

Phasemaker

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User Manual
version 1.1

Version history

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1.0	October 17, 2016	Initial publication
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Introduction

This guide covers sound programming tips and parameter cheat sheets, useful for musicians who want to dive into parameter automation and sophisticated sound programming of the Phasemaker synthesizer Audio Unit Extension.



The Phasemaker concept

Phasemaker is a so-called '6 operator FM synthesizer'. FM stands for Frequency Modulation, which was the first digital synthesis technology to become mainstream; mostly thanks to Yamaha and its DX and TX ranges of synthesizer products. Most FM synthesizers (this one included) actually use phase modulation, but the distinction between FM and PM is rather esoteric, so for sake of clarity we will stick with 'FM'.

The FM synths from the 80s proved revolutionary, because they could create sounds that were impossible to achieve with the analog synthesis technology of the time. They could even recreate realistic instruments (such as guitars, pianos, brass instruments and wind instruments) to a degree that had never been heard before. The downside to these early FM synths was that they were virtually impossible to program. Where analog synths came with lots of accessible knobs and sliders, FM synths brought deep multilayered menu systems to the table, operated with buttons on a tiny screen.

There is a lot of charm in the sonic possibilities of FM synthesis - both for retro sounds and for novel timbres that break away from the (virtual) analog tradition. Phasemaker intends to make these sounds available in a way that is still easy to program.

Because the FM concept is essentially based on complex trigonometric maths it will never be truly easy. But we can at least try to make it as hands-on and straightforward as possible.

FM Synthesis 101

All sound is made of waves. Sine waves to be exact. A simple sine wave covers exactly one frequency, and it is therefore the most boring sound in the universe. More interesting sounds, basically any other sound, is made up out of multiple - often thousands - of sine waves.

Synthesizers let you sculpt musical sounds by generating signals that consist of many frequencies; typically controlled by the musician. Analog synthesis is sometimes also referred to as 'subtractive synthesis, because it starts with rich signals that contain lots of sound frequencies. It then uses filters to hack away unwanted frequency bands until a pleasant sound remains.

FM synthesis actually does the opposite: it starts with a basic dull wave (typically a sine wave) and then uses other waves to interact with the base wave to make it do more interesting things. More specifically: it changes the pitch of the wave.

Let's take a sine wave at a certain frequency. Now slowly make the pitch of the wave go up and down. It becomes a wailing tone, like a police siren. Not particularly nice to listen to. However, if we increase the speed of this 'going up and down' then at some point it stops being an unpleasant whine and it becomes an 'overtone' that is part of the timbre.

This is the essence of FM synthesis: really fast changes in pitch which generate overtones - also called 'side bands' - that make the sound rich and dynamic even though it usually starts with a really boring wave.

