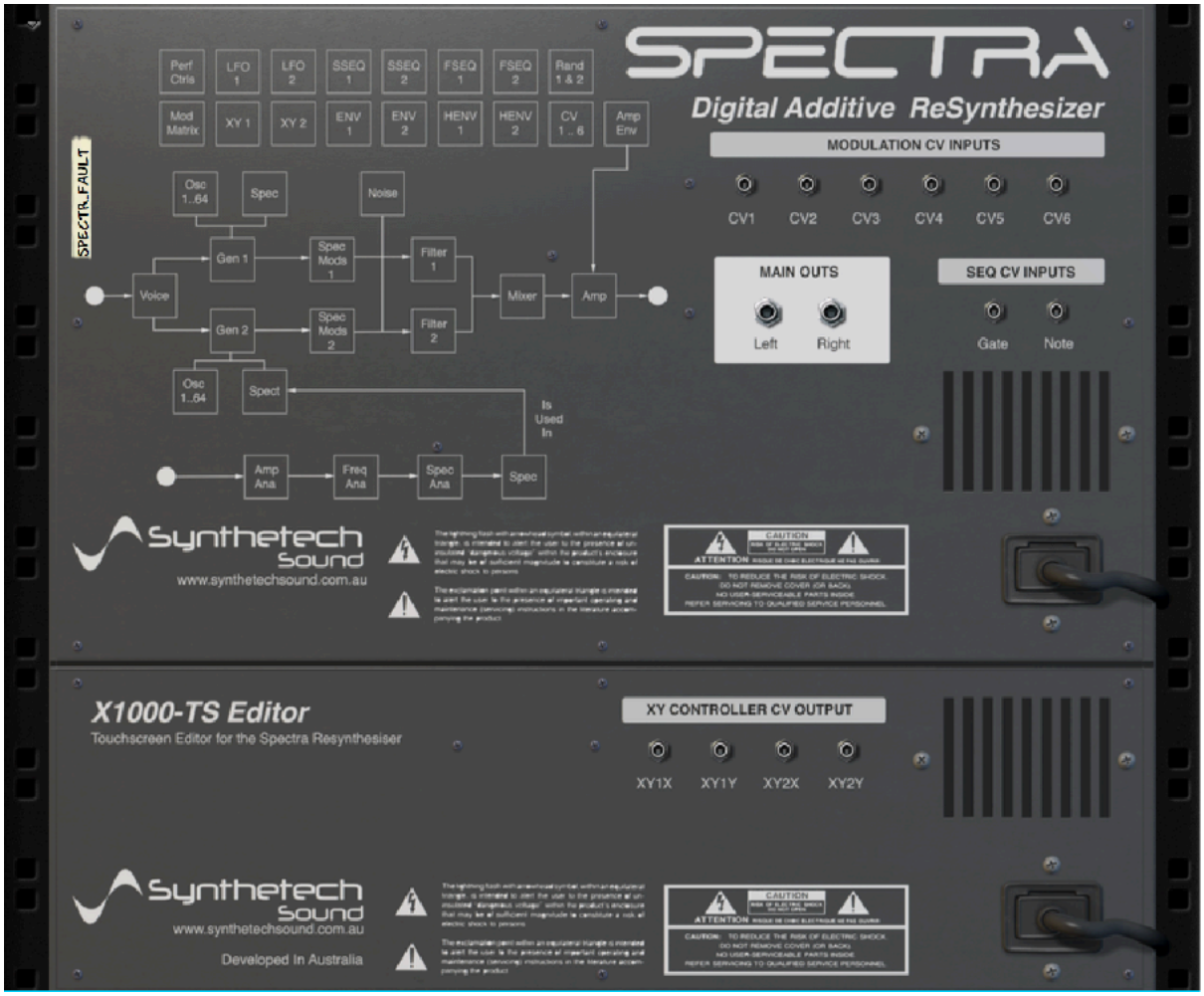


Figure 3 - Spectra Back Panel

Spectra Architecture

The following diagram depicts the high level architecture of the Spectra Re-synthesiser.

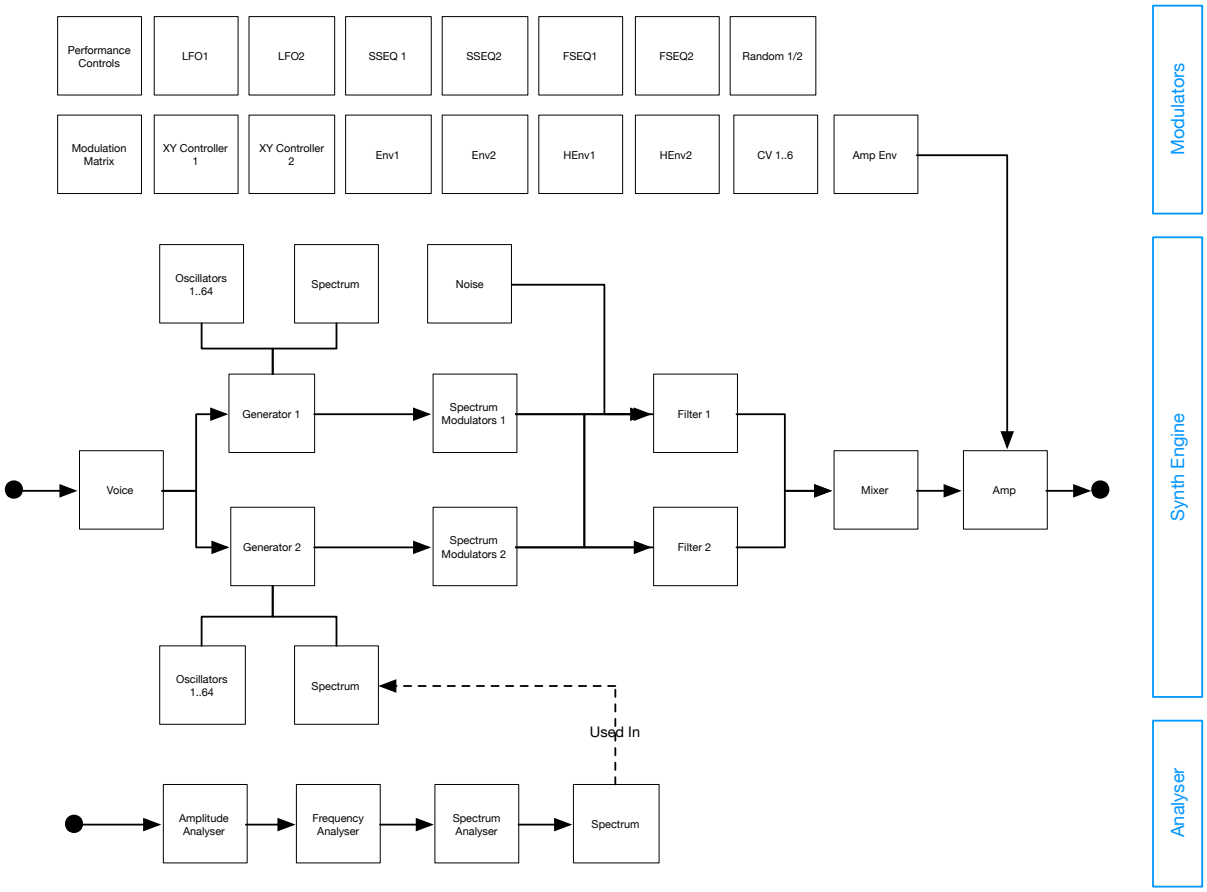


Figure 4 - Spectra Architecture

Modulators

Modulators are devices which effect the sound created by the Synthesis Engine. Modulators are critical for creating sounds which 'move'.

Synthesis Engine

The Synthesis Engine is responsible for generating sound. Technically its Spectrum modulators and Filters are both modulators but are included as part of the synthesis engine.

Analyser

The Analyser is responsible for sampling audio and analysing it down to its fundamental sine waves.

These 3 major components are all critical components of a re-synthesiser

About Additive Synthesis

Additive synthesis is a way of creating sound which relies on adding sine waves of related and sometimes un-related frequency together.

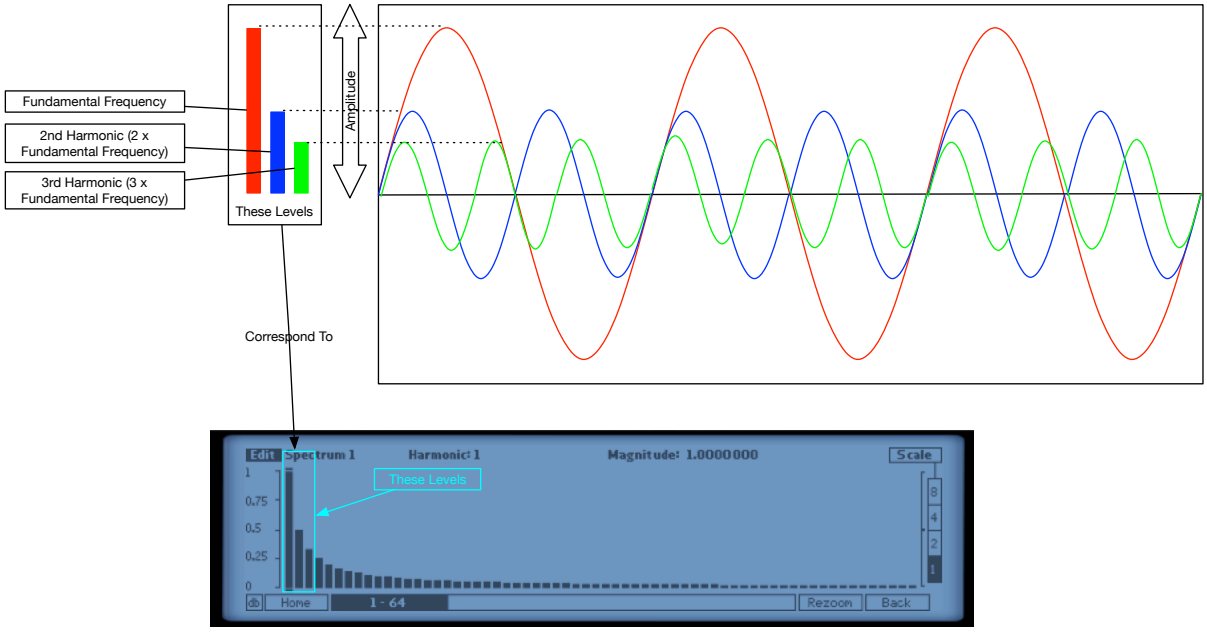


Figure 5 - Additive Synthesis - Combining Sine Waves in the Spectrum Editor

When creating sound with an additive synthesiser, each sine wave oscillator within the Generator used to contribute to the sound is called a **harmonic**. In periodic sounds these harmonics are related by their frequency using a simple formula discovered by French mathematician Jean-Baptiste Fourier and so additive synthesis is sometimes also referred to as "Fourier Synthesis". In additive synthesis the first harmonic or harmonic #1 is commonly referred to as the fundamental frequency and serves as the base frequency for all of the other harmonics. Harmonic #2 has a frequency 2 times the fundamental frequency while harmonic #3 has a frequency 3 times the fundamental frequency and so on. This pattern is commonly referred to as a "Fourier series" and in Spectra, you can have a Fourier series of up to 256 harmonics enabling you to craft almost any periodic waveform possible.

This screen shot of the Spectrum editor in Spectra shows a sawtooth waveform harmonic spectrum or Fourier series using all 256 harmonics.

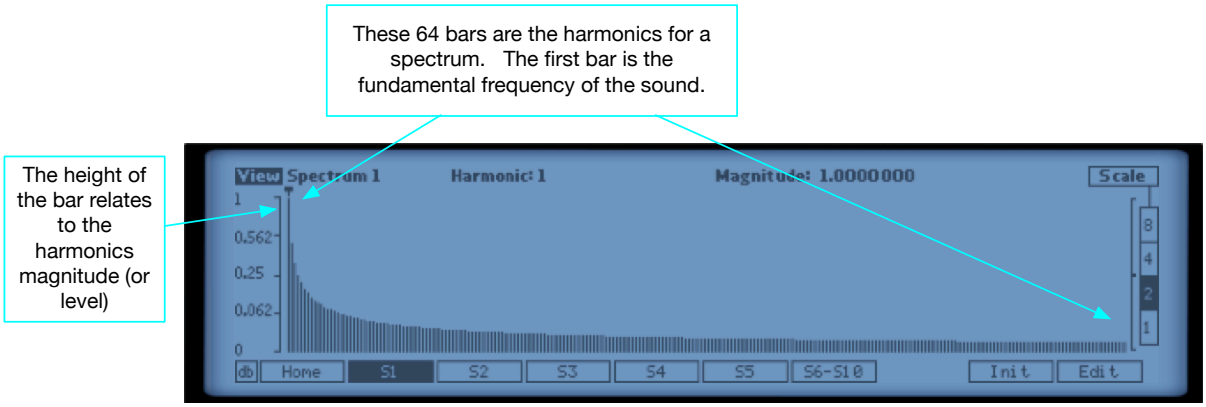


Figure 6 - Histogram of a spectrum containing 256 harmonics

If you want to create a sine waveform using Spectra you can do this by drawing a single harmonic with a Magnitude > 0.0 as shown below using the Spectrum Editor.

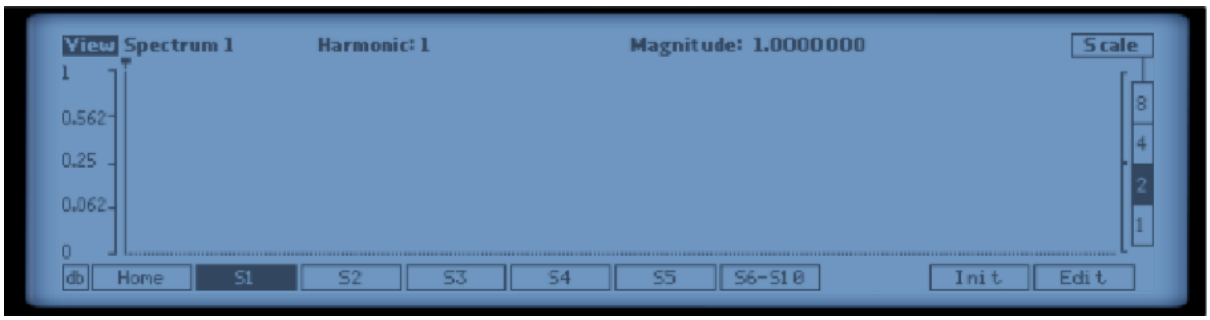


Figure 7 - A Sine wave Spectrum

Note that the magnitude directly effects amplitude. Magnitude and level are sometimes used interchangeably in this manual. Magnitude and level are subtly different. If you want more information about this difference you can do this by searching for "FFT Power Spectrum" using a search engine of your choice.

A Sawtooth wave is constructed in a similar manner though sawtooth waves have more harmonics. Interestingly the Harmonic Spectrum for a Sawtooth follows an additional pattern to the existing Fourier series. Where the Fourier series pattern is frequency based, the magnitude of each harmonic follows a pattern of being calculated as 1.0 *

(1.0/Harmonic Number). The following screen shot shows the magnitude harmonic Spectrum of a sawtooth wave with this pattern clearly visible.

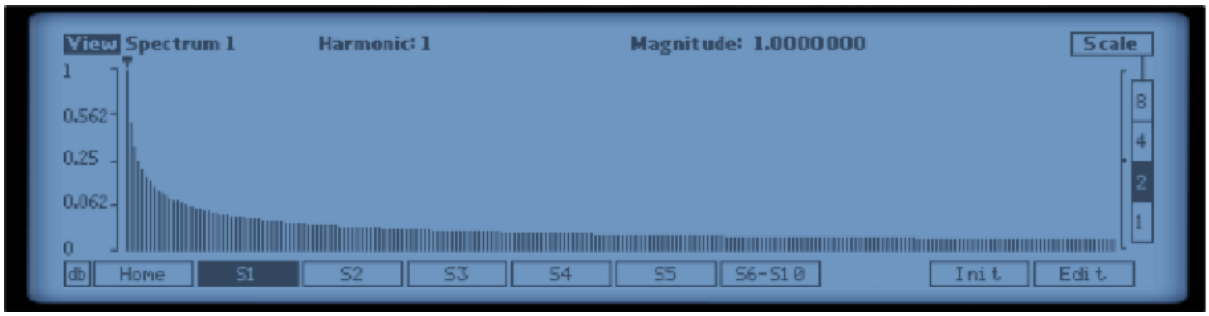


Figure 8 - Spectrum of a Sawtooth wave.

Spectra contains in built definitions for all of the basic/common waveforms. The following screenshot represents the spectrum of a square wave. Notice its values are identical to the sawtooth wave, however a square wave contains no even numbered harmonics.

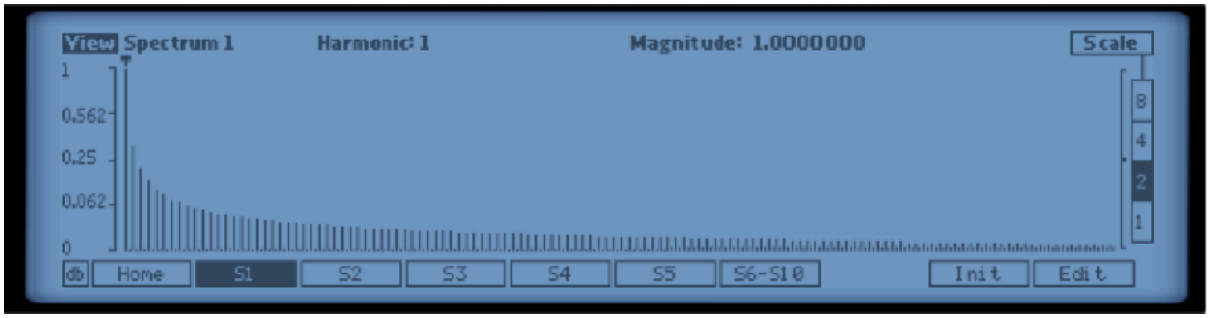


Figure 9 - Spectrum of a Square wave.

Finally, this is what the spectrum of a triangle wave looks like. Like a square wave a triangle wave has no even harmonics.

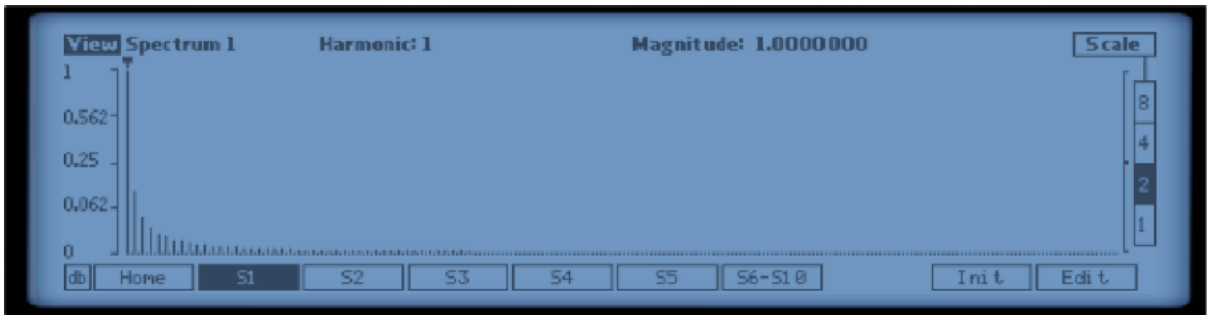


Figure 10 - Spectrum of a Triangle wave.

You can view the spectrum of any internal spectrum by using the analyser and selecting the appropriate internal generator as the analysis source

What is so exciting about additive synthesis is it can reproduce **any** waveform shape simply by adding sine waves together. Spectra can reproduce any periodic waveform and things get even more exciting because Spectra can also analyse sounds to identify its harmonic signature or the formula for creating the sound. Spectra can perform both of these functions and this means Spectra can produce and/or reproduce any periodic sound timbre within the constraints of 256 harmonics.

About Spectral Analysis

In order to re-synthesise a sound, you must have the capability to analyse the sound in order to determine its harmonic spectrum. Fourier Analysis is the opposite process to Fourier Synthesis. Where Fourier Synthesis combines sine waves into a harmonic spectrum to create a sound, Fourier Analysis breaks down a sound into its component sine harmonics or spectrum.

While the process of Fourier Analysis can be mathematically complex, Spectra makes Fourier Analysis easy. To analyse a sound you only need only to import a sample of the sound. Alternatively you can analyse sound internally from Spectra's synthesis engine or draw a waveform for analysis.

A Previous Version of Spectra in 2016 (Render by Nirude)

About Resynthesis

Resynthesis is the processes of analysis to obtain the harmonic spectrum of an audio source, and using the analysed harmonic spectrum within the synthesis process.

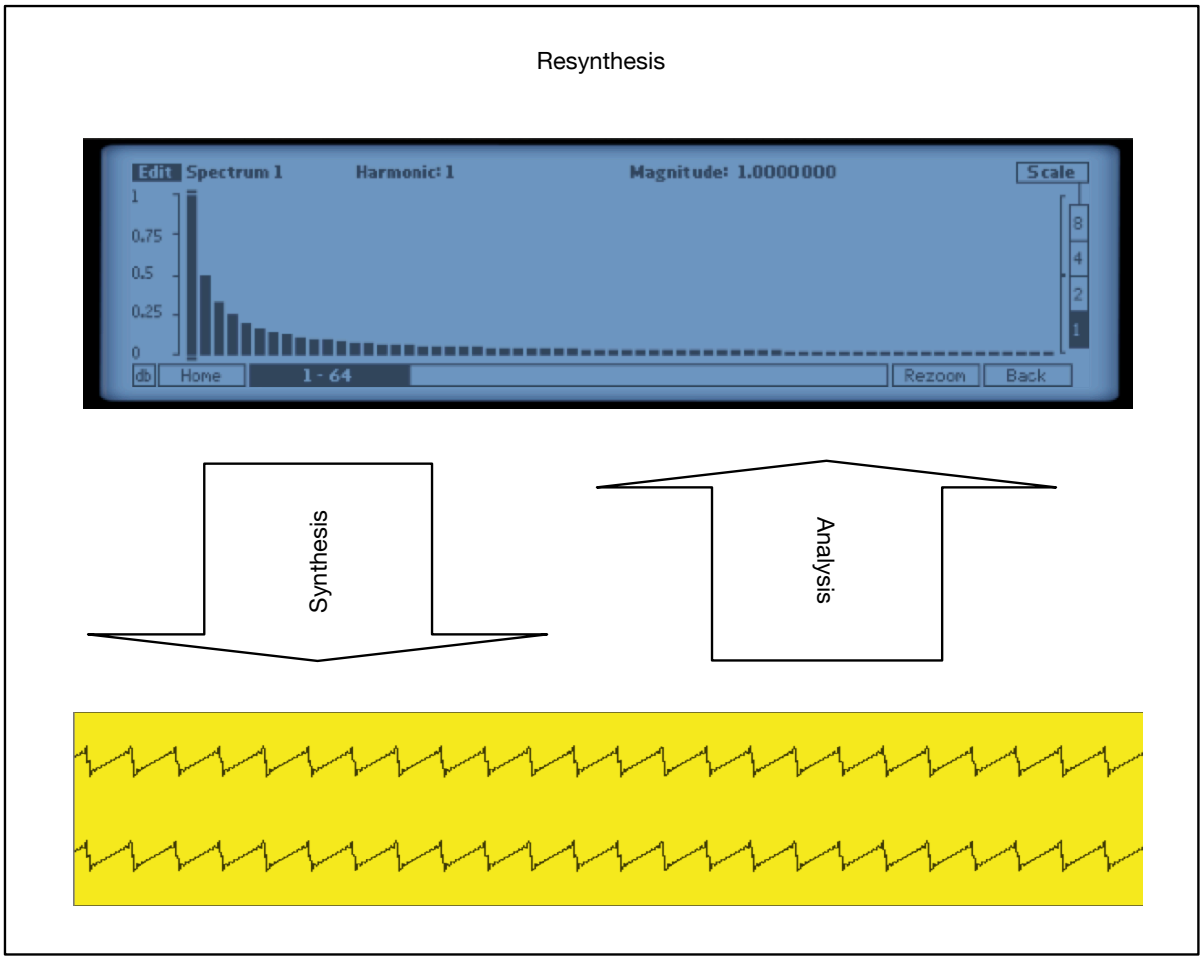


Figure 11 - Re-synthesis

A previous version of Spectra from 2016 (Renders by Nirude)

Parameter Reference

Performance Controls

Figure 12 - Performance Controls

Pitch bend Range Up

Range: (0 to 24 [Two Octaves])

This parameter enables you to specify the amount of pitch bend to apply when increasing pitch via the pitch bend wheel. Amounts can be specified in increments of a semitone with the minimum value of 0 applying no pitch bend while the maximum 24 parameter setting results in a 2 octave pitch bend.

Pitch bend Range Down

Range: (0 to 24 [Two Octaves])

This parameter enables you to specify the amount of pitch bend to apply when decreasing pitch via the pitch bend wheel. Amounts can be specified in increments of a semitone with the minimum value of 0 applying no pitch bend while the maximum 24 parameter setting results in a 2 octave pitch bend.

Pitch bend Wheel

Range: (-100% to +100% [Bipolar])

The pitch bend wheel is a modulator which enables you to raise or lower the pitch of Spectra's output during a performance. Moving the wheel up increases pitch relative to the Pitch bend Range Up setting while moving the wheel down decreases pitch relative to the Pitch bend Range Down setting.

Modulation (Mod) Wheel

Range: (0% to 100% [Unipolar])

The Modulation Wheel or "Mod Wheel" can be used to modulate any number of parameters by assigning it as a source for any destination in the mod matrix.

Keyboard Voices

Range: (2 - 12)

In poly mode, multiple notes can be played and mixed together. The maximum polyphony of Spectra is 12 notes. While the maximum polyphony is 12, the real maximum polyphony is determined by the specifications of your computer.

Keyboard Mode

Range: {Poly, Legato, Mono}

Spectra has 3 different keyboard modes which enable the player to vary how the synthesiser responds to playing.

Poly

In 'Poly' mode multiple notes can be played at any one time, with the maximum number of notes determined by the 'Voices' parameter. If you exceed the number of notes

specified in the Voices parameter the oldest note will be stolen in order to create the new note.

Legato

In 'Legato' Mode only one note can be played at any one time. If two notes are played then the note triggered last will 'steal' the note from the first played note and the amplitude envelope for the playing note will not be re-triggered.

Mono

In 'Mono' mode only one note can be played at any one time. If two notes are played then the note triggered last will 'steal' the note from the first played note. If the first played note is held down after the last note has stolen the note and then the second note is released, the first note will be re-triggered.

Portamento Time

Range: (0.0ms {OFF} - 6.00 seconds)

Portamento is the ability of a played notes pitch to glide to the pitch of a second played note. The Portamento Amount controls the amount of time it will take for the first note's pitch to complete its glide to the second.

Portamento Lag

Range: (-100 - 100%)

Portamento Time is applied separately to Gen1 and Gen2. This parameter enables you to lag the portamento amount of 1 of the generators behind the other. If the knob is turned to the left, Gen1's portamento time will lag Gen2 by the percentage indicated on the knob with Gen2's portamento time equaling the value specified in the Portamento Time parameter. Conversely if the knob is turned to the right, Gen2's portamento time will lag Gen1 per the amount specified on the dial. a 100% lag means that maximum portamento is applied. When the knob is perfectly centred at '0%' then both Generators will have an equal amount of portamento applied per the time specified in the Portamento Time parameter.

If the Portamento Time is set to a maximum of 3 seconds then Portamento Lag will have no effect.

The Modulation Matrix

Figure 13 - Modulation Matrix

The Modulation Matrix or Mod Matrix is a key element in creating sounds that 'move'. The Mod Matrix enables you to patch or route one of several Modulation Sources to one or more Modulation Destinations in a way reminiscent of the old patch cables on a modular system or patch bay. For example if you wanted to control the Filter Cut off/ Bias of Filter 1 with the output of LFO 1 you could simply create a Modulation Matrix patch by setting the Modulation Source in Slot 1 to "LFO 1" and the Modulation Destination to "FIL1 Bias" and then specifying a non-zero Modulation Amount. Effectively the Modulation Matrix enables you to turn knobs without using your hands.

Modulation Sources

Spectra has a number of Modulation Sources. The following table lists the Modulation Sources available.

No	Modulation Source	Polarity	No	Modulation Source	Polarity
1	Off	NA	14	Env 2	Unipolar
2	Mod Wheel	Unipolar	15	Random 1	Bipolar
3	Note	Bipolar	16	Random 2	Bipolar
4	Velocity	Unipolar	17	XY1 X	Unipolar
5	Aftertouch	Unipolar	18	XY1 Y	Unipolar
6	Breath	Unipolar	19	XY2 X	Unipolar
7	Expression	Unipolar	21	XY2 Y	Unipolar
8	Sustain	Unipolar	22	CV 1	Unipolar/Bipolar
9	Pitch Bend	Bipolar	23	CV 2	Unipolar/Bipolar
10	LFO 1	Bipolar	24	CV 3	Unipolar/Bipolar
11	LFO 2	Bipolar	25	CV 4	Unipolar/Bipolar
12	Amp Env	Unipolar	26	CV 5	Unipolar/Bipolar
13	Env 1	Unipolar	27	CV 6	Unipolar/Bipolar

Each modulation source has a polarity. Polarity is important because it effects how modulation of the destination is applied. The following diagram shows the difference between Unipolar sources and Bipolar sources.

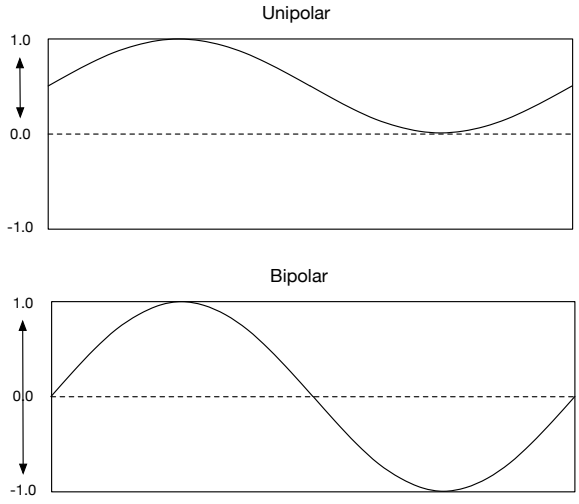
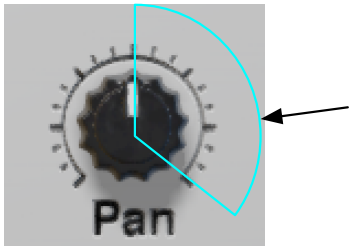


Figure 14 - Unipolar modulation sources vs Bipolar modulation sources

Notice that Unipolar sources modulate from 0 to 1.0 while Bipolar source can modulate from -1.0 to 1.0. This is important because in Spectra modulation begins from the current knob setting. The following diagrams show how Unipolar and Bipolar modulations are applied to a knob using both positive and negative amounts (See Modulation Amount).



Unipolar modulation using a positive modulation amount will modulate the destination starting from the current knob location to the maximum knob location scale by the modulation amount without ever going below the current knob setting

Figure 15 - Unipolar Modulation using a Positive Amount

Unipolar modulation using a negative modulation amount will modulate the destination from the current knob location to the minimum knob location scale by the modulation amount without ever going above the current knob setting

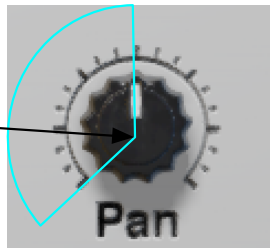
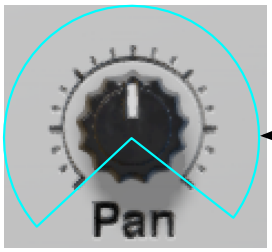


Figure 16 - Unipolar Modulation using a Negative Amount



Bipolar modulation using a positive modulation amount will modulate the destination from the current knob location to the maximum knob and then to the to the minimum knob setting scaled by the modulation amount

Figure 17 - Bipolar Modulation using a Positive Amount

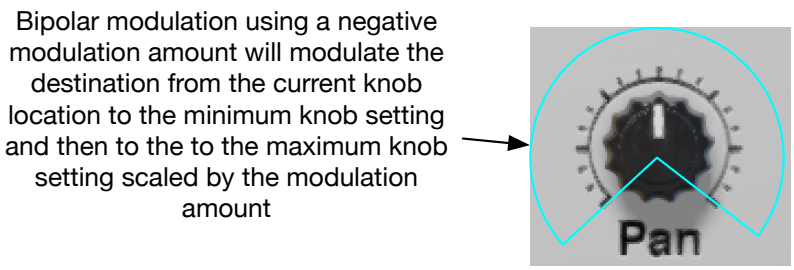


Figure 18 - Bipolar Modulation using a Negative Amount

Modulation Map

Each Modulation Slot has the option of assigning a Map to the Modulation Source. There are 5 User Definable Modulation Maps available which enable you to specify a transfer function for scaling a modulation source value.

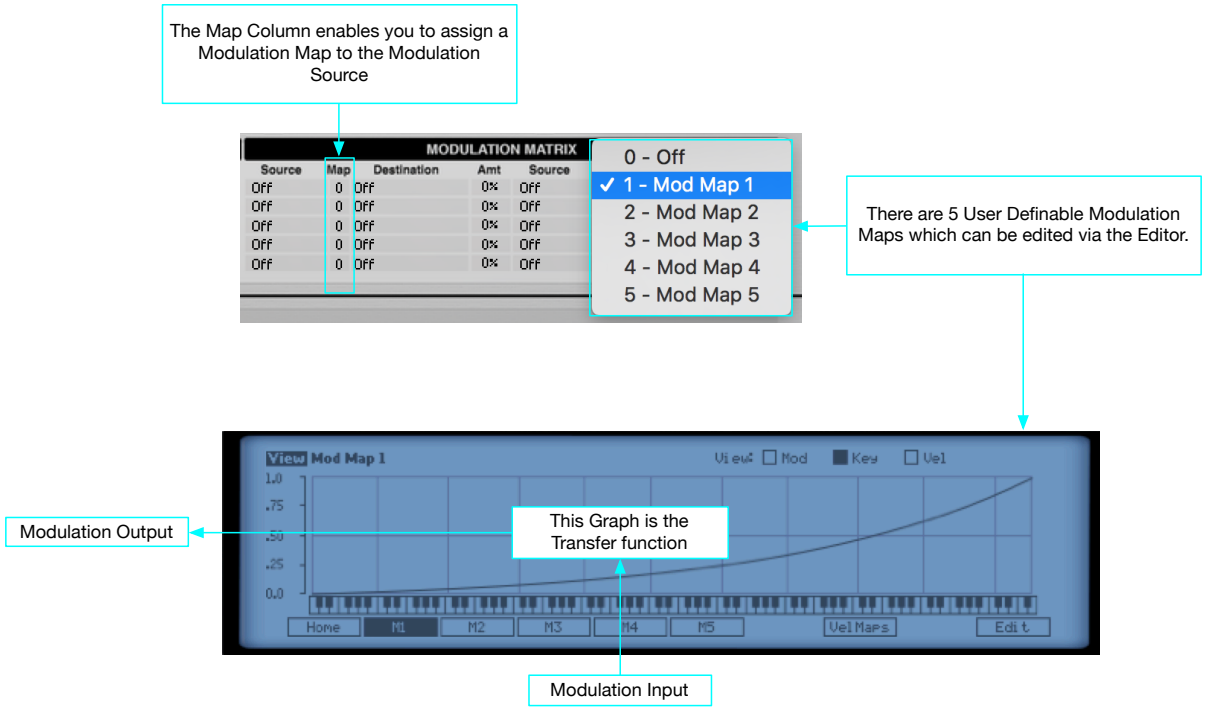


Figure 19 - Applying a Map to a Modulation Source

Modulation Destinations

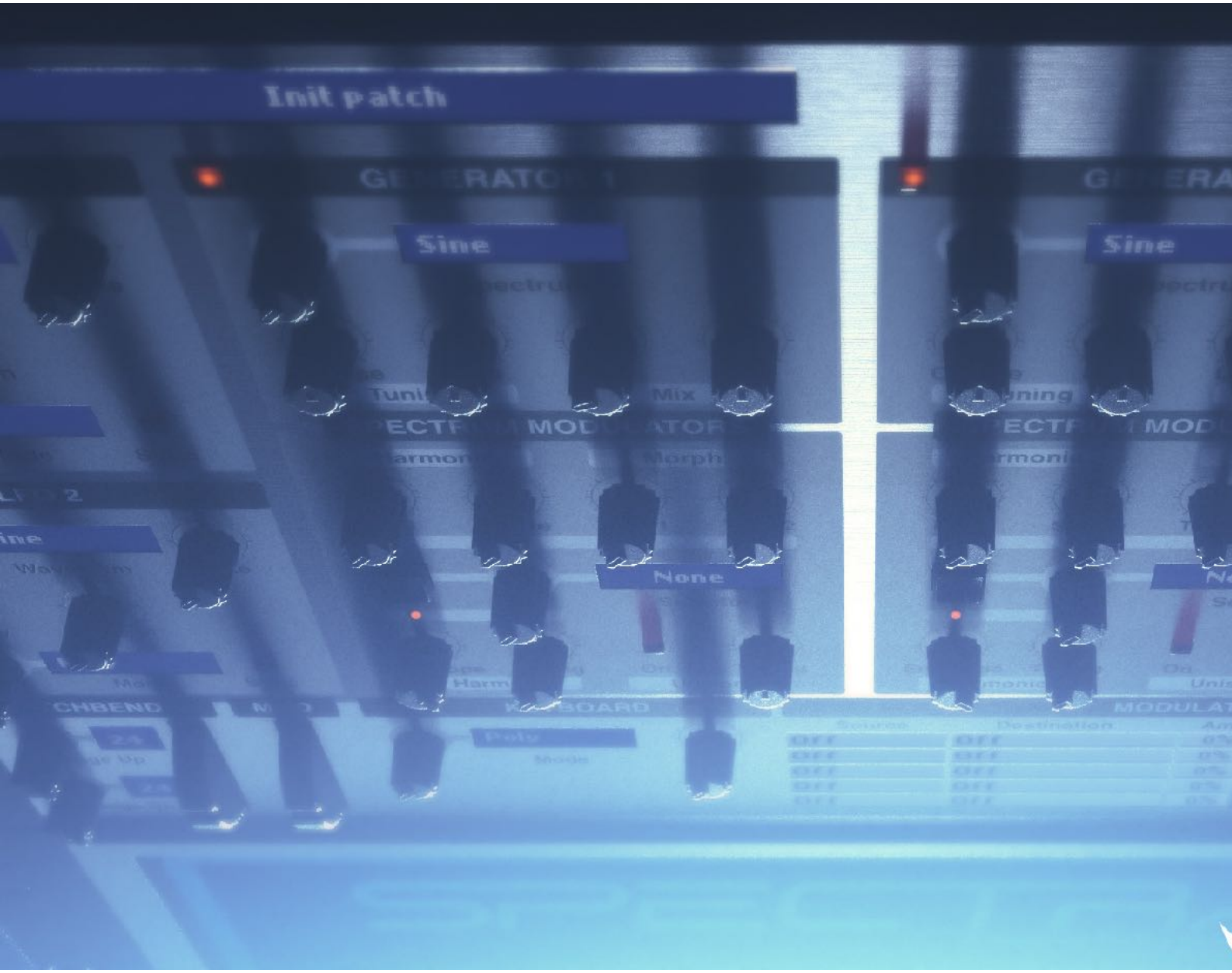
Spectra has a number of Modulation Destinations. The following table lists the Modulation Destinations available.

