Nebulae

Description

Nebulae is a granular sampler and DSP platform. Its phase vocoder audio engine provides elastic audio, which can be time stretched, granