

propellerhead

PX7 FM SYNTHESIZER

OPERATION MANUAL

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PX7 FM Synthesizer

Introduction



The PX7 Rack Extension is an FM synthesizer cloned on a classic Japanese FM synthesizer from the eighties. The PX7 features six sinewave oscillators - or operators - which are used for generating sound, or for frequency modulating each other.

The PX7 was designed to offer all the vast sound possibilities of "the original" but with a more user friendly front panel. All parameters correspond exactly to the ones in the original instrument, which makes it possible to recreate all the famous sounds. The PX7 also offers some additional macro controls which makes it easy to tweak presets with great results.

A few words about FM synthesis

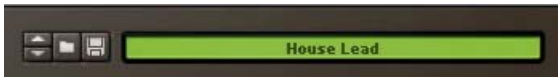
PX7 uses frequency modulation (FM) synthesis to generate sounds. Basically, FM synthesis is achieved by letting sinewave oscillators frequency modulate each other in various configurations (algorithms) - at various levels and rates. The sonic results of FM synthesis can vary dramatically; from warm bell-like sounds to weird noises - and everything in between!

A significant difference, compared to analog subtractive synthesis, is the absence of filters. Instead of removing and attenuating frequencies by using filters, overtones are generated by increasing the amount of frequency modulation. That's why you won't find any filters in the PX7.

The scope of this manual is not to try and describe FM synthesis in detail. If you would like to know more about FM synthesis, please do a Google search on the Internet. There are tons of interesting articles and resources that describe FM synthesis and classic Japanese FM synthesizers.

Using PX7

Loading and saving patches



Loading and saving patches is done in the same way as with any other internal Reason/Reason Essentials device - see the “Sounds and Patches” chapter in the Reason/Reason Essentials Operation Manual pdf for details.

Using the macro controls to tweak factory sounds

If you want to get started with the PX7 without really knowing where to begin, here is a quick way:

1. **Load a factory preset.**
2. **Tweak the Brightness, Touch, Attack and Decay sliders.**



These sliders control complete sets of parameters in a “macro” fashion. This means you will get great changes in sound by just moving one slider. Note that the sliders are bipolar, with zero (no change) in the center positions.

- **The Brightness slider affects all frequency modulation levels, causing the timbre to change.**
A positive value makes the sound brighter and a negative value makes the sound subdued.
- **The Touch slider controls the keyboard velocity control of Brightness.**
Higher values make the sound more responsive.
- **The Attack slider controls all EG Rate 1 parameters, effectively working as an Attack parameter would in a regular ADSR envelope generator.**
- **The Decay slider controls all EG Rate 2 and 3 parameters, effectively working as a Decay parameter would in a regular ADSR envelope generator.**

Global “play” controls



Bend

The pitch bend wheel can be used for bending note pitches up and down. PX7 also responds to Pitch Bend MIDI data from a connected MIDI master keyboard. You set the desired Pitch Bend Range with the “Bend Range” control to the right of the Mod Wheel.

Mod wheel

The Mod Wheel can be used for controlling the LFO modulation amount of the pitch and/or amplitude. PX7 also responds to ModWheel MIDI data from a connected MIDI master keyboard. You set the desired LFO pitch modulation amount with the “Pitch Mod Sensitivity” knob and the amplitude modulation amount with the “LFO Sens” knobs (individually for each operator).

Note On LED

This LED lights up as soon as MIDI Note On data is sent to PX7.

Bend Range

- **Set the desired Pitch Bend range for the “Bend” wheel with the up/down buttons.**
Range: +/-12 semitones in steps of +/-1 semitone.

Transpose

- **Click the up/down buttons to transpose the global pitch up or down.**
Range: +/-24 semitones in steps of +/-1 semitone.

Mono

- **Click to play the PX7 in monophonic mode.**

Legato

Legato only works in Mono mode (see above). The Legato function works as follows:

- **Hold down a key and then press another key without releasing the previous.**
Notice that the pitch changes, but the envelopes do not start over. That is, there will be no new “attack”.

Portamento

Portamento can only be used in Mono mode (see above) with or without Legato.

- **In Mono mode without Legato, the pitch will glide between consecutive notes, with the time set with the Portamento knob.**
- **In Mono mode with Legato on, the pitch will glide between consecutive notes only when you play legato.**
If you release the previous key before hitting the new key, there will be no portamento effect.

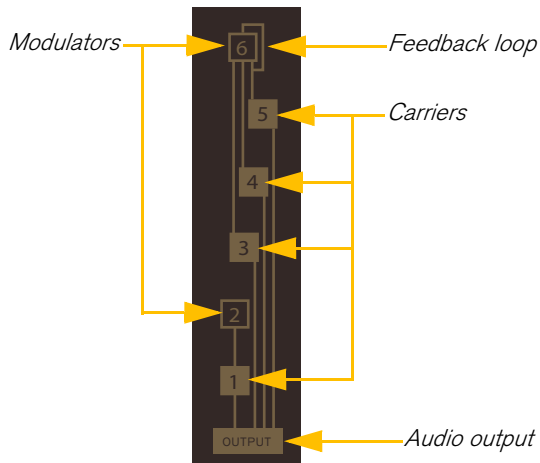
Algorithm controls

The PX7 features six operators (sinewave oscillators). Depending on if an operator works as a sound generator (carrier) or modulator, the functionality is quite different. If an operator should work as a sound generator or modulator is determined by the Algorithm selector in the lower right corner of the PX7, so let's begin by describing this.

Algorithm



An algorithm is basically an operator connection diagram which defines how the six sinewave oscillators are interconnected. An operator can either be connected and used as a sound generator (carrier) or as a modulator. In PX7 a carrier is shown with a filled background and a modulator is shown with a dark background with a frame. The carriers are always routed directly to the Output in the diagrams. The picture below shows the connection principle in algorithm 22 as an example:



Operators 1, 3, 4 and 5 are carriers (as indicated by their filled backgrounds). They are connected straight to the audio Output.

Operators 2 and 6 are modulators.

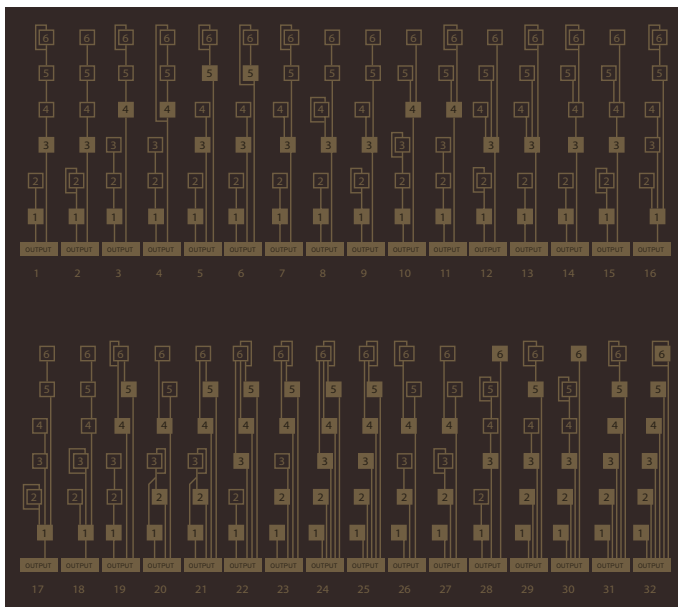
Operator 2 frequency modulates Operator 1.

Operator 6 has a feedback loop and frequency modulates Operators 3, 4 and 5.

Note that even though Operator 6 is shown with three separate output connections, it's the same modulation signal in all three outputs.

Connections in algorithm 22

The PX7 features the same 32 algorithms as the original classic Japanese FM synth. Below are diagrams of the 32 different algorithms in PX7:



→ **Select the desired Algorithm by clicking the up/down buttons.**

A diagram of the selected algorithm is displayed above the Algorithm selector.

Op Feedback



In addition to the Algorithm selector is the Op Feedback knob. All algorithms have one operator with a feedback connection (signal routed back to the operator's input), the Op Feedback knob sets the feedback amount. Range: 0-7

- **Increasing the Op Feedback level will produce a brighter sound, with more overtones.**
- **If several operators are used for generating the feedback signal, the result will be more complex signals - and in some cases noise.**

Operator controls

The PX7 features six identical operators (sinewave oscillators) which are all built up the same way, with the same controls. Here we will describe the controls of one of the operators.



On/Off

- **Click to activate/deactivate the operator.**

Fixed

- **Click the Fixed button to get a fixed frequency from the operator, no matter where on the keyboard you play.** This is mostly useful when you are using algorithms where the operator is used as a modulator.

Coarse

- **Turn the Coarse knob to set the coarse tuning of the operator.**
If the Fixed button is off, the display shows the pitch ratio (partial), where 1.0 is the nominal pitch. 0.5 is an octave down, 2.0 is an octave up, 3.0 is three times the nominal pitch all the way up to 31.0 times the nominal pitch.
If the Fixed button is on, the Coarse knob sets the operator's basic frequency to 1, 10, 100 or 1000 Hz.

Fine

- **Turn the Fine knob to fine tune the operator.**
If the Fixed button is off, the display's value is shown according to the formula: $\text{Coarse} * (1 + \text{Fine}/100)$.
If the Fixed button is on, the Fine knob sets the operator's frequency between 1 and 9.772 times the currently set Coarse frequency (see above).
Range: 0-99.

Detune

- **Turn the Detune knob to detune the operator.**
The operator pitch can be detuned in even smaller steps than with the Fine knob.
Range: +/- 7 steps.

Velo Sens

→ Turn the Velo Sens knob to set the operator's amplitude sensitivity to keyboard velocity.

LFO Sens

→ Turn the LFO Sens knob to set the operator's sensitivity to LFO amplitude modulation when using the Mod wheel.

Pan

→ Set the operator's L/R Output panning position with the Pan knob.

This only has any effect when you use an algorithm where the operator is routed as a carrier, i.e. NOT as a modulator.

! Note that the Pan function was not available on the original Japanese FM synth.

Envelope Generators (EG)



The operator envelope generators can affect the sound in two significantly different ways:

- If the operator is a carrier in the selected algorithm, i.e. routed straight to the output, the envelope affects the amplitude of the sound.
- If the operator is a modulator in the algorithm, i.e. modulates another operator, the envelope affects the timbre of the sound.

The envelope generators in PX7 are of a special type, called Level & Rate envelopes. As opposed to the traditional analog-style Attack-Decay-Sustain-Release envelope, this type uses a number of Levels that are reached at different Rates.

In practice this means that low Rate values will render slow Level changes and high Rate values will result in fast Level changes, i.e. the other way around compared to the Attack, Decay and Release parameters in traditional ADSR envelope generators.

! To make the envelope controls more intuitive to those who are familiar to ADSR envelopes, we decided to make the Rate sliders work similar to traditional A, D and R parameters, i.e. the highest Rates (shortest times) are reached when the sliders are all the way down.

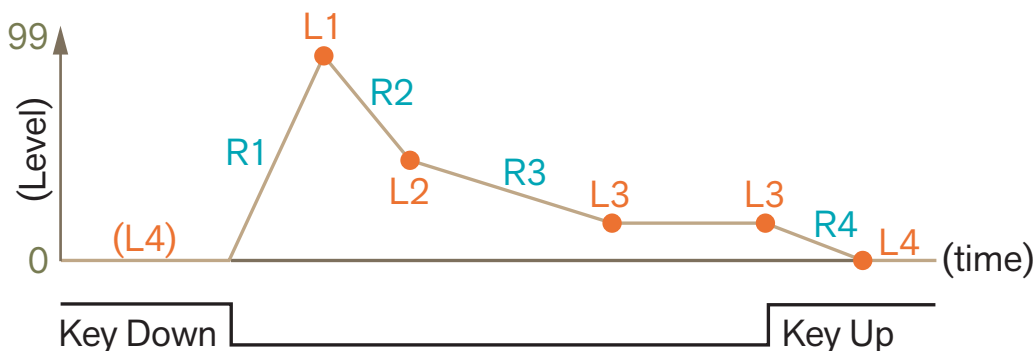
Another thing to bear in mind is that even with the same Rate setting, the envelope will take longer to change between big Level changes than small changes. If two adjacent Levels are the same, the Rate value between these levels doesn't matter at all.

The figure printed on the front panel shows the various Level and Rate stages:



The envelope stages printed on the front panel

Here is how the envelope generator works:



- **When you press a key on the keyboard, the level goes from level L4 to level L1 at the R1 rate.**
- **When level L1 has been reached, the level starts to change to the L2 value at the R2 rate.**
- **When level L2 has been reached, the level starts to change to the L3 value at the R3 rate.**
- **The L3 value is then maintained as long as you hold down the key.**
The level L3 corresponds to the Sustain level in a standard ADSR envelope.
- **When you release the key, the level changes to the L4 value at the R4 rate.**
- ! **Note that the L4 level doesn't necessarily have to be zero, in which case the L4 level will sustain infinitely. This is normally useful only if the operator is a modulator in the algorithm.**

Keyboard Rate Scaling



With the Keyboard Rate Scaling parameter you can define how the decay for each operator's envelope generator should be affected depending on where on the keyboard you play.

- **With the Rate knob set to 0, the decay is the same across the keyboard.**
- **A high Rate value results in longer bass note decays and shorter treble note decays.**

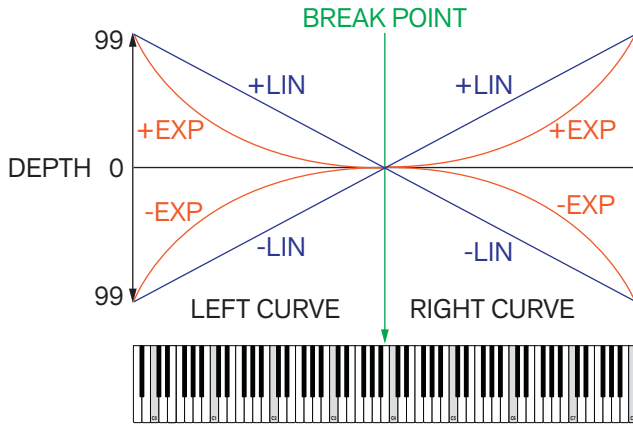
Range: 0-7

Keyboard Level Scaling



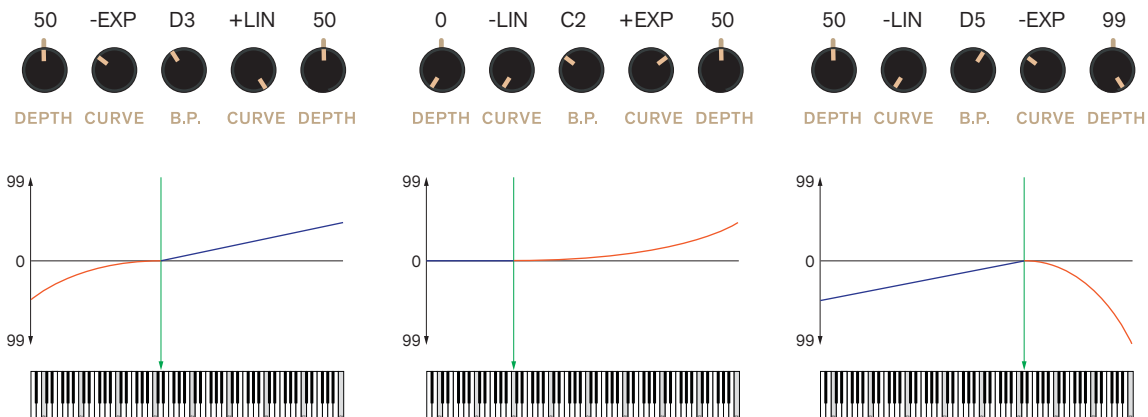
Keyboard level scaling is another special feature in classic FM synthesizers. If you like, you could compare this function to the "Keyboard Tracking" function found in other synthesizers.

Since the timbre of frequency modulated sounds can vary a lot depending on where on the keyboard you play, it is necessary to be able to scale the envelope generator's modulation amount differently across the keyboard - especially for operators that work as modulators in the algorithm. The figure below shows the principle:



- B.P.**
 The B.P. (Breakpoint) parameter is used for defining the desired “center” key on the keyboard. On either side of the breakpoint you can have different curves and depths.
 Range: A-1 to C8
- Depth**
 The Depth parameters defines the scaling amount and can be set differently for the right and left curves on either side of the Breakpoint key.
 Range: 0-99
- Curve**
 One of four different curve types can be selected for the left and right curves respectively:
 -LIN, -EXP, +EXP and +LIN.

The figure below shows three examples of different Breakpoint (B.P.), Depth and Curve settings:



Level



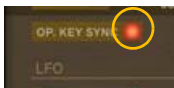
- Set the output level for the operator.
- If the operator is a carrier in the selected algorithm, the Level knob controls the output volume.
- If the operator is a modulator in the selected algorithm, the Level knob controls the modulation amount.

Global modulation controls



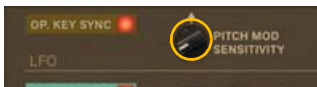
At the bottom of the front panel are two modulation sections that are used for controlling all operators globally.

OP Key Sync



- Click the OP Key Sync LED button to force the sinewaves of all operators to start in phase with each other (at 0 degrees) when you play a note on the keyboard.
If Key Sync is Off, there will be slight timbre variations even if you play the same note exactly the same way.

Pitch Mod Sensitivity



- Set the pitch modulation sensitivity for all operators when using the “Mod wheel”.

LFO



PX7 features an LFO which can be assigned to modulate pitch and amplitude. There are six different waveforms to choose from: Triangle, Saw Down, Saw Up, Square, Sine and Sample&Hold.

- Click the Tempo Sync LED button to sync the LFO to the sequencer tempo in Reason/Reason Essentials.
- Click the Poly LED button to get a separate LFO for each voice.
In “Poly off” mode all LFOs are synced to each other, effectively acting as a single LFO on all voices.
- Click the Key Sync LED button to restart the LFO when you press a key on the keyboard.
In “Key Sync off” mode, the LFO starts at a random position in the LFO cycle.
- Set the LFO rate with the Speed knob.

- **With the Delay knob you set the time it should take for the LFO to apply modulation after you hit a key.**
- **Select LFO waveform by clicking the up/down buttons above the Waveform display.**
- **Set the desired pitch modulation depth with the LFO to Pitch knob.**
This control is independent from the ModWheel control.
- **Set the desired amplitude modulation depth with the LFO to Amp knob.**
This control is independent from the ModWheel control.

Pitch Envelope

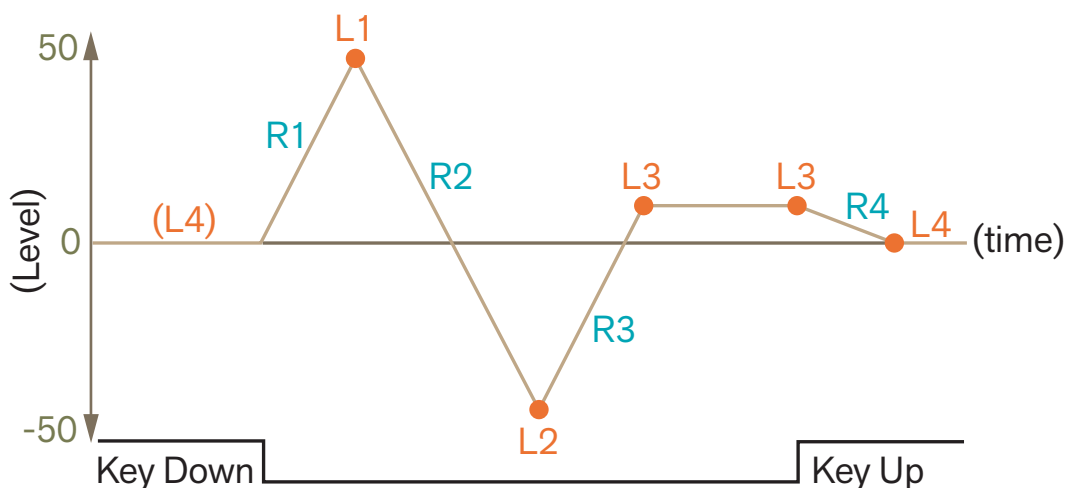


The global Pitch Envelope can be used for modulating the pitches of all operators. The pitch modulation envelope is global for all operators.

Like the other envelope generators in PX7, the Pitch Envelope is of the Level & Rate type. One difference, though, is that the Levels are bipolar relative to the nominal pitch. Nominal pitch is achieved when the Level sliders are in their center positions. The range of the Level parameters is +/- 4 octaves.

! The highest Rates (shortest times) are reached when the Rate sliders are all the way down.

The figure below shows the Pitch Envelope principle:



The Pitch Envelope Generator principle

- **When you press a key on the keyboard, the pitch goes from value L4 to value L1 at the R1 rate.**
 - **When value L1 has been reached, the pitch starts to change to the L2 value at the R2 rate.**
 - **When value L2 has been reached, the pitch starts to change to the L3 value at the R3 rate.**
 - **The L3 value is then maintained as long as you hold down the key.**
The level L3 corresponds to the Sustain level in a standard ADSR envelope.
 - **When you release the key, the level changes back to the L4 value at the R4 rate.**
- ! Note that the L4 value doesn't necessarily have to be zero, in which case the L4 value will change the nominal pitch.**

For more details on how the Envelope Generators in PX7 work, see [“Envelope Generators \(EG\)”](#).

Connections

! Remember that CV connections will not be stored in the PX7 patch!



Sequencer Control In

The Sequencer Control CV and Gate inputs allow you to play PX7 from another CV/Gate device (typically a Matrix or an RPG-8). The signal to the CV input controls the note pitch, while the signal to the Gate input delivers note on/off along with velocity. There are also inputs for modulating the Pitch Bend and ModWheel parameters.

Modulation In

These control voltage (CV) inputs (with associated trim pots) can modulate the Brightness, Touch, Attack and Decay macro controls.

Operator Amplitude Modulation Input

The amplitudes of operator 1-6 can be individually modulated from external CV sources.

Audio Out

These are the main audio outputs. When you create a new PX7 device, these outputs are auto-routed to the first available channel in the main mixer in Reason/Reason Essentials.