No	Destination	No	Destination	No	Destination
1	Off	23	Gen1 Tuning Crs	46	Gen2 Multi Amt
2	Amplitude	24	Gen1 Tuning Fn	47	Gen2 Single Amt
3	Gen1&2 Freq	25	Gen1 Level	48	Gen2 HEnv Amt
4	Gen1&2 Tun Crs	26	Gen1 Pan	49	Gen2 Synth Amt
5	Gen1&2 Tun Fn	27	Gen1 Ring	50	Gen2 Uni Tuning
6	Gen1&2 Level	28	Gen1 Harmonic	51	Gen2 Uni Spread
7	Port Time	29	Gen1 Morph1 Amt	52	Noise Level
8	LFO1 Rate	30	Gen1 Morph2 Amt	53	Noise Pan
9	LFO2 Rate	31	Gen1 Multi Amt	54	Spectral Seq1
10	AEnv Attack	32	Gen1 Single Amt	55	Spectral Seq2
11	AEnv Release	33	Gen1 HEnv Amt	56	Filter Seq1
12	Env1 Attack	34	Gen1 XSynth Amt	57	Filter Seq2
13	Env1 Release	35	Gen1 Uni Tuning	58	Mod 1 Amt
14	Env2 Attack	36	Gen1 Uni Spread	59	Mod 2 Amt
15	Env2 Release	37	Gen2 Frequency	60	Mod 3 Amt
16	Fil1 Frequency	38	Gen2 Tuning Crs	61	Mod 4 Amt
17	Fil1 Morph Amt	39	Gen2 Tuning Fn	62	Mod 5 Amt
18	Fil1 Env1 Amt	40	Gen2 Level	63	Mod 6 Amt
19	Fil2 Frequency	41	Gen2 Pan	64	Mod 7 Amt
20	Fil2 Morph Amt	42	Gen2 Phase	65	Mod 8 Amt
21	Fil2 Env2 Amt	43	Gen2 Harmonic	66	Mod 9 Amt
22	Gen1 Frequency	44	Gen2 Morph1 Amt	67	Mod 10 Amt
		45	Gen2 Morph2 Amt		

Modulation Amount

Range: (-100% - 100%)

The Modulation Amount provides a way to scale the modulation. At a value of 0 there is no modulation effect. A value of 100% or -100% is the maximum modulation. Negative modulation amounts are quite handy. For example you can use a negative modulation amount to invert an envelopes modulation of a generator output (amplitude).



A previous version of Spectra from 2016 (Render by Nirude)

Generators

Spectra has three Generators. The Generators are the principle source of sound synthesis in Spectra. Generator 1 and Generator 2 are spectral waveform generators. They produce periodic sounds or waveforms. Generator 3 is a spectral noise generator. It creates spectral white noise.

Figure 20 - Spectra's Generators

If you are familiar with subtractive synthesis Generators are similar to standard Oscillators except each Generator contains a bank of up to 256 sine wave oscillators defined by a spectrum which get added together resulting in a waveform shape. Each of the sine wave oscillators in the Generator effectively provide a harmonic tone or overtone relative to the base or fundamental frequency.

On/Off

Range: (ON, OFF)

This switch enables and disables output of the Generator. By turning the Generator 'Off' it should be noted that this effectively stops the generators from writing their output to the mixer, therefore turning a generator off will not improve performance. This is because each generators output is used within 1 or more features within the Spectrum Modulators section and other functions such as the Ring Modulator in Generator 1.

Spectrum

Range: (1 - 62 see the table below for Spectrum names)

The Spectrum Selector enables you to specify different Spectra in order to vary timbre. Spectra has 62 built in Spectra which provide a broad palette for sound creation. Spectra also has 10 User Spectra which can be re-synthesised from internal or external sources or drawn by hand using the Editor.

Users should note that a complete spectrum is made up of both the magnitudes and phases.

No	Name	No	Name	No	Name
1	Sine	22	FM Bass	43	Ring
2	Saw	23	Formant	44	Sinex
3	Square	24	Stineweg	45	Nylonic
4	Triangle	25	FM Piano	46	SciFi
5	Silence	26	Vox F	47	Nentindo
6	Organ 1	27	Arpic	48	Voltage
7	Organ 2	28	Symmetric	49	Shaped
8	Organ 3	29	4001	50	Clavinet
9	Spectrum 1	30	Warm Saw	51	Pulse 1
10	Spectrum 2	31	Granular	52	Pulse 2
11	Spectrum 3	32	Granular	53	Pulse 3
12	Spectrum 4	33	Aaaaah	54	Pulse 4

13	Spectrum 5		34	Jazz		55	Pulse 5
14	Spectrum 6		35	Tines		56	Pulse 6
15	Spectrum 7		36	Bello		57	Gap Saw 1
16	Spectrum 8		37	Systolic		58	Gap Saw 2
17	Spectrum 9		38	Pulse		59	Gap Saw 3
18	Spectrum 10		39	Overtone1		60	Gap Saw 4
19	Machine		40	Overtone2		61	Gap Saw 5
20	Vox M		41	Overtone3		62	Gap Saw 6
21	New Age		42	Bright			

Ring (Generator 1 Only)

Range: (0% to 100%)

The Ring Modulator takes the output of signal of Generator 2 and multiplies it by the output of Generator 1. This effectively creates a new output for Generator 1 which contains the sums and differences of all of the frequencies from Generator1 and Generator2. The Ring Modulator value controls the depth or amount of the Ring Modulated signal mixed back into Generator 1. At 100% the resulting signal is all Ring Modulated single. At 50% the signal is half Generator 1 and half Ring Modulated signal.

Phase (Generator 2 Only)

Range (-100% [-90 degrees] to + 100% [+90 degrees])

The phase parameter (available for Generator 2 only) enables you to alter the starting phase of all of the harmonics by up to +- 90 degrees. This can be helpful if you want to soften a sound where Generator 1 and Generator 2 are using the same spectrum. Introducing a phase offset will 'soften' the sound and reduce the overall sound by up to 3db. At -100% the phase of all of the harmonics in Generator 2 are altered to -90 degrees of their original value. At 100% the phase of all of the harmonics in Generator 2 are alter to +90 degrees of their original value.

Key (Tracking)

Range: (0% to 100%)

The Key Tracking parameter in the Generator section is a scaler of how much the midi note impacts the Generator's output pitch. At 100% key tracking notes are scaled to the keyboard input and therefore all unmodulated and played notes will be output per their normal keyboard pitch. At 50% the pitch is scaled such that each semitone note on the

keyboard will be output as a quarter tone. At 0% scaling all of the keys will have the same pitch (as note 64).

Tuning – Coarse

Range: (-24 semitones to +24 semitones)

The Coarse Tuning knob enables the altering of the tuning of the Generator by +- 2 octaves in increments of a semitone.

Tuning – Fine

Range: (-50 cents to +50 cents)

The Fine Tuning knob enables the altering of the tuning of the Generator by +- quarter-tone in increments of cents. A cent is 1/100th of a semitone.

Mix – Level

Range: (-inf db to 0.0 db)

The Level knob controls the output level of the Generators output. It should be noted individual harmonic amplitudes can be altered in the Spectrum Editor.

Mix – Pan

Range: (-100% to 100%)

The Pan knob alters the placement of the Generator's output within the stereo field. The Default setting of 0 results in the Generators output being centred within the stereo field. A Setting of -100% results in the Generators output being completely left within the stereo field while a setting of +100% results in the Generators output being completely right.
Spectral Modulators and Morphing

Noise Generator

Spectra has a spectral noise generator which synthesises white noise.

Figure 21 - The Spectral Noise Generator

Noise On/Off

Range: (ON, OFF)

This switch enables and disables output of the Noise generator. By turning the Generator 'Off' it should be noted that turning off the noise generator can aid performance.

Mix – Level

Range: (-inf db to 0.0 db)

The Level knob controls the output level of the Noise generators output.

Mix – Pan

Range: (-100% to 100%)

The Pan knob alters the placement of the Noise generator's output within the stereo field. The Default setting of 0 results in the output being centred within the stereo field. A Setting of -100% results in the output being completely left within the stereo field while a setting of +100% results in the Generators output being completely right.

An earlier version of Spectra in 2016 (Render by Nirude)

Spectrum Modulators

Figure 22 - Spectrum Modulators

This section of Spectra really separates it as distinctly additive. Apart from this section of the user interface the user could be forgiven for thinking Spectra was a subtractive synthesiser. Because Spectra operates at the fundamental level of sound creation it is very easy for it to enable fairly dramatic modulations of waveform harmonics. That is what this section is about. Modulating the harmonic spectrum of the Generator in real time.

Each Generator has its own set of Spectrum Modulators which enable you to modulate multiple harmonics from pre developed spectra or user developed spectra. You can also modulate a single harmonic and morph between multiple spectra. The morphing capability in Spectra sometimes sounds like a simple crossfade, however this is not the

case. The morphing feature is a true spectral morph of the source spectrum with the target. Spectra can morph the Generators Spectrum with up to two morph targets meaning you have a significant amount of control around shaping the timbre of sound. The following diagram provides a high level of the Spectrum Modulator controls and how they are applied.

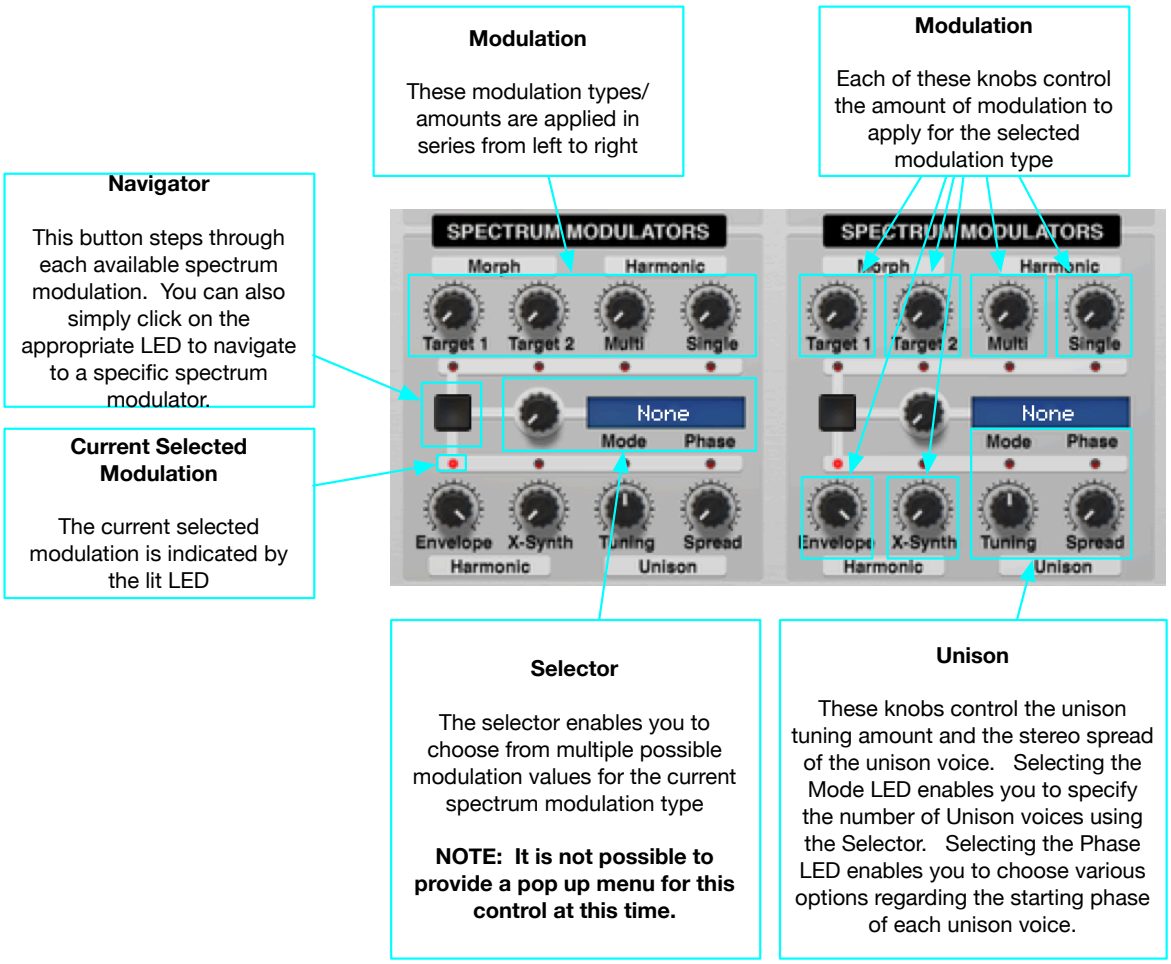


Figure 23 - Spectrum Modulators explained

Navigator and Selector

The navigation button enable you to select a Modulation Type for editing. Pressing this button will toggle through all of the Modulation Types in order. The selected Modulation Type is indicated by the lit LED.

You can navigate directly to each modulation type by clicking on its corresponding LED.

Once you have navigated to the Modulation Type destination, you can then set the value of the Modulation Type using the Modulation Type Parameter. Once the Modulation Type is chosen you can apply the Modulation Type by turning the appropriate Amount knob. For example, if you have navigated to the "Harmonic Multi" Modulation Type and selected "Octave" as the Modulation Type you can then apply that modulation type by turning the "Harmonic – Multi" Amount knob.

The Modulation Amount knobs can be used even if its Modulation Type is not selected.

Target 1 and Target 2 (Morphing Two Spectra)

Selector Range: (1 - 64/62 see the table below for Morph Target names)

Amount Range: (0 - 100%)

This modulation type enables you to morph between two spectra. Spectra enables two morph targets for each Generator. You can select the Morph Target using the selector while the Amount knob controls the amount of morph to apply. The following table

No	Name	No	Name	No	Name
1	Sine	22	FM Bass	44	Sinex
2	Saw	23	Formant	45	Nylonic
3	Square	24	Stineweg	46	SciFi
4	Triangle	25	FM Piano	47	Nentindo
5	Silence	26	Vox F	48	Voltage
6	Organ 1	27	Arpic	49	Shaped
7	Organ 2	28	Symmetric	50	Clavinet
8	Organ 3	29	4001	51	Pulse 1
9	Spectrum 1	30	Warm Saw	52	Pulse 2
10	Spectrum 2	31	Granular	53	Pulse 3
11	Spectrum 3	32	Granular	54	Pulse 4
12	Spectrum 4	33	Aaaaah	55	Pulse 5

13	Spectrum 5		34	Jazz		56	Pulse 6
14	Spectrum 6		35	Tines		57	Gap Saw 1
15	Spectrum 7		36	Bello		58	Gap Saw 2
16	Spectrum 8		37	Systolic		59	Gap Saw 3
17	Spectrum 9		38	Pulse		60	Gap Saw 4
18	Spectrum 10		39	Overtone1		61	Gap Saw 5
19	Machine		40	Overtone2		62	Gap Saw 6
20	Vox M		41	Overtone3		63	SSeq 1
21	New Age		42	Bright		64	SSeq 2
			43	Ring		**Target 1 Only**	

The two morph targets operate in series so the output of Morph Target 1 is fed into the input of Morph Target 2. This means if you have Target 2 at 100% you won't hear any of the Generators Spectrum or any of Target 1's spectrum.

Morph Target 1 has two additional available morph targets. These are SSeq 1 and SSeq 2.

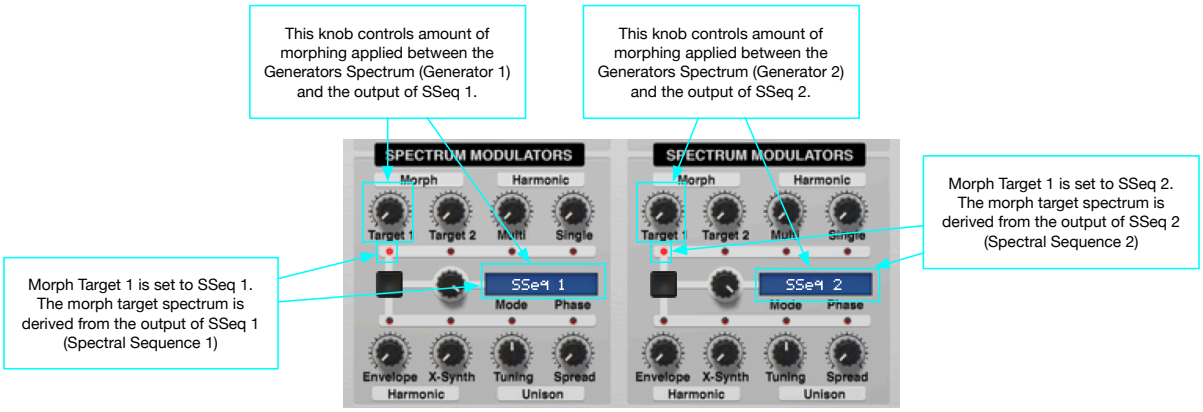


Figure 24 - Specifying a Morph Sequence Target

When you select these values as the morph target the value of the target is derived from the specified Morph Sequence. Morph Sequences can be edited via the Editor. (see Sequences in the Editor Section).

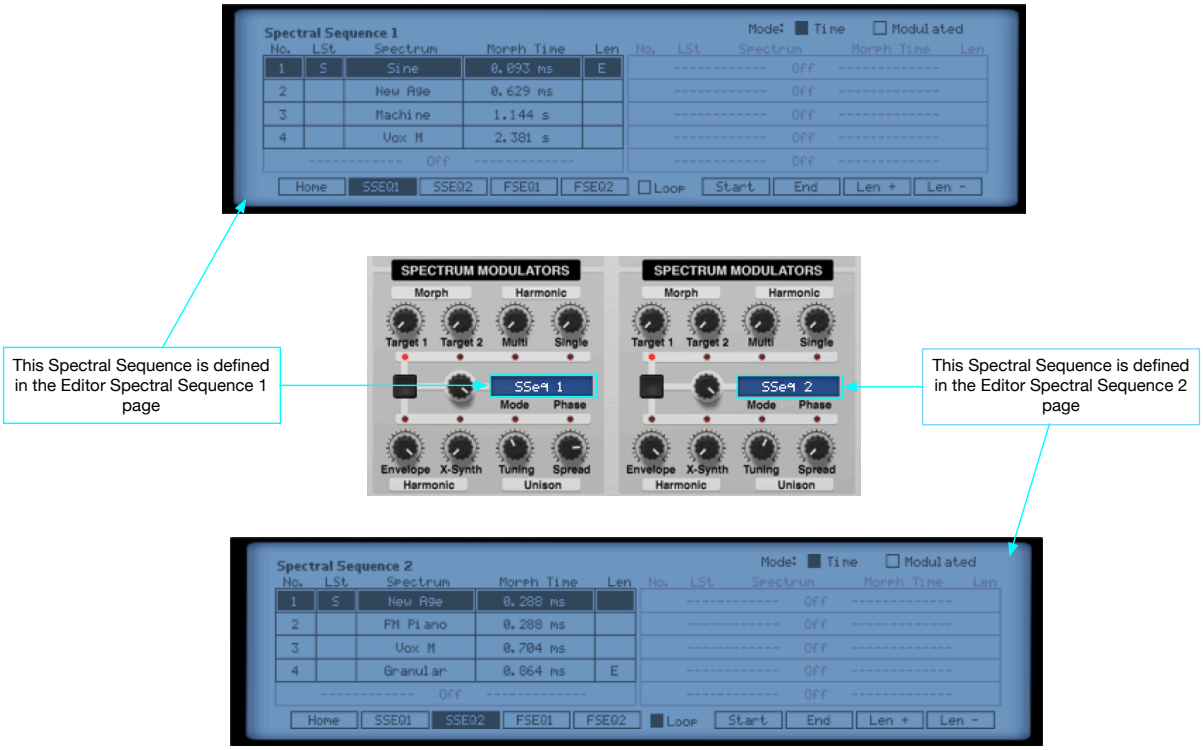


Figure 25 - Spectral Sequences used as a Morph Target

Multi (Modulating Multiple Harmonics)

Selector Range: (1 - 34 see the table below for Morph Target names)

Amount Range: (0 - 100%)

This modulation type enables you to alter multiple harmonics within the Generators spectrum using a single knob . The available spectra for this modulation type are described in the following table

You can program a Custom Spectrum or "Multi" to define your own multiple harmonic modulation spectrum.

No	Multi	Description
1	+All	Increases all of the Harmonics. The Harmonics are increased per a Sawtooth spectrum. If you apply this multi to a Sine Spectrum you will have a Sawtooth Spectrum when the Multi Amount knob is at 100%
2	-All	Decreases all of the Harmonics. At 100% only the Fundamental will remain. This will transition any spectrum to a Sine spectrum.
3	+Even	Increases all of the Even Harmonics. The Even Harmonics are increased per a Sawtooth spectrum.
4	-Even	Decreases all of the Even Harmonics. At 100% only the Fundamental and odd Harmonics will remain.
5	+Odd	Increases all of the Odd Harmonics. The Harmonics are increased per a Square spectrum.
6	-Odd	Decreases all of the Odd Harmonics. At 100% only the Fundamental and even Harmonics will remain.
7	+Low	Increases the volume of Harmonics 2 through 8. The Harmonics are increased per a Sawtooth spectrum.
8	-Low	Decreases the volume of Harmonics 2 through 8. At 100% Harmonics 2 through 8 will be silent.
9	+Mid	Increases the volume of Harmonics 9 through 32. The Harmonics are increased per a Sawtooth spectrum.
10	-Mid	Decreases the volume of Harmonics 9 through 32. At 100% Harmonics 9 through 32 will be silent.
11	+High	Increases the volume of Harmonics 33 through 64. The Harmonics are increased per a Sawtooth spectrum.
12	-High	Decreases the volume of Harmonics 33 through 64. At 100% Harmonics 33 through 64 will be silent.
13	Harm204+	Increases the volume of Harmonics 9 through 32. The Harmonics are increased per a Sawtooth spectrum.
14	Formant1	This multi increases and decreases Harmonics 2 through 64 in order to create a formant shaped spectrum.
15	Formant2	This multi increases and decreases Harmonics 2 through 64 in order to create a formant shaped spectrum.
16	Formant3	This multi increases and decreases Harmonics 2 through 64 in order to create a formant shaped spectrum.
17	+Peak H8	Increases Harmonics 2 through 64 around a 50% peak at Harmonic 8
18	-Peak H8	Decreases Harmonics 2 through 64 around a 50% cut at Harmonic 8
19	+Peak H16	Increases Harmonics 2 through 72 around a 50% peak at Harmonic 16

20	-Peak H16	Decreases Harmonics 2 through 72 around a 50% cut at Harmonic 16
21	+Peak H32	Increases Harmonics 2 through 88 around a 50% peak at Harmonic 32
22	-Peak H32	Decreases Harmonics 2 through 88 around a 50% cut at Harmonic 32
23	+Peak H64	Increases Harmonics 2 through 100 around a 50% peak at Harmonic 64
24	-Peak H64	Decreases Harmonics 2 through 100 around a 50% cut at Harmonic 64
25	+Octaves	Increases Octave Harmonics relative to the fundamental. Harmonics 2,4,8,16,32,64,128, 256. This Multi can be useful for creating Organ like sounds or adding an organ like quality to the sound.
26	-Octaves	Decreases Octave Harmonics relative to the fundamental. Harmonics 2,4,8,16,32,64,128, 256
27	+Fifths	Increases Fifth Harmonics relative to the fundamental. Harmonics 3,6,12,24,48,96,192. This Multi can be useful for creating Organ like sounds or adding an organ like quality to the sound.
28	-Fifths	Decreases Fifth Harmonics relative to the fundamental. Harmonics 3,6,12,24,48,96,192. This Multi can be useful for creating Organ like sounds or adding an organ like quality to the sound.
29	+Oct&Fif	Increases Octave and Fifth Harmonics relative to the fundamental. Harmonics 2,3,4,6,8,12,16,24,32,48,64,96,128,192,256. This Multi can be useful for creating Organ like sounds or adding an organ like quality to the sound.
30	-Oct&Fif	Decreases Octave and Fifth Harmonics relative to the fundamental. Harmonics 2,3,4,6,8,12,16,24,32,48,64,96,128,192,256
31	Multi 1	This is a user definable multi.
32	Multi 2	This is a user definable multi.
33	Multi 3	This is a user definable multi.
34	Multi 4	This is a user definable multi.

Single (Modulating a Single Harmonic)

Selector Range: (Harmonic 1 through Harmonic 64)

Amount Range: (0 - 100%)

This modulation type enable you to alter a single harmonic within the Generators spectrum.

You can also modulate which single harmonic is being modulated using the GEN1 Harmonic or GEN2 Harmonic Modulation Destination

Harmonic Envelope

Selector Range: (Off, HEnv1, HEnv2)

Amount Range: (1 - 15)

This Harmonic Envelope knob assigns a Harmonic Envelope to the Generator. This enables you to apply one of two Harmonic Envelopes to the Generators spectrum during sound generation. This is similar to applying an amplitude envelope to a sound but in the case of the Harmonic Envelope you are applying 256 amplitude envelopes, one to each sine wave harmonic.

The Range determines which harmonics will be modulated by the selected Harmonic Envelope.

Value	Description
1 - 256	The harmonic envelope is applied to all of the harmonics
1 - 128	The harmonic envelope is applied to harmonics 1 to 128 without effect to the other harmonics
1 - 64	The harmonic envelope is applied to harmonics 1 to 64 without effect to the other harmonics
1 - 32	The harmonic envelope is applied to harmonics 1 to 32 without effect to the other harmonics
1 - 16	The harmonic envelope is applied to harmonics 1 to 16 without effect to the other harmonics
16 - 256	The harmonic envelope is applied to harmonics 16 to 256 without effect to the other harmonics
16 - 128	The harmonic envelope is applied to harmonics 16 to 128 without effect to the other harmonics
16 - 64	The harmonic envelope is applied to harmonics 16 to 64 without effect to the other harmonics
16 - 32	The harmonic envelope is applied to harmonics 16 to 32 without effect to the other harmonics

32 - 256	The harmonic envelope is applied to harmonics 32 to 256 without effect to the other harmonics
32 - 128	The harmonic envelope is applied to harmonics 32 to 128 without effect to the other harmonics
32 - 64	The harmonic envelope is applied to harmonics 32 to 64 without effect to the other harmonics
64 - 256	The harmonic envelope is applied to harmonics 64 to 256 without effect to the other harmonics
64 - 128	The harmonic envelope is applied to harmonics 64 to 128 without effect to the other harmonics
128 - 256	The harmonic envelope is applied to harmonics 128 to 256 without effect to the other harmonics

X-Synthesis

Selector Range: (Normal, Extend, Ignore)

Amount Range: (0 - 100%)

Spectra can cross synthesise the output of Generator 1's Spectrum Mods with Generator 2's Spectrum and then Generator 2's Single Harmonic and/or Morph Targets. The X Synth function effectively applies the Envelope of Generator 1's Spectrum Mod's output to the harmonics of Generator 2's spectrum. The following diagram depicts what occurs as a result of the X-Synth function using 'Normal' mode.

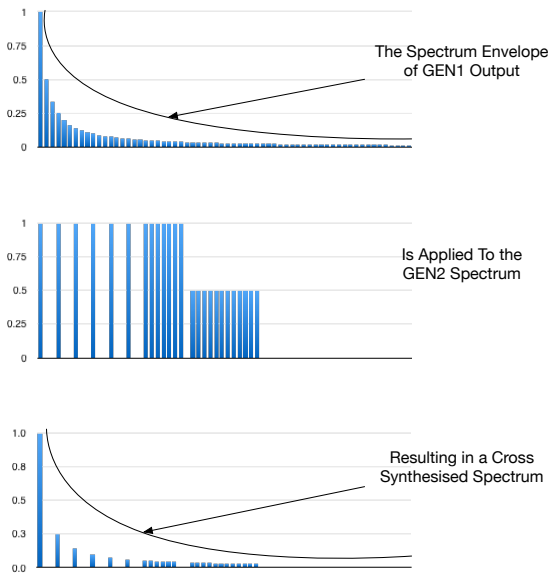


Figure 26 - X Synthesising a Spectrum

Unison Mode Selector

Range: (Off, Unison 2, Unison 4, Unison 6)

Unison is when at least two sounds share the same pitch and articulation or 'move as one'. The Unison mode selector turns unison on and off and enables you to select how many unison voices will play. When 'Off' is selected only 1 voice plays out of the Generator. With "Unison 2", 2 voices play and so on.

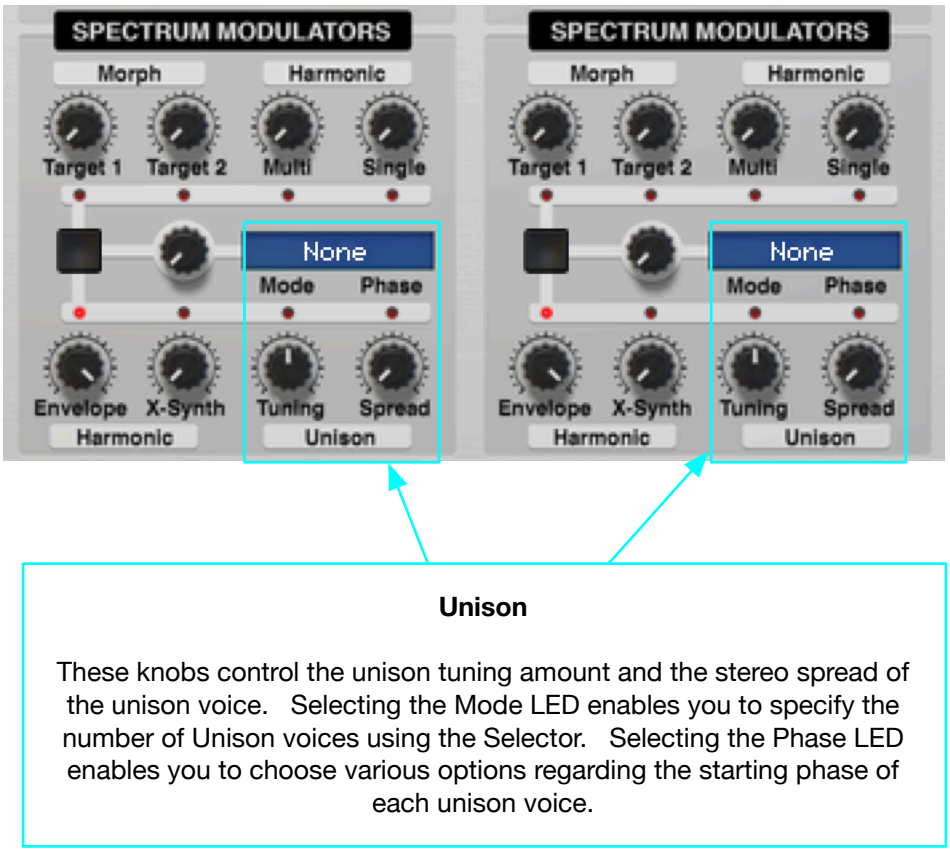


Figure 27 - Unison Modulators

Unison Tuning

Range: (-100% - +100% cents)

The Unison Tuning knob enables you to detune the unison Generators in each voice.

Unison Phase

Range: (Locked, Spread)

This setting enables you to specify the start phases of Unison voices. 'Locked' phases provide a more 'Digital' and harder sound while 'Spread' phases ensure more of an analog style of sound.

Unison Spread

Range: (Locked, Spread)

Unison spread controls how wide the unison voices are panned relative to the Generator Pan knob. At 0% all unison voices will be panned at the location specified by the Generators Pan setting. At 100% the unison voices will be spread out across the stereo field.

A Previous Version of Spectra in 2016 (Render by Nirude)

Filters

Figure 28 - Filters

Spectra has two spectral filters. Each contain a number of built in filter types and 10 user definable filters. The User definable filters enable you to specify the filters impulse response by drawing it in the Editor or creating an impulse response using the Filter Designer. **(for more information on how to create a custom filter see the Filter section for the Editor)**.

This is an extremely powerful feature which effectively means that you can reproduce a significant number of types of filters within the constraints imposed by the Editor. For example you can create an absolute brick wall filter or a custom comb filter or an 18 db Low Pass filter simply by drawing its impulse response in the editor.

The Spectral Filters behave in a way similar to a graphic equaliser. Like a graphic equaliser the Spectral Filter is made up of 256 frequency bands which accentuate or attenuate bands of frequencies. The frequency range of each band corresponds with each note on a keyboard.

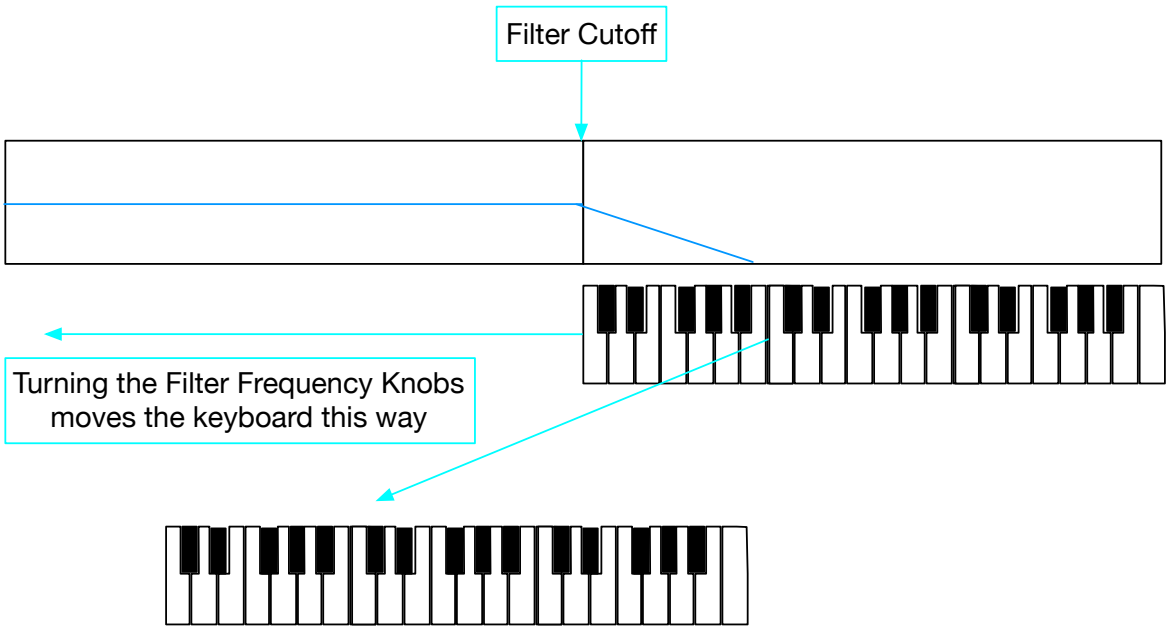


Figure 29 - How the Filter Bias works

Filter Frequency

Range: (13.75 Hz to 21.10 Khz)

The Filter Frequency knob enables you to rotate the spectral filter. Effectively this enables you to change the filter cutoff frequency exactly like a standard time-based filter.

Filter Type

Range: (1 - 28 see the table below for Filter Type names)

The Filter Type knob enables you to set the Filter Type to one of the built in or one of the 10 user definable spectral filters.

While an All Pass Filter has been included in the Filter Init Section of the Editor, it should be noted that this filter does not have any effect on the signal which passes through the filter. This particular filter was used during testing and may be helpful to users in future.

Filter Routing

Range: (Options of Generator 1, Generator 2, Noise)

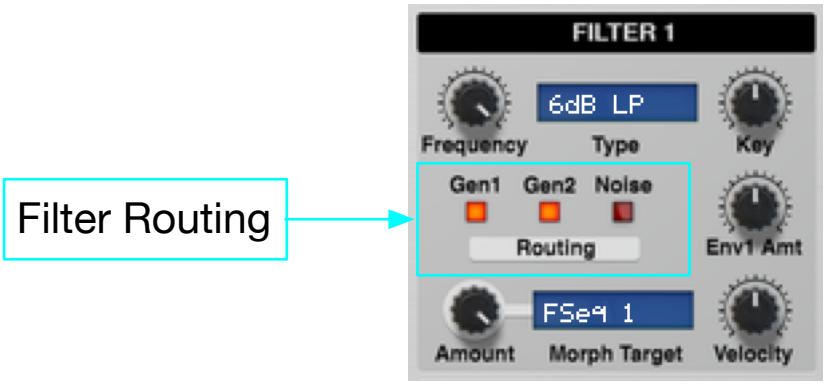


Figure 30 - Filter Routing Options

These buttons enable you to route any or all of the Generators through the Filter. Filter 2 is always applied in series to Filter 1 however you can route Generator 1 to Filter 1 and Generator 2 to Filter 2 in order to simulate a simplified parallel Filter Routing.

Morph Target

Range: (1 - 28 see the table below for Filter Type names)

The Morph Target enables you to specify a filter from one of the built in or one of the 10user definable spectral filters and to Morph the chosen filter with the Filter selected via the Filter Type Parameter.

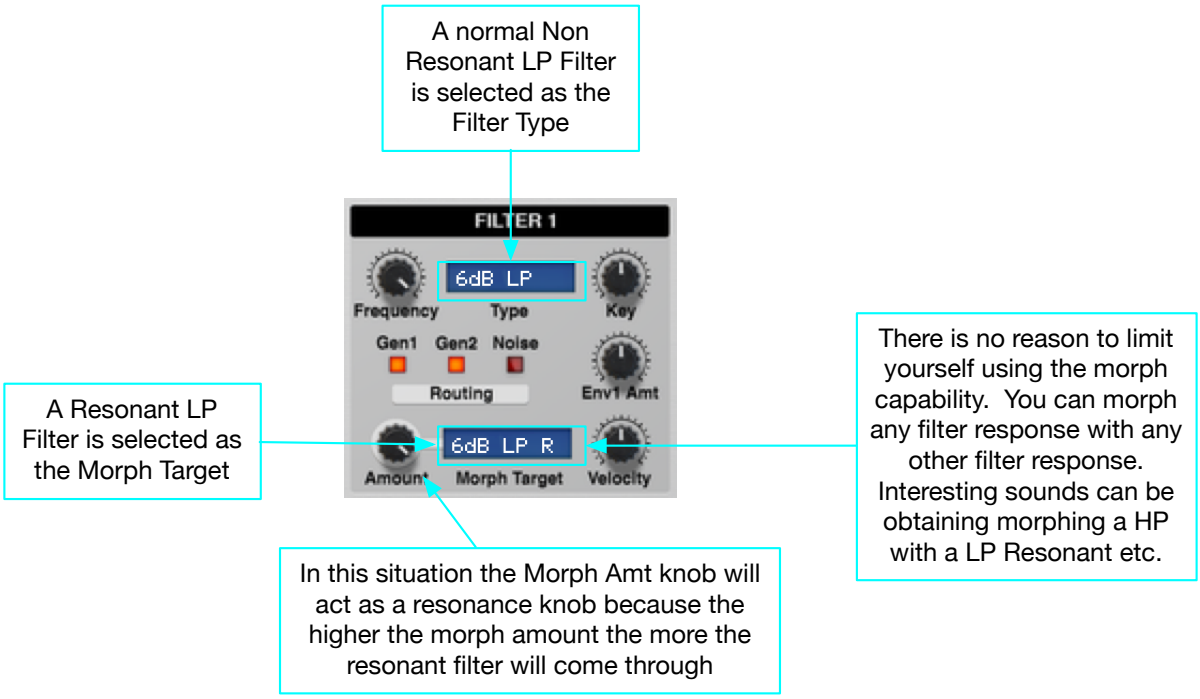


Figure 31 - Filter Morphing using the Filter Sequences (FSeq)

The Filters each have two special morph targets. These are FSeq 1 and FSeq 2. When you select these values as the morph target the value of the target is derived from the specified Filter Morph Sequence. Filter Morph Sequences can be defined and/or edited via the Editor. (see FSEQ in the Sequence/Editor Section).

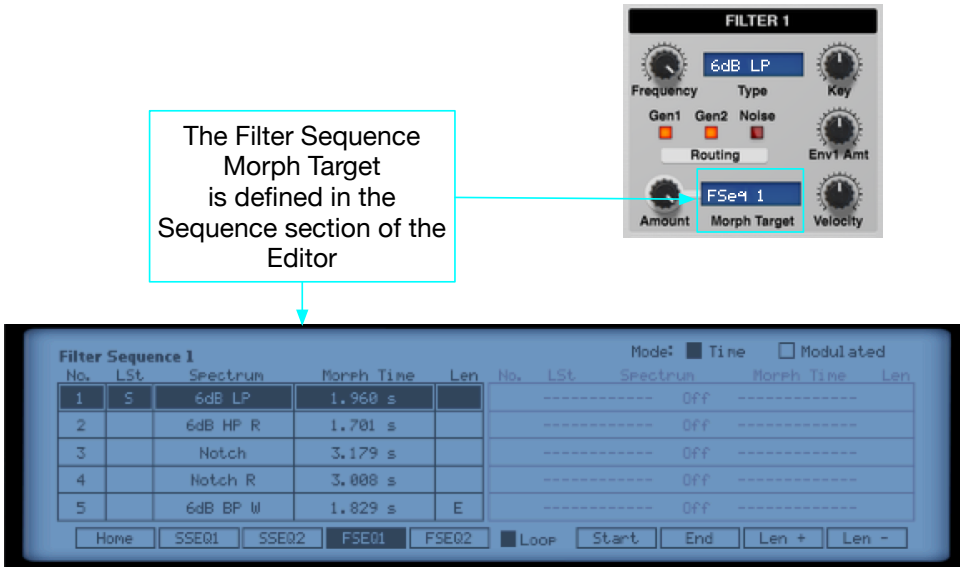


Figure 32 - Filter Morphing using the Filter Sequences (FSeq)

Morph Amount

Range: (0 - 100%)

This parameter controls the morph amount applied to the blending of the Filter specified in the Type parameter and the Filter specified as the Morph Target. It should be noted that this sounds very much like a linear crossfade of the two filters, but it is indeed truly morphed in the frequency domain.

Key (Tracking)

Range: (-200% - 200%)

Filter Key Tracking enables you to specify how the Filter tracks to keyboard input. If the Key Tracking value is 0% then the filter tracks to the frequency of the generator (note). At 100% key tracking the filter tracks 1 octave above the note and results in all notes having a the same harmonic content. At 200% notes get brighter as the notes increase in frequency.

Env# Amount

Range: (0 - 100%)

This parameter is a pre-configured modulation routing. Envelope 1 is pre-configured to modulate Filter 1's frequency. Envelope 2 is pre-configured to modulate Filter 2's frequency. This can certainly be over-ridden by maintaining a 0% value for the Env# Amount parameter and configuring an alternative modulation in the matrix if you desire.

This knob is effectively the modulation amount setting for the following modulation routing

Source	Map	Destination	Amount
Env 1	0 - None	Fil1 Frequency	The value of this knob

Velocity

Range: (-100% - 100%)

This parameter is also a preconfigured modulation routing. The Velocity value here is modulating the Env# Amount parameter within the same filter. It should be noted that the Velocity amount is ADDED to the Env# Amount. This should be taken into account if unexpected results are experienced.

This knob is effectively the modulation amount setting for the following modulation routing

Source	Map	Destination	Amount
Velocity	VelMap 1	Fil# Env# Amt	The value of this knob

Note there is a Velocity Map available which enables you to scale the Velocity Modulation source value. This map can be edited via the Editor. From the Editor 'Home' page navigate to 'Maps' then 'VelMaps' and then select 'Vel F1'. This will display the Velocity map for Filter 1.

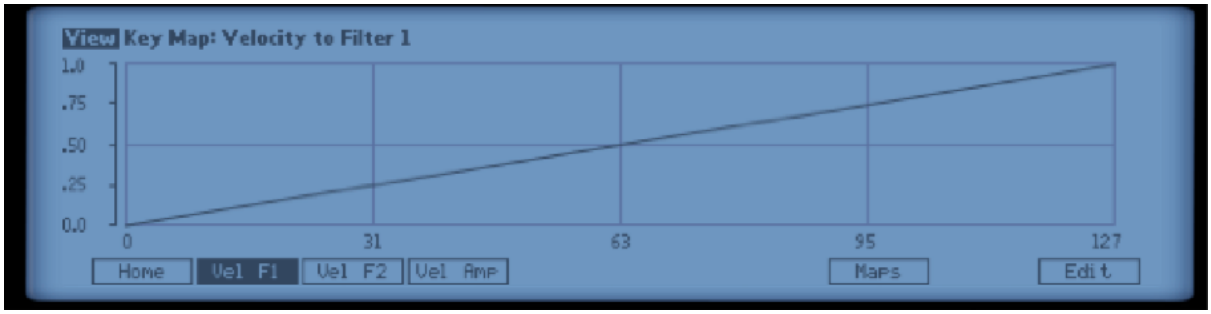


Figure 33- Velocity Map for Filter 1 Velocity to Env1 Amount

A previous version of Spectra from 2016 (Render by Nirude)

LFOs

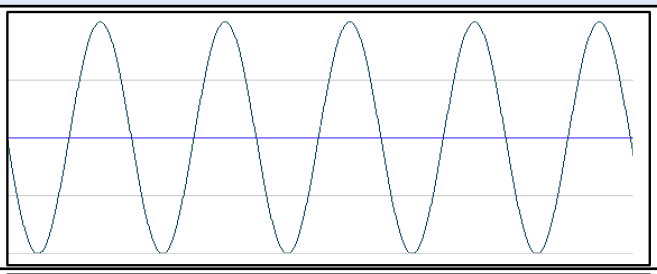
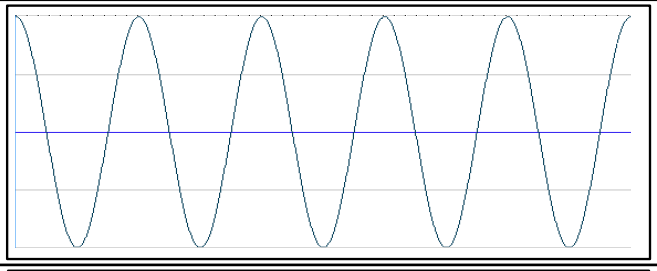
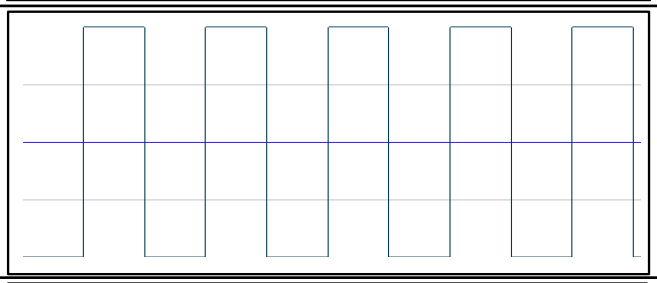
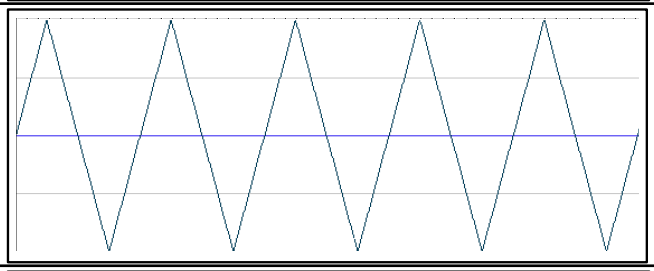
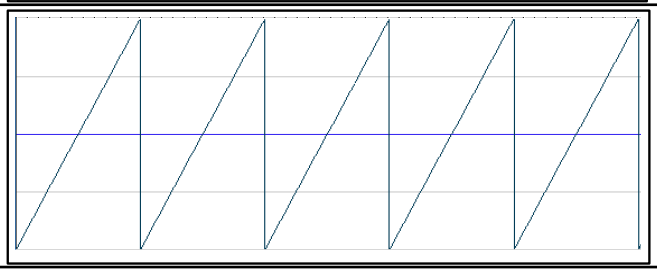
Figure 34 - LFOs

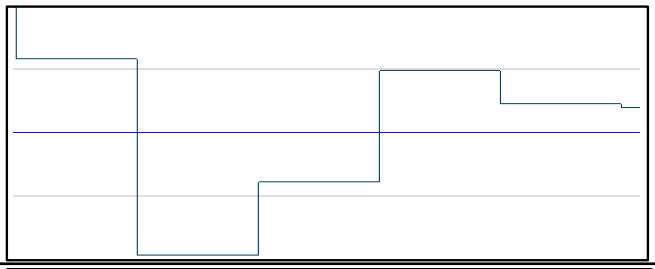
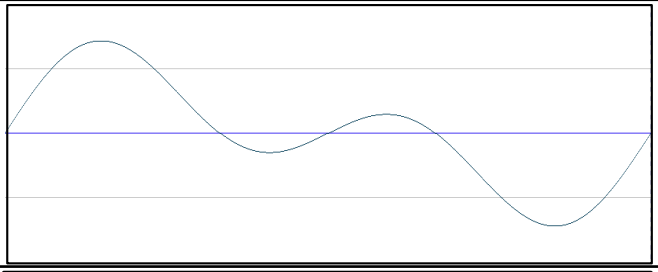
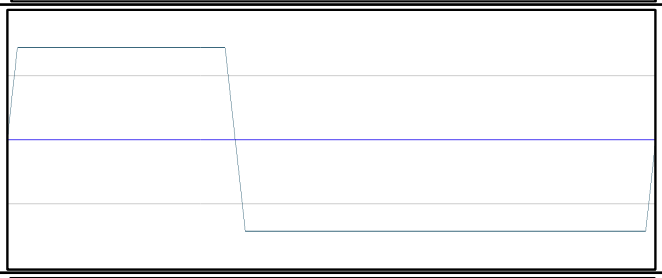
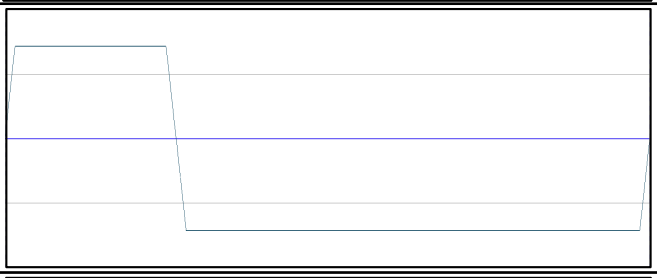
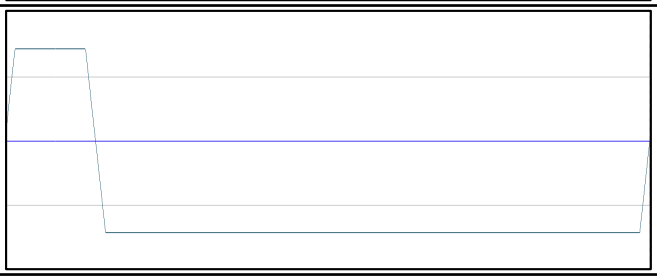
LFO stands for Low Frequency Oscillator. LFO's are generally referred to as 'modulators'. This is because the purpose of Low Frequency Oscillators is to enable the synth player to continuously change or modulate one or more parameters while still being able to play with one or both hands. LFO's achieve this by generating waveforms whose shapes can be applied to other parameters. The classic example is if you want to be able to add vibrato to a sound. In this instance an LFO generating a sine wave can be used to modulate or change an oscillator's pitch continuously over time. Spectra has two LFO's which can be used to modulate a whole myriad of Spectra's parameters.

Waveform

Range: (1 - 12 see the table below for Waveform names)

The LFO's have the following selectable waveforms.

Waveform	Description
Sine	
Cosine	
Square	
Triangle	
Saw	

Sample and Hold	
2 Sines	
Pulse 33	
Pulse 25	
Pulse 12	
Shape 1	This is a user definable Shape which you can draw within the Editor. From the Editor Home page select 'Modulators' then select 'Shapes'.
Shape 2	This is a user definable Shape which you can draw within the Editor. From the Editor Home page select 'Modulators' then select 'Shapes'.

Rate

Range: (0.01 Hz - 30.0 Hz)

The Rate knob controls the frequency at which the LFO's oscillate. The rate settings depend on whether or not the LFO's rate is synced to tempo. (See also "Sync" in this section). When the LFO is not synced to tempo its rate is determined by the following table. When the Sync control is set to on the rate is calculated based on the current time signature and tempo of the song per the following table.

Delay

Range: (0.00 ms - 26.0 sec)

The Delay parameter enables you to specify a period of delay/time from the time the LFO is triggered before the LFO starts oscillating.

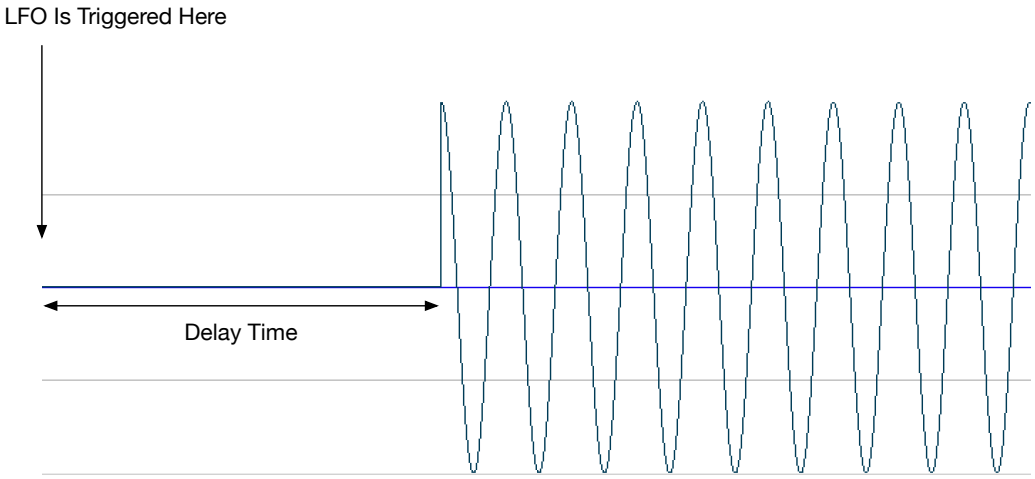


Figure 35 - LFO Delay

The time settings depend on whether or not the LFO's is synced to tempo. When the LFO is not synced to tempo the Delay times are per the following table.

Fade In

Range: (0.00 ms - 26.0 sec)

The Fade In control enables the fading in of the LFO's output. This can be handy for transitioning from the delay output to the full amplitude waveform output of the LFO. The Fade In parameter is a time period similar to the LFO Delay parameter.

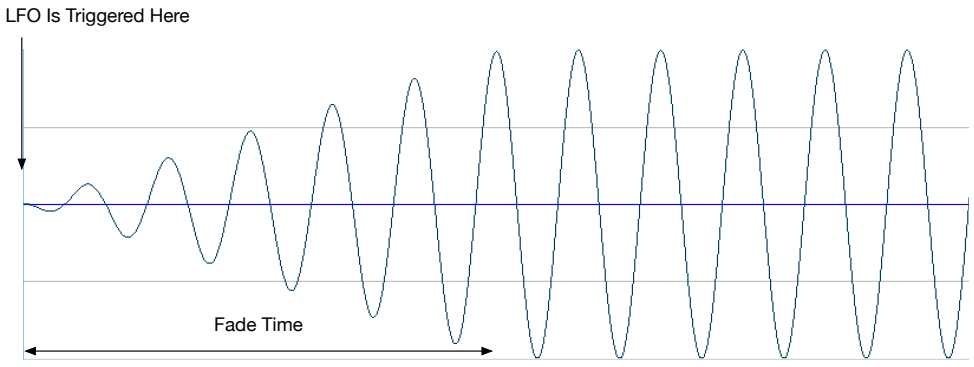


Figure 36 - LFO Fade In

When the LFO is not synced to tempo the Fade In times are per the following table. Note these times are also identical to the times used within the LFO Delay and Envelope stages.

Sync

Range: (ON, OFF)

The Sync parameter can be used to lock the LFO's rate to the current time signature and tempo. When the Sync control is on (lit) the Rate, Delay and Fade In parameters are all locked to the current time signature and tempo per the following table.

No	Sync Type	Duration Description	No	Sync Type	Duration Description
1	16/1D	Sixteen dotted whole notes	16	1/2D	A dotted half note
2	16/1	Sixteen whole notes	17	1/2	A half note
3	16/1T	Sixteen whole note triplets	18	1/2T	A half note triplet
4	8/1D	Eight dotted whole wholes	19	1/4D	A dotted quarter note
5	8/1	Eight whole notes	20	1/4	A quarter note
6	8/1T	Eight whole note triplets	21	1/4T	A quarter note triplet

7	4/1D	Four dotted whole notes	22	1/8D	A dotted eighth note
8	4/1	Four whole notes	23	1/8	An eighth note
9	4/1T	Four whole note triplets	24	1/8T	An eighth note triplet
10	2/1D	Two dotted whole notes	25	1/16D	A dotted sixteenth note
11	2/1	Two whole notes	26	1/16	A sixteenth note
12	2/1T	Two whole note triplets	27	1/16T	A sixteenth note triplet
13	1/1D	A dotted whole note	28	1/32D	A dotted thirty second note
14	1/1	A whole note	29	1/32	A thirty second note
15	1/1T	A whole note triplet	30	1/32T	A thirty second note triplet

Mode

Range: (Free, Mono, Poly, One Shot, Trigger, Trig Hld)

Each LFO in Spectra has its own 'Mode' setting. The mode setting determines when the LFO is triggered. There are 3 possible settings for the mode. The following table describes each mode and details how the LFO is triggered within that mode.

Mode	
Setting	Description
Free	In this mode the LFO is triggered when Spectra is loaded and is not retriggered when you press a key. All modulation destinations connected to this LFO share the same LFO output
Mono	In this mode the LFO is triggered on the first note after a period where no notes are playing and all notes share this LFO.
Poly	In this mode the LFO is triggered for each Note On message received and each voice has its own LFO.

One Shot	In this mode the LFO is triggered for each Note On message received however the LFO only plays through the LFO Waveform 1 Time and then stops. This can be handy for generator frequency modulations, etc.
Trigger	In this mode the LFO is triggered on the first note after a period where no notes are playing and when the LFO's Trigger button is pressed. The LFO will continue to output a waveform until the Trigger button is released. All notes share this LFO.
Trig Hld	This mode is identical to Trigger mode, except when the note is released the LFO will continue to output a waveform until the waveform completes.

Trigger

Range: (Momentary ON, OFF)

The Trigger button is a momentary button can be used to trigger the LFO. The Trigger button has an effect on the LFO only when the LFO Mode is set to 'Trigger' or 'Trig Hld'.

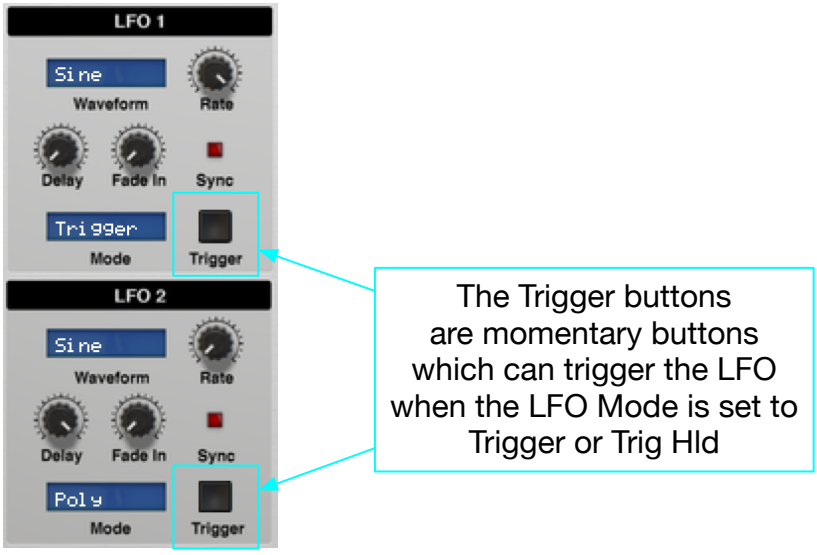


Figure 37 - LFO Fade In

The Amplifier

Figure 38- the Amplifier

Level

Range: (-inf db to 6.20 db)

The Level knob controls the output level of the Generators output. It should be noted individual harmonic amplitudes can be altered in the Spectrum Editor.

Velocity

Range: (-100% - 100%)

The Velocity knob scales the amount by which velocity modulates the amplifier output. At the 0% no scaling is applied. A Positive Velocity amount means that notes will sound louder as you play harder. A Negative Velocity amount means that notes will sound softer as you play harder.

The Editor

Figure 39 - The Editor

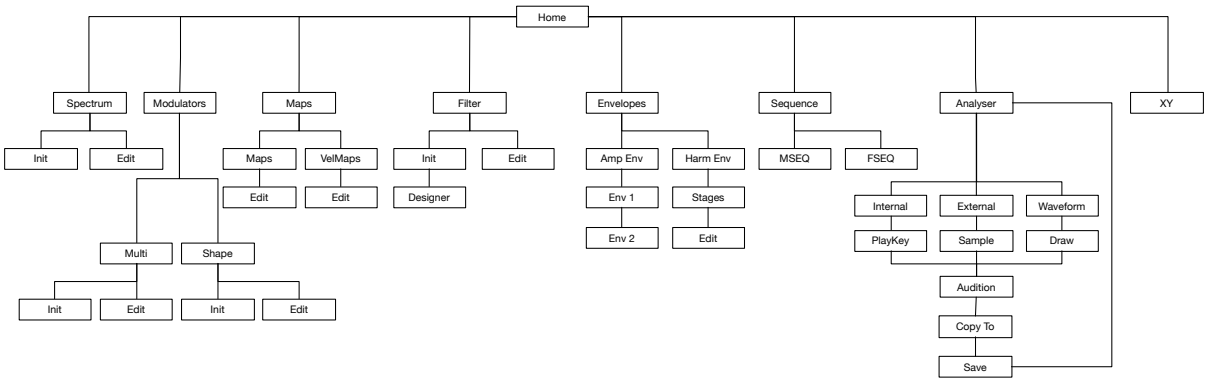
General

A design goal of Spectra was to try and 'hide" the (complicated) additive aspects for persons not wanting to delve into the inner workings of additive synthesis. For those people who want to get in and create their own audio spectrums, spectral filters, harmonic envelopes, analyse sounds, create spectral sequences and other general mayhem, Spectra provides a graphical LED Editor. The LED Editors Splash screen or home page provides a single point of access to all of the available areas enabling complete control of you Spectra synthesiser.

Figure 40 - Editor Splash Screen (Home)

Navigation

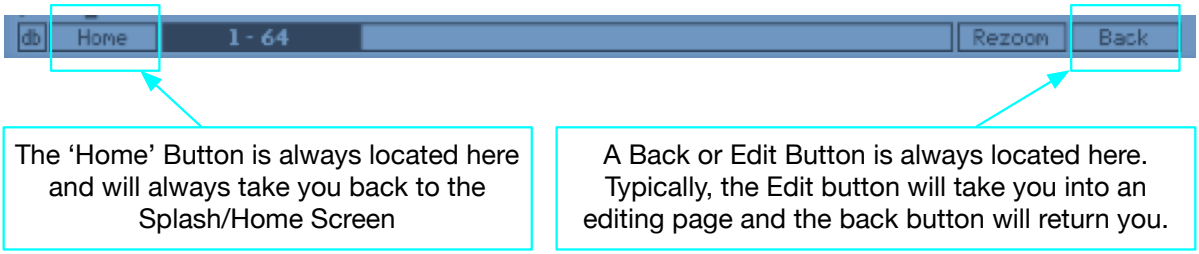
In general terms the Navigation buttons are located at the bottom of each screen. These buttons enable you to move around the screens and their sub screens in order to edit aspects of the synthesiser. The following diagram depicts a basic overview of editor



navigation.

Figure 41 - Basic navigation around the editor

Almost every screen except for the Splash screen has a 'Home' button. Selecting "Home" in any screen will always take you back to the Splash screen or Home screen.



Many screens have a 'Back' button. When available the 'Back' button will take you back to the previous screen.

Figure 42 - Basic navigation around the editor

Freeze/Copy Spectrum Values

When editing harmonics it is sometimes beneficial to have the same value across all or a range of the harmonics. For example if you wanted to set the magnitudes for the first 64 visible harmonics in the Spectrum Edit Screen to 0, you could achieve this more quickly by setting harmonic 1 to 0,

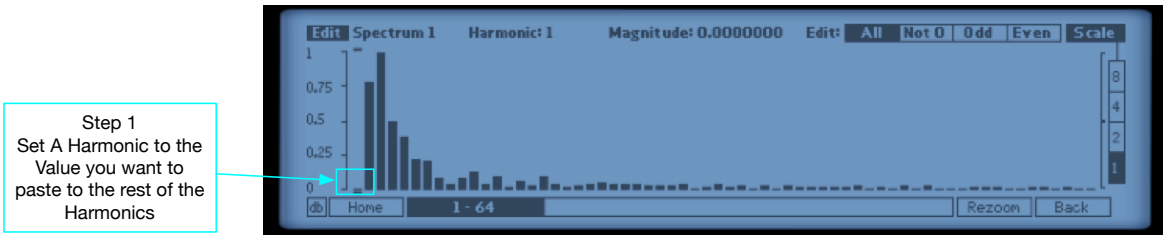


Figure 43 - Copying Spectrum Values Step 1

then, clicking the magnitude value in the caption area (note this highlights the value),

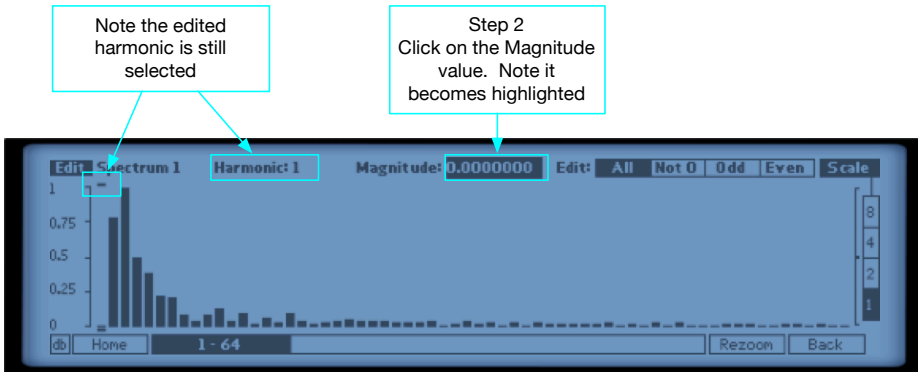


Figure 44 - Copying Spectrum Values Step 2

and finally clicking harmonic 1 again and dragging the value across all 64 harmonics. Effectively this is setting the value of the harmonic and freezing the value (similar to cutting) and then applying this value to all of the harmonics as they are edited.

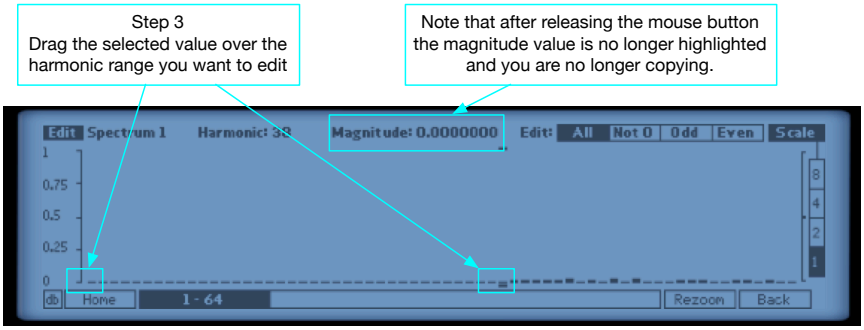


Figure 45 - Copying Spectrum Values Step 3

Setting a Value from the Scale Bar

When editing (in Edit Mode) Spectrum Magnitudes, Multis, Shapes, Maps, Filters or Harmonic Envelope values you can quickly set a value to any of the values in the scale by selecting the harmonic to update and then clicking on the number within the scale. Note this only works in Edit or Draw mode (i.e. it doesn't work in View Modes).

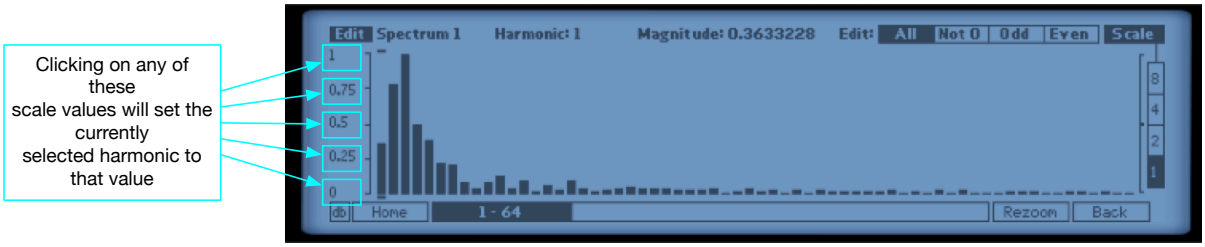


Figure 46 - Setting a value from the scale bar

Using the Precision Editing Tools

The precision tools enable very minute alterations to a harmonics value. The following diagram shows the precision tools within the Spectrum Magnitudes screen. They are also available in the Phases, Tuning and Filter Edit screens.

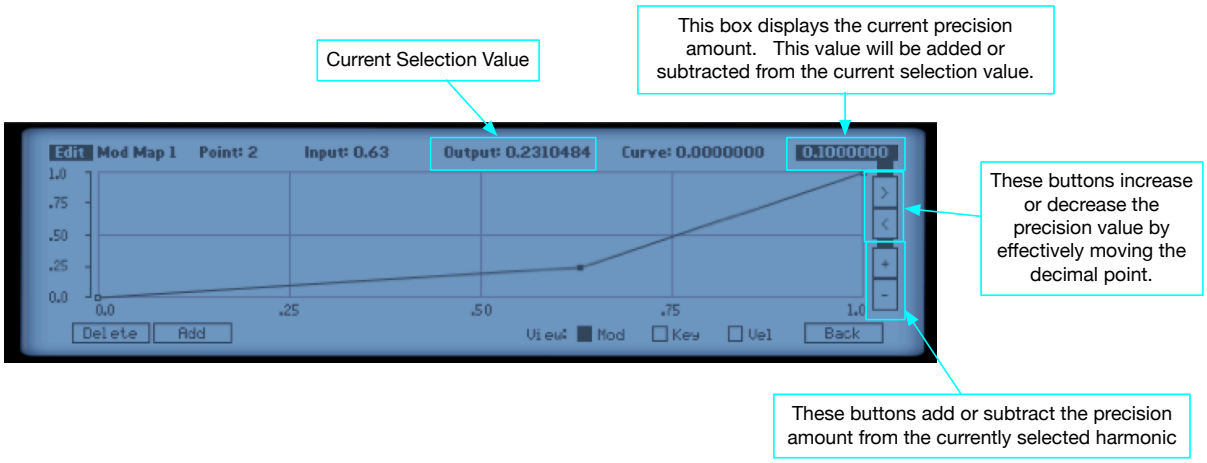


Figure 47 - Using the Precision Editing Tools

Spectrum

Selecting the 'Spectrum' menu item from the Home screen will take you to the Spectrum View screen.

Figure 48 - the Spectrum menu item in the Home Screen

The Spectrum View screen enables you to view the entire spectrum or all 256 harmonics.

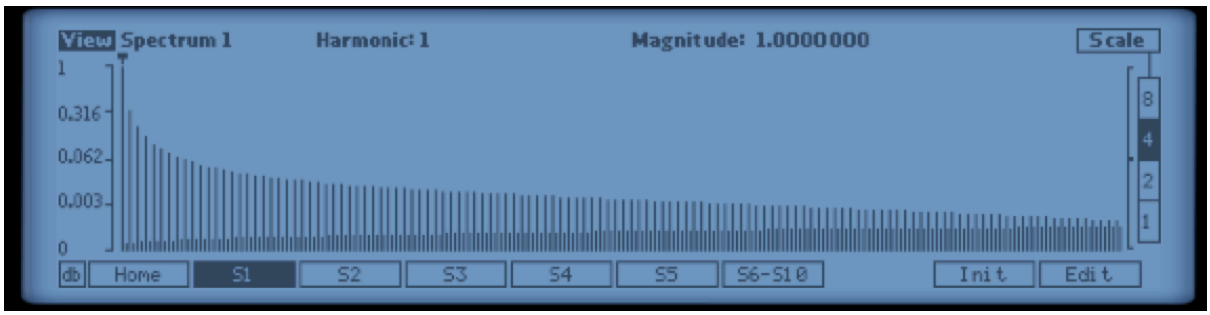


Figure 49- the Spectrum Editor screen showing Magnitudes

As in every screen the navigation buttons are located at the bottom of the Spectrum View screen. These buttons enable you to navigate to any of the existing 10 user definable spectra. The selected spectra or current spectra is indicated by the inverted or filled navigation button. The following diagram describes the elements of the Spectrum View screen.

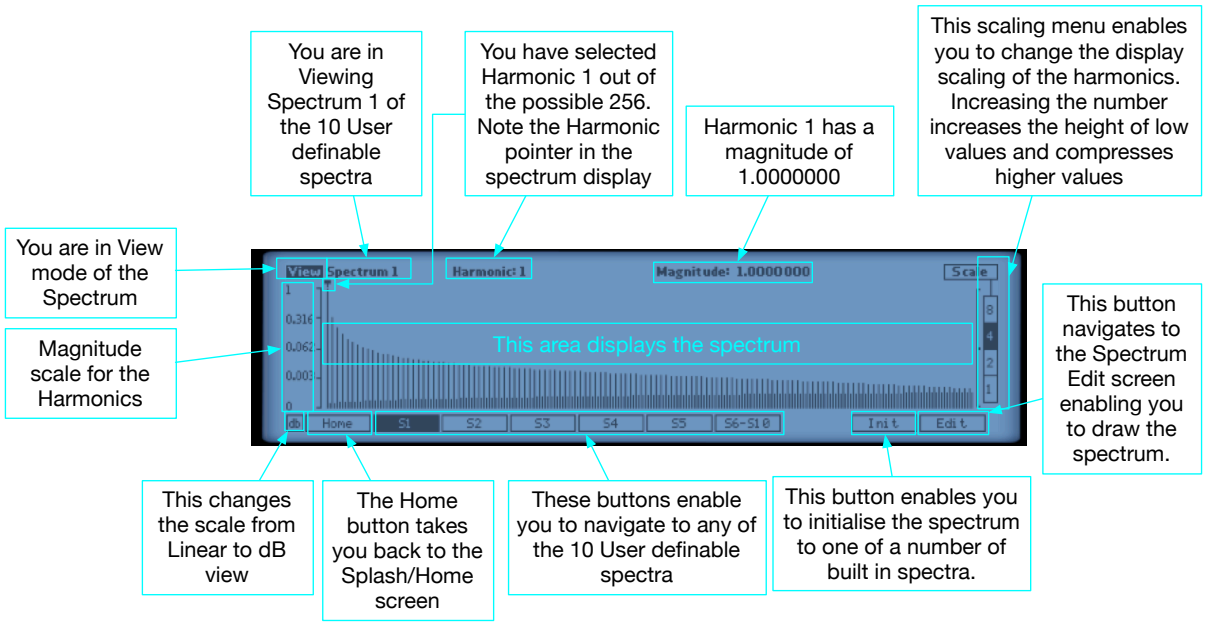


Figure 50 - Elements of the Spectrum View Screen

Editing a Spectrum

Spectra has 10 user configurable spectra which can be edited by the user. In Spectra you have a maximum of 256 harmonics available to sculpt sound. Selecting the Edit navigation button in the Spectrum View screen takes you to the Spectrum Edit Screen.

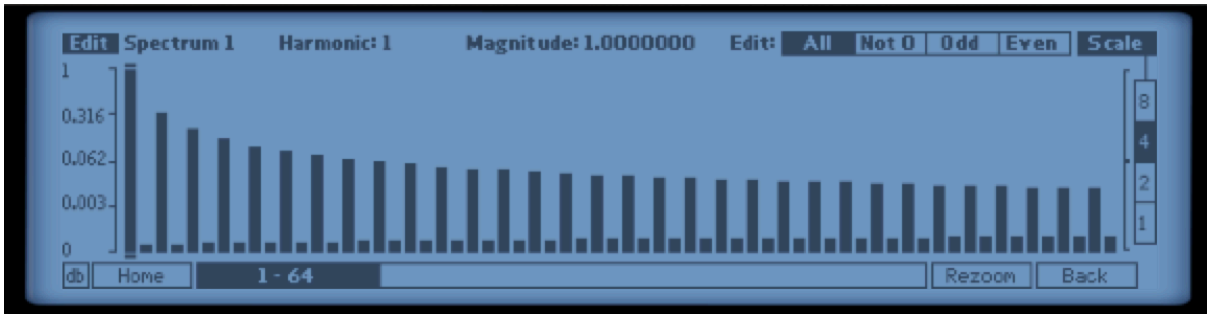


Figure 51 - The Spectrum Edit Screen

Changing a Magnitude value is easy and intuitive. Simply place the mouse cursor on the harmonic you want to alter, press and hold the mouse button and move the mouse to the desired level. As you perform this function the display will provide feedback about the current value. If you make a change and want to undo it, you can use the Undo function via the Reason -> Edit -> Undo menu item or alternatively use the key command of CTL+Z. The following diagram describes the elements of the Spectrum Edit Screen.

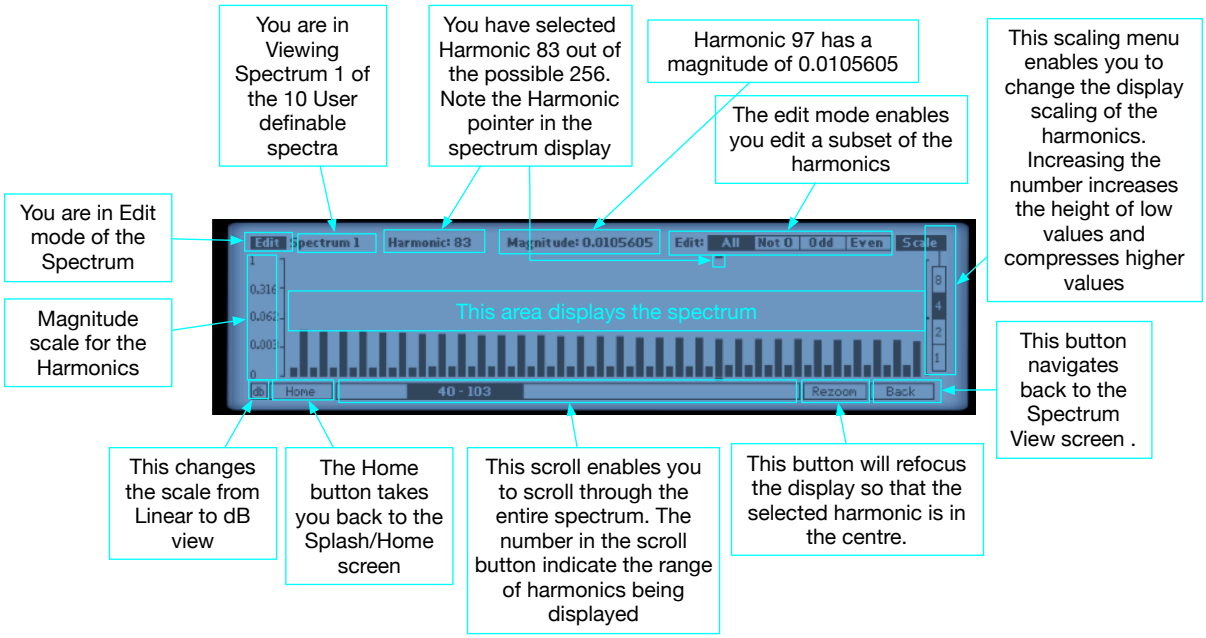


Figure 52 -Elements of the Spectrum Edit Screen

Initialising A Spectrum

Selecting the Init navigation button in the Spectrum View Screen enables you to select from a number of preset spectra.

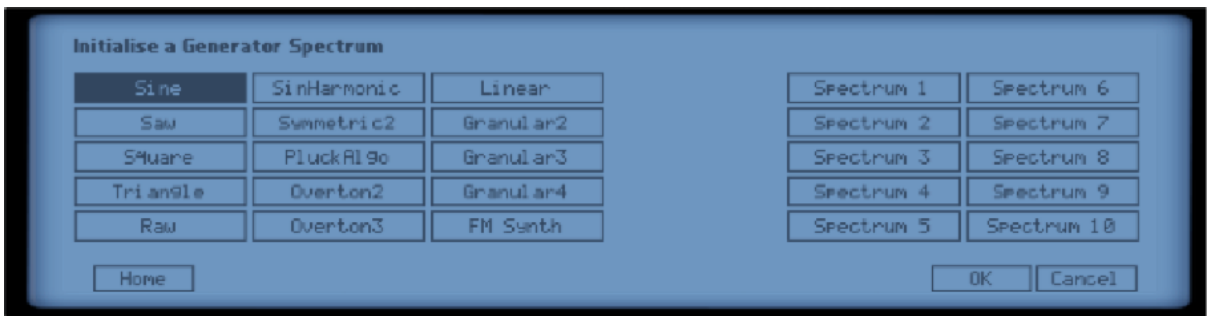


Figure 53 - The Spectrum Init Screen

From here you are able to select one of the internal preset spectra or alternative one of the current user definable spectra for initialising a spectrum.

The elements of the Spectrum Init screen are as follows.

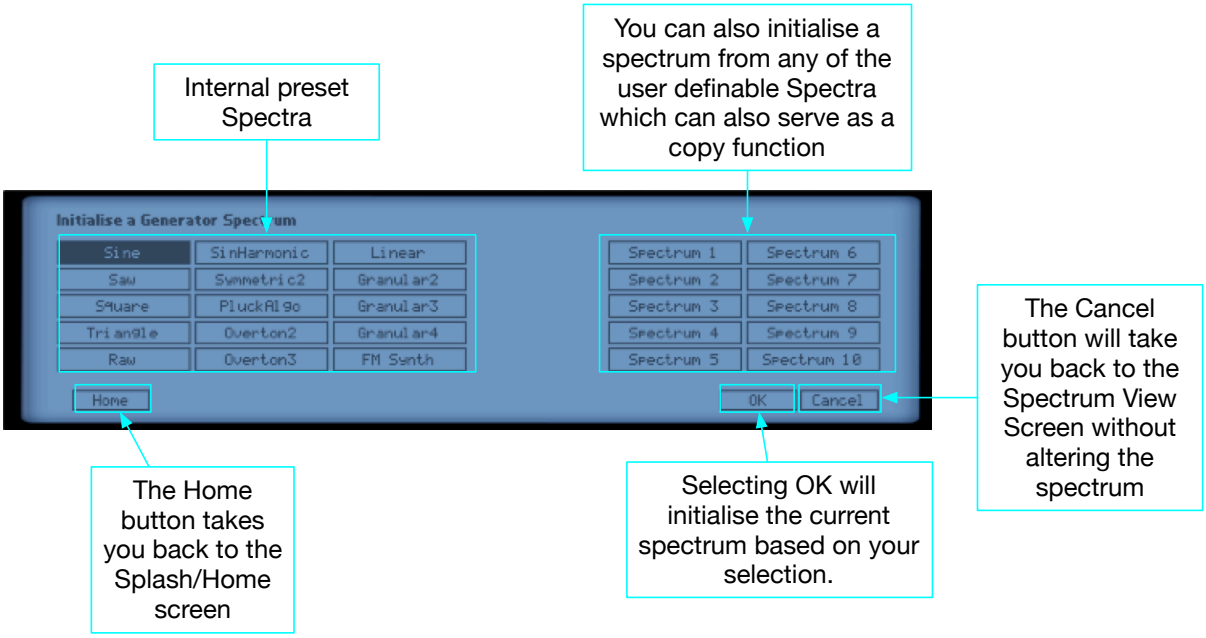


Figure 54 - Elements of the Spectrum Init Screen

Initialising a spectrum from another user definable spectrum is essentially a copy functionality

Modulators

The "Modulators" menu item in the editor enables you to edit the 4 user definable Multis and/or the 2 user definable Shapes. The Multis enable you to alter multiple spectrum harmonics in real time via a single knob which is similar to wavetable or wave shaping transitions. The Shapes are user definable waveform/shapes which can be used within the LFO's.

Figure 55 - The Modulators menu Item in the Editor Home Screen

Multis

The four user definable Multiple Harmonic (Multi) spectra enable you to define how multiple harmonic levels will be modulated when the Multi knob in the Spectrum Mods section is turned.

The following diagram shows a user defined Multi in the Multi View page of the Editor.

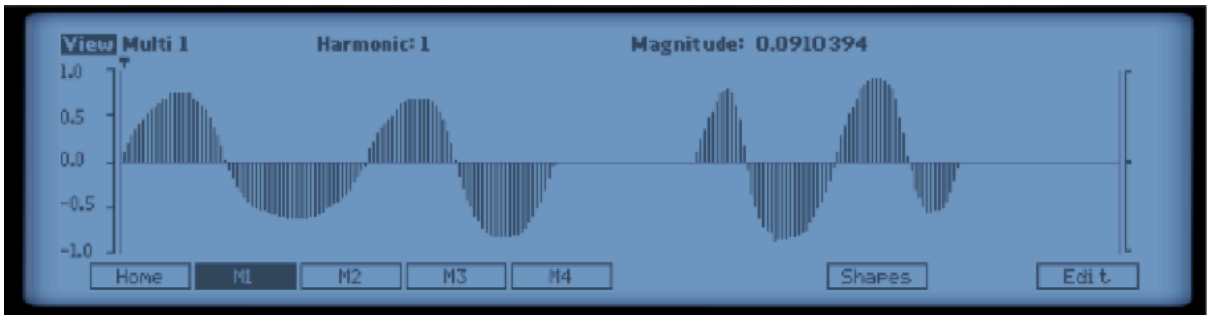


Figure 56 - The Multi View Screen

As in every screen the navigation buttons are located at the bottom of the Multi View screen. These buttons enable you to navigate to any of the existing 4 user definable Multis. The selected Multi is indicated by the inverted or filled navigation button. The following diagram describes the elements of the Multi View screen.

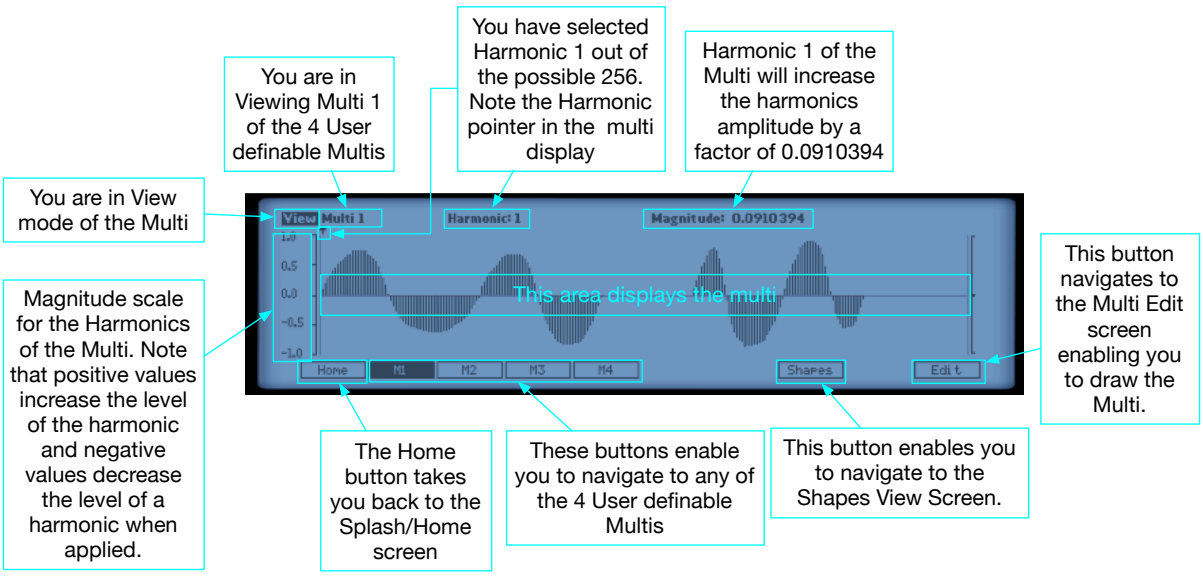


Figure 57- Elements of the Multi View Screen

A Multi is applied to the Waveform Spectrum in the following manner

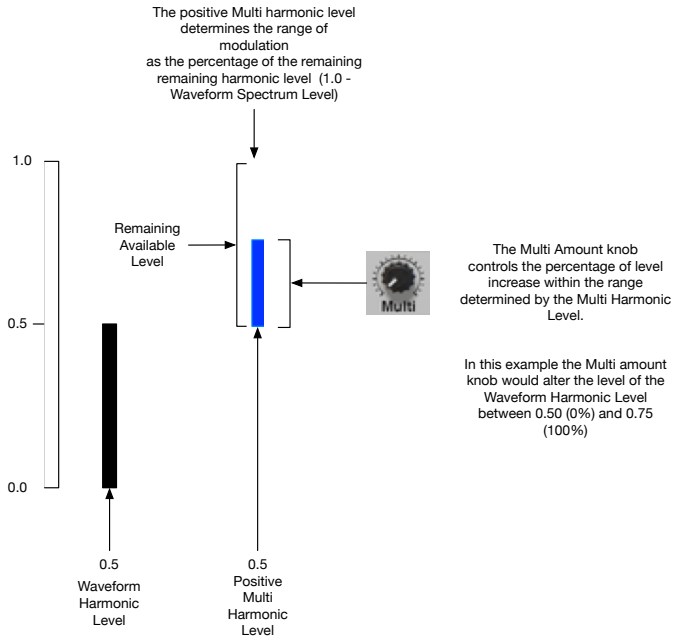


Figure 58- Positive Multi Harmonic Modulation Explained

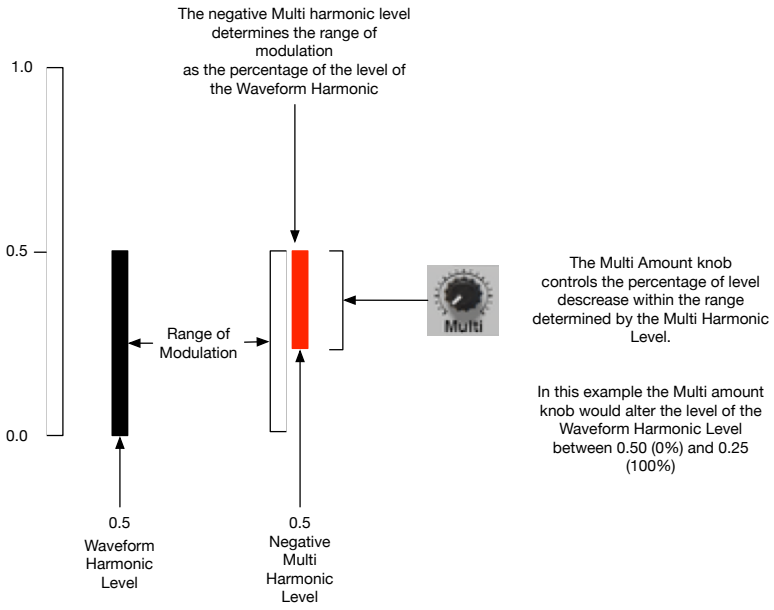


Figure 59- Negative Multi Harmonic Modulation Explained

Effectively this means:

1. If the Multi Harmonic Level is 0.0 then the corresponding Waveform Harmonic's value will not be altered when the Multi knob is turned.
2. If the Multi Harmonic Level is a positive value then the corresponding Waveform Harmonic's value will be increased.
3. If the Multi Harmonic Level is a negative value then the corresponding Waveform Harmonic's value will be decreased.
4. The amount of change applied is controlled by the Multi knob.
5. The result of the modulation will never be more than 1.0
6. The result of the modulation will never be less than 0.0.

Editing a Multi

Spectra has 4 user configurable Multis which can be edited by the user. In Spectra you have a maximum of 256 harmonics available to sculpt sound. Selecting the Edit navigation button in the Multi View screen takes you to the Multi Edit Screen.

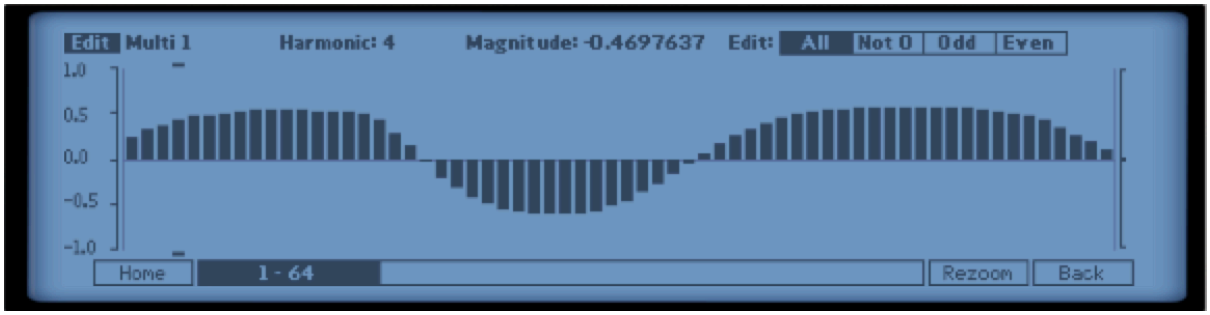


Figure 60 - The Multi Edit Screen

Changing a Multi value is easy and intuitive. Simply place the mouse cursor on the harmonic you want to alter, press and hold the mouse button and move the mouse to the desired level. As you perform this function the display will provide feedback about the current value. If you make a change and want to undo it, you can use the Undo function via the Reason -> Edit -> Undo menu item or alternatively use the key command of CTL+Z. The following diagram describes the elements of the Multi Edit Screen.

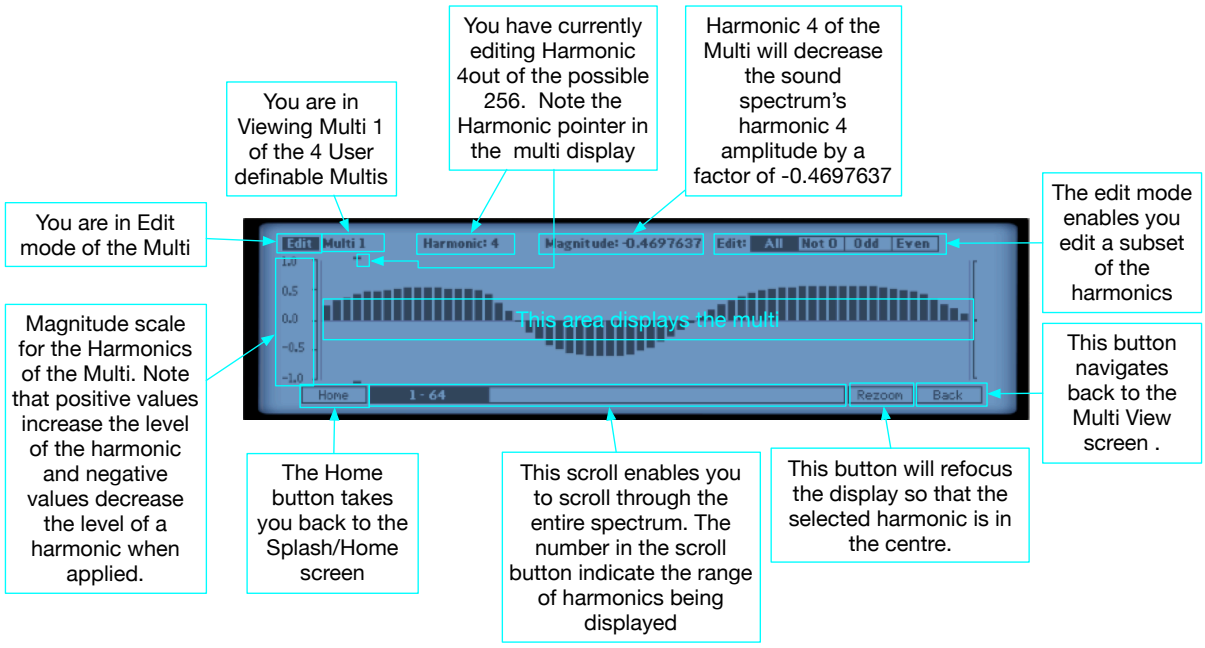


Figure 61 - Elements of the Multi Edit Screen

Shapes

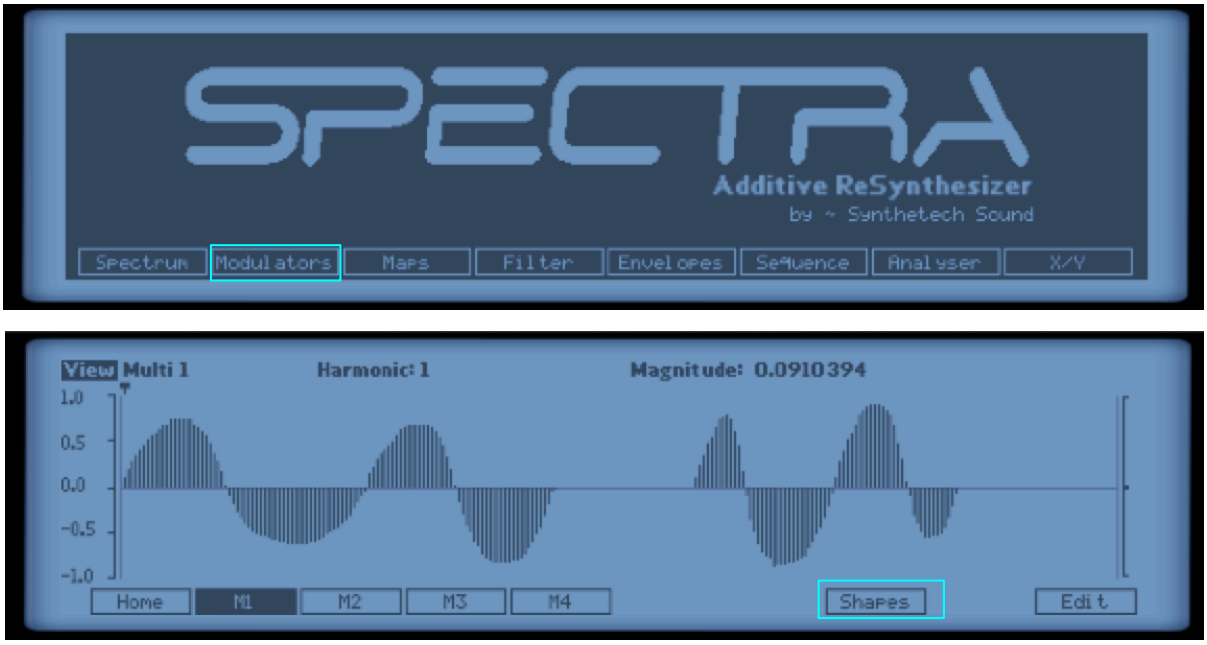


Figure 62 - Navigating to Shapes in the Editor

Another type of Modulator is a 'Shape'. Effectively a Shape can be a periodic Waveform Shape, a shape resembling an Envelopes contour or any modulation shape you can draw within the constraints of a defined shape.

The 2 user definable Shapes enable you to draw detailed modulations which can be plugged into the LFO's.

The following diagram shows the Shape View page of the Editor.

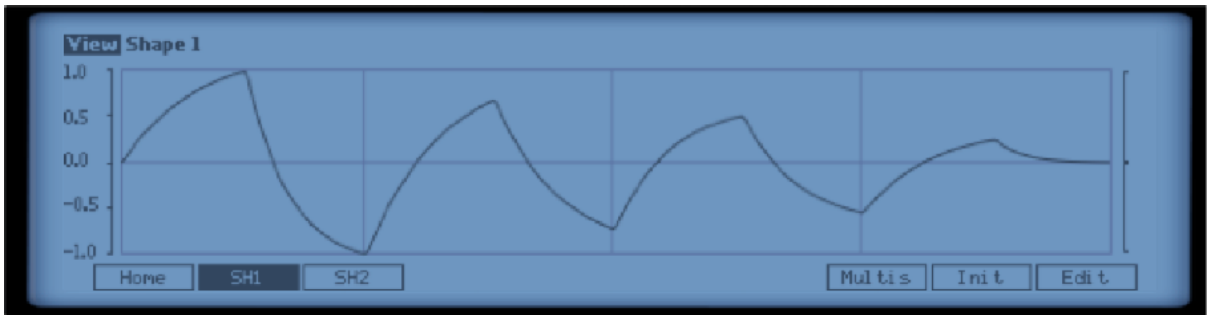


Figure 63 - The Shape View Screen

As in every screen the navigation buttons are located at the bottom of the Shape screen. These buttons enable you to navigate to either of the user definable Shapes. The selected Shape is indicated by the inverted or filled navigation button. The following diagram describes the elements of the Shape View screen.

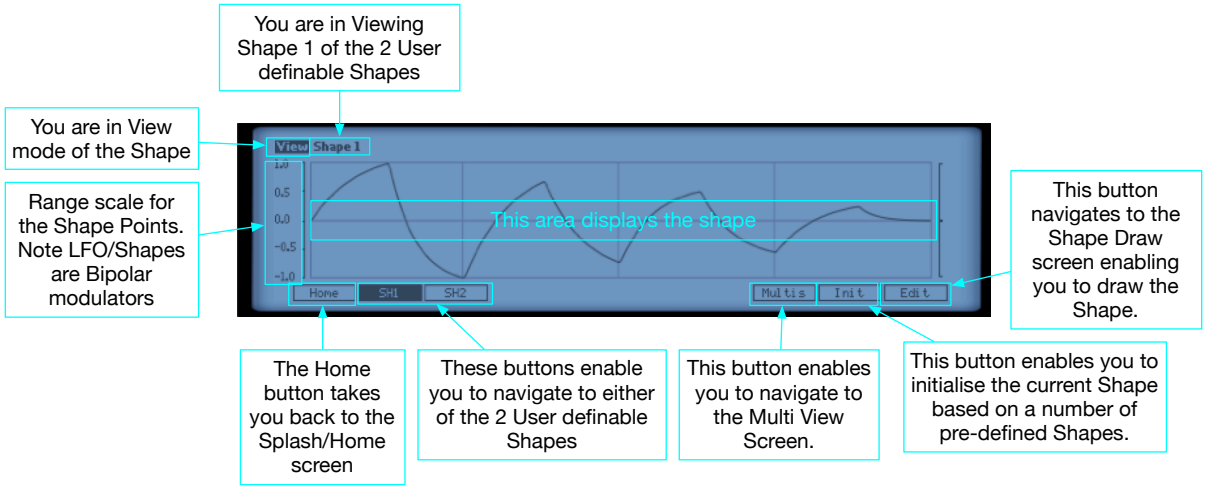


Figure 64 - Elements of the Shape View Screen

Editing A Shape

Spectra has 2 user configurable Shapes which can be edited by the user. Selecting the Edit navigation button in the Shape View screen takes you to the Shape Draw Screen.

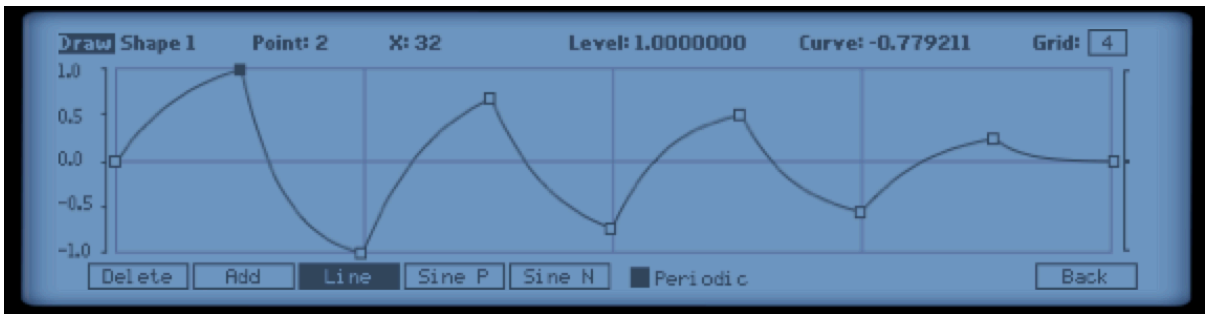


Figure 65 - The Shape Draw Screen

Changing a Shape point value is easy and intuitive. Simply place the mouse cursor on a point you want to alter, press and hold the mouse button and move the mouse to the

desired location. As you perform this function the display will provide feedback about the current value. If you make a change and want to undo it, you can use the Undo function via the Reason -> Edit -> Undo menu item or alternatively use the key command of CTL+Z. The following diagram describes the element of the Shape Draw Screen.

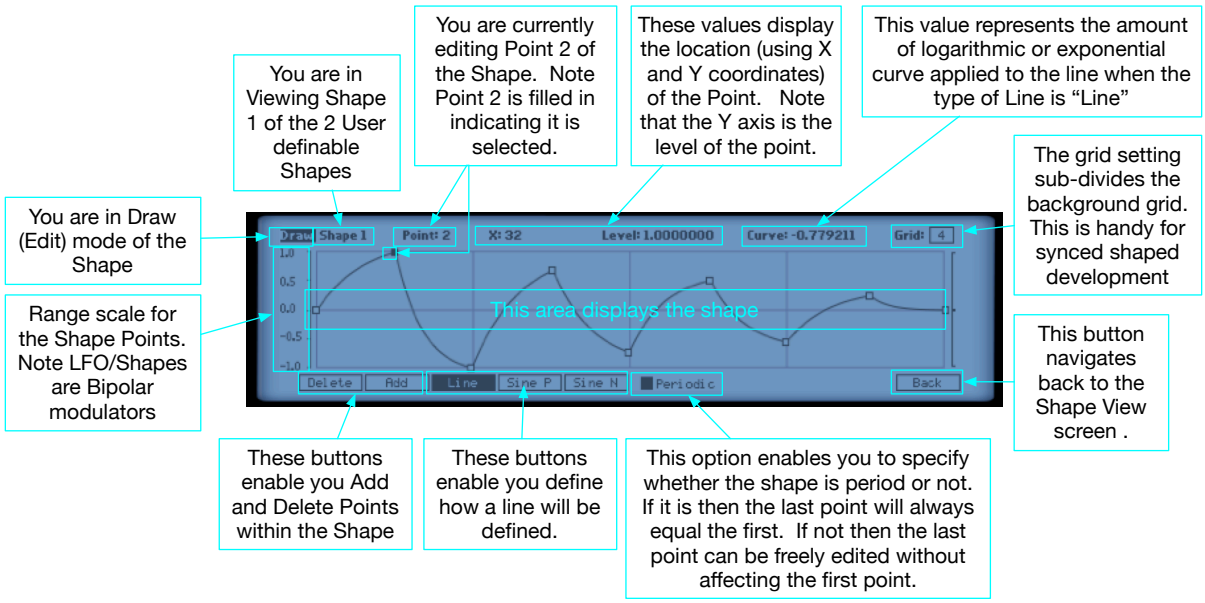


Figure 66 - Elements of the Shape Draw Screen

Adding a Point

In order to add a point while in the Shape Draw Screen, simply select the Add button in the navigation bar. Note this will highlight the Add button meaning you are in Add mode. Next, select a location within the Shapes grid where you want the point to go. Upon releasing the mouse button the point will be added, the Add button will become 'unselected' and the added point will become the selected point. If you have already added the maximum number of points the Add button will not appear.

If the currently edited Shape already has the maximum number of points then the Add button will no long be displayed.

Deleting a Point

In order to delete a point while in the Shape Draw Screen, simply select the point you want to delete and press the delete button. Upon pressing the delete button the point will be removed from the Shape. Note that the first and last points can never be deleted and that if these points are selected the Delete button is not available. Also note that the minimum number of points is 2. If a Shape only contains 2 points then the Delete button is also not available.

Changing the Line Type

Every point within a Shape has a line type. The line type enables you to control how the line from the previous point to the current selected point is drawn. The available line types are as follows.

Line Type	Description
Line	This line type results in a straight line being drawn from the previous point with an optional logarithmic or exponential curve applied. A Curve can be applied to a 'Line' by selecting a mid point of the line and dragging the line to result in an appropriate or user desire curve amount.
Sine P	This line type results in a sine wave with a positive phase to be drawn from the previous point. Note you cannot alter the curve of a Sine P line type.
Sine N	This line type results in a sine wave with a negative phase to be drawn from the previous point. Note you cannot alter the curve of a Sine N line type.

To change the line type of a point, simply select the point which will display the current line type of the point, and then select a different line type (Line, Sine P or Sine N). The curve of the line will altered. If you select 'Line' as the line type, note that you can apply a logarithmic or exponential curve to the line by selecting a point on the line and dragging that point to affect a curve of the line. Sine P and Sine N curves can not be altered this way as they are defined by the Sine Function.

Is Periodic

This option makes it easier to draw periodic (or repeating) types of Shapes. Periodic Shapes are effectively Waveforms. If the Shape is periodic then the first and last points always share the same Level value. Selecting either the first point or the last point will

select both the first and last point when the Shape is periodic. Editing the Y value in this situation will edit the value for both points.

Non Periodic Waveforms are sometimes handy for use in a One-Shot or Triggered LFO mode.

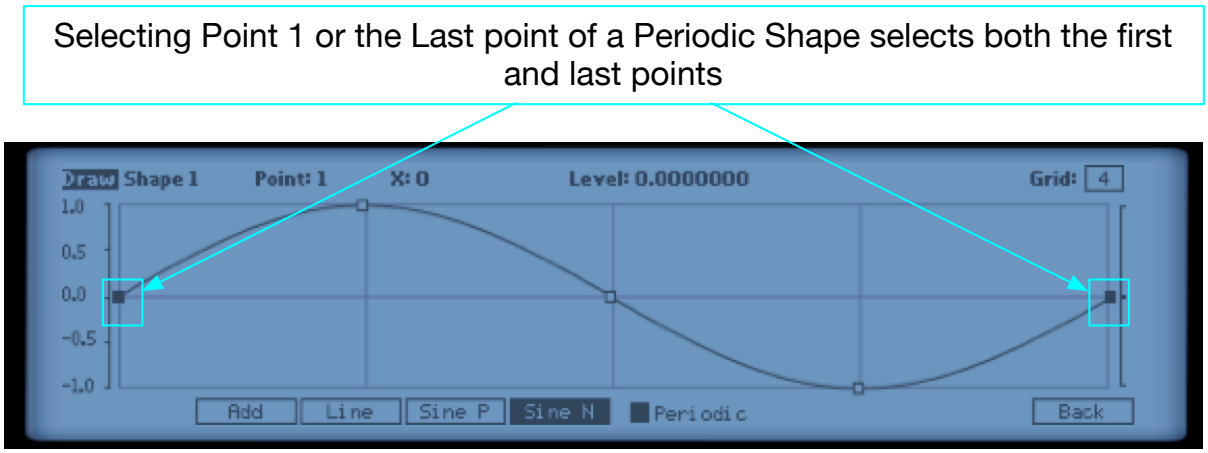


Figure 67 - Periodic Waveforms share the same start and end Points

Initialising A Shape

Selecting the Init navigation button in the Shape View Screen enables you to select from a number of available preset Shapes.

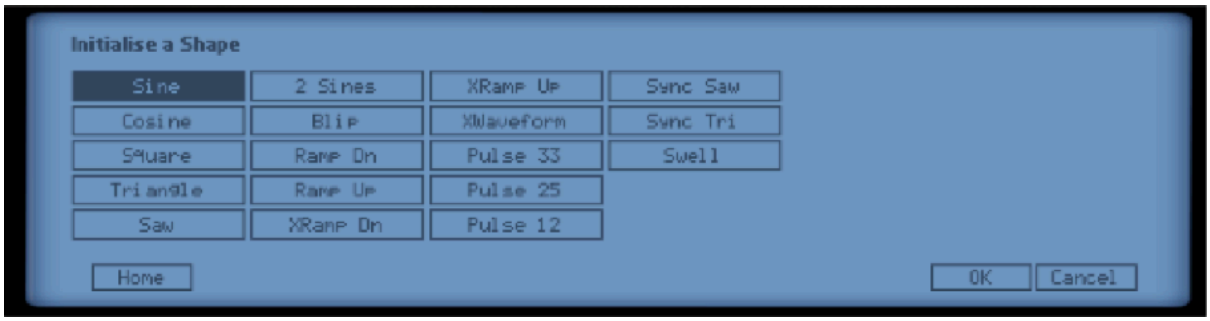


Figure 68 - The Shape Init Screen

From here you are able to select one of the internal preset shapes for initialising a spectrum. Pressing the 'OK' button will initialise the current Shape using the shape you have selected while the 'Cancel' button will take you back to the Shape View screen without altering the Shape.

The elements of the Shape Init screen are as follows.

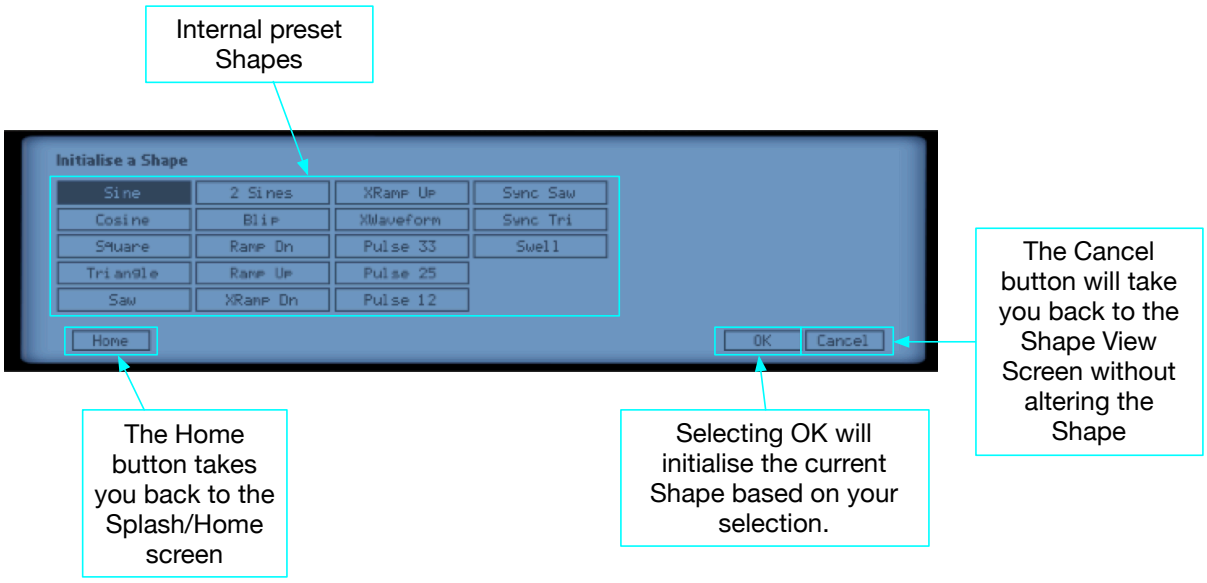


Figure 69 - Elements of the Shape Init Screen

A Previous Version of Spectra from 2016 (Render by Nirude)

Maps

A Map or Modulation Map is functionality which enables you to scale or map a modulation source value to a new value. Maps are used within the Modulation Matrix and can be applied to one, none or multiple modulation slots. The following diagram depicts how to apply a map to a modulation source in the modulation matrix.

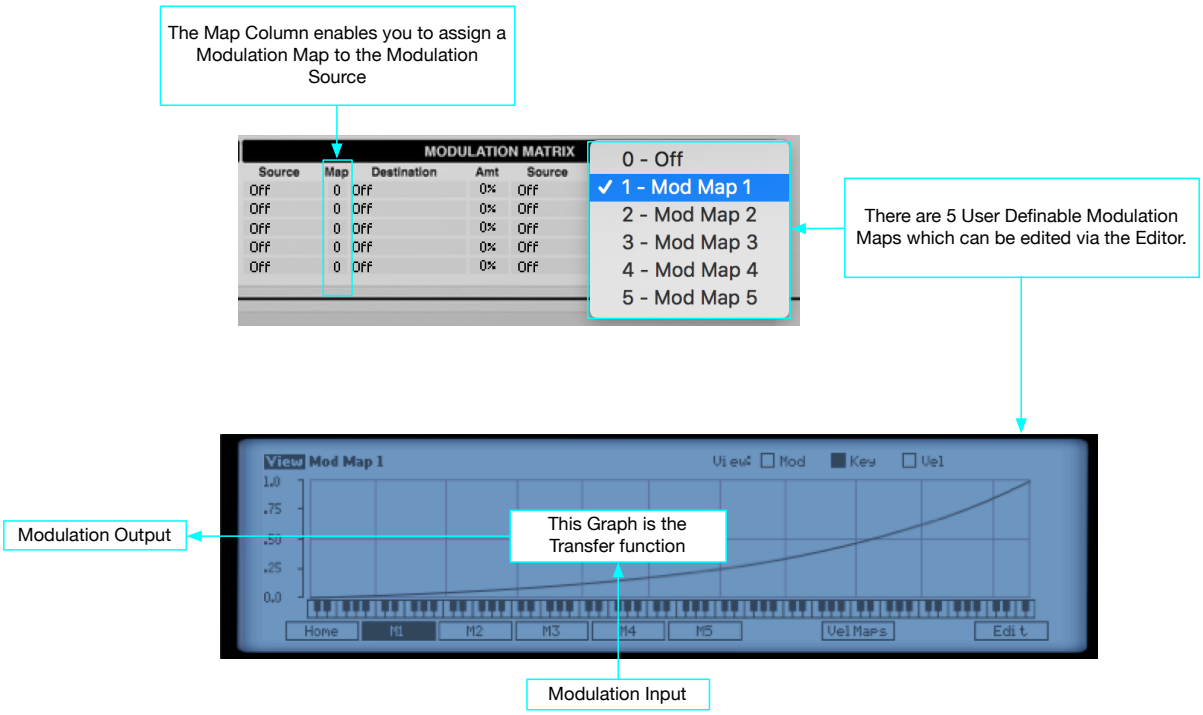


Figure 70 - Applying a Map to a Modulation source in the Modulation Matrix

To Navigate to the Maps in the Editor simply select the Maps Menu Item on the Editor Home page.

Figure 71 - The Maps Menu Item in the Home Screen

Modulation Maps

Spectra has 5 user definable modulation maps. These maps are effectively transfer functions which can be applied to any modulation source. The Map View screen enables you navigate to any of the 5 user definable maps or the the Velocity Map screen.

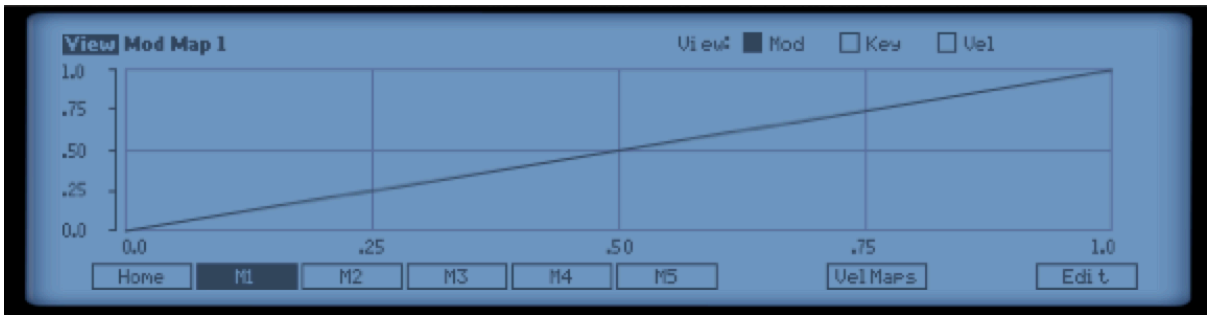


Figure 72 - The Map View Screen

The following describes the elements of the Map View Screen.

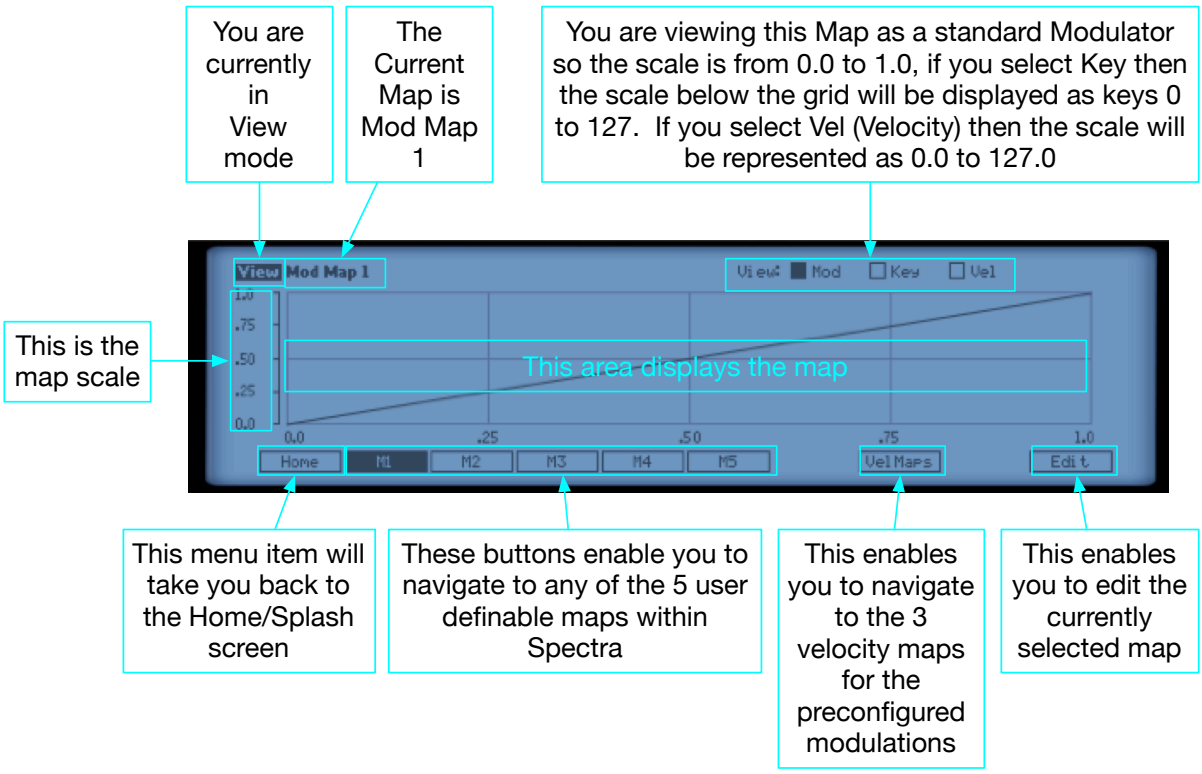


Figure 73 - Elements of the Map View Screen

Maps can be applied to any modulation source and can also be applied to multiple modulation sources. This means that you may want to view the map relevant to a specific modulation source. For example you may be wanting to apply a map to 'Note' modulation source. In this situation it can be useful to view the modulation map relevant to the source. To do this simply select the Key option at the top of the screen.

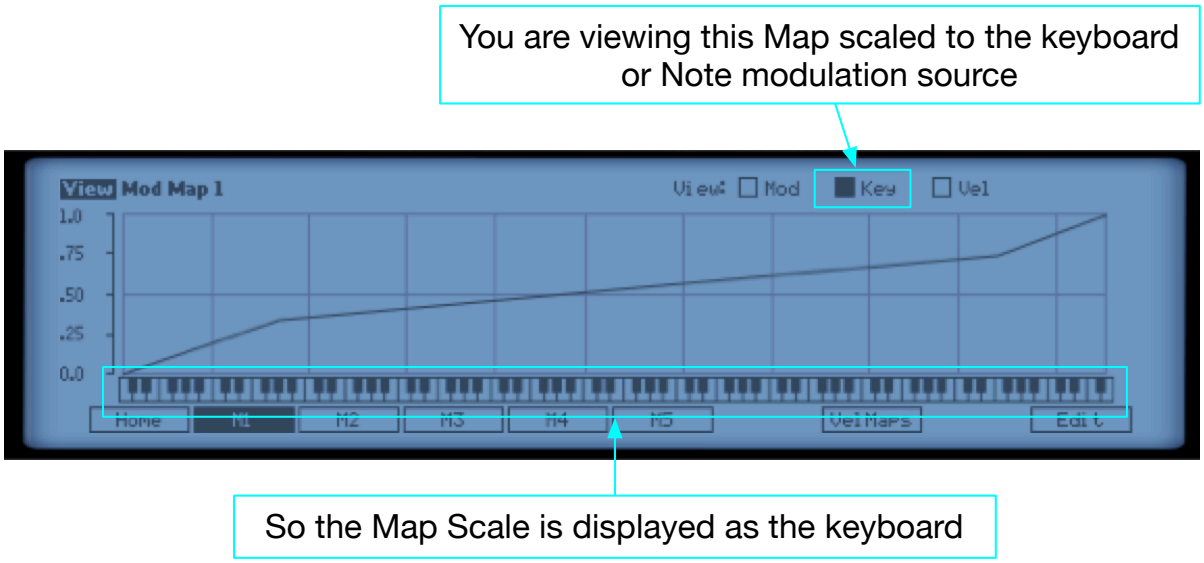


Figure 74 - Altering the View and Scaling of a Map

Alternatively you can view the Map relevant to Velocity which displays the map scaled from 0.0 to 127.0 or using the standard Mod View will scale the map from 0.0 to 1.0.

Changing the View of the map does not change the map itself. The map values remain the same but are displayed relevant to the selected view.

Editing a Map

Spectra has 5 user configurable Maps which can be edited by the user. Selecting the Edit navigation button in the Map View screen takes you to the Map Draw Screen.

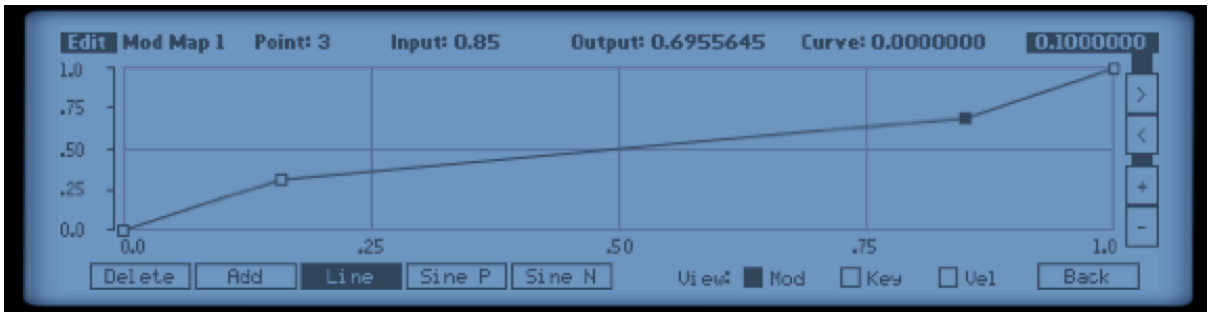


Figure 75 - The Map Edit Screen

Changing a Map point value is easy and intuitive. Simply place the mouse cursor on a point you want to alter, press and hold the mouse button and move the mouse to the desired location. As you perform this function the display will provide feedback about the current value. If you make a change and want to undo it, you can use the Undo function via the Reason -> Edit -> Undo menu item or alternatively use the key command of CTL+Z. The following diagram describes the elements of the Map Edit Screen.

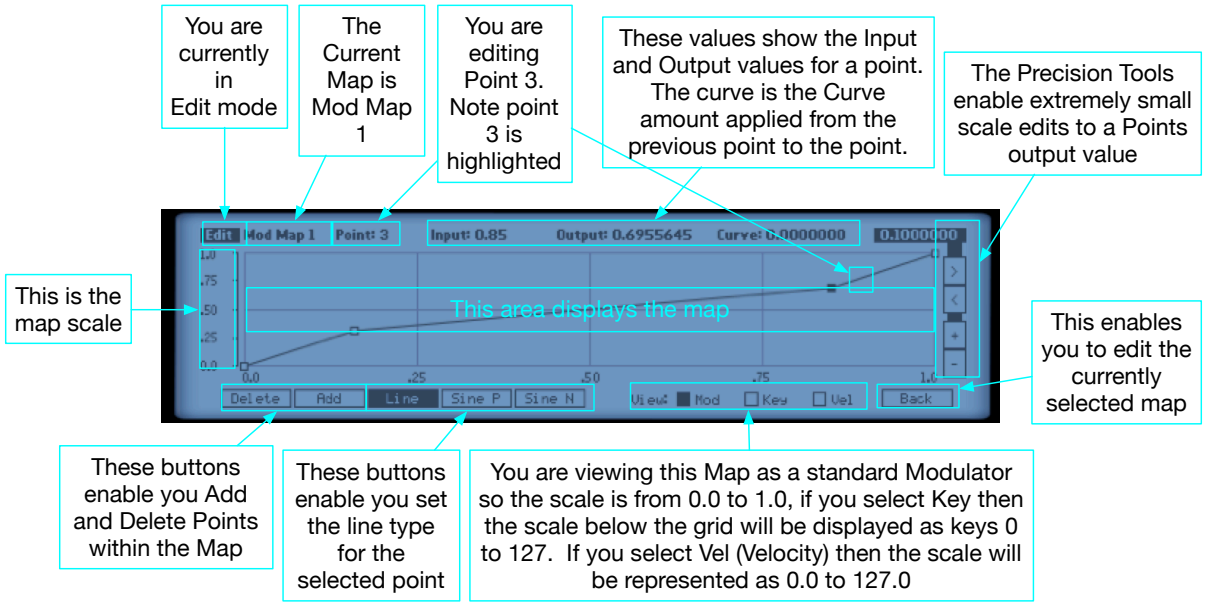


Figure 76 - Elements of the Map Edit Screen

Adding a Point

In order to add a point while in the Map Edit Screen, simply select the Add button in the navigation bar. Note this will highlight the Add button meaning you are in Add mode. Next, select a location within the Shapes grid where you want the point to go. Upon releasing the mouse button the point will be added, the Add button will become 'unselected' and the added point will become the selected point. If you have already added the maximum number of points the Add button will not appear.

Deleting a Point

In order to delete a point while in the Map Edit Screen, simply select the point you want to delete and press the delete button. Upon pressing the delete button the point will be removed from the Map. Note that the first and last points can never be deleted and that if these points are selected the Delete button is not available. Also note that the minimum number of points is 2. If a Shape only contains 2 points then the Delete button is also not available.

Changing the Curve of a line connecting two points

A Curve can be applied to a 'Line' by selecting a mid point of the line and dragging the line to result in an appropriate or user desired curve amount.

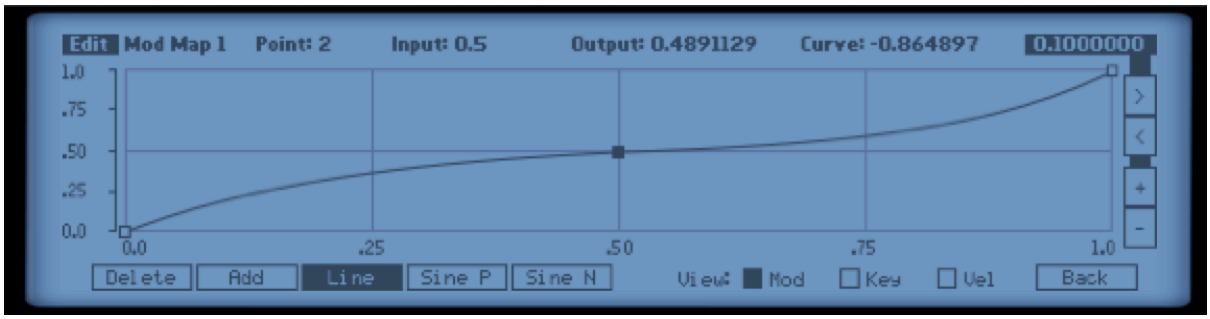


Figure 77 - Curves applied to lines in a map

Velocity Maps

Velocity Maps are identical to maps, however they are associated with pre-defined velocity modulations within Spectra. The following diagram illustrates to what parameters the Velocity maps are applied. Because the velocity maps are relevant to the Velocity modulation source these maps are always displayed with the Velocity scale.

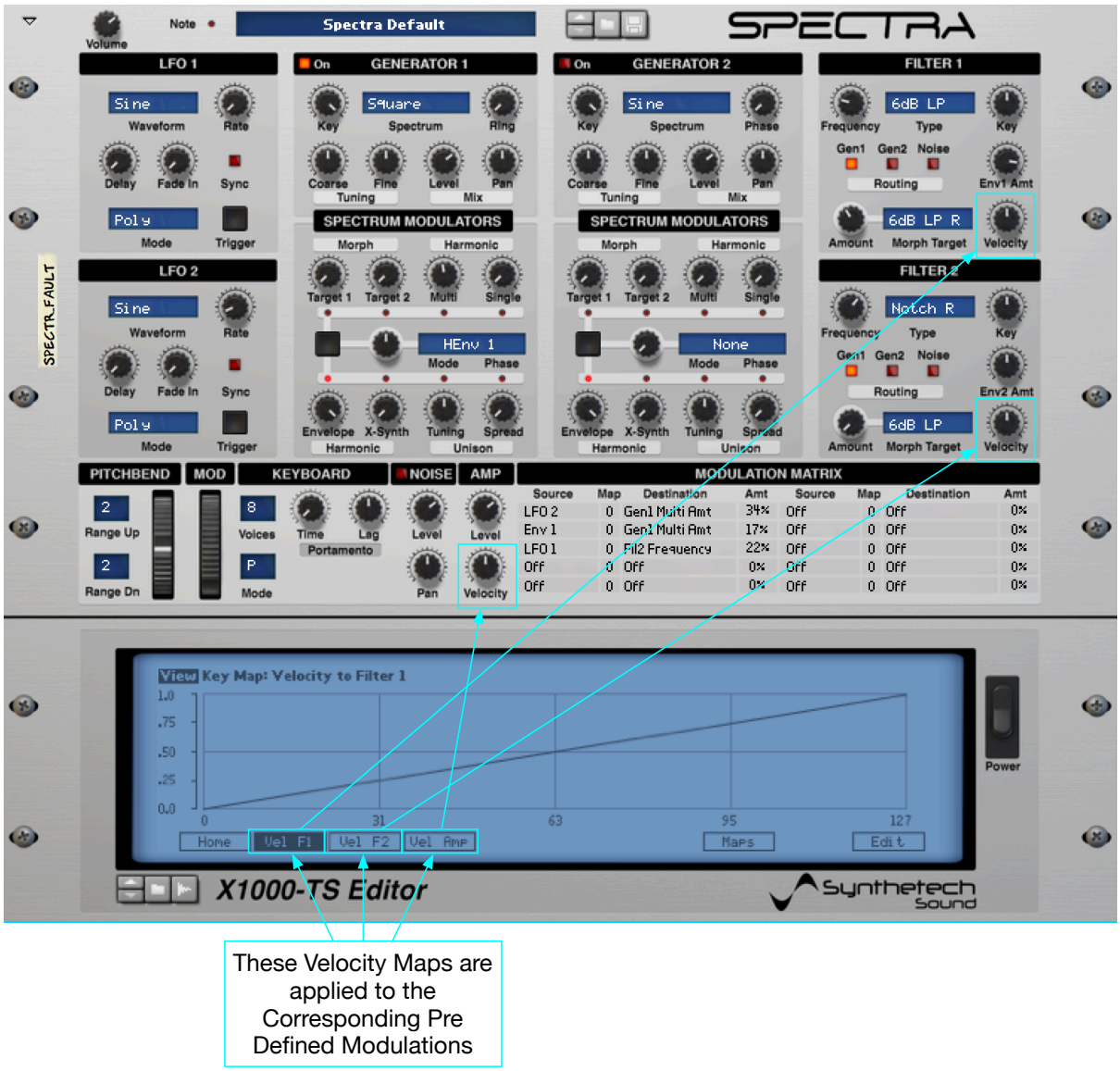


Figure 78 - Velocity Maps and where they are applied.

Filter

The 2 Filters in Spectra are Spectral Filters. There are a number of preset Filter impulse responses available, however the Filter section in the Editor enables you to freely edit any of the 10 user-definable spectral filters. This is an extremely powerful feature which effectively means that you can reproduce a significant number of types of filters within the constraints imposed by the Editor. For example you can create an absolute brick wall filter or a completely custom filter or an 18 db Low Pass filter simply by drawing its impulse response in the editor.

The Spectral Filters behave in a way similar to a graphic equaliser. Like a graphic equaliser the Spectral Filter is made up of 256 frequency bands which accentuate or attenuate bands of frequencies. The frequency range of each band corresponds with each note on a keyboard. To begin editing a user-definable filter simply select the 'Filter' button in the Splash Screen (Home).

Figure 79 - The 'Filter' button in the Splash Screen.

After pressing the 'Filter' button you will be in the Filter View Screen. The purpose of the filter screen is to provide a high level view of the filter response. The following image shows the filter response of a low pass filter.

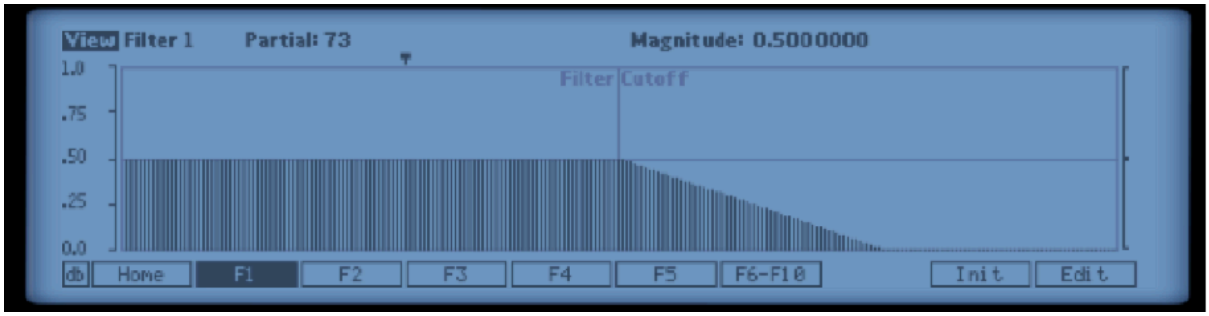


Figure 80 - The Filter View Screen

The image below describes all of the Elements of the Filter View Screen.

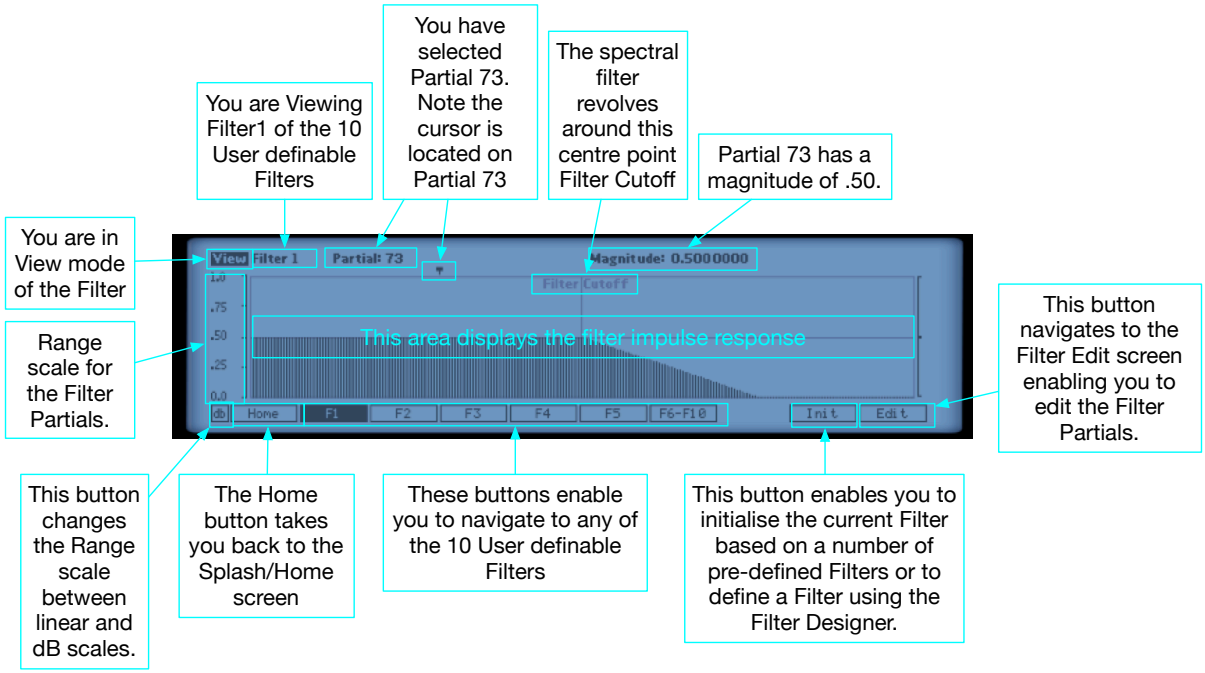


Figure 81 - Elements of the Filter View Screen.

Spectra has 10 User Definable Filters in order to provide ample user definable Filter impulses for the Filter Morph Sequences.

Editing a Filter

Selecting the Edit Button in the Filter View Screen will navigate to the Filter Edit Screen.

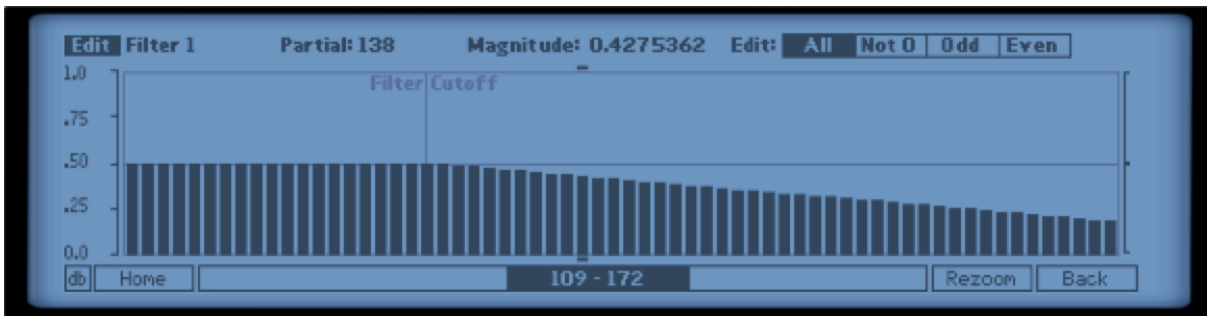


Figure 82 - The Filter Edit Screen.

Changing a Partial's magnitude value is easy and intuitive. Simply place the mouse cursor on the partial you want to alter, press and hold the mouse button and move the mouse to the desired level. As you perform this function the display will provide feedback about the current value. If you make a change and want to undo it, you can use the Undo function via the Reason -> Edit -> Undo menu item or alternatively use the key command of CTL+Z. The following diagram describes the elements of the Filter Edit Screen.

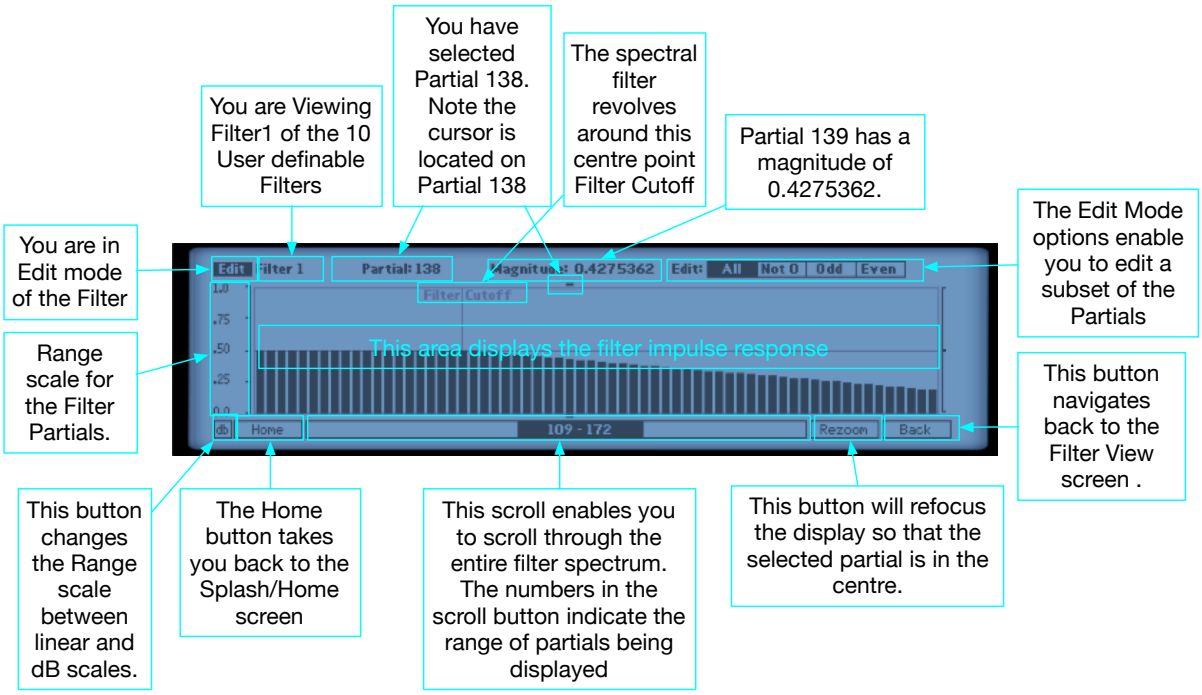


Figure 83 - Elements of the Filter Edit Screen.

Setting a Filter Partial's Magnitude to 0.5 results in a neutral (no attenuation or accentuation of that frequency band.

Initialising A Filter

Selecting the Init navigation button in the Filter View Screen enables you to select from a number of available preset Filter impulse responses.

Figure 84 - The Filter Init Screen

From here you are able to select one of the internal preset filter impulse responses for initialising a spectrum. Pressing the 'OK' button will initialise the current Filter using the filter impulse response you have selected while the 'Cancel' button will take you back to the Filter View screen without altering the Filter.

The elements of the Filter Init screen are as follows.

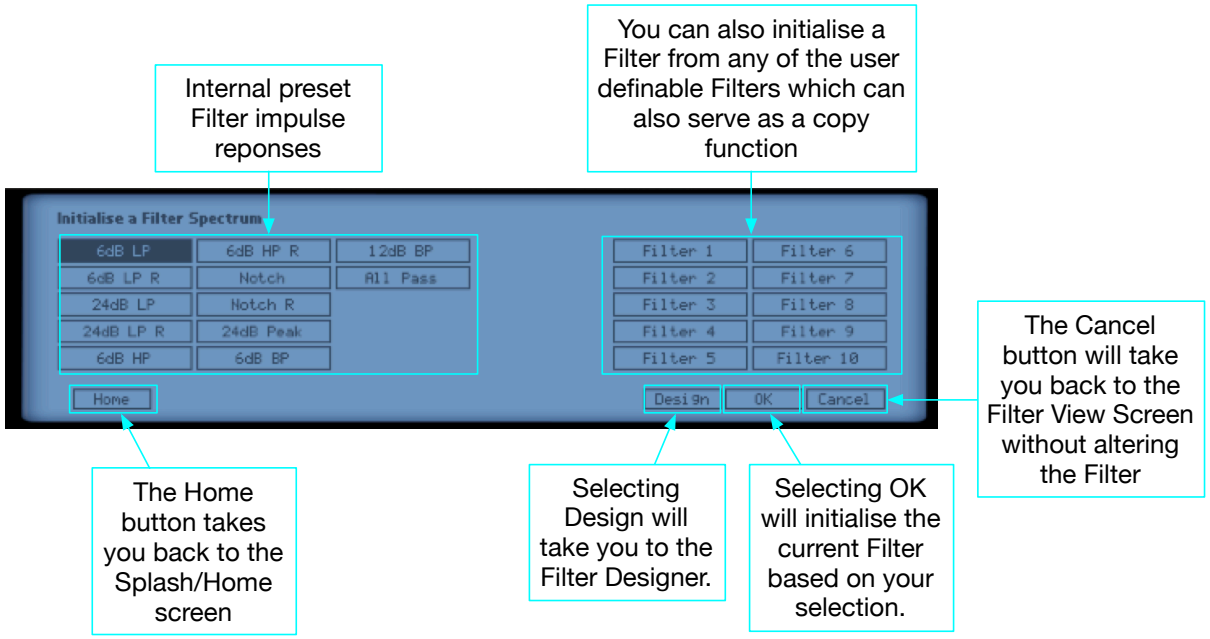


Figure 85 - Elements of the Filter Init Screen

Filter Designer

The Filter Designer is a tool which enables you to develop filter impulse responses using the drawing tools in a manner similar to drawing Shapes, Maps and Waveforms.

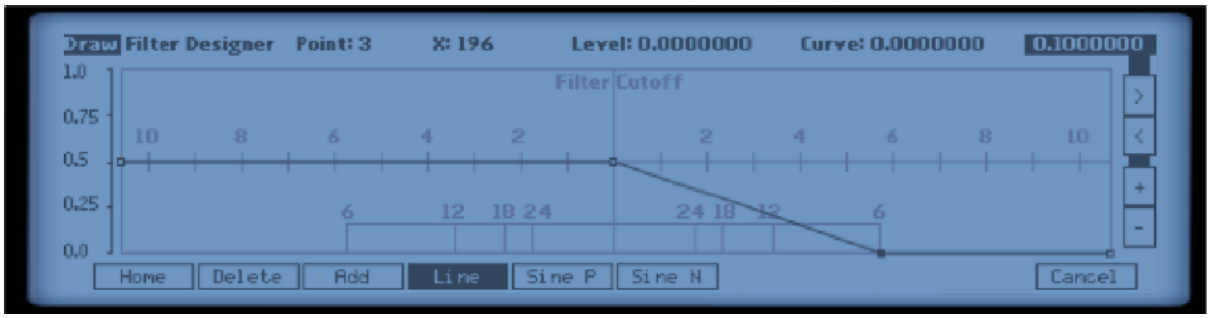


Figure 86 - The Filter Designer

The Filter Designer gives you the ability to draw more precise filter impulse responses which can be used as a starting point for later editing using the Filter Edit screen. The following diagram describes the elements of the Filter Designer Screen.

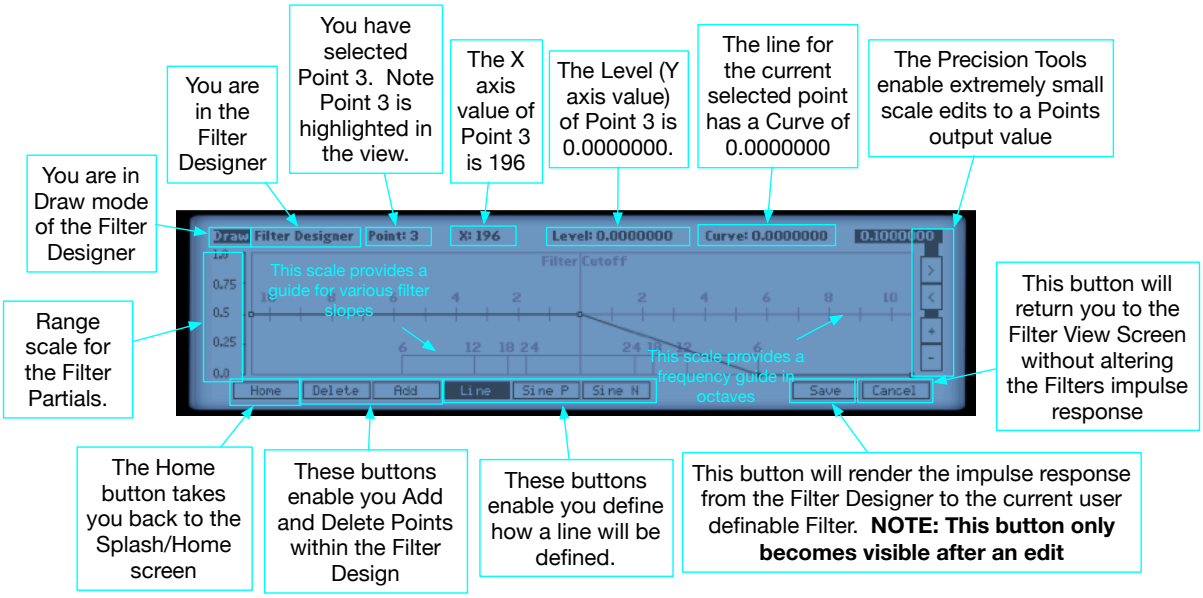


Figure 87 - Elements of The Filter Designer

Note the Save button in the Filter Designer only gets displayed after you have made an edit to the Filter Design.

Adding a Point

In order to add a point while in the Filter Designer, simply select the Add button in the navigation bar. Note this will highlight the Add button meaning you are in Add mode. Next, select a location within the Filter Designer grid where you want the point to go. Upon releasing the mouse button the point will be added, the Add button will become 'unselected' and the added point will become the selected point. If you have already added the maximum number of points (which is 22) the Add button will not appear.

Deleting a Point

In order to delete a point while in the Filter Designer, simply select the point you want to delete and press the delete button. Upon pressing the delete button the point will be removed from the filter impulse response design. Note that the first and last points can never be deleted and that if these points are selected the Delete button is not available. Also note that the minimum number of points is 2. If a Filter Design only contains 2 points then the Delete button is also not available.

Changing the Line Type

Every point within a Filter Design has a line type. The line type enables you to control how the line from the previous point to the current selected point is drawn. The available line types are as follows.

Line Type	Description
Line	This line type results in a straight line being drawn from the previous point with an optional logarithmic or exponential curve applied. A Curve can be applied to a 'Line' by selecting a mid point of the line and dragging the line to result in an appropriate or user desire curve amount.
Sine P	This line type results in a sine wave with a positive phase to be drawn from the previous point. Note you cannot alter the curve of a Sine P line type.
Sine N	This line type results in a sine wave with a negative phase to be drawn from the previous point. Note you cannot alter the curve of a Sine N line type.

To change the line type of a point, simply select the point which will display the current line type of the point, and then select a different line type (Line, Sine P or Sine N). The curve of the line will altered. If you select 'Line' as the line type, note that you can apply a logarithmic or exponential curve to the line by selecting a point on the line and dragging that point to affect a curve of the line. Sine P and Sine N curves can not be altered this way as they are defined by the Sine Function.

Envelopes

An envelope is a modulator which can be used to shape sound by adding a contour. Typically, envelopes are used to modulate (shape) the amplitude of a sound but can also be used to modulate the filters, pitch or a myriad of other parameters.

Envelopes typically have several stages. Spectra's Envelopes are Multi-Segmented which means you can choose how many stages (between 2 and 16) you want for each envelope. Spectra's Harmonic Envelopes are six stage envelopes (DALDSR) consisting of Delay, Attack, Decay, Sustain and Release stages. An extra page on the Harmonic Envelope screen also enables the editing of the levels of the attack stage envelopes in the Harmonic Envelope.

Figure 88 - Navigating to the Envelope Screen.

MSEG's

Spectra has 3 Multi-Segmented envelopes each with from 2 to 16 stages. The Amplitude Envelope (Amp Env) in Spectra is hard wired to modulate the amplitude of Generator 1, Generator 2 and the Noise Generator. Envelope 1 and Envelope 2 are hard wired to modulate Filter 1 and Filter 2 Frequency respectively. This can be over-ridden though by ensuring both the Env# Amount and the Velocity knobs for the filter are set to 0.0. You can then apply modulations via the Modulation Matrix in any manner.

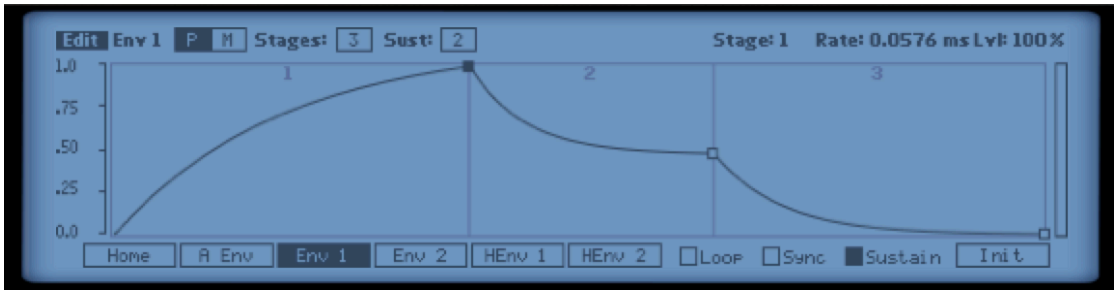


Figure 89 - The MSEG Envelope View Screen.

The following describes the elements of the MSEG View Screen.

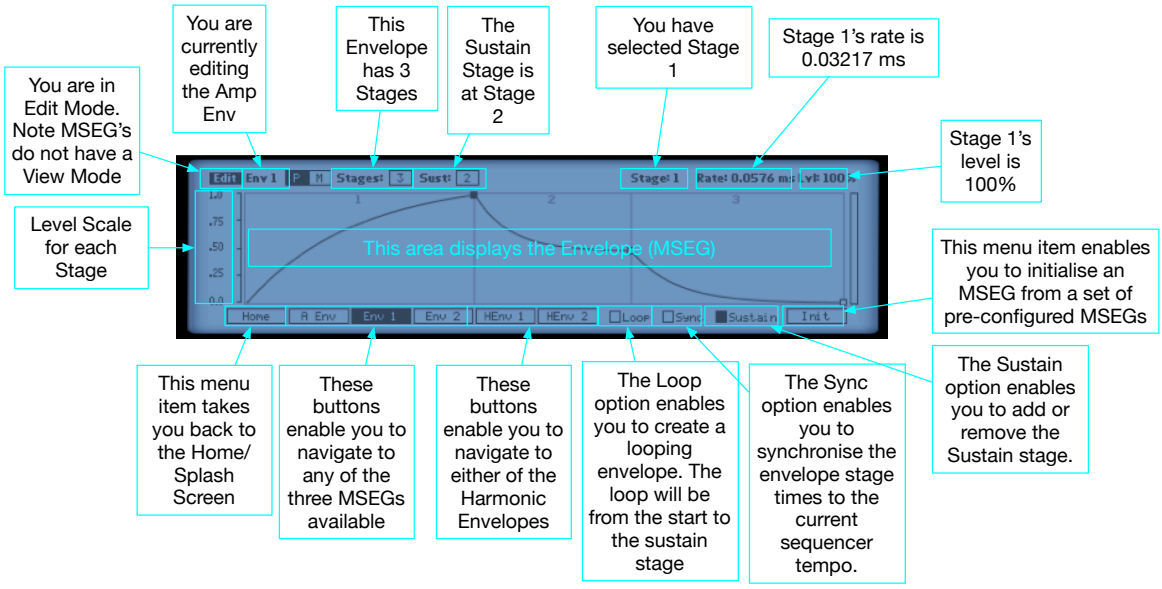


Figure 90 - Elements of the MSEG Envelope View Screen.

Loop

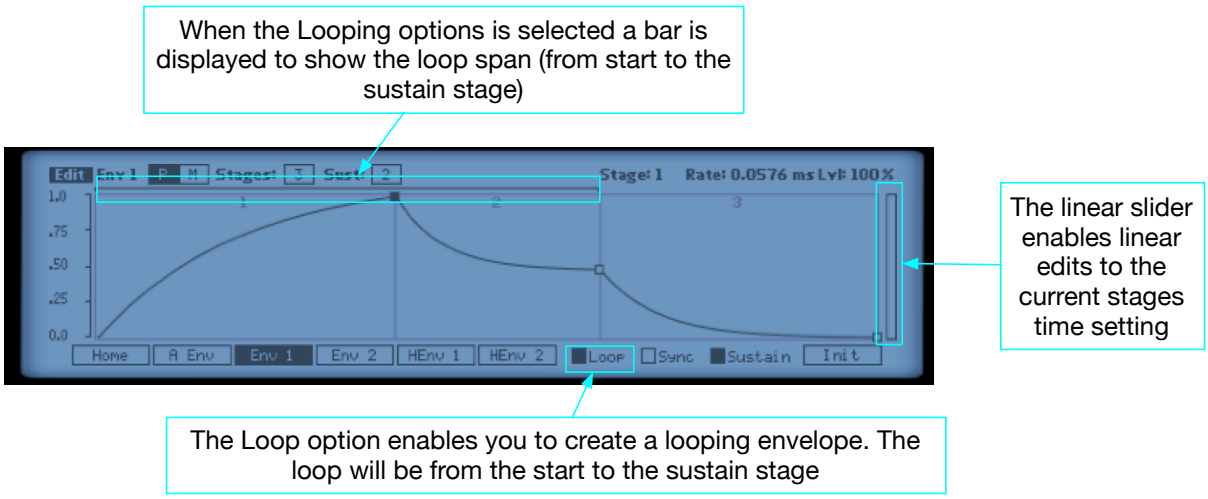


Figure 91 - Looping an MSEG.

Stage Levels

Envelope Stage Levels are as follows.

Level %	DB	Level %	DB	Level %	DB
100	0	65	-3.74173	30	-10.4576
95	-0.44553	60	-4.43697	25	-12.0412
90	-0.91515	55	-5.19275	20	-13.9794
85	-1.41162	50	-6.0206	15	-16.4782
80	-1.9382	45	-6.93575	10	-20
75	-2.49877	40	-7.9588	5	-26.0206
70	-3.09804	35	-9.11864	0	-Inf

Sync

The Sync parameter can be used to lock an MSEG's time to the current tempo. When the Sync control is on (lit) the MSEGs entire rate (sum of all stages) is locked to the current tempo based on the selected divisor.

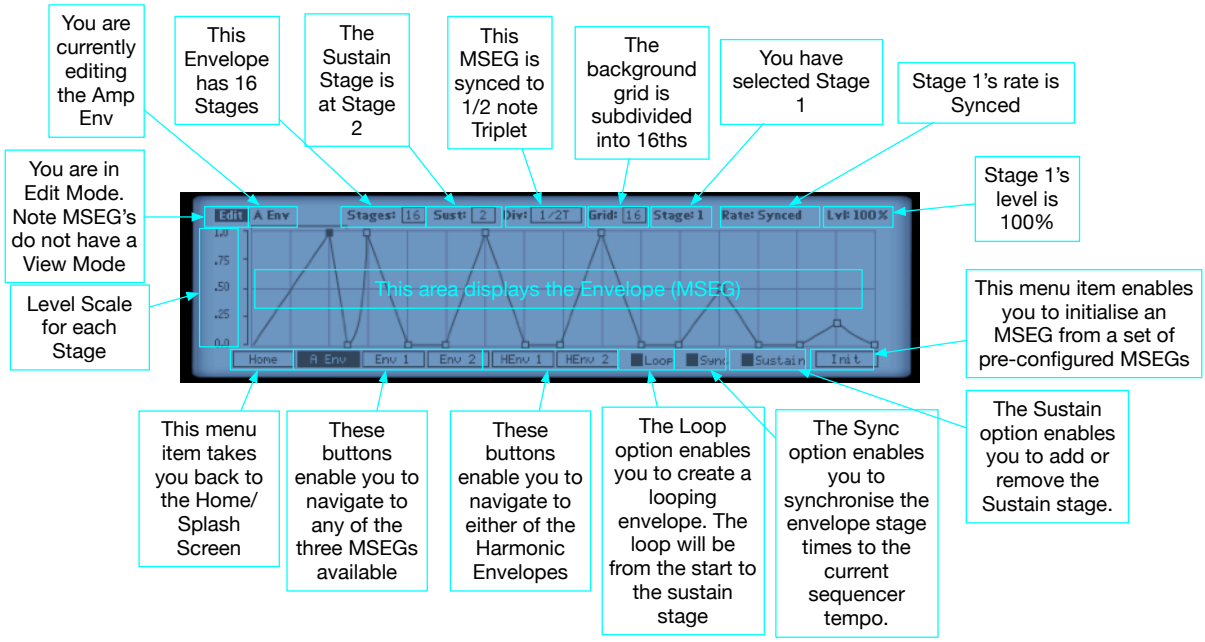


Figure 92 - Harmonic Envelope View Screen

The available divisors are as follows

No	Sync Type	Duration Description	No	Sync Type	Duration Description
1	1/32T	A thirty second note triplet	18	1/2	A half note
2	1/32	A thirty second note	19	1/2D	A dotted half note
3	1/32D	A dotted thirty second note	20	1/1T	A whole note triplet
4	1/16T	A sixteenth note triplet	21	1/1	A whole note
5	1/16	A sixteenth note	22	1/1D	A dotted whole note
6	1/16D	A dotted sixteenth note	23	2/1T	Two whole note triplets
7	1/8T	An eighth note triplet	24	2/1	Two whole notes
8	1/8	An eighth note	25	2/1D	Two dotted whole notes
9	1/8D	A dotted eighth note	26	4/1T	Four whole note triplets
10	3/8	3 1/8 Notes	27	4/1	Four whole notes
11	5/8	5 1/8 Notes	28	4/1D	Four dotted whole notes
12	6/8	6 1/8 Notes	29	8/1T	Eight whole note triplets
13	7/8	7 1/8 Notes	30	8/1	Eight whole notes
14	1/4T	A quarter note triplet	31	8/1D	Eight dotted whole wholes
15	1/4	A quarter note	32	16/1T	Sixteen whole note triplets
16	1/4D	A dotted quarter note	33	16/1	Sixteen whole notes
17	1/2T	A half note triplet	34	16/1D	Sixteen dotted whole notes

Harmonic Envelopes

As previously stated, an envelope is a modulator which can be used to shape sound by adding a contour.

A Harmonic envelope is an array of envelopes which when applied to the generator provide a contour to the amplitude of each harmonic in the Generator. This is an extremely powerful feature which enables you to easily create significant movement within a waveforms harmonics. Because each Generator has up to 256 harmonics, the Harmonic Envelopes in Spectra each have 256 DALDSR envelopes or one for each Harmonic.

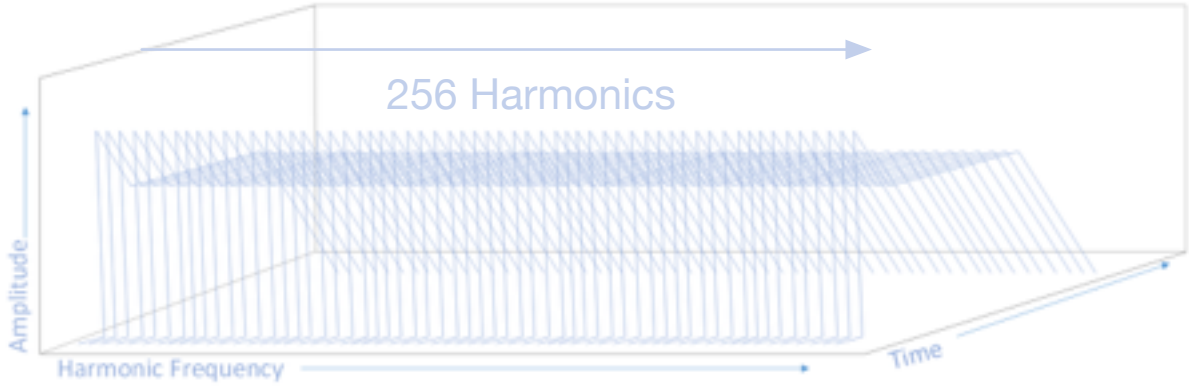


Figure 93 - Harmonic Envelope

Applying the Harmonic Envelopes

Spectra has 2 Harmonic Envelopes. You can freely assign these Harmonic Envelopes to Generator 1 and/or 2. Both Generators can share the same Harmonic Envelope. Both Generators can also have separate Harmonic Envelopes. Basically the Harmonic Envelopes are Amplitude Envelopes applied to each Harmonic before the Spectrums Harmonics are added together to create sound. The following diagram illustrates how the Harmonic Envelopes work in the context of a voice.

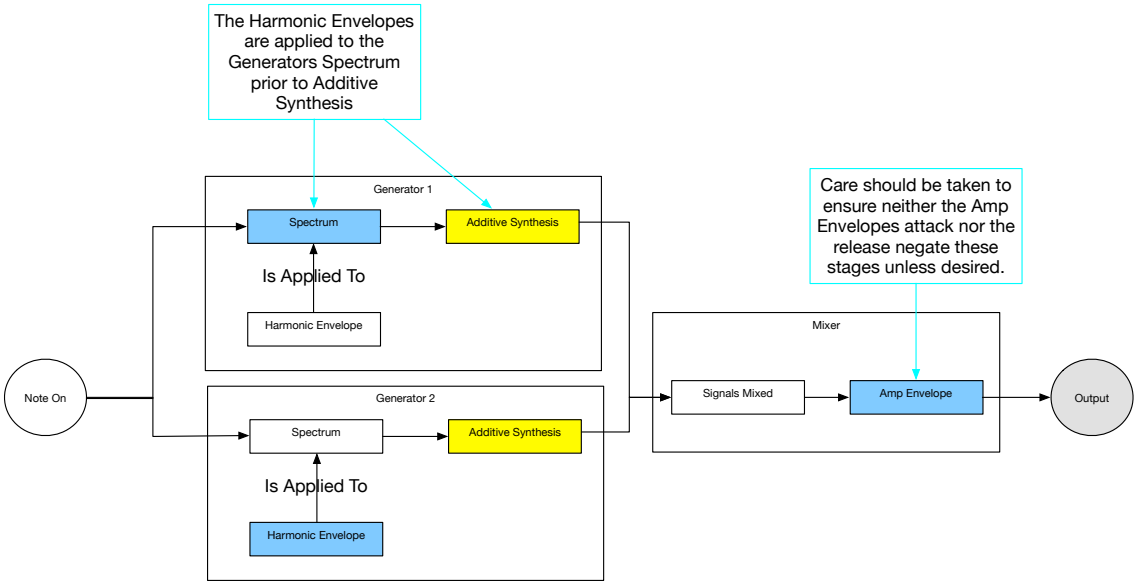


Figure 94 - Harmonic Envelopes and the Amplitude Envelope

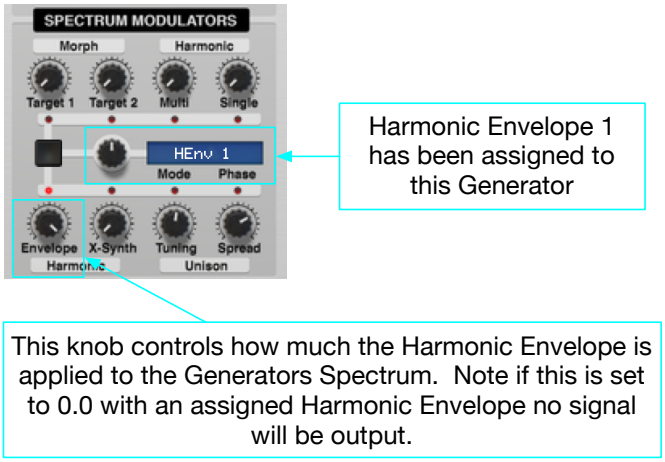


Figure 95 - Assigning a Harmonic Envelope to a Generator

Harmonic Envelope Navigation

The Harmonic Envelope View screen for each Harmonic Envelope enables you to see all 256 values for a single stage (i.e. Delay, Attack, Attack Level, Decay, Sustain or Release) at once. The following image of an arbitrary harmonic envelope shows all 256 Delay stages of Harmonic Envelope 1.

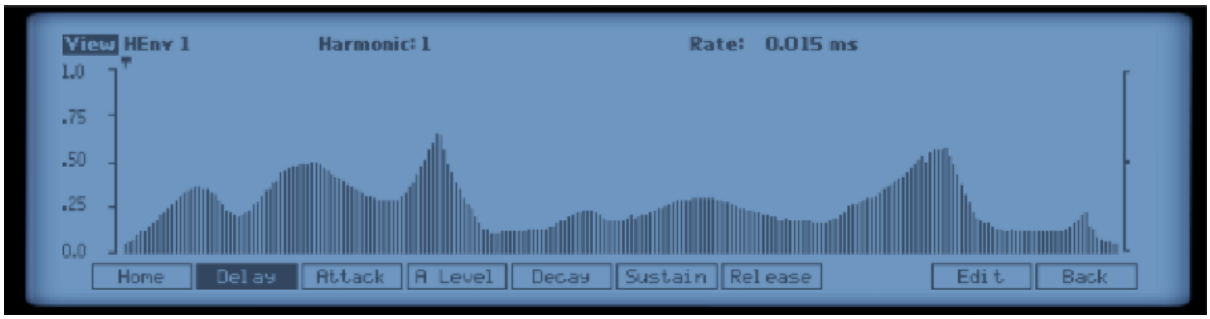


Figure 96 - Harmonic Envelope View Screen

The elements of the Harmonic Envelope View screen are described in the following diagram.

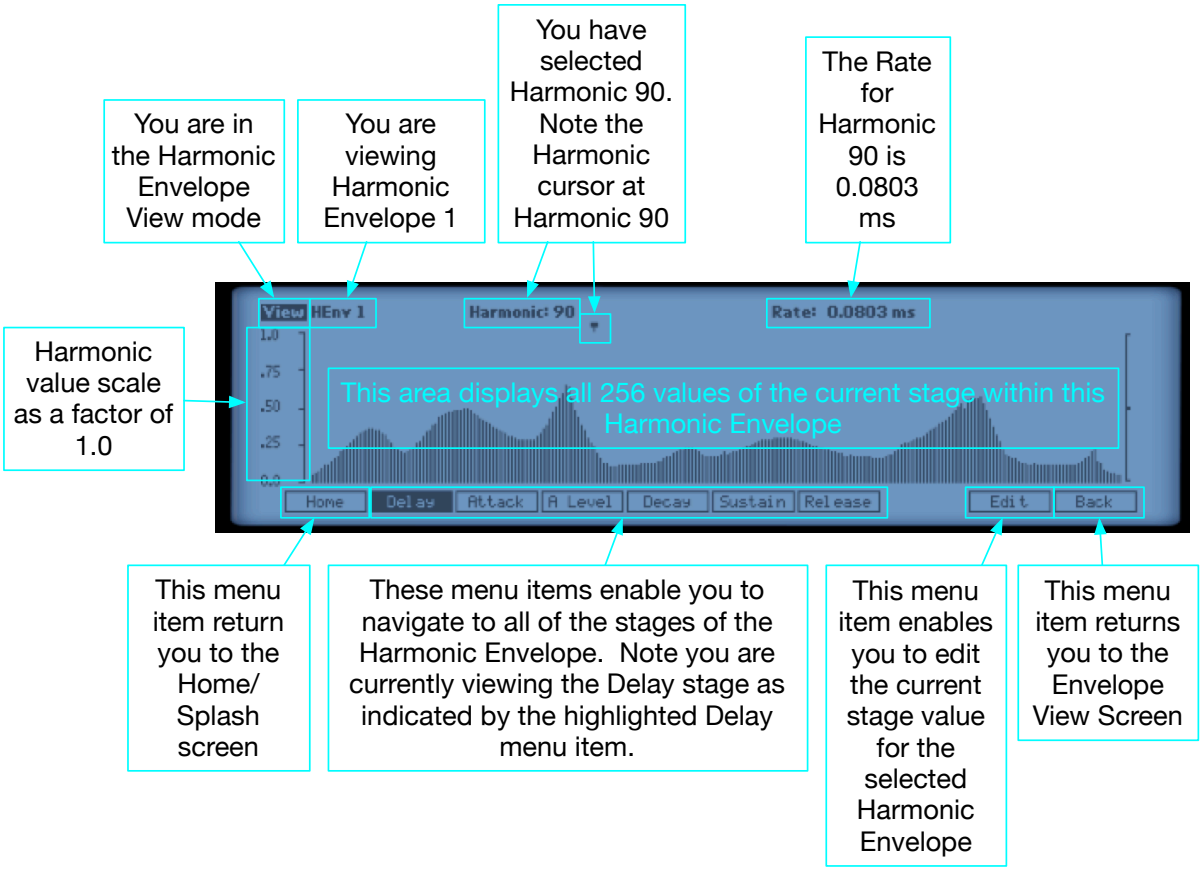


Figure 97- Elements of the Harmonic Envelope View Screen

Editing a Harmonic Envelope Stage

Spectra has 2 user configurable Harmonic Envelopes each with 6 editable stages. In Spectra you have a maximum of 256 harmonics so each stage of a Harmonic Envelope contains 256 Harmonics. Selecting the Edit navigation button in the Harmonic Envelope View screen takes you to the Harmonic Envelope Edit Screen for the currently selected stage.

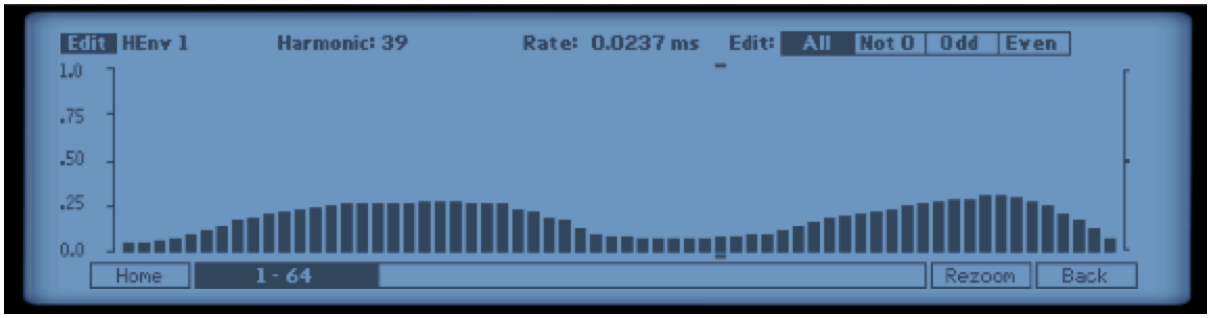


Figure 98 - Navigation buttons in the Spectrum Editor

Changing a Harmonic Envelope stage value is easy and intuitive. Simply place the mouse cursor on the harmonic you want to alter, press and hold the mouse button and move the mouse to the desired level. As you perform this function the display will provide feedback about the current value. The following diagram describes the elements of the Multi Edit Screen.

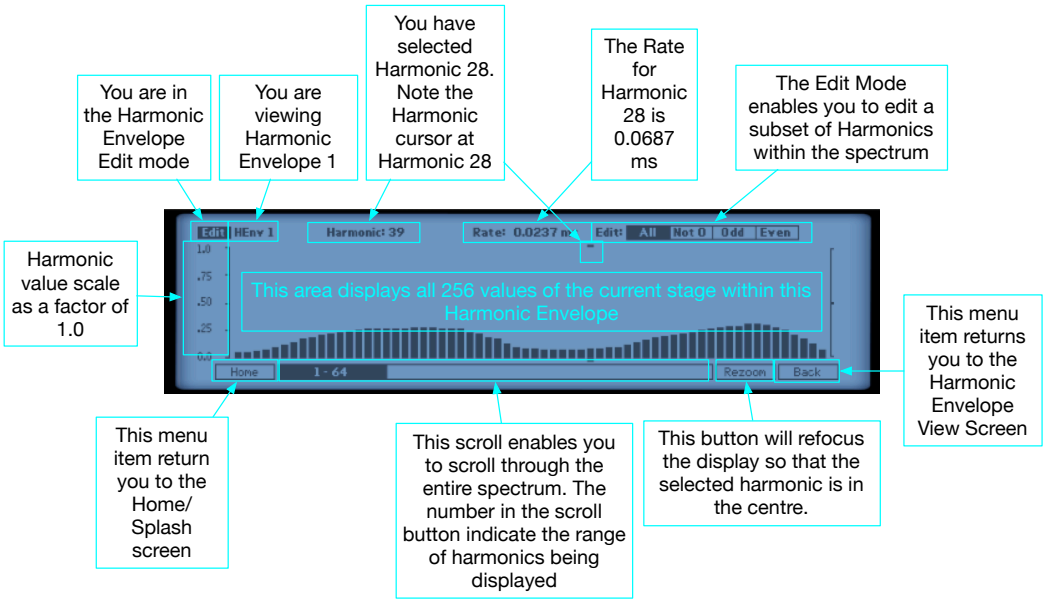


Figure 99 -Elements of the Harmonic Envelope Edit Screen

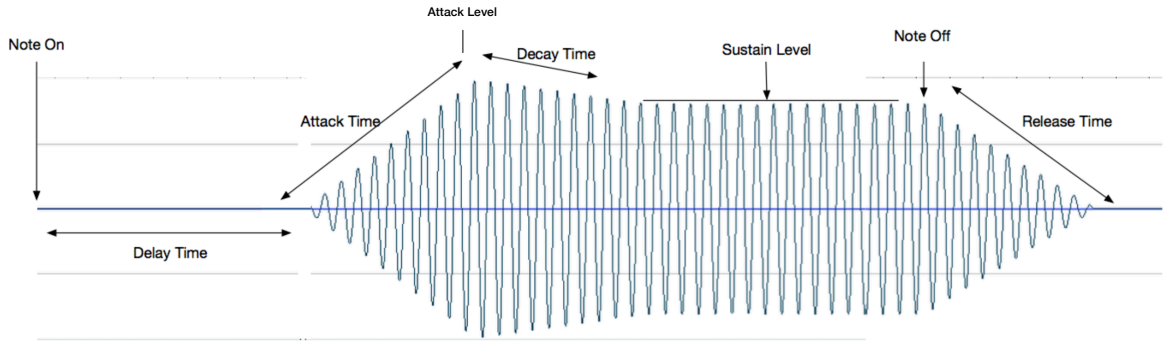


Figure 100 - Each Envelope in the Harmonic Envelope is a DALDSR Envelope

Delay

This parameter sets the amount of time the envelope will take before initiating the Attack stage. During the delay stage the envelope generates 0 values. This means if an envelope with a Delay stage greater than 0 is applied to a Generators amplitude there will be silence from the moment the key is pressed until the completion of the Delay stage or start of the Attack Stage.

Attack

This parameter sets the amount of time the envelope will take to get from the initial 0 level to the peak envelope level. The Attack stage begins after the completion of the Delay level. If the Delay level is set to 0 then the Attack stage begins immediately when a key is pressed.

Attack Level

This parameter sets the level that the envelope will reach once the Attack stage has completed.

Level	DB	Level	DB	Level	DB
1.00	0	0.65	-3.74173	0.3	-10.4576
0.95	-0.44553	0.6	-4.43697	0.25	-12.0412
0.9	-0.91515	0.55	-5.19275	0.2	-13.9794
0.85	-1.41162	0.5	-6.0206	0.15	-16.4782
0.8	-1.9382	0.45	-6.93575	0.1	-20
0.75	-2.49877	0.4	-7.9588	0.05	-26.0206
0.7	-3.09804	0.35	-9.11864	0.001	-60

Decay

This parameter sets the amount of time the envelope will take to get from the peak level (completion of the Attack stage) to the Sustain level. Note, if the Sustain level is set to 100% then the Decay level is effectively 0ms.

Sustain

This parameter sets the level that the envelope will reach once the Decay stage has completed.

Level	DB	Level	DB	Level	DB
1.00	0	0.65	-3.74173	0.3	-10.4576
0.95	-0.44553	0.6	-4.43697	0.25	-12.0412
0.9	-0.91515	0.55	-5.19275	0.2	-13.9794
0.85	-1.41162	0.5	-6.0206	0.15	-16.4782
0.8	-1.9382	0.45	-6.93575	0.1	-20
0.75	-2.49877	0.4	-7.9588	0.05	-26.0206
0.7	-3.09804	0.35	-9.11864	0.001	-60

Release

This parameter sets the amount of time the envelope will take to get from the sustain level to zero once the note has been released.

Sequences

Spectra has four spectral sequences which can modulate the morph target spectrum for Target 1 within each Spectrum Modulator section or the Filter Morph Targets for Filter 1 and Filter 2.

To navigate to the Sequence page in the Editor, simply select the 'Sequence' menu item in the Splash Screen (Home).

Figure 101 - Navigating to the Sequence Screen in the Editor

In Spectra there are two types of Sequences; Spectral Sequences or SSEQ's and Filter Sequences or FSEQ's.

Figure 102 - A Spectrum Sequence

Figure 103 - A Filter Sequence

These two types of Sequences behave exactly the same except for the fact that an SSEQ is a sequence of Waveform Spectra and can only be used within the Spectrum Modulators while the FSEQ is a sequence of Filter Spectra and can only be used by the Filter Morph Targets.

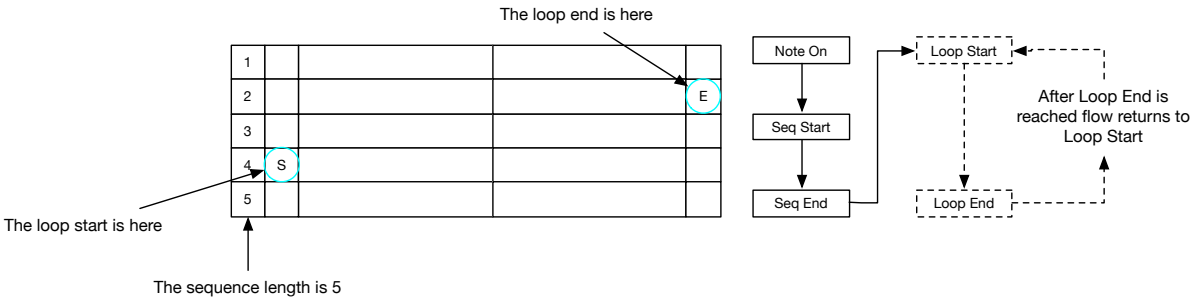


Figure 104 - Looping Sequence Flow

Each sequence can have a maximum of 10 stages and a minimum of 2. Further to this, both of the sequence types can operate as either one-shot or looped and each morph sequence can be configured to operate over time or driven by a modulation source.

Both sequence types operate within the scope of a voice, so there are essentially four sequences, 2 SSEQ's and 2 FSEQ's per voice. All of the Sequences for a voice which are modulated over Time are triggered by the note on event of the voice and play until the sequence is completed as in the case of a one-shot sequence or until the note dies out completely.

The following image explains the elements in the Sequence screen.

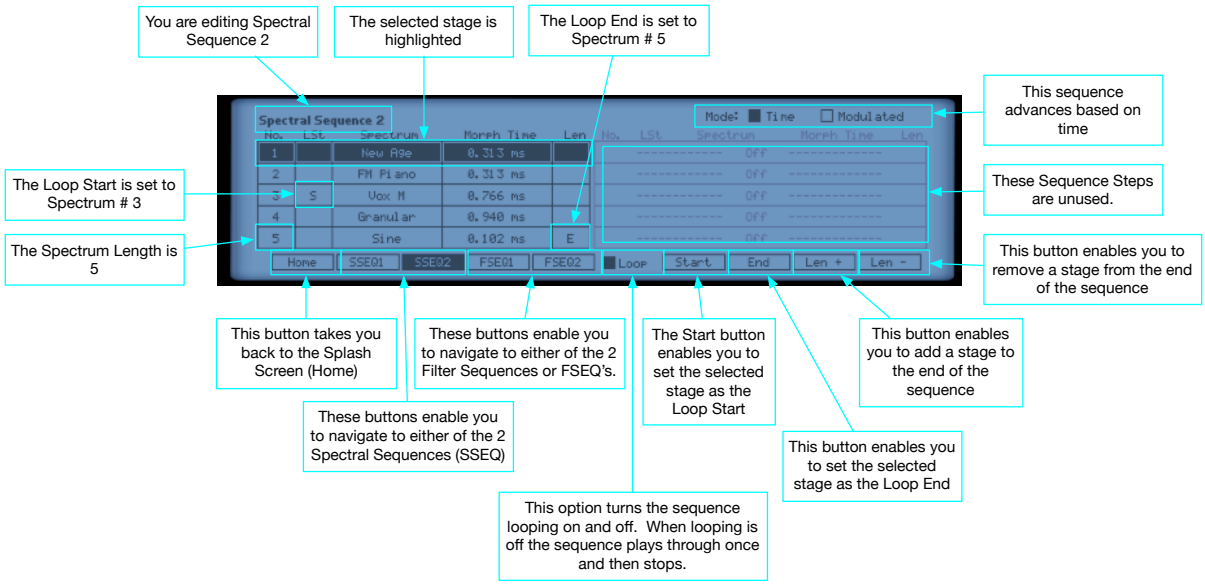


Figure 105 - Elements of the Sequence Screen

Morph Sequences and Spectral Modulation

It is important to understand the order spectrum mods are applied to the Generator spectrum in series per the following diagram.

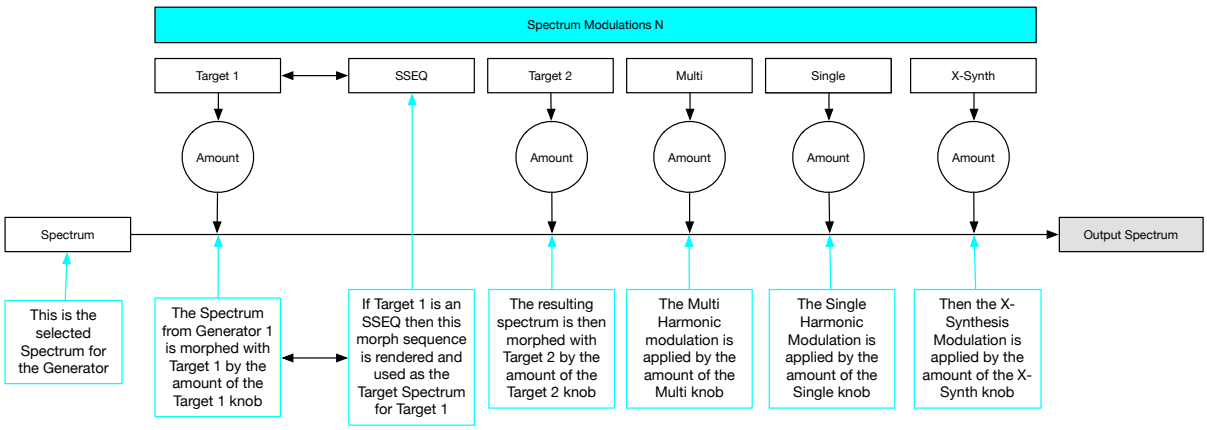


Figure 106 - SSEQ's in the context of Spectrum Modulation

Given this situation it is important to understand that some of the down-stream modulations applied after the spectral sequence more could potentially negate the sequence. For example if the amount knob for Target 2 is at 100% then the Spectral sequence will not be heard because Target 2 will be dominating the sound spectrum.

Using a Modulation Source to drive the Sequence

There may be times when you would like to drive a Sequence from a Modulation Source. In order to active this functionality take the following steps.

1. Configure your Morph Sequence as Desired and ensure you have specified "Modulation" as the Mode. Note the Morph Times do not require being set because the modulator will be driving the Sequence location.

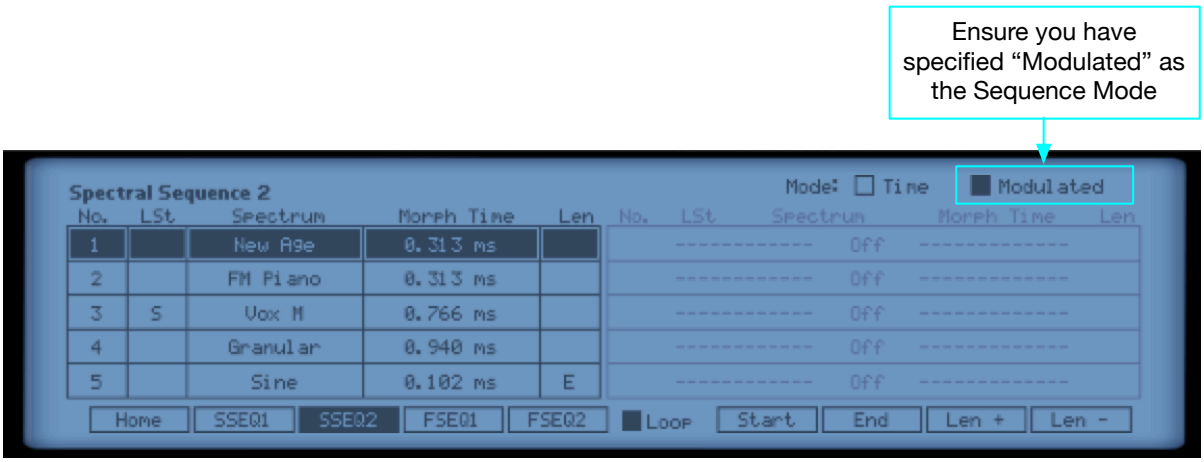


Figure 107 - Using a Modulation Source to drive a Sequence

2. Specify the sequence defined in Step 1 as the Target Spectrum for Target 1 for either or both Generator 1 and/or Generator 2.

Figure 108 - Set the Morph Target of Target 1 to the Sequence

3. Add a Modulation to the Modulation Matrix ensuring the destination is the sequence defined in Step 1 and you can now use the Modulator to move through the sequence.

Source	Map	Destination	Amt
Mod Wheel	0	Filter Seq2	100%

Figure 109 - Create a modulation for the Sequence

A previous version of Spectra from 2016 (Render by Nirude)

Analyser

Spectra contains a simple (periodic waveform) spectrum analyser. Spectral Waveform Analysis is a process which samples an audio waveform and then breaks the sound down into its component sine waves. From this component sine wave information, Spectra can then reconstruct or re-synthesise the waveform.

The waveform analyser in Spectra is optimised for determining periodic, harmonic content. What does this mean? Periodic waveforms are waveforms which have a similar repeating shape. For example a sawtooth, sine, square and triangle wave are all periodic waveforms.

Effectively this means the analyser in Spectra is a waveform analyser. Spectral Waveform Analysis analyses the waveform input in order to determine the magnitude (and phase) of each analysed frequency band within the sound. All of the bands together represent the analysed spectrum frequency range. In engineering terms this is often referred to as transforming a signal from the time domain to the frequency domain.

All of the waveform spectra within Spectra were developed using the Analyser except for the Sine, Saw, Square, Triangle and Silence Spectrums. These were made using established mathematical equations for computing these spectra.

Spectra's Analysis Capabilities Explained

Spectra cannot reproduce any sound from analysis.

Spectra is optimised to perform "Point in Time" analysis. Point in Time analysis means that Spectra can analyse multiple consecutive frames of audio but relies on a single frame for determining the analysed spectrum. Each frame is usually around 46 milliseconds. Because of this relatively short analysis time, Spectra is optimised for analysing periodic, harmonic sounds. As previously stated, a harmonic sound is a sound made from a Fourier series of sine waves. In a Fourier series the first harmonic is created by a sine wave oscillating at the fundamental frequency, the second harmonic is also created by a sine wave but it oscillates at 2 times the rate of the fundamental, and so on.

This means that Spectra as its implemented now, will not be able to analyse inharmonic sounds. An inharmonic sound is any sound which does not follow the Fourier series approach for its construction. Inharmonic sounds often sound like metal clangs, noise and/or some drum or percussive sounds. You can approximate these by using the ring modulator which creates the sum and difference of the frequencies from Gen1 and Gen2 and/or various tunings of the Generators.

Pseudo Inharmonic sounds can be drawn in the editor. You can create a pseudo inharmonic sound by drawing a spectrum and zeroing some of the beginning harmonics.

Because Spectra performs analysis from a single frame, as its implemented now, **Spectra will not be able synthesise speech or any sound longer than its current single frame analysis duration of 46 milliseconds.**

While this implementation does determine some limitations to Spectra's capability the analyser can be used to re-synthesise an almost infinite array of harmonic (periodic) waveforms.

For people familiar with the K5000 series of synthesisers made by Kawai, Spectra's Analysis capabilities are similar to the analysis features provided by the sound diver application for the K5000.

The Analysis Process

The analysis process in Spectra has been designed much like a wizard in order to walk you through the process. Once you start the process the process will guide you through each step required to achieve a result.

Each of these steps will be described in some detail in the following sections. In each section the process diagram illustrated below will be used to show where you are in the process. The process is relatively simple with the only deviation of the process being the selection of internal, sampling or drawing a waveform as the source for your analysis. As you can see from the process diagram below most of the steps are replicated for internal and external analysis.

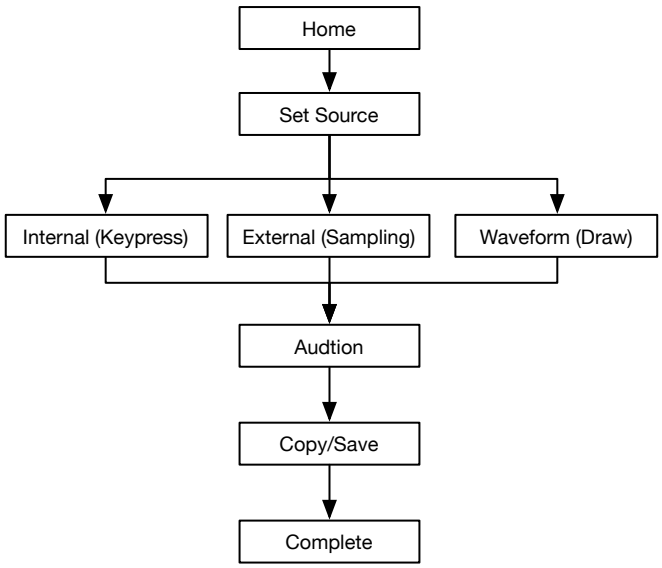


Figure 110 - The Analysis Process (High Level)

Initiating Analysis

The spectral analyser can be accessed via the home screen by selecting the "Analyser" menu item.

Figure 111 - The Analyser button in the Splash Screen

Selecting the Source

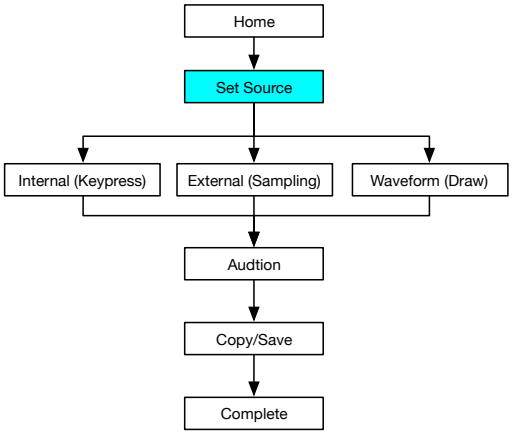


Figure 112 - Selecting the Source Input in the Analysis Process

After selecting the Analyser option in the home screen, you must specify the source of the audio to be analysed per the following screen.

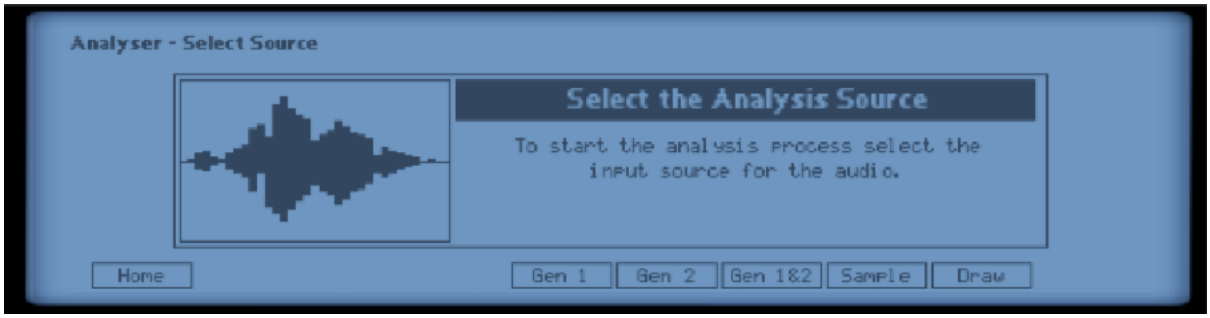


Figure 113 - Selecting the input source for Spectral Analysis

Analysis can be performed either from a number of sources. When analysing from an Internal Source you have the option of using Generator 1, Generator 2 or Generator 1 and 2 as the analysis source. During analysis from an internal source, all of the Spectrum Modulations are applied and added to the result.

Analysis from a Sample source means that Spectra can analyse an external signal. The Analyser also has the capability to enable you to draw a periodic Waveform for analysis.

Analysing an Internal Source

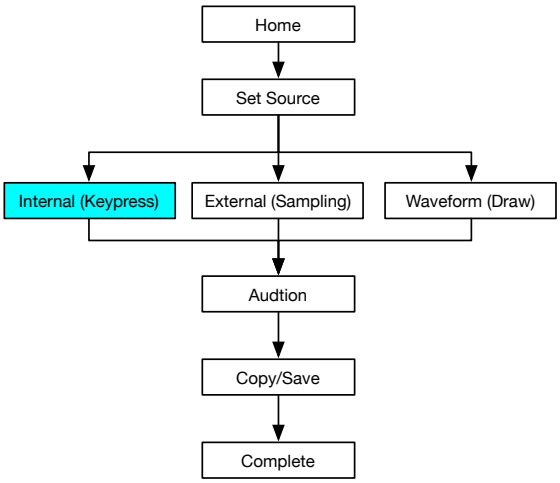


Figure 114 - Analysing a Single Internal Generator

Spectra can analyse the output of its own Generators (with the exception of the Noise Generator). The following diagram shows what happens when you analyse from an internal source using either Generator 1 or Generator 2 as the analysis source.

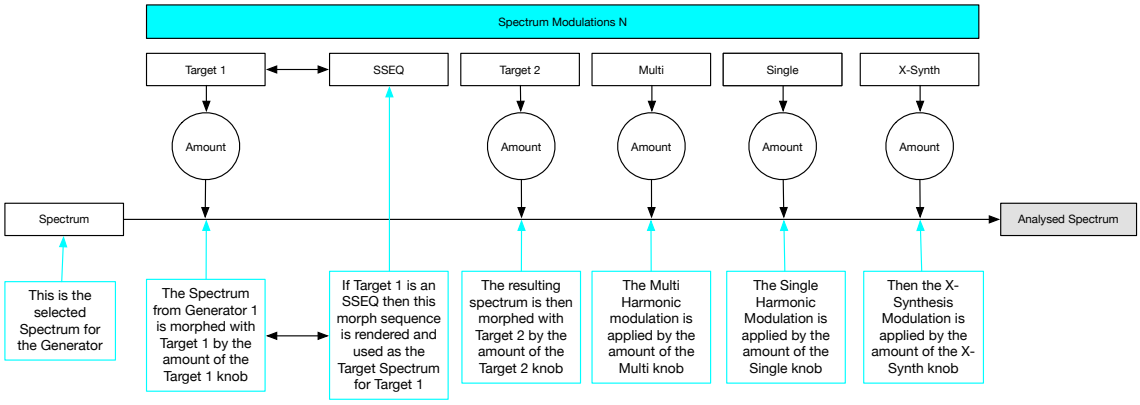


Figure 115 - Analysing a Single Internal Generator

It should be noted that if Morph Target 1 is set for a Morph Sequence the result will depend on where in the morph sequence the analysis is performed. Effectively if you stop playing (all notes) the analysis will be taken from the point where you stopped. The following diagram shows using both Generator 1 and Generator 2 as the analysis source.

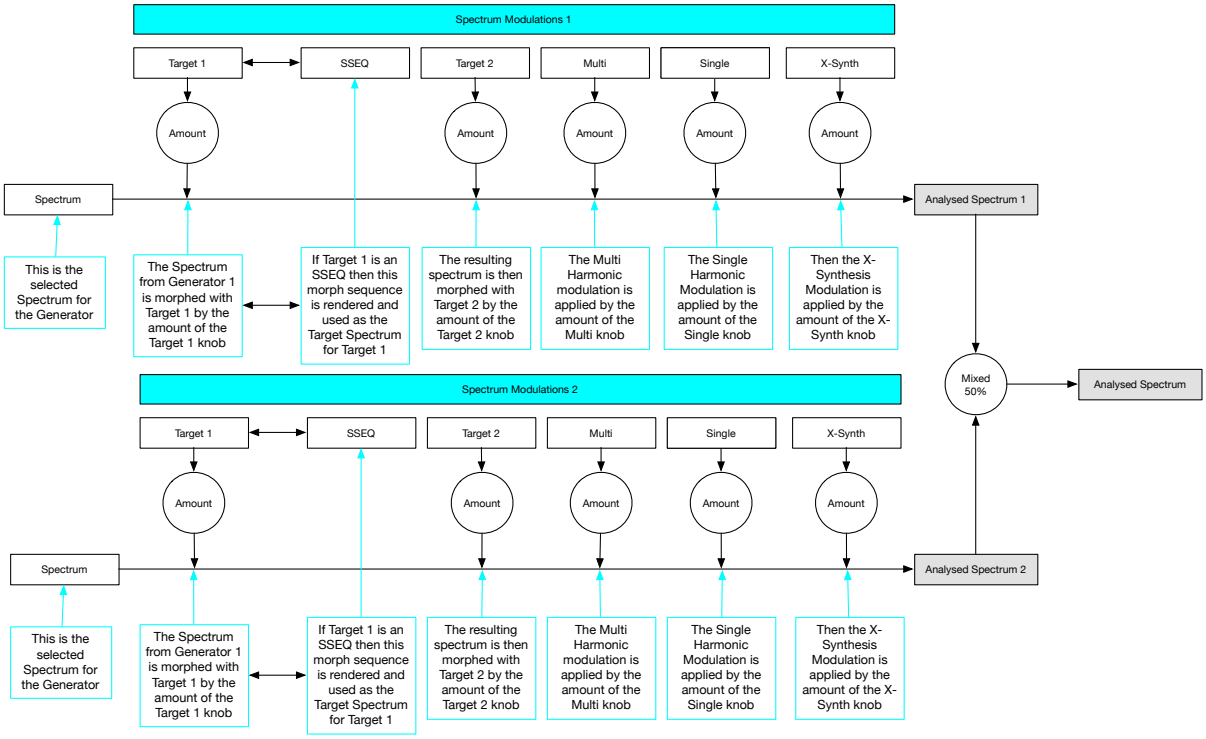


Figure 116 - Analysing both Internal Generators

It should be noted that if Morph Target 1 for Generator 1 and/or Generator 2 is set for a Morph Sequence the result will depend on where in the morph sequence the analysis is performed. Effectively if you stop playing (all notes) the analysis will be taken from the point where you stopped. Note that filter modulation or modulation of any kind is not included in the final analysed spectrum. Once a key has been played the Audition Screen is displayed.

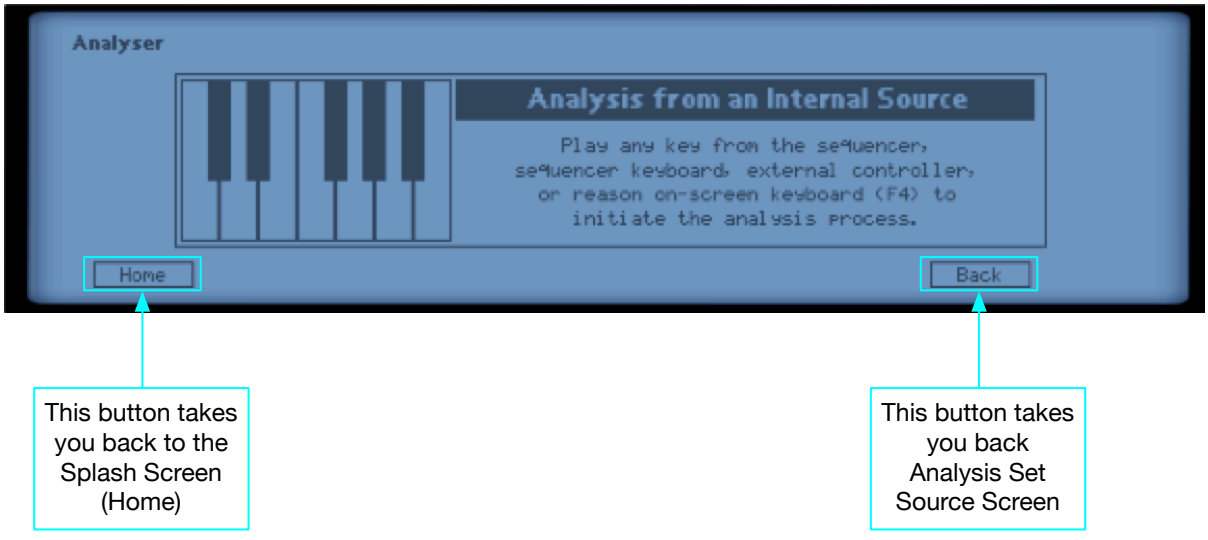


Figure 117- Analysis from an Internal Source

Analysing a Sample

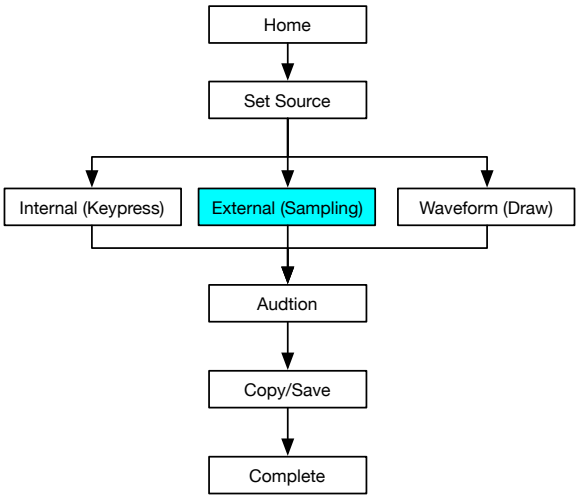


Figure 118 - External Source in the Analysis Process

Selecting the Sample option from the Analyser Set Source screen will take you to the Analysers Sample Page. If you haven't loaded any samples then the page will be displayed as follows.

Figure 119 - Analyser Sample Page with no Samples Loaded.

To load a sample you can use the Sample Browser. The Sample Browser is a Propellerhead component which enables Spectra to load samples.

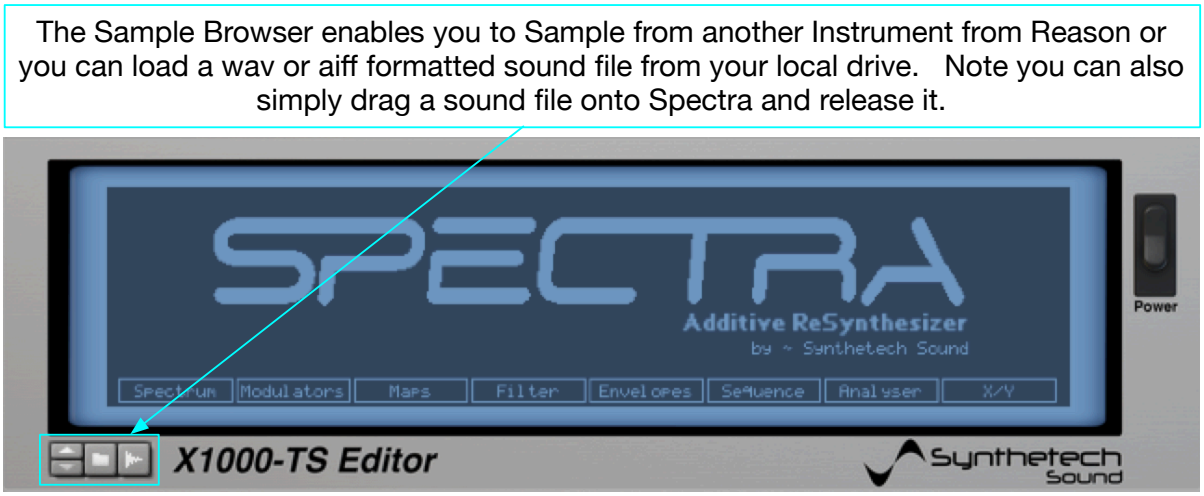


Figure 120 - The Sample Browser.

Once you have loaded a sample for analysis it is displayed in the editor.

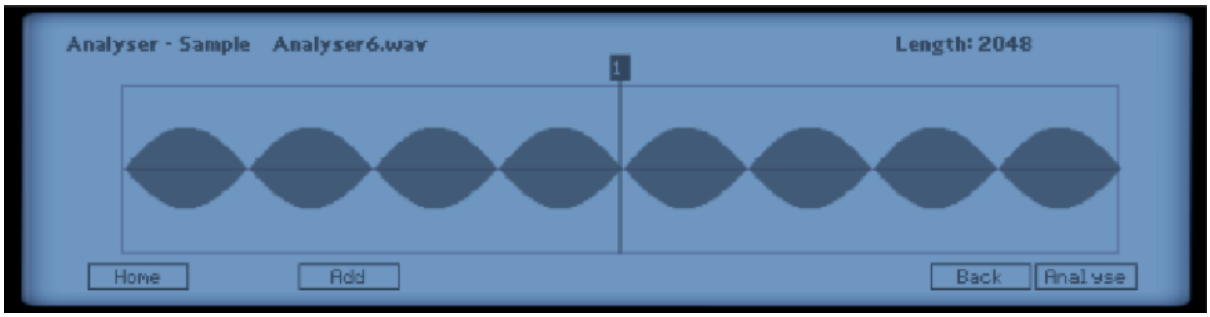


Figure 121 - Sample Waveform displayed in the Editor.

Spectra's Sampling Waveform display only displays the envelope of each waveform.

The following diagram explains the elements of the Sample screen in the Analyser.

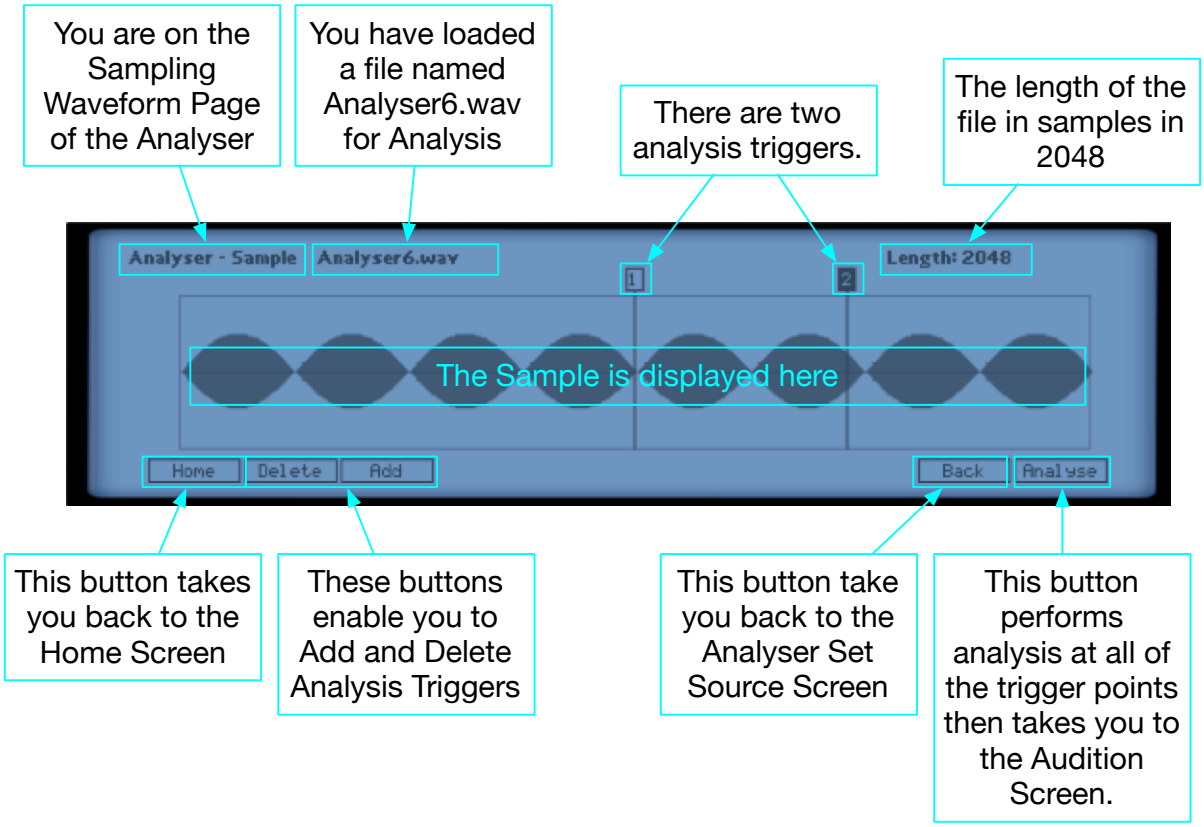


Figure 122 - Elements of the Sample Screen.

Adding a Trigger

In order to add a Trigger while in the Sample Screen, simply select the Add button in the navigation bar. Note this will highlight the Add button meaning you are in Add mode. Next, select a location within the Sample grid where you want the point to go. Upon releasing the mouse button the Trigger will be added, the Add button will become 'unselected' and the added Trigger will become the selected Trigger. If you have already added the maximum number of Triggers (10) the Add button will not appear.

Deleting a Trigger

In order to delete a Trigger while in the Sample Screen, simply select the Trigger you want to delete and press the delete button. Upon pressing the delete button the selected Trigger will be removed from the display. Note Trigger 1 can never be deleted if there is only 1 Trigger the Delete button is not available.

Drawing a Waveform for Analysis

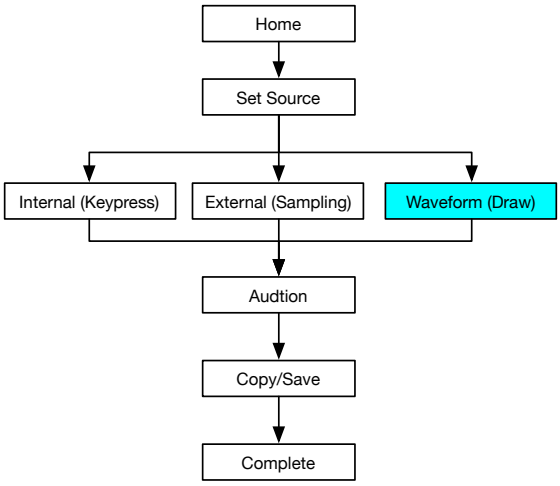


Figure 123 - Waveform Draw in the Analysis Process.

Spectra enables the user to draw a waveform for analysis. The waveform is always considered to be periodic so the last point will always have the same Level as the first point. Selecting the Draw navigation button in the Analyser Set Source screen takes you to the Waveform Draw Screen.

Figure 124 - the Waveform Draw Screen in the Analyser

Changing a Waveform point value is easy and intuitive. Simply place the mouse cursor on a point you want to alter, press and hold the mouse button and move the mouse to the desired location. As you perform this function the display will provide feedback about the current value. If you make a change and want to undo it, you can use the Undo function via the Reason -> Edit -> Undo menu item or alternatively use the key command of CTL+Z. The following diagram describes the element of the Waveform Draw Screen.

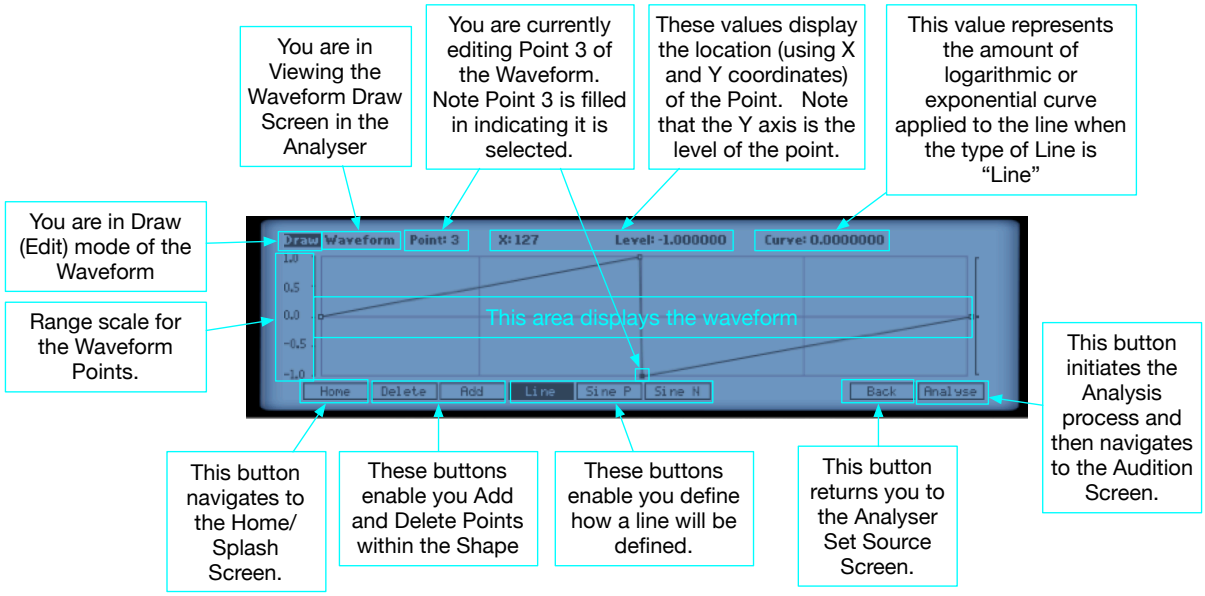


Figure 125 - Elements of the Waveform Draw Screen

Adding a Point

In order to add a point while in the Waveform Draw Screen, simply select the Add button in the navigation bar. Note this will highlight the Add button meaning you are in Add mode. Next, select a location within the Waveform grid where you want the point to go. Upon releasing the mouse button the point will be added, the Add button will become 'unselected' and the added point will become the selected point. If you have already added the maximum number of points the Add button will not appear.

Deleting a Point

In order to delete a point while in the Waveform Draw Screen, simply select the point you want to delete and press the delete button. Upon pressing the delete button the point will be removed from the Waveform. Note that the first and last points can never be deleted and that if these points are selected the Delete button is not available. Also note that the minimum number of points is 2. If a Waveform only contains 2 points then the Delete button is also not available.

Changing the Line Type

Every point within a Waveform has a line type. The line type enables you to control how the line from the previous point to the current selected point is drawn. The available line types are as follows.

Line Type	Description
Line	This line type results in a straight line being drawn from the previous point with an optional logarithmic or exponential curve applied. A Curve can be applied to a 'Line' by selecting a mid point of the line and dragging the line to result in an appropriate or user desire curve amount.
Sine P	This line type results in a sine wave with a positive phase to be drawn from the previous point. Note you cannot alter the curve of a Sine P line type.
Sine N	This line type results in a sine wave with a negative phase to be drawn from the previous point. Note you cannot alter the curve of a Sine N line type.

To change the line type of a point, simply select the point which will display the current line type of the point, and then select a different line type (Line, Sine P or Sine N). The curve of the line will altered. If you select 'Line' as the line type, note that you can apply a logarithmic or exponential curve to the line by selecting a point on the line and dragging that point to affect a curve of the line. Sine P and Sine N curves can not be altered this way as they are defined by the Sine Function.

Auditioning

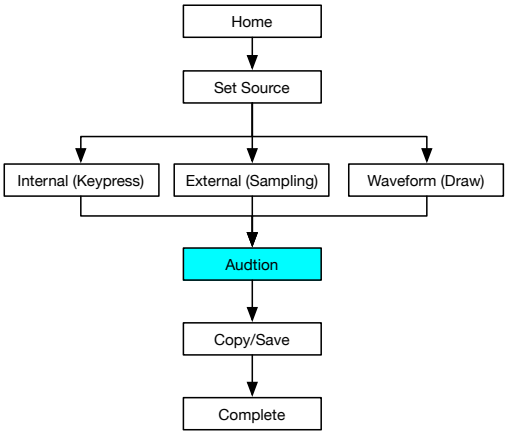


Figure 126 - Auditioning Stage of the Analysis Process

The audition stage of the analysis process lets you hear the analysis results. To audition the analysed spectrum you can play a note either on your controller keyboard, via the on screen Piano keys (F4) or by playing a note within the sequencer.

When auditioning an analysed spectrum it is important to remember that playback of the analysed spectrum is via one Generator only without any modulation of any type. This is because at this stage the critical decision is around whether or not you have accurately captured the timbre of the input source. Movement of the spectrum and/or sound can be added outside of the analysis process.

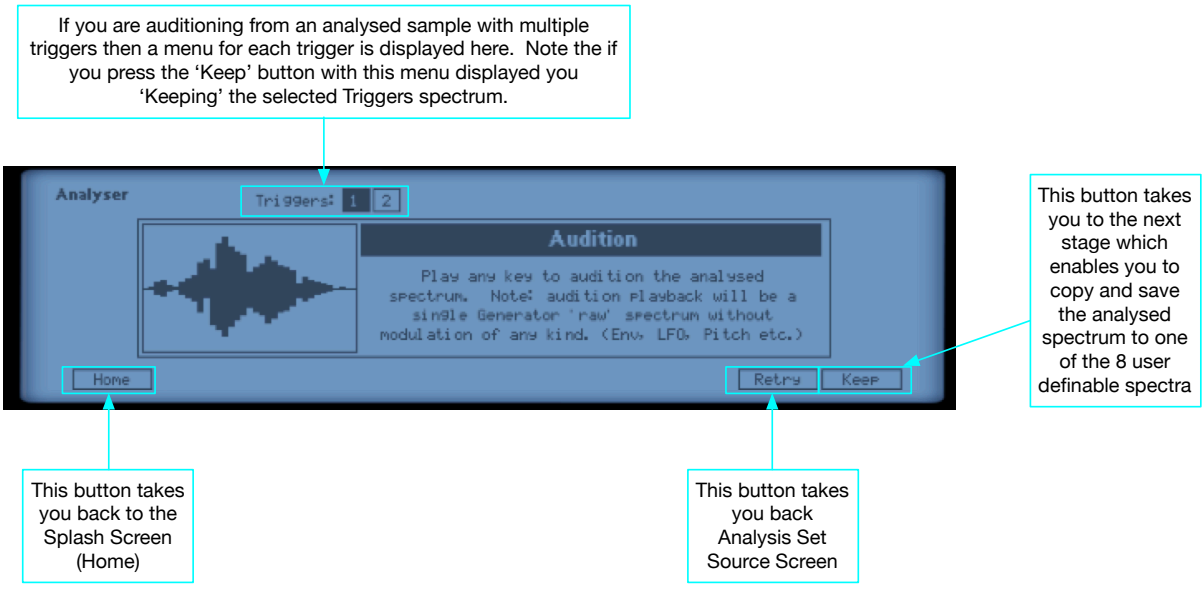


Figure 127 - The Audition screen of the Analysis Process

Copying and Saving the Spectrum

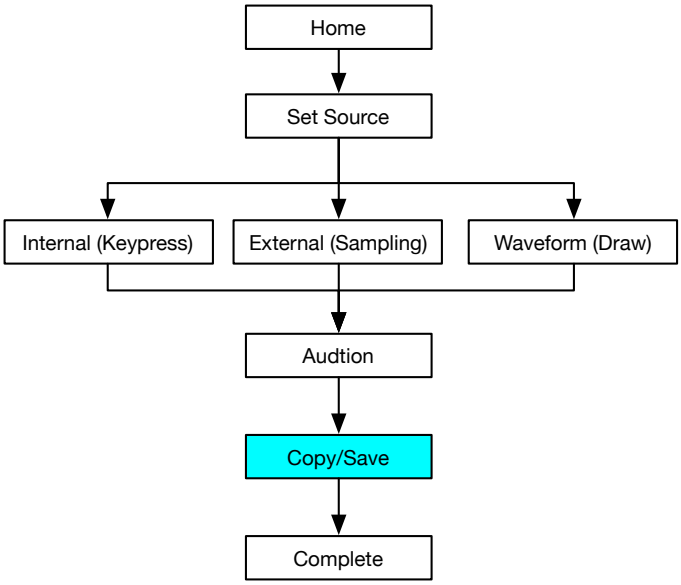


Figure 128 - Copying and Saving stage of the Analysis Process

This step of the process lets you specify one of the 10 user definable spectra locations in which to save your analysed spectrum.

