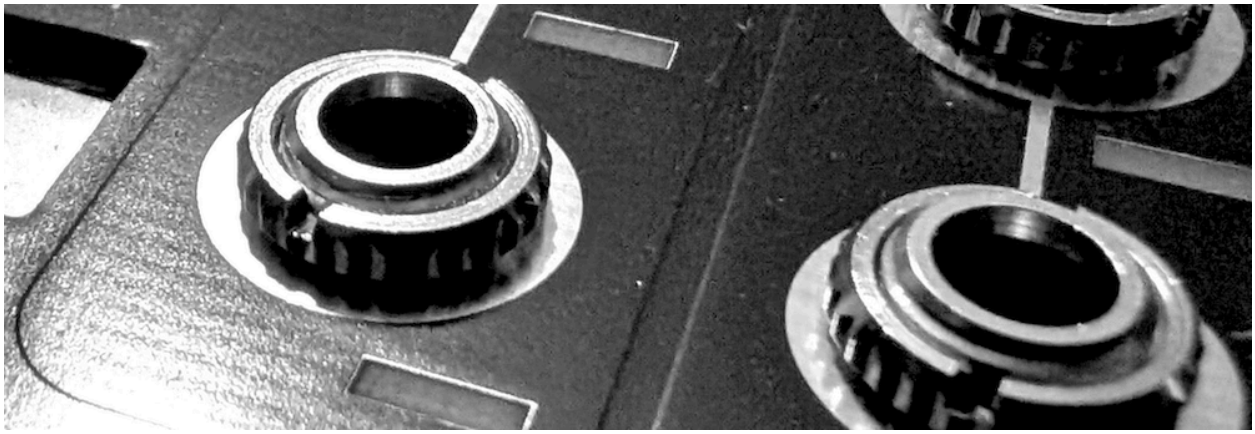
LUNA v1.1

by neutral labs



Manual

Hello, owner.

Luna is a very special kind of synth, a homage to so-called Lunetta synths popularised by Stanley Lunetta in the 70s and 80s. It uses CMOS logic chips both to create timbres and sequence patterns. Those chips are the basic building blocks of all digital circuits, and by exposing all of their inputs and outputs as sockets on the front panel, you will be able to construct your own (temporary) musical computer. The sonic territory you'll enter will be quite different from that of more traditional synthesizers: metallic, screeching, gritty, at times demanding, but never boring.

Luna comes with plenty of quality-of-life features that set it apart from the Lunetta machines of old, so you should have no problem turning your wild patches into something musical. Best of luck on your journey, I hope you'll discover something wonderful and inspiring!

Specifications

- Width: 42 HP
- Supply voltage (either):
  - Eurorack 10-pin header: +12V/-12V
  - USB power: +5V
- Current draw:
  - Eurorack
    - +12V: typ. 55 mA, max. 75 mA
    - -12V: unused, 0 mA
    - 5V: unused, 0 mA
  - USB
    - typ. 50 mA, max. 60 mA
- all logic inputs: 0V to 5V usable, -12V to 12V max.
- all **CLK** inputs have Schmitt triggers
- **LPG** inputs: 0V to 5V usable, -12V to 12V max.
- **MIX** inputs: AC coupled, 20V peak-to-peak usable
- **MIDI** input: TRS type A (MIDI standard), 24 PPQN
- all logic outputs: 0V to 5V, DC coupled, short circuit protected
- audio output: 4V peak-to-peak, AC coupled, headphone compatible

Connecting Luna to USB power

Connect the provided USB-A-to-USB-C cable (or any other USB-C cable) to a USB power source, such as a USB power supply or a power bank. If you have previously removed the module unit from its case, make sure the internal power cable is once again correctly inserted into the white XH connector on the back of the board. Some USB power supplies can be noisy. Luna goes to great lengths to filter that noise, and most supplies should work well. **If you experience excessive hum or buzzing on the audio output, try another power supply or power bank.**

Connecting Luna to Eurorack power

Connect a 10-pin Eurorack power cable to the 2x5 power header on the back of the module. There is an arrow indicator next to the word **STRIPE** on the circuit board. Unsurprisingly, the red stripe side of the cable goes on the side that says **STRIPE**. The module (and your power supply) is protected in case you should ever connect it the wrong way around, it simply won’t power up.

First setup

If you don't enjoy reading manuals from start to finish, you should really make an exception for this one, since Luna is a very special piece of kit. If you can't be bothered to, here's what you absolutely need to know to get going:

- Every socket with a golden ring around it is an output, the rest are inputs. **Do not connect output to output.** They're protected against such tomfoolery, but best not to take any chances.
- There are 5 oscillators on the left side. They can be tuned with the knobs. The first 2 are quantised chromatically by default, though this can be changed. Oscillators 3 to 5 are by default connected internally to the 3 **MIX** inputs on the top right side.
- There are 3 touchpads on the lower left side. They output gate signals, and by default they are connected internally to the 3 **LPG** inputs on the right.
- While the display is active (touchpad stripe below the display to toggle between active and standby), the 3 touchpads don't have their normal function, but are used to change effects and/or navigate the menu. Set the display to standby to resume normal operation.
- There are 3 audio channels on the right. They take in the signal from **MIX**, adjust the volume as set by **VOL**, apply a tilt EQ via **TILT**, and run the result through a low-pass gate that is activated via the **LPG** input. You can toggle between sustain or trigger mode using **TRIG**, the release time is adjusted with **REL**.
- The 3 channels are mixed and sent to the audio output on the top left. You can apply a variety of effects via the display and the **FX** controls on the bottom right. The **MIX** control adjusts the wet/dry mix of the effect or effects.
- Everything that has not been covered so far is a logic input or output of some kind. You can freely patch between oscillators, logic blocks and low-pass gates until you like the noise you hear, or, for a less ambitious goal, until you can tolerate it.
- The trick to mastering Luna is to understand that logic signals can be combined to either sequence things (when slow) or to generate timbres (when at higher frequencies). For some patch ideas, check the very end of this manual.

A word about the display

Luna comes with a tiny OLED display. It's just big enough to show some relevant information when you need it, and stay out of your way most of the time. That's why for normal operation you will typically have the display in standby. Activate it to change an effect, or maybe set a MIDI channel, and then go back to standby to concentrate on your patching. It will go dark after 60 seconds in standby. Most of us are staring at screens too much already in their daily life, so hopefully this philosophy is appreciated.

Oscillators

Luna has 5 oscillators in 2 distinct groups that behave differently. All oscillators output square waves that are useful as digital logic block inputs (0V low, 5V high, DC coupled).

Oscillators 1 and 2 are by default quantised to the chromatic EDO-12 scale as commonly used in western music. They can also be tuned to other scales, such as major or minor, as well as a variety of microtonal scales. See **SCALE** in the menu section of this manual. It is possible to control the pitch of these 2 oscillators via the internal sequencer, CV or MIDI, see **SEQ**, **CV** and **MIDI** in the menu section.

Oscillators 3, 4 and 5 have a much wider range than the other two. Each of them has a **DIV** 3-way toggle switch that switches between low (LFO), medium and high frequency operation. Those 3 oscillators are normalled to the 3 **MIX** inputs of the low-pass gates. Inserting a patch cable into one of the **MIX** inputs severs this connection.

Touchpads

By default, the 3 round touchpad outputs generate a logic high signal while touched, and a logic low signal while left alone. The 4th touchpad (the small strip below the display) is used to toggle the display between active and standby. While the display is active, the 3 touchpads are used to navigate the effects and menu, and will not generate logic signals.

The touchpad outputs are internally connected to the 3 **LPG** inputs by default (though this can be changed, see menu section). This means you can play the 3 channels without patching. Inserting a patch cable into one of the **LPG** inputs severs the internal connection and uses the signal from the cable instead.

It is possible to activate any of the touchpad outputs via MIDI clock or MIDI note events. See **PAD** in the menu section. (Note: If you just want to activate the LPGs via MIDI, see the **LPG** section instead. MIDI events can directly trigger the LPGs, and this way you won't have to sacrifice the normal touchpad functionality.)

Logic gates (NOT, XOR, AND)

NOT performs the Boolean "not" function: A high input will result in a low output and vice versa.

XOR performs the Boolean "exclusive or" function: The output will be high if one, and only one, of the inputs is high, and the other is low. Otherwise the output will be low. Mixing two oscilltors via **XOR** is a common way to introduce beautiful overtones while crafting a timbre.

AND performs the Boolean "and" function: The output will be high only if both inputs are high. This can be useful as a sort of gate control, by routing a timbral signal into one input, and a gating control signal into the other.

Binary counter (BIN)

This is a 4-bit binary counter. Each rising edge seen on the **CLK** input will add 1 to the counter. The resulting binary number will be represented by the 4 outputs. A rising edge on the **RST** input will reset the state to 0. **CLK** is a Schmitt trigger input. (In case that term in unfamiliar: It means the input has different voltage thresholds for the high-to-low and low-to-high transitions, so a continuous value analog signal containing some noise won't trigger it twice.)

A 4-bit binary counter is by nature able to divide any incoming signal into lower frequency signals at one half, one quarter, or one eighth of the frequency. This means it can be employed as a kind of sub-oscillator.

This behaviour is also very useful for sequencing, like putting an event on every second, fourth or eighth step of a sequence.

Ring counter (RING)

This is a 5-step ring counter. Each rising edge seen on the **CLK** input will add 1 to the counter. The counter state is represented by a single output being active, and the state will wrap around after reaching 5. A rising edge on the **RST** input will reset the state to 0. **CLK** is a Schmitt trigger input.

Like the binary counter, the ring counter can be useful for sequencing. It’s also possible to turn it into a 4-step or lower counter by running a patch cable from any of its outputs to the **RST** input, though a 5-over-4 pattern can be a lot of fun.

Shift register (SR)

These are 2 individual serial-to-parallel shift registers. A rising edge on the **CLK** input will shift the current value of the **DAT** input into the register, and advance all current output bits by one position, causing one bit to be shifted off into oblivion. A rising edge on the **RST** input will reset the state to all lows. The **CLK** inputs are Schmitt trigger inputs.

Multiplexer (MUX)

This is a 4-to-1 channel multiplexer. The binary number formed by the 2 select inputs **S0** (least significant bit) and **S1** (most significant bit) determines which of the 4 data channels **D0**, **D1**, **D2** and **D3** will be connected to the output.

Low-pass gate (LPG) channels

There are 3 identical low-pass gate channels that are able to turn the digital mess you've patched between the logic blocks into something more musical.

Each channel takes the signal from **MIX** (which is oscillator output 3, 4 or 5 without any patch cable inserted). The input gain is adjusted by **VOL**. The signal then goes through a tilt EQ. The **TILT** control boosts low frequencies and attenuates high frequencies when turned counterclockwise, and vice versa clockwise. You can think of it as kind of a low shelf/high shelf EQ combination with both gain controls linked in opposition to one another. It will turn the incoming square waves into something more rounded, or something more "edgy", depending on the knob position.

Finally, the signal goes into a low-pass gate. This is a low-pass filter that has its cutoff controlled by a gate signal with applied release time set by **REL**. With the **TRIG** toggle switch in the up position, the gate will remain open as long as the gate signal is high (sustain). In the bottom position, it will open on a rising edge of the gate signal and immediately start the release part of the envelope.

Note that in the top position, you don't have to send a discrete on/off gate signal, but you can input a continuous value signal between 0V and 5V instead, with the voltage determining the cutoff frequency. (Higher or lower voltages are fine, they will not damage the device.)

Also note that these are vactrol-free LPGs, emulating vactrol-like behaviour with optocouplers, as traditional vactrol-based LPGs contain toxic cadmium sulfide and are restricted under RoHS regulations. It is still a fully analog circuit though, and one that has been specifically designed to enhance the sonic characteristics of the combined square waves coming out of the logic blocks.

Effects (FX)

Luna has 2 effect slots A and B that run in series (A into B). By default, there is no effect on the B slot. Activate the display by touching the touch strip below it, and use touchpads 1 and 3 to cycle through the available effects. The effects for both slots will be shown while the display is in standby, with the active slot marked.

The **FX** section on the bottom right controls the effects settings. **CTL1** and **CTL2** set certain parameters depending on the type of effect (see table below). **MIX** adjusts the wet/dry mix. In the fully counterclockwise position, you won't hear any effect, in the fully clockwise position you will hear only the effect. (All 3 controls will continue to work even if the display is inactive.)

Use touchpad 2 to toggle between the A and B effect slots. (If you hold touchpad 2, it will change its function and can then be used to access the config menu. Hold it again to revert back to slot selection.)

When you change slots, the last remaining **CTL1** and **CTL2** settings will be remembered for the slot you're changing from. The new slot will not immediately jump to the current **CTL1** and **CTL2** settings, only if and when the **CTL1** and **CTL2** controls are changed. It is possible to modulate the **CTL1** and **CTL2** controls via the **CV1** and **CV2** inputs, see the CV section of this manual.

The **MIX** control is analog, and will affect the **FX** output as a whole. It can be desirable to adjust the wet/dry mix of each effect individually, especially when running effects on both slots. Hold touchpads 1 and 3 at the same time, and you will be able to change the individual effect mix using touchpads 1 and 3, and exit using touchpad 2. This setting will be remembered by effect by slot. The default setting is 100% wet for all effects except for **DELAY** and **RVERB** in slot B, where it is 50%.

Effect	Description
DRIVE	Distortion effect that gets very brutal. **CTL1** is drive amount, **CTL2** is tone.

DELAY	Delay effect that goes completely bonkers with high amounts of feedback. **CTL1** is delay time, **CTL2** is feedback amount.
RVERB	Dusty 80s reverb, **CTL1** is color, **CTL2** is decay time.
TLLPF **TLBPF** **TLHPF**	4-pole transistor ladder filter in low-pass, band-pass or high-pass configuration. **CTL1** is resonance, **CTL2** is cutoff frequency.
SVLPF **SVBPF** **SVHPF**	2-pole state variable filter in low-pass, band-pass or high-pass configuration. **CTL1** is resonance, **CTL2** is cutoff frequency.
COMB	Comb filter. **CTL1** is feedback damping, **CTL2** is time.
CRUSH	Bit crusher. **CTL1** mangles the bits of incoming audio, **CTL2** introduces sample rate reduction.
CHORS	Chorus effect. **CTL1** is modulation rate. **CTL2** is modulation depth.
PHASR	Phaser effect. **CTL1** is modulation rate. **CTL2** is modulation depth.

Config menu

In order to access the config menu, activate the display by touching the touch strip below it. By default, touchpad 2 will toggle between the 2 effect slots as indicated by a white rectangle around “A” or “B”. Hold touchpad 2 until the rectangle moves to the menu icon (3 horizontal lines). Touchpad 2 can now be used to enter the menu.

Once in the menu, use touchpads 1 and 3 to cycle through the first level menu items. Touchpad 2 will enter a submenu or perform an action. Holding touchpad 2 will return to **FX** selection from anywhere in the config menu.

Menu item	**Description**
LPG	Selects how the LPGs trigger with no cable patched into the **LPG** input. The default **PAD** means it’s triggered by the touchpad of the same number. **DRONE** keeps the gate open, unless the **TRIG** switch is in the down position. **SEQ1** and **SEQ2** will trigger with each sequencer step. **CLOCK** means it will get triggered by MIDI clock (each quarter note). **MIDIx** with x being a digit means the gate opens for each note received on MIDI channel x.

OSC	Selects the pitch source for each oscillator. The default **KNOB** means it's controlled only by the knob, **SEQ** sets the sequencer as the source (see Sequencer section of this manual). **MIDIx** with x being a digit from 1 to 9 means pitch will come from any MIDI note received on MIDI channel x.
PADx	Sets the source for the 3 touchpad outputs. The default **TOUCH** means the output is controlled by the touchpad. **CLOCK** means it will pulse with the MIDI clock (once each quarter note). **MIDIx** with x being a digit from 1 to 9 means the output will be high for any MIDI note received on MIDI channel x.
CV	Sets the destination for the **CV** inputs. The default **PITCH** adds the control voltage to the oscillator's pitch. **SEQ** means the input is used as a clock/step advance for the sequencer associated with that oscillator. **CTL1A**, **CTL2A**, **CTL1B** and **CTL2B** select the **CTL1** or **CTL2** control of **FX** slot A or B as destination.
SCALE	Use this to quantise the tuning of oscillators 1 and 2. **NONE** means the tuning is unquantised. The default **EDO12** is the common western 12-tone chromatic scale. **MAJ**, **MIN**, **MAJ5** and **MIN5** are major, minor, major pentatonic and minor pentatonic scales. **EDO7**, **EDO9**, **EDO15** and **EDO17** are microtonal equal temperament scales subdividing the octave into 7, 9, 15 or 17 steps.
ROOT	This sets the root note for the scales configured with the **SCALE** option. Note that **EDO12** has no associated root note, because it lacks a tonal center.
RSEQ	Enter sequence recording mode for sequencer 1 or 2. See the Sequencer section of this manual.
STORE	This saves the current configuration to flash memory, including all sequences as well as the current **FX** selection and **FX** settings. Everything will be recalled automatically at device start-up.
RESET	This resets the configuration to the default, including all **FX** settings. It will also erase all sequences. (The resulting default state is not automatically saved to flash memory.)
EXIT	Figuring out the function of this mystical menu item is left as an exercise to the reader. Proceed with caution!

Sequencer

Luna has 2 sequencers, one associated with oscillator 1 and one associated with oscillator 2. Those sequencers record pitch information only, not gate length, but you can work with gates as well, see below.

In order to record a sequence, enter the **RSEQ1** or **RSEQ2** option in the config menu. Use touchpads 1 and 3 to navigate through the steps of the sequence. Set the frequency for each step using oscillator knob 1 or 2. The frequency in Hz will be displayed. If the frequency falls on a specific scale note (or scale quantisation is enabled), that note will be displayed instead.

Use touchpad 2 to exit and save the sequence. Holding touchpad 2 will enter length selection mode, where you can use touchpads 1 and 3 to set the sequence length. The maximum number of steps is 64.

In order to play a sequence, set the pitch source for **OSC1** or **OSC2** to **SEQ** in the config menu. Set the **CV1** or **CV2** source to **SEQ**, so any incoming clock signal into that CV input will advance the sequencer. (Note that the clock signal doesn't have to be regular, for fun you can use any irregular digital signal coming out of any of the logic blocks.) You can use a copy of the clock signal to apply gates if desired, e.g. via an **AND** logic gate or any of the 3 LPGs. There is also the option to select **SEQ1** or **SEQ2** as the **LPG** source in the config menu, which will automatically trigger the LPG with each sequencer step.

Another option is to start and stop the sequence via MIDI. Again, set the pitch source for oscillator 1 or 2 to **SEQ** in the config menu. Now send a MIDI start or continue message to start the sequencer, and it will run in time with the MIDI clock. You can use MIDI clock to generate gates on either the touchpad outputs or directly trigger the LPGs. (See **PAD** and/or **LPG** in the Config menu section of this manual.) Send a MIDI stop message to stop the sequencer.

Use the config menu **STORE** option to save any sequences along with the current configuration.

Firmware upgrade

In order to upgrade the firmware, unzip the archive and locate the update file (suffix UF2). Remove the module from the Eurorack or desktop case. **THE USB-C PORT ON THE BACK OF THE DESKTOP CASE WILL NOT WORK FOR A FIRMWARE UPGRADE!**

Plug a USB-C data cable into your computer. **MAKE SURE IT IS A DATA CABLE, NOT A CHARGING-ONLY CABLE!** While holding the **UPDATE** button on the back of the module, plug the other end of the cable into the USB-C port next to the **UPDATE** button. Let go of the button. A drive should appear on your computer. Copy the UF2 file onto the drive. The drive will disappear and Luna will reboot. You will not see the file appear in the drive, it is not an actual drive, just a mechanism to copy the firmware.

Now place the module back into the case. Note that a firmware upgrade will reset your configuration to the default, and delete any stored sequences!

Troubleshooting

Problem	**Possible solution**
I’m trying to update and the drive does not appear on my computer.	Make sure you’re using a data cable. Make sure to use the USB-C port on the back of the module, not the USB-C power port on the back of the desktop case. Hold the **UPDATE** button while inserting the cable, then let go.
I’m touching one of the touchpads, but the associated LPG doesn’t trigger.	The LPG needs to be set to **PAD**, see the **Config menu** section.
My sequence isn’t playing.	Make sure you have a sequence recorded on that oscillator. Set the **OSC** source to **SEQ**, and in case you’re not using MIDI, set the **CV** destination to **SEQ** as well, and send a clock signal into the **CV** input.

There is no sound at all.	You may have turned the **MIX** knob all the way clockwise, and selected a filter for **FX** with the cutoff closed.
The **MIX** knob affects the full **FX** mix, but I want to be able to set individual wet/dry mix per **FX** slot.	See the **Effects (FX)** section on page 8: Touch pads 1 and 3 at the same time and you'll be able to change the individual mix per effect slot.

Patch ideas

- Oscillator 1 and 2 in the (default) EDO12 scale, send both into an **XOR** gate and the **XOR** output into a MIX input. Adjust tuning for interesting harmonics. Also great with MIDI or CV control over the oscillator pitch.
- Patch an oscillator into the **BIN CLK** input, and another into an **SR CLK** input. Send one of the **BIN** outputs into the **SR DAT** input. With both oscillator set to relatively slow frequencies, you can now send the **SR** and remaining **BIN** outputs into the **LPG** inputs with the **TRIG** switches down for some interesting quasi-stochastic sequencing. Change the frequencies slightly to discover new patterns. Turn them way up to make some nasty drones.
- Record a sequence into one of the oscillators, with large jumps between the notes, and use that oscillator to clock the **BIN** counter. Use the 3rd and 4th **BIN** outputs to clock the **RING** counter and one of the **SR** shift registers. Feed another oscillator's output into the **SR DAT** input. Trigger the **LPG** inputs from some of the **SR** and **RING** outputs. The changing sequence on the oscillator will cause the gate patterns to change speed.
- Clock the **BIN** counter and use two of its outputs going into an **AND** gate each, and patch some audio rate oscillators into the other input of each **AND** gate. The **AND** outputs will now be gated by the **BIN** outputs.
- Patch 3 oscillators into the **MUX D0** to **D3** inputs. Patch 2 more oscillators into the **MUX S0** and **S1** inputs. The **MUX** output will be a sort of complex oscillator made from the combined (time-multiplexed) square waves.