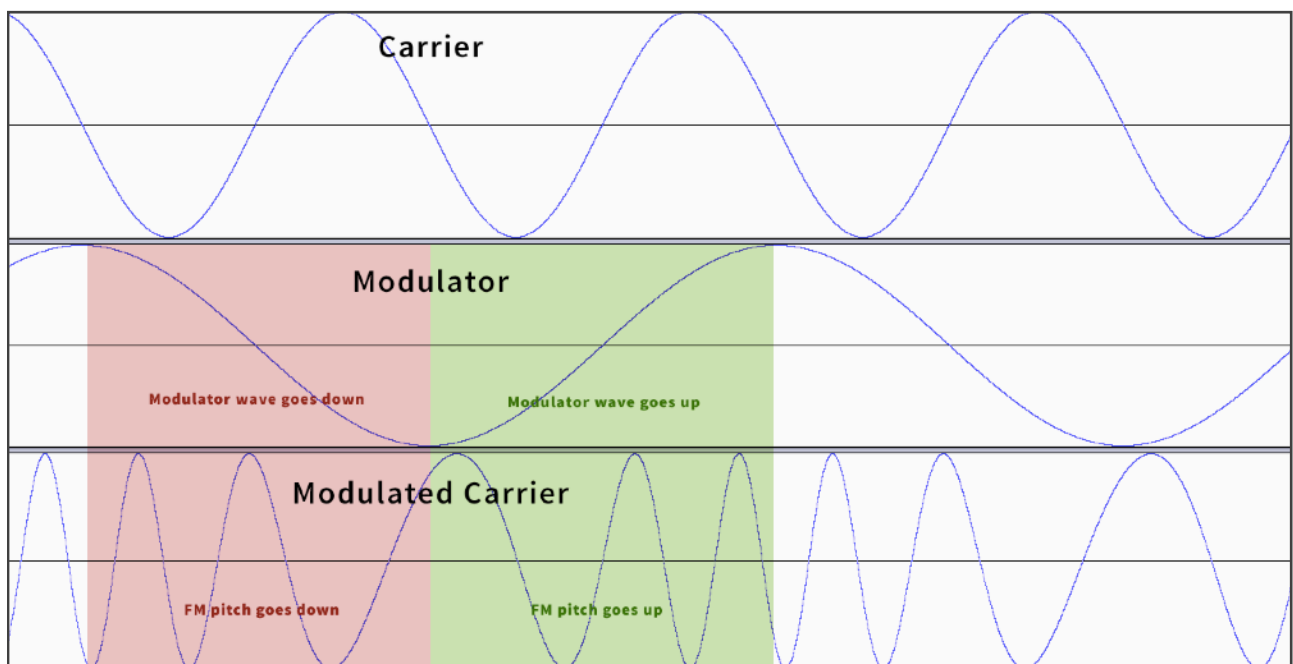
Carriers and Modulators

Analog synths have oscillators. FM synths have them as well, but they have two different types: carriers and modulators.

Carrier oscillators make sound. Every sound you hear coming out of an FM synth was created by carrier waves. Carriers are pretty much comparable to oscillators on conventional synths. Each carrier has its own envelope.

Modulators on the other hand are silent. But they tell the carriers how to change their sound. When the modulator wave goes up, it raises the pitch of the carrier accordingly.

When the modulator wave goes down, it slows down the pitch of the carrier wave. By doing this really fast the modulator helps boring carriers become pretty cool.

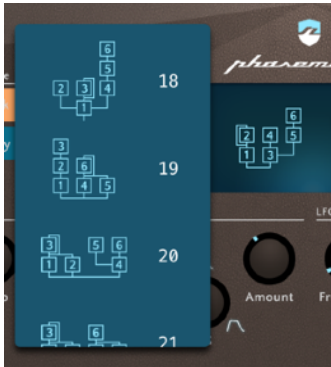


When a modulator has the same frequency as the carrier wave, it makes for a more interesting sound than just the unmodulated carrier. Double the modulator frequency, and the sound gets even more interesting. If you use a modulator frequency that is not a multiple or fraction of the carrier frequency you can create sounds that have wooden or glassy or metallic character.

This is the concept of “ratios” and “fixed” frequencies. When an operator is in ‘ratio’ mode it means the frequency is locked to the key that the synth is playing. The ratio can be once, twice, half, a third or even twenty times the base frequency. If you play a higher note, the frequency of the operator is also higher - proportional to its ratio.

When an operator is in ‘fixed’ mode however, its frequency is not related to the key that was played. Fixed frequencies are typically specified in Herz (waves per second). Phasemaker allows operators to be set in a very wide range of 0.1Hz - 10000Hz using the Coarse Tune and Fine Tune controls.

Algorithms



As if this isn't complex enough, modulators can also be modulated by other modulators. And operators can be modulated by multiple modulators. All this makes for some pretty complex sound potential. There are lots of different ways that our 6 operators can be laid out. These layouts are called 'Algorithms'. Phasemaker has 42 different algorithms.

You can easily identify the carriers and the modulators in each algorithm. The carriers make sound, so they are always the last (bottom-most) operator in each chain. Sometimes there is only one, sometimes there are more. If an operator feeds into another operator, it is always a modulator.

Choosing the right algorithm for your sound may look like a daunting task, but there is a logic behind it. All algorithms have between one and six carriers. Since each carrier can independently make sound, you can think of them as sound layers.

If, for example, you have an algorithm with three carriers (and three modulators) you have three layers to play with. You could pick one carrier to be the main 'meat' of your sound. Use a second carrier to add a subtle sub-bass layer, and the third one to create an interesting attack. Because each operator has its own envelope, you can let the main layer sustain longer than the attack sound.

If you look at the algorithm layouts you'll notice that every algorithm has an operator with a little loop around it. This is the 'feedback loop'. If you raise the program's feedback level, some of the output of this operator will be fed back into itself. In subtle amounts feedback can give a sharper edge to the sound. Raise the feedback and the operator will devolve into chaos and eventually only produce noise bursts. Phasemaker has a noise-oscillator on board, but on classic FM synthesizers this was the only way to generate noise for e.g. synthesising percussion sounds. Very clever!



Normal and Strong Operators

Since version 1.1, Phasemaker has introduced Strong operators which have a far higher maximum modulation index than Normal operators. The modulation index determines how pronounced the frequency sidebands (overtones) can get when you increase the level of a modulator. This sounds complicated, but when you play around with it you'll hear what it means: you can now make your carriers scream!

AM Operators

Phasemaker has an unusual third kind of operator: the AM operator. AM stands for amplitude modulation. Where FM modulates the pitch of a carrier wave, AM modulates the volume instead.

AM operators can be in any part of an algorithm, but they do not produce sound. They modulate the signal that is fed into them. So it doesn't make sense to have an AM operator at the beginning of a chain; you always need something to feed into them. Interestingly this means you can use AM operators to hear modulators which typically do not produce sounds.

Essentially the AM operator takes the signal that is fed into it and makes the volume go up and down so fast (up to 10KHz) that the effect becomes an overtone. However, the AM operator can also be slowed down to a really sluggish 0.1Hz and everything in between. This means that using the AM operator feature you can turn every operator into an LFO for slowly evolving drones or have a square wave modulate other square waves for classic AM chip-sounds.

A Tour Around the Phasemaker Extension



1. Edit Mode buttons

Use these buttons to switch between edit screens. The Quick, Program and LFO button give access to screen for editing the current sound. The Utility screen lets you manage patches (storing, renaming, etc.) and also offers a 'mutation' feature for semi-randomly generating new sounds.

2. Operator buttons

Give access to detailed settings for each of the 6 available operators.

3. Algorithm

This shows (and lets you change) the algorithm that makes the current sound. The algorithm is the 'layout' of the operators and shows which operators are carriers and which ones are modulators. Carriers are always the last (bottom-most) operators in a chain. All others are modulators. In the example above the carriers are operators 1 and 3. All other operators are modulators that feed into the carriers.

4. Polyphony indicators

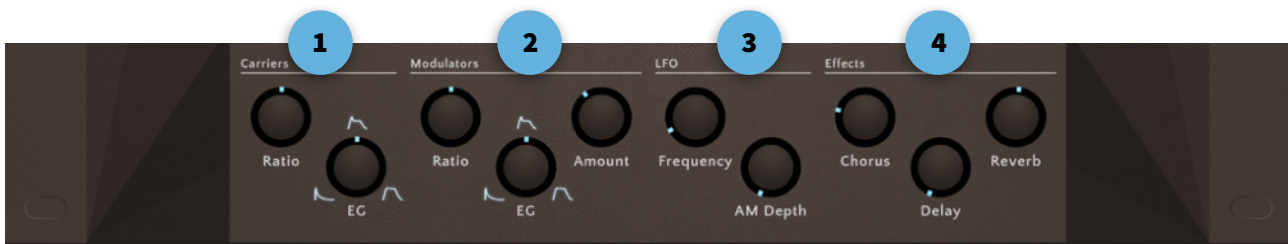
This figure shows how many notes are currently playing. The maximum polyphony of Phasemaker is 32. Note that some sounds have a long 'release time'. This means that they are still sounding (slowly fading out) for some time after you've ended the actual note. If you're playing many chords with such sounds you can quickly eat up a lot of voices.

Next to the polyphony indicator is the indicator which shows whether the current sound is in Poly Mode or Legato Mode. Poly Mode is the normal mode and means that you can play multiple sounds at the same time. In Legato Mode when you play overlapping notes in sequence (while holding them) the notes will be glued together to one long rubbery tone.

5. Value indicator

Whenever you change the value of a knob or control on the screen this indicator shows the value you're setting.

Quick Edit Screen



The Quick Screen gives fast access to various key parameters of the sound, which can all be set in more detail in other screens of the plugin. By bringing them together on this page, you can quickly set up the design of a new sound program before diving deeper into all the nitty-gritty details.

1. Carrier settings

These two controls, the Carrier Ratio and the Carrier Envelope Generator (EG) determine the overall character of your sound.

The Ratio lets you change the pitch ratio of all your carriers - changing this will override all ratio settings for operators that are currently marked as carriers according to the currently selected Algorithm. You can later dive into the individual Operator Edit screens and change these settings per operator.

The EG will set the AMP Envelope for all carriers. This knob simultaneously changes the values for the Attack, Decay, Sustain and Release values. The values of this knob range from “Short percussive” via “Bass” to “Lead” and ends with “Pad/Drone”. Obviously all variables can be set in detail per operator by diving into the individual operator editors.

2. Modulator settings

These are essentially the same as the Carrier settings, but apply to all operators that are earmarked as a modulator by the current algorithm. Modulators don’t generate sounds, but they will alter what the carriers sound like. So by changing these controls you will hear changes in the overtones created by the carriers.

In addition the Ratio and EG settings there is also an “Amount” knob. This will adjust the Level settings of each modulator. The higher this setting, the ‘brighter’ the overtones will be. Depending on how the sound was designed, this will result in an effect similar to the filter cutoff knob on traditional synths.

3. LFO settings

Each sound has an LFO which can modulate the pitch (vibrato) and amplification (tremolo) of the sound. The Frequency knob adjusts how fast the LFO oscillates. The frequency ranges from pretty slow to almost-audio-rate. The AM Depth knob specifies how much the level of the operators should be modulated by the LFO. Low settings result in very subtle changes, high settings can let the levels wobble up and down from maximum volume to complete silence. Note that the effect of the LFO depends on how sensitive each operator is to the LFO. In the Operator Edit screens you can specify per operator how much it should ‘listen’ to LFO settings.

4. Effects

This lets you adjust how strong the Reverb, Chorus and Delay effects apply to this program.

Program Edit Screen



The Program Edit screen lets you set some overall parameters of the program which are not specific to operators.

1. Pitch Envelope

Applies an envelope to the pitch of the program. For example to create an initial dip or spike in the sound's pitch. You can use this to add punch to a sound or add a pitch effect after a sound is released. Using the polarity setting you can specify whether the envelope (attack, decay, regular pitch, release) goes up-down-up or down-up-down. During the sustain-phase the pitch is the regular note's pitch (in other words: no pitch shift is applied during sustain).

2. Signal Section

Various controls to adjust the level and cleanness of the signal.

The Gain knob is the overall volume level of the sound. Values are in dB relative to the signal's maximum level. Higher values amplify the level beyond their maximum. Keep in mind that effects like Delay and Chorus may add extra energy onto of the signal level. Although soft-saturation is applied at the final stage, overdriven sounds may sound rather unpleasant. It may be better to boost the plugin's output in the host (which may have some spare headroom) rather than pumping up the gain at this stage.

Feedback takes the signal of the 'feedback operator' (the operator with the funny little loop around it) and feeds it back into itself. This adds some grit or dirt to the sound, with extreme values resulting in chaotic noise bursts. The actual effect depends on where the feedback loop is applied in the algorithm. Use with caution.

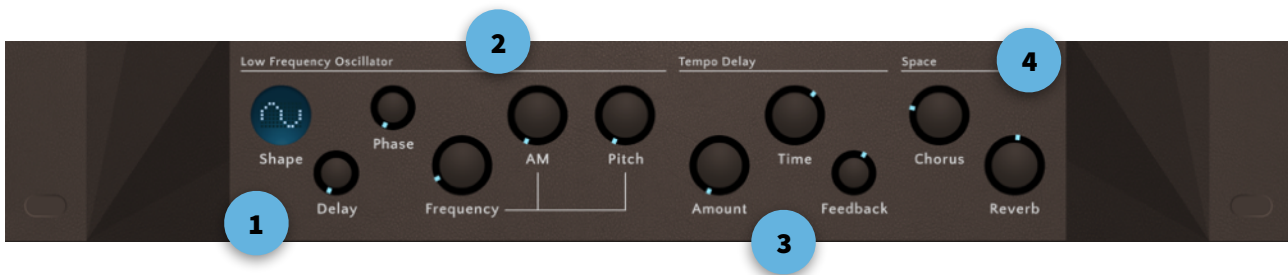
Legato lets you string notes together instead of playing them in parallel. The value of the Legato knob specifies how fast the pitch glides from the first note to the second note. Release the second note while you're still holding the first note and the pitch will bounce back to where it came from, resulting in a cool rubbery effect.

Fuzz, when enabled, takes the signal out of the AMP section and applies a subtle distortion to it. This will also add some energy to the signal, so you may need to dial down the gain a little bit.

3. Operator Levels

Let you quickly adjust the levels of each of the 6 individual operators. Note that you can also set the levels for each operator using the EG editor on their own Operator Edit page.

LFO + FX Screen



1. LFO Shape Section

This specifies the wave shape of the LFO, and how it kicks in after triggering a note.

Shape indicates the currently selected waveform for the LFO. Sine is the default. Tap it to change to other wave shapes.

Delay lets you adjust how it takes before the LFO kicks in. Values range from instantly, via a few milliseconds delay up to 5 seconds.

Phase lets you select in detail at what point in its phase the LFO should start. At minimum value the LFO is free running ('FRE') and will pick up at the point where it currently happens to be. Every tone will sound slightly different. The other values indicate the phase angle of the wave: 0° angle, 90° angle, 180° angle, 270° angle.

2. LFO Frequency and Depth

Lets you set how fast the LFO oscillates and how strong the it will be applied to both the Amplitude ('tremolo') and Pitch ('vibrato') of the sound.

Note that the Pitch amount is a global value. It will be applied equally to all operators. The AM amount, however, applies to individual operators depending on their 'LFO %' settings. If the LFO % of an operator is set to 0, then no AM LFO will be applied to that operator.

3. Delay Section

This is for setting the delay effect. The delay is synced to the host tempo if the host supports it. Amount is the strength of the effect. Time is the delay between taps. Positive values are in 16th steps, negative values are fractions of a step - good for making faux-reverb effects or adding some complexity to a sound. Feedback lets you specify how long it takes for a sound to completely die out. Essentially it adjusts how much of the delay signal is fed back into the delay effect once it has done a single echo

4. Space Effects Section

These two effects make your mono instrument sound stereo. The Chorus uses a very short feedback loop to make a richer and wider sound. The Reverb will add ambiance to your sound by giving the impression of being in a 3D space.

Editing Operators



1. Choose the operator you want to edit

Each operator has its own detailed edit screen. Even when the current algorithm doesn't use all 6 operators you can still set them. It is possible to automate algorithm settings during performance and then the unused operator settings may suddenly be used.

2. Oscillator shape

Here you can choose the oscillator type. The first 8 waves are recreations of oscillators from a certain famous 80s synthesizer module. They are based on sections of sine waves, creatively reordered to generate interesting timbres. Some of these have slightly unusual DC bias shifts, which may lead to unwanted distortion effects when driven too far. Watch your levels.

3. Tuning and offsets

This is one of the more complex sections of the Phasemaker synthesizer architecture. First off, you have to decide whether this operator uses fixed frequency or a ratio of the note that is playing. 'Ratio' mode is the default (and most often used) setting.

Ratio mode

When Coarse Tune, Fine Tune and Transpose are at their minimum values, the operator will play at the exact 1:1 frequency of the note that was triggered. Coarse Tune will multiply the frequency in large steps. 1 is the minimum value (play at 1x the note's frequency). Set it to 2, and it will be twice the note's frequency, etc. Move the value down and it will be fractions of the note's frequency (1:2, 1:3, 1:4, etc.).

Fine Tune will add to the multiplication factor in steps of 0.01x and Transpose will shift the entire operator up or down in steps of a semitone (ranging from -12 to +12).

Fixed mode ('Ratio' button disabled)

In this mode you can set a fixed frequency value for the operator, ranging from 0.1Hz - 10KHz. The way this is done is essentially the same as the old DX FM synths. First you choose the magnitude using the Coarse knob and then multiply this in smaller steps using the Fine knob to get these ranges:

-1 = 0.1Hz - 1Hz

0 = 1Hz - 10Hz

1 = 10Hz - 100Hz

2 = 100Hz - 1000Hz

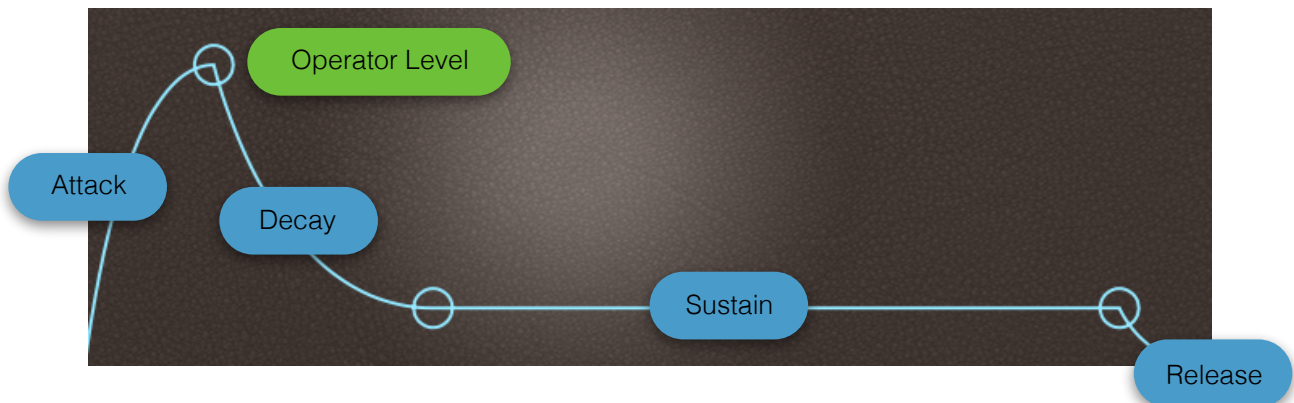
3 = 1000Hz - 10000Hz

The selected frequency is displayed in the EG window. At first it may seem like an esoteric 80s technocratic approach, but once it clicks it's actually a pretty neat way to quickly and accurately cover a huge frequency bandwidth using only 2 controls.

4. Envelopes

Envelopes are the key to interesting, lively sounds. Especially when applied to modulators they will let you change the amount and character of your overtones over time, drastically changing the personality of the sound. Regardless of whether an operator is a carrier or a modulator, the EG (Envelope Generator) will work the same.

There are 4 stages in a Phasemaker envelope: Attack, Decay, Sustain, Release



Combined with the envelope you can also set the level (peak volume) of the operator relative to the other operators. The level of your operator is the highest peak in the envelope; typically the top of the attack curve.

You can design your envelope by dragging the points/segments directly in the EG window. Alternatively you can tap the magnifying glass icon and go to the Envelope Editor to set everything in more detail.

5. Expression Section

These three controls let you set various characteristics of how the operator will behave within the current program.

'LFO %' determines how much effect the Amplitude Modulating LFO will have on this operator. Set it to 0 for the LFO to have no effect, set it maximum value to make the LFO sweep between peak to silence.

'Velocity' lets you specify how velocity sensitive this operator is. Set it to 0 to make this operator completely independent of the velocity (the strength with which a key was hit on the keyboard). If you set it to maximum the entire level of this operator will depend on the velocity of the current note, making for a very expressive operator.

Operator Type



Phasemaker 1.1 has three different Operator types

Normal Operator

This is the default operator type. It has a mild modulation index curve and is usable for any kind of instrument. It can be safely pushed to its maximum level, even when multiple modulators are chained together. FM aliasing is minimal throughout most of the octave range. The modulation curve is similar to that used on the DX7.

Strong Operator

This operator has a very high maximum modulation index. The modulation index (the level of a modulator) controls the strength of overtones introduced by FM on a carrier. It can range from a subtle hint of overtones to a wild screaming mess of chaotic frequencies.

Be cautious with high modulator levels - especially for sounds in higher octave ranges or modulated by a chain of modulator operators. These things can go wild!

When applied to carriers, there is no difference between Normal or Strong operators.

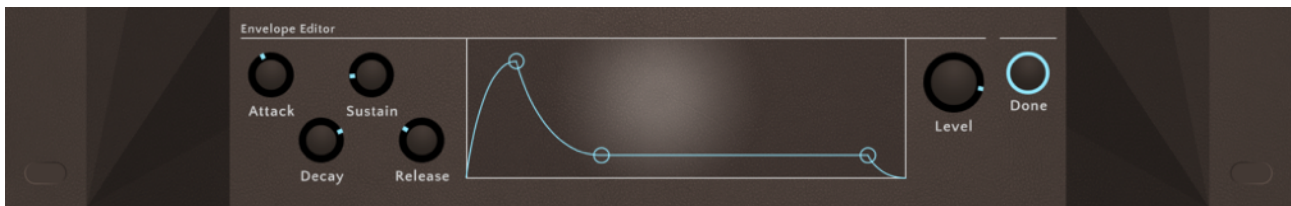
AM Operator

'AM Operator' lets you switch this operator to Amplitude Modulation Mode. In this mode the operator takes its input feed and applies amplitude modulation to it (rapidly changing the volume/amplitude by multiplying the incoming signal with its own amplitude). If the operator doesn't get any input signal, it will not produce any sound so make sure there is another operator feeding into your AM Operators.

6. Clipboard Section

This lets you copy/paste operator settings between operators. Ideal for if you want several operators to do more or less the same thing.

Envelope Editor



The Envelope Editor can be called up by tapping the “Magnifying Glass” icon in the EG window. It lets you make more detailed adjustments to the envelope. Points and segments can be adjusted by directly dragging them in the graph, or by changing values using the knobs.

You can go back to the Operator Edit window by tapping the “Done” button (or by tapping the corresponding “Operator” button at the top of the screen).

Utility Screen



1. Manage Section

This handles preset management.

- The Init button resets the current sound to its default values. Important for people who like to design their sounds from scratch.
- The Delete button deletes the currently selected User Preset. Note: you can also delete presets directly from the User Preset list using the normal Swipe-to-Delete gesture.
- Rename lets you rename the currently selected User preset
- Store lets you save the current settings as a User Preset. You can not overwrite existing presets, so saving under the same name is not possible. Phasemaker will automatically add a number to the patch for you. If needed, you can then delete the old version by swiping it out of the list.

2. Mutation Lab

This is feature for automatically generating pseudo-random sounds. Doing completely random programs is not very usable for FM synthesis, as there is a near 100% chance of ending up with completely unusable chaos. So behind the Mutation Lab is an algorithm which makes sure that there is a significant chance of coming up with something musically usable (nothing is guaranteed however).

The Envs, Ratios and Character knobs let you specify how radical the settings of these various characteristics of the final sound could potentially be. But sometimes a minor adjustment in FM settings can cause a radical change in the sound, so even conservative settings can sometimes end up with pretty wild sounds.

AU & MIDI Controller lists

Every aspect of the Phasemaker plugin that can be accessed via the on-screen user interface can also be controlled and automated using AU parameters and MIDI CC codes. The following controller numbers are for MIDI CC. The respective Audio Unit parameters use their corresponding names.

Operator Parameters

Operator parameters are used to control each of the 6 individual operators.

	Op 1	Op 2	Op 3	Op 4	Op 5	Op 6
Osc Wave	33	46	59	73	86	99
Mode (ratio/fixed)	34	47	60	74	87	100
Level	35	48	61	75	88	101
Operator Mode*	36	49	62	76	89	102
LFO %	37	50	63	77	90	103
Velocity Sense	38	51	65	78	91	104
Coarse Tune	39	52	66	79	92	105
Fine Tune	40	53	67	80	93	106
Transpose	41	54	68	81	94	107
Attack	42	55	69	82	95	108
Decay	43	56	70	83	96	109
Sustain	44	57	71	84	97	110
Release	45	58	72	85	98	111

Example: to set the Level of Operator 2 to maximum, send MIDI CC#48 with value 127

**) values for Operator types:*

[0] Normal Operator

[1] AM Operator

[2] Strong Operator

Sustain Pedals / Hold Mode

Phasemaker responds to MIDI CC #64, to support MIDI Sustain Pedals.

Program parameters

These are the parameter codes for the overall program settings (i.e. not specifically linked to individual operators).

	Gain	Algorithm	Feedback	Legato	Fuzz	Chorus
CC#	7	17	18	5	32	115

	PitchEG A	PitchEG D	PitchEG R	PitchEG Pol	Reverb	Delay Amt.
CC#	22	23	25	24	119	117

	Delay Time	Delay FB	LFO Freq	LFO Delay	LFO Phase	LFO Wave
CC#	116	118	26	27	28	29

	LFO Pitch	LFO Amp				
CC#	30	31				

Example: to set a really fast Legato glide send MIDI CC#5 with value 100.. To switch off Legato send MIDI CC#5 with a value of 0

Quick Edit parameters

These are the parameter codes for the controls on the Quick Edit page. They are only available as CC codes. They can not be AU Parameters because they apply to multiple AU Parameters at the same time, and they are different parameters every time depending on the currently selected Algorithm.



	Carrier Ratios	Carrier Envs.	Mod. Ratios	Mod. Envs.	Mod. Amount	
CC#	12	13	14	15	16	

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