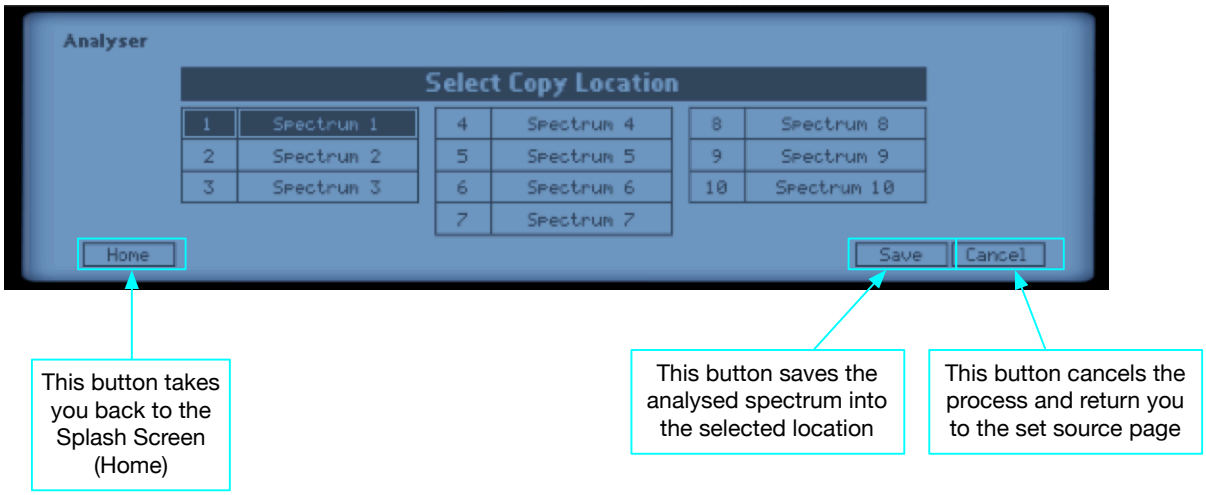


Figure 129 - Specifying the Save location for an Analysed Spectrum

Completing the Analysis Process

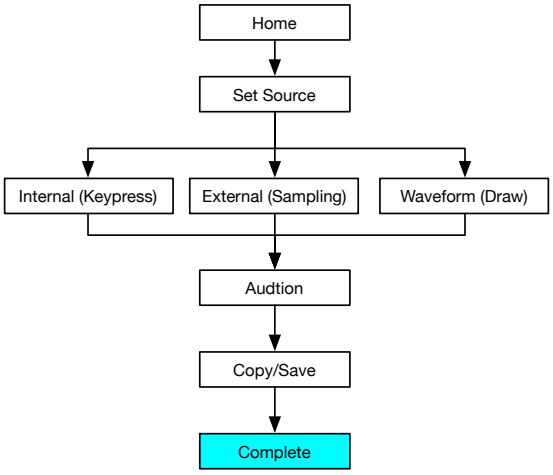


Figure 130 - The completion stage of the Analysis process

After Saving has been completed the 'Analysis Complete' screen is displayed. From here you can edit the spectrum you just analysed, analyse another waveform or quit the analysis process. The following image depicts the Analysis Complete Screen and describes the functions for each button.

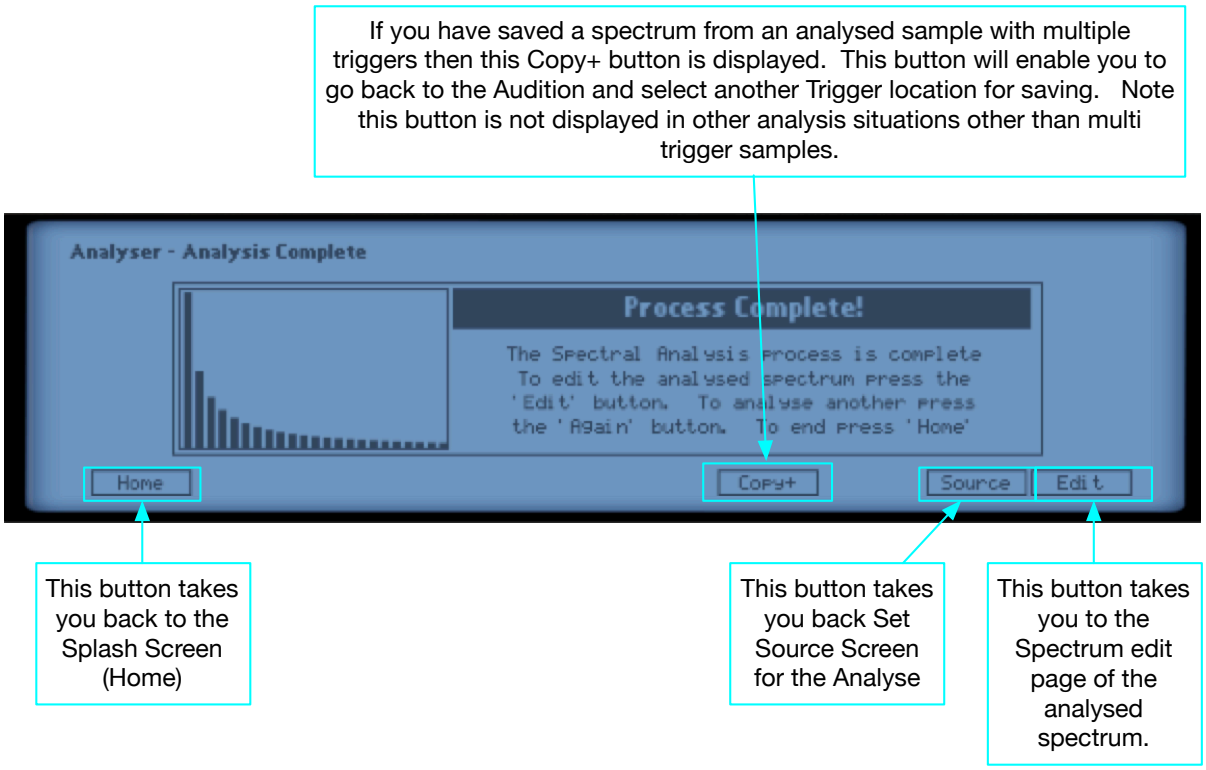


Figure 131 - Analysis Process - Process Complete!

XY Controllers

Figure 132 - Navigating to Spectra's XY Controllers

Spectra has 2 XY Controllers which serve as Modulation Sources. These modulation source controllers can be used to modulate any internal Modulation Destination and/or any external Modulation Destination.

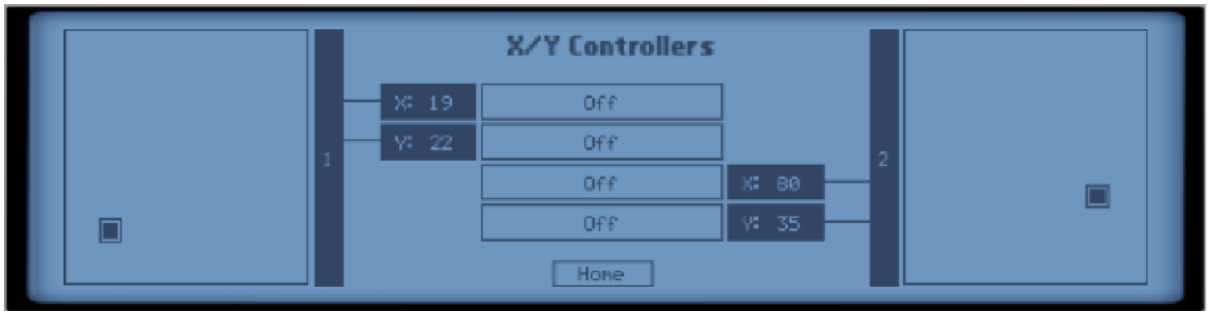


Figure 133 - Spectra's XY Controllers

To modulate an external device with the XY Controller you must connect the appropriate XY Controller CV Out (on the back panel) with the appropriate CV In on the target device.

The XY Controller Destinations control the routing of the XY Controller to an internal Spectra Modulation Destination. In addition, you can specify the XY Controllers as Modulation Sources within the mod matrix if you would like to modulate multiple modulation destinations with a single XY Controller source. The possible XY Controller Destination values are identical to the Modulation Destination Values in the mod matrix.

No	Destination	No	Destination	No	Destination
1	Off	23	Gen1 Tuning Crs	46	Gen2 Multi Amt
2	Amplitude	24	Gen1 Tuning Fn	47	Gen2 Single Amt
3	Gen1&2 Freq	25	Gen1 Level	48	Gen2 HEnv Amt
4	Gen1&2 Tun Crs	26	Gen1 Pan	49	Gen2 Synth Amt
5	Gen1&2 Tun Fn	27	Gen1 Ring	50	Gen2 Uni Tuning
6	Gen1&2 Level	28	Gen1 Harmonic	51	Gen2 Uni Spread
7	Port Time	29	Gen1 Morph1 Amt	52	Noise Level
8	LFO1 Rate	30	Gen1 Morph2 Amt	53	Noise Pan
9	LFO2 Rate	31	Gen1 Multi Amt	54	Spectral Seq1
10	AEnv Attack	32	Gen1 Single Amt	55	Spectral Seq2
11	AEnv Release	33	Gen1 HEnv Amt	56	Filter Seq1
12	Env1 Attack	34	Gen1 XSynth Amt	57	Filter Seq2
13	Env1 Release	35	Gen1 Uni Tuning	58	Mod 1 Amt
14	Env2 Attack	36	Gen1 Uni Spread	59	Mod 2 Amt
15	Env2 Release	37	Gen2 Frequency	60	Mod 3 Amt
16	Fil1 Frequency	38	Gen2 Tuning Crs	61	Mod 4 Amt
17	Fil1 Morph Amt	39	Gen2 Tuning Fn	62	Mod 5 Amt
18	Fil1 Env1 Amt	40	Gen2 Level	63	Mod 6 Amt
19	Fil2 Frequency	41	Gen2 Pan	64	Mod 7 Amt
20	Fil2 Morph Amt	42	Gen2 Phase	65	Mod 8 Amt
21	Fil2 Env2 Amt	43	Gen2 Harmonic	66	Mod 9 Amt
22	Gen1 Frequency	44	Gen2 Morph1 Amt	67	Mod 10 Amt
		45	Gen2 Morph2 Amt		

Controller 1 X Destination

The Controller 1 X Destination specifies the modulation destination to which the XY Controller 1 X source value is routed.

Controller 1 Y Destination

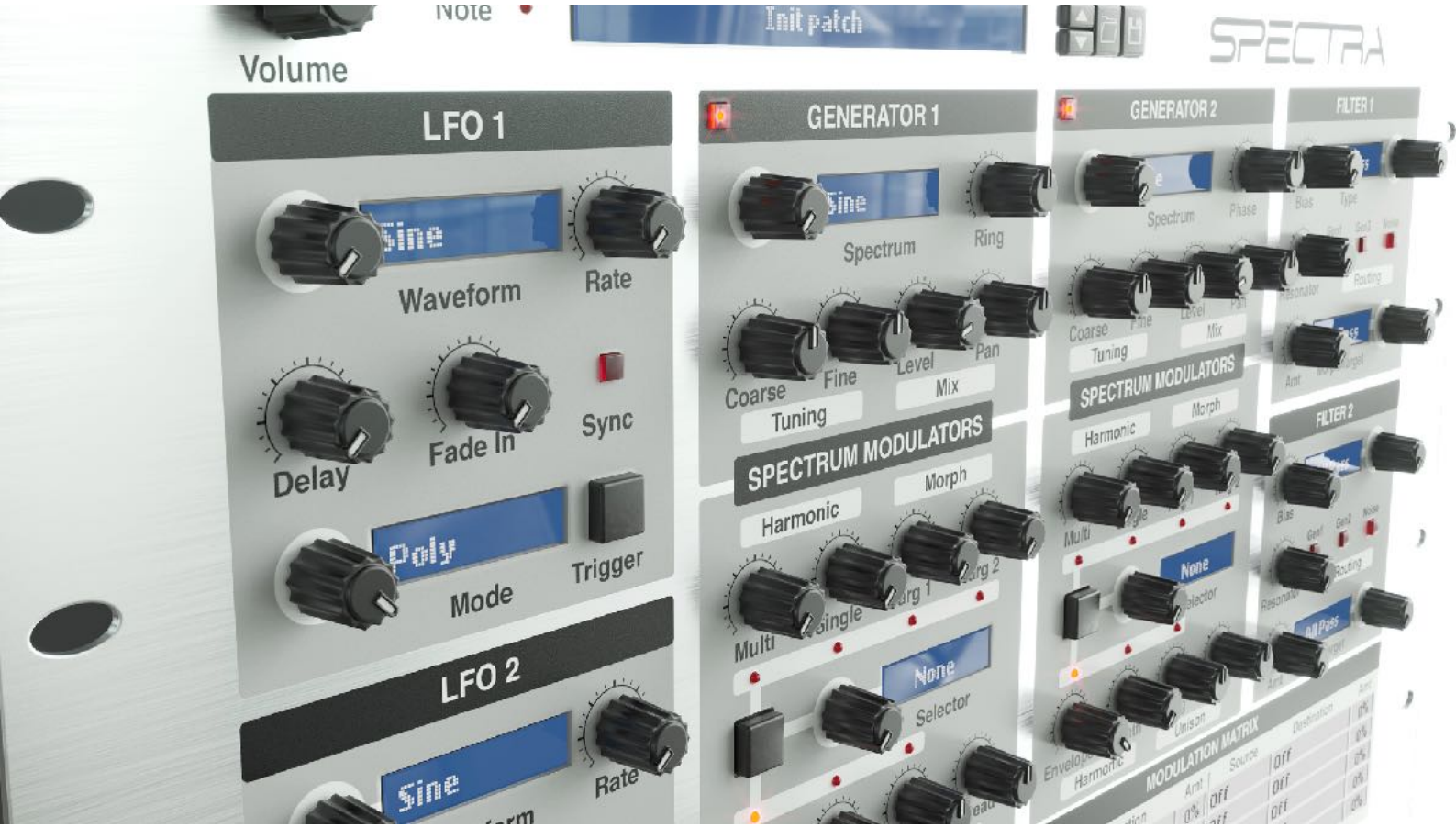
The Controller 1 Y Destination specifies the modulation destination to which the XY Controller 1 Y source value is routed.

Controller 2 X Destination

The Controller 2 X Destination specifies the modulation destination to which the XY Controller 2 X source value is routed.

Controller 2 Y Destination

The Controller 2 Y Destination specifies the modulation destination to which the XY Controller 2 Y source value is routed.



An earlier version of Spectra from 2016 (Render by Nirude)

Midi Specification and Remote Mapping

UI Group	UI Name	Parameter Name	Midi CC	Remote Name		
				Long	Medium	Short
RESERVED	Bank Select	Reason Defined	0	Reason Defined	Reason Defined	Reason Defined
RESERVED	Mod Wheel	Reason Defined	1	Reason Defined	Reason Defined	Reason Defined
RESERVED	Breath Control	Reason Defined	2	Reason Defined	Reason Defined	Reason Defined
RESERVED	Data Entry LSB	Reason Defined	3	Reason Defined	Reason Defined	Reason Defined
PERF	Polyphony	polyphony	4	Polyphony	Polyphon	Poly
PERF	Velocity	Velocity	5	Amplitude Velocity	Amp Vel	AmpV
RESERVED	Data Entry MSB	Reason Defined	6	Reason Defined	Reason Defined	Reason Defined
PERF	Volume	volume	7	Volume	Volume	Vol
PERF	PB Range Up	pitchbendrangeup	8	PB Range Up	PB Rg Up	PBUp
RESERVED	Reason Reserved	Reason Defined	9	Reason Defined	Reason Defined	Reason Defined
PERF	PB Range Dn	pitchbendrangedown	10	PB Range Down	PB RG Dn	PBDn
RESERVED	Expression	Reason Defined	11	Reason Defined	Reason Defined	Reason Defined
PERF	Portamento Time	portamentotime	12	Portamento Time	PortTime	PtTm
PERF	Portamento Lag	portamentolag	13	Spectra Reserved	Spectra Reserved	Spectra Reserved
PERF	Keyboard Mode	keyboardmode	14	Keyboard Mode	Key Mode	KMod
LFO 1	Waveform	lfoonewaveform	15	LFO1 Waveform	LFO1Wave	L1WF
LFO 1	Rate	lfooneratetime	16	LFO1 Rate	LFO1Rate	L1RT
LFO 1	Rate (Synced)	lfooneratetimesynced	17	LFO1 Rate Sync	LFO1RtSy	L1RS
LFO 1	Mode	lfoonemode	18	LFO1 Mode	LFO1Mode	L1MO
LFO 1	Sync	lfoonesync	19	LFO1 Sync	LFO1Sync	L1SY
LFO 2	Trigger	lfoonetrigger	20	LFO1 Trigger	LFO1Trig	L1Tr
LFO 1	Delay	lfoonedelaytime	21	LFO1 Delay	LFO1Dely	L1DL
LFO 1	Delay (Synced)	lfoonedelaytimesynced	22	LFO1 Delay Sync	LFO1DeSy	L1DS
LFO 1	Fade	lfoonefadetime	23	LFO1 Fade In	LFO1Fade	L1FA
LFO 1	Fade (Synced)	lfoonefadetimesynced	24	LFO1 Fade In Sync	LFO1FaSy	L1FS
LFO 2	Waveform	lfotwowaveform	25	LFO2 Waveform	LFO2Wave	L2WF

LFO 2	Rate	lfotworatetime	26	LFO2 Rate	LFO2Rate	L2RT
LFO 2	Rate (Synched)	lfotworatetimesync	27	LFO2 Rate Sync	LFO2RtSy	L2RS
LFO 2	Mode	lfotwomode	28	LFO2 Mode	LFO2Mode	L2MO
LFO 2	Sync	lfotwosync	29	LFO2 Sync	LFO2Sync	L2SY
LFO 3	Trigger	lfotwotrigger	30	LFO2 Trigger	LFO2Trig	L2Tr
LFO 2	Delay	lfotwodelaytime	31	LFO2 Delay	LFO2Dely	L2DL
RESERVED	Bank Select LSB	Reason Defined	32	Reason Defined	Reason Defined	Reason Defined
LFO 2	Delay (Synced)	lfotwodelaytimesynced	33	LFO2 Delay Sync	LFO2DeSy	L2DS
LFO 2	Fade	lfotwofadetime	34	LFO2 Fade In	LFO2Fade	L2FA
LFO 2	Fade (Synced)	lfotwofadetimesynced	35	LFO2 Fade In Sync	LFO2FaSy	L2FS
GEN 1	On	genoneplay	36	GEN1 On/Off	GEN1OnOf	G1ON
GEN 1	KeyboardTracking	genonekeytracking	37	GEN1 Key Tracking	GEN1KeyT	G1KT
RESERVED	Bank Select MSB	Reason Defined	38	Reason Defined	Reason Defined	Reason Defined
GEN 1	Waveform	genonewaveform	39	GEN1 Spectrum	GEN1Spec	G1SP
GEN1	RingDepth	ringdepth	40	Ring Depth	Ring Dep	Ring
GEN 1	Tuning Course	genonecoarse	41	GEN1 Coarse Tuning	GEN1Coar	G1CT
GEN 1	Tuning Fine	genonefine	42	GEN1 Fine Tuning	GEN1Fine	G1FT
GEN 1	Mix Level	genonelevel	43	GEN1 Level	GEN1Leve	G1LE
GEN 1	Mix Pan	genonepan	44	GEN1 Pan	GEN1 Pan	G1PA
GEN 1	Navigator	genonespectrumnav	45	GEN1 Navigator	GEN1Navi	G1NA
GEN 1	Harmonic Multi Select	genonemulti	46	GEN1 Multi Sel	GEN1Mult	G1MU
GEN 1	Harmonic Single Select	genonesingle	47	GEN1 Single Sel	GEN1Sing	G1SI
GEN 1	Morph 1 Select	genonemorphone	48	GEN1 Morph1 Sel	GEN1Mor1	G1M1
GEN 1	Morph 2 Select	genonemorphtwo	49	GEN1 Morph2 Sel	GEN1Mor2	G1M2
GEN 1	Harmonic Env Select	genoneharmenv	50	GEN1 HEnv Sel	GEN1HEnv	G1HE
GEN 1	X-Synth Type	genonexsynthtype	51	GEN1 XSynth Sel	Gen1XSyT	G1XT
GEN 1	Multi Amount	genonemultiamount	52	GEN1 Multi Amt	GEN1MulA	G1MA
GEN 1	Single Amount	genonesingleamount	53	GEN1 Single Amt	GEN1SinA	G1SA
GEN 1	Morph One Amount	genonemorphoneamount	54	GEN1 Morph1 Amt	GEN1Mo1A	G11A
GEN 1	Morph Two Amount	genonemorphtwoamount	55	GEN1 Morph2 Amt	GEN1Mo2A	G12A

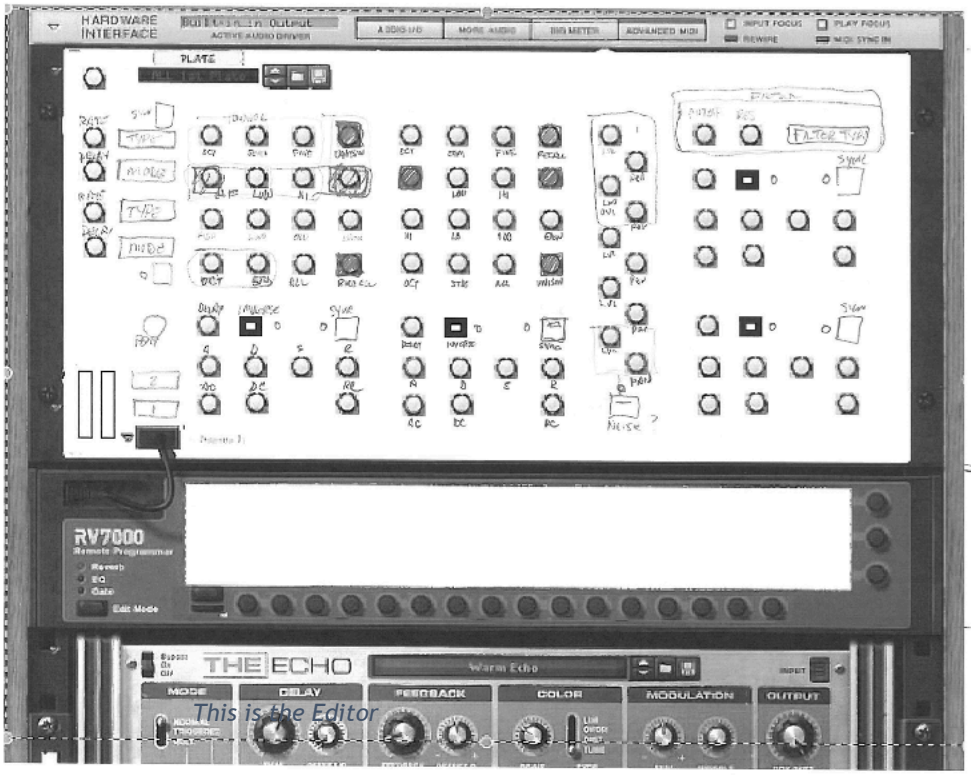
GEN 1	Harmonic Env Amount	genoneharmenvamount	56	GEN1 HEnv Amt	GEN1HEnA	G1HA
GEN 1	X-Synth Amount	genonexsynthamount	57	GEN1 XSynth Amt	GEN1XSyA	G1XA
GEN 1	Unison On/Off	genoneunisonmode	58	GEN1 Unison	GEN1Unis	G1UN
GEN 1	Unison Tuning	genoneunisontuning	59	GEN1 Uni Tuning Amt	GEN1UTuA	G1UA
GEN 1	GenOneUnisonPhase	genoneunisonphase	60	GEN1 Uni Phase Mode	GEN1UPhM	G1UP
GEN 1	GenOneUnisonSpread	genoneunisonspread	61	GEN1 Unison Spread	GEN1UnSp	G1US
GEN 2	On	gentwoplay	62	GEN2 On/Off	GEN2OnOf	G2ON
GEN 2	Key	gentwokeytracking	63	GEN2 Key Tracking	GEN2KeyT	G2KT
RESERVED	Sustain	Reason Defined	64	Reason Defined	Reason Defined	Reason Defined
GEN 2	Waveform	gentwowaveform	65	GEN2 Spectrum	GEN2Spec	G2SP
GEN 2	Spectra Reserved	gentwophase	66	GEN 2 Phase	GEN2Phas	G2Ph
GEN 2	Tuning Course	gentwocoarse	67	GEN2 Coarse Tuning	GEN2Coar	G2CT
GEN 2	Tuning Fine	gentwofine	68	GEN2 Fine Tuning	GEN2Fine	G2FT
GEN 2	Mix Level	gentwolevel	69	GEN2 Level	GEN2Leve	G2LE
GEN 2	Mix Pan	gentwopan	70	GEN2 Pan	GEN2 Pan	G2PA
GEN 2	Navigator	gentwospectrumnav	71	GEN2 Navigator	GEN2Navi	G2NA
GEN 2	Harmonic Multi Select	gentwomulti	72	GEN2 Multi Sel	GEN2Mult	G2MU
GEN 2	Harmonic Single Select	gentwosingle	73	GEN2 Single Sel	GEN2Sing	G2SI
GEN 2	Morph 1 Select	gentwomorphone	74	GEN2 Morph1 Sel	GEN2Mor1	G2M1
GEN 2	Morph 2 Select	gentwomorphtwo	75	GEN2 Morph2 Sel	GEN2Mor2	G2M2
GEN 2	Harmonic Env Select	gentwoharmenv	76	GEN2 HEnv Sel	GEN2HEnv	G2HE
GEN 3	X-Synth	gentwoxsynthtype	77	GEN2 XSynth Sel	GEN2XSyT	G2XT
GEN 2	Multi Amount	gentwomultiamount	78	GEN2 Multi Amt	GEN2MulA	G2MA
GEN 2	Single Amount	gentwosingleamount	79	GEN2 Single Amt	GEN2SinA	G2SA
GEN 2	Morph One Amount	gentwomorphoneamount	80	GEN2 Morph1 Amt	GEN2Mo1A	G21A
GEN 2	Morph Two Amount	gentwomorphtwoamount	81	GEN2 Morph2 Amt	GEN2Mo2A	G22A
GEN 2	Harmonic Env Amount	gentwoharmenvamount	82	GEN2 HEnv Amt	GEN2HEnA	G2HA
GEN 2	X-Synth Amount	gentwoxsynthamount	83	GEN2 XSynth Amt	GEN2XSyA	G2XA
GEN 2	Unison On/Off	gentwounisonmode	84	GEN2 Unison	GEN2Unis	G2UN

GEN 2	Unison Tuning	genttwounisontuning	85	GEN2 Uni Tuning Amt	GEN2UTuA	G2UA
GEN 2	GenTwoUnisonPhase	gentwounisonphase	86	GEN2 Uni Phase Mode	GEN2UPhM	G2UP
GEN 2	GenTwoUnisonSpread	gentwounisonspread	87	GEN2 Unison Spread	GEN2UnSp	G2US
NOISE	Noise Play	noiseplay	88	Noise On/Off	NoisOnOf	NSON
NOISE	Noise Level	noiselevel	89	Noise Level	NoiseLev	NSLE
NOISE	Noise Pan	noise pan	90	Noise Pan	NoisePan	NSPA
FILTER1	Frequency	filteronefrequency	91	FIL1 Frequency	FIL1Freq	F1FR
FILTER1	Type	filteronetype	92	FIL1 Type	FIL1Type	F1TY
FILTER1	Routing Gen One	filteronegenone	93	GEN1 to FIL1	FIL1Gen1	F1G1
FILTER1	Routing Gen Two	filteronegentwo	94	GEN2 to FIL1	FIL1Gen2	F1G2
FILTER1	Noise Filter One	filteronenoise	95	Noise to FIL1	FIL1Nois	F1NS
RESERVED	Reason Reserved	Reason Defined	96	Reason Defined	Reason Defined	Reason Defined
RESERVED	Reason Reserved	Reason Defined	97	Reason Defined	Reason Defined	Reason Defined
RESERVED	Reason Reserved	Reason Defined	98	Reason Defined	Reason Defined	Reason Defined
RESERVED	Reason Reserved	Reason Defined	99	Reason Defined	Reason Defined	Reason Defined
RESERVED	Reason Reserved	Reason Defined	100	Reason Defined	Reason Defined	Reason Defined
RESERVED	Reason Reserved	Reason Defined	101	Reason Defined	Reason Defined	Reason Defined
FILTER1	Morph Amount	filteronemorphamount	102	FIL1 Morph Amt	FIL1MorA	F1MA
FILTER1	Morph Target	filteronemorphtarget	103	FIL1 Morph Target	FIL1MorT	F1MT
FILTER1	Tracking	filteronetrackingamount	104	FIL1 Key Tracking	FIL1Trac	F1TR
FILTER1	Env1 Amount	filteroneenvamount	105	FIL1 Env1 Amount	FIL1EnAm	F1EA
FILTER1	Velocity	filteronevelocity	106	FIL1 Vel to Env1	FIL1Velo	F1VE
FILTER2	Frequency	filtertwofrequency	107	FIL2 Frequency	FIL2Freq	F2FR
FILTER2	Type	filtertwotype	108	FIL2 Type	FIL2Type	F2TY
FILTER2	Routing Gen One	filtertwogenone	109	GEN1 to FIL2	FIL2Gen1	F2G1
FILTER2	Routing Gen Two	filtertwogentwo	110	GEN2 to FIL2	FIL2Gen2	F2G2
FILTER2	Noise Filter Two	filtertwonoise	111	Noise to FIL2	FIL2Nois	F2NS
FILTER2	Morph Amount	filtertwomorphamount	112	FIL2 Morph Amt	FIL2MorA	F2MA
FILTER2	Morph Target	filtertwomorphtarget	113	FIL2 Morph Target	FIL2MorT	F2MT
FILTER2	Tracking	filtertwokeytrackingamount	114	FIL2 Key Tracking	FIL1Trac	F1TR

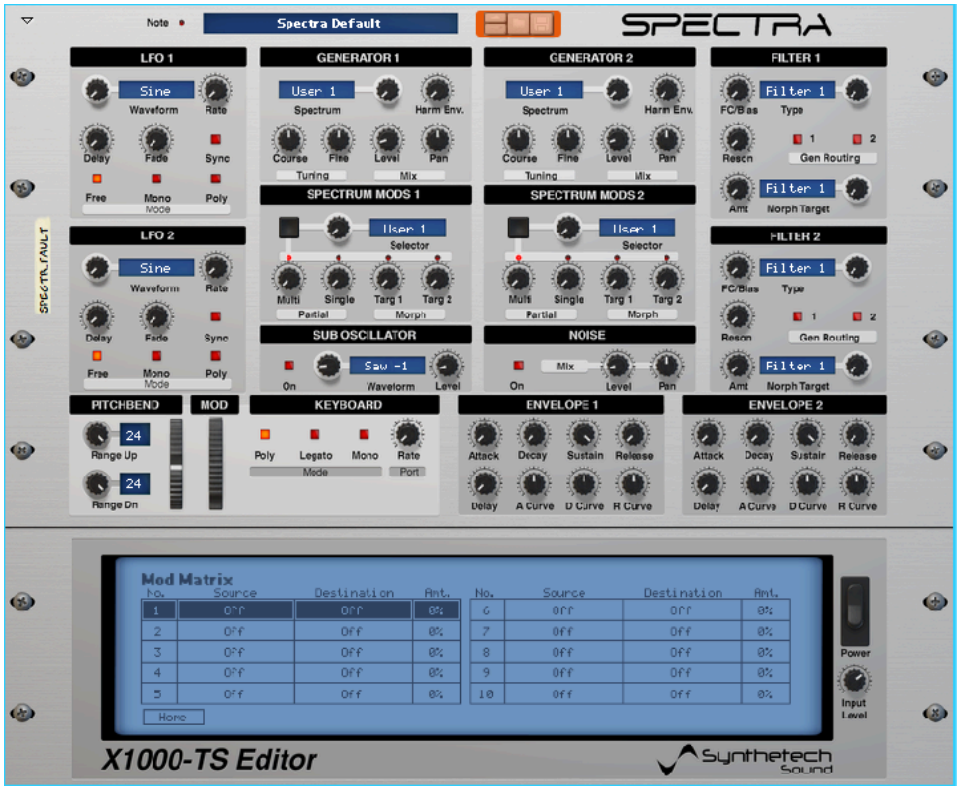
RESERVED	Reason Reserved	Reason Defined	115	Reason Defined	Reason Defined	Reason Defined
FILTER2	Env2 Amount	filtertwoenvamount	116	FIL2 Env1 Amount	FIL1EnAm	F1EA
FILTER2	Velocity	filtertwovelocity	117	FIL2 Vel to Env2	FIL1Velo	F1VE
AMP	Level	amplevel	118	Amp Level	Amp Lvl	AmpL
MATRIX1	Mod Source 1	matrixsource1	119	Mod Source 1	Mod S1	MS01
RESERVED	Reason Reserved	Reason Defined	120	Reason Defined	Reason Defined	Reason Defined
RESERVED	Reason Reserved	Reason Defined	121	Reason Defined	Reason Defined	Reason Defined
RESERVED	Reason Reserved	Reason Defined	122	Reason Defined	Reason Defined	Reason Defined
RESERVED	Reason Reserved	Reason Defined	123	Reason Defined	Reason Defined	Reason Defined
RESERVED	Reason Reserved	Reason Defined	124	Reason Defined	Reason Defined	Reason Defined
RESERVED	Reason Reserved	Reason Defined	125	Reason Defined	Reason Defined	Reason Defined
RESERVED	Reason Reserved	Reason Defined	126	Reason Defined	Reason Defined	Reason Defined
RESERVED	Reason Reserved	Reason Defined	127	Reason Defined	Reason Defined	Reason Defined
MATRIX1	Mod Map 1	modmap1	128	Mod Map 1	Mod M1	MM01
MATRIX1	Mod Destination 1	matrixdestination1	129	Mod Dest 1	Mod D1	MD01
MATRIX1	Mod Amount 1	matrixamount1	130	Mod Amount 1	Mod A1	MA01
MATRIX1	Mod Source 2	matrixsource2	131	Mod Source 2	Mod S2	MS02
MATRIX1	Mod Map 2	modmap2	132	Mod Map 2	Mod M2	MM02
MATRIX1	Mod Destination 2	matrixdestination2	133	Mod Dest 2	Mod D2	MD02
MATRIX1	Mod Amount 2	matrixamount2	134	Mod Amount 2	Mod A2	MA02
MATRIX1	Mod Source 3	matrixsource3	135	Mod Source 3	Mod S3	MS03
MATRIX1	Mod Map 3	modmap3	136	Mod Map 3	Mod M3	MM03
MATRIX1	Mod Destination 3	matrixdestination3	137	Mod Dest 3	Mod D3	MD03
MATRIX1	Mod Amount 3	matrixamount3	138	Mod Amount 3	Mod A3	MA03

MATRIX1	Mod Source 4	matrixsource4	139	Mod Source 4	Mod S4	MS04
MATRIX1	Mod Map 4	modmap4	140	Mod Map 4	Mod M4	MM04
MATRIX1	Mod Destination 4	matrixdestination4	141	Mod Dest 4	Mod D4	MD04
MATRIX1	Mod Amount 4	matrixamount4	142	Mod Amount 4	Mod A4	MA04
MATRIX1	Mod Source 5	matrixsource5	143	Mod Source 5	Mod S5	MS05
MATRIX1	Mod Map 5	modmap5	144	Mod Map 5	Mod M5	MM05
MATRIX1	Mod Destination 5	matrixdestination5	145	Mod Dest 5	Mod D5	MD05
MATRIX1	Mod Amount 5	matrixamount5	146	Mod Amount 5	Mod A5	MA05
MATRIX2	Mod Source 6	matrixsource6	147	Mod Source 6	Mod S6	MS06
MATRIX3	Mod Map 6	modmap6	148	Mod Map 6	Mod M6	MM06
MATRIX4	Mod Destination 6	matrixdestination6	149	Mod Dest 6	Mod D6	MD06
MATRIX5	Mod Amount 6	matrixamount6	150	Mod Amount 6	Mod A6	MA06
MATRIX6	Mod Source 7	matrixsource7	151	Mod Source 7	Mod S7	MS07
MATRIX7	Mod Map 7	modmap7	152	Mod Map 7	Mod M7	MM07
MATRIX8	Mod Destination 7	matrixdestination7	153	Mod Dest 7	Mod D7	MD07
MATRIX9	Mod Amount 7	matrixamount7	154	Mod Amount 7	Mod A7	MA07
MATRIX10	Mod Source 8	matrixsource8	155	Mod Source 8	Mod S8	MS08
MATRIX11	Mod Map 8	modmap8	156	Mod Map 8	Mod M8	MM08
MATRIX12	Mod Destination 8	matrixdestination8	157	Mod Dest 8	Mod D8	MD08
MATRIX13	Mod Amount 8	matrixamount8	158	Mod Amount 8	Mod A8	MA08
MATRIX14	Mod Source 9	matrixsource9	159	Mod Source 9	Mod S9	MS09
MATRIX15	Mod Map 9	modmap9	160	Mod Map 9	Mod M9	MM09
MATRIX16	Mod Destination 9	matrixdestination9	161	Mod Dest 9	Mod D9	MD09

MATRIX17	Mod Amount 9	matrixamount9	162	Mod Amount 9	Mod A9	MA09
MATRIX18	Mod Source 10	matrixsource10	163	Mod Source 10	Mod S10	MS10
MATRIX19	Mod Map 10	modmap10	164	Mod Map 10	Mod M10	MM10
MATRIX20	Mod Destination 10	matrixdestination10	165	Mod Dest 10	Mod D10	MD10
MATRIX2	Mod Amount 10	matrixamount10	166	Mod Amount 10	Mod A10	MA10
PERF	XY1.X	xycontroller1x	167	XY Controller1 X	XY1X	XY1X
PERF	XY1.Y	xycontroller1y	168	XY Controller1 Y	XY1Y	XY1Y
PERF	XY2.X	xycontroller2x	169	XY Controller2 X	XY2X	XY2X
PERF	XY2.Y	xycontroller2y	170	XY Controller2 Y	XY2Y	XY2Y
PERF	XY1X Destination	xycontroller1xdestination	171	XY1X Destination	XY1XDest	X1XD
PERF	XY1Y Destination	xycontroller1ydestination	172	XY1Y Destination	XY1YDest	X1YD
PERF	XY2X Destination	xycontroller2xdestination	173	XY2X Destination	XY2XDest	X2XD
PERF	XY2Y Destination	xycontroller2ydestination	174	XY2Y Destination	XY2YDest	X2YD
RESERVED	Aftertouch	Reason Defined		Reason Defined	Reason Defined	Reason Defined
RESERVED	Pitchbend	Reason Defined		Reason Defined	Reason Defined	Reason Defined



Spectra's Original Design from May 2014



An earlier version of Spectra from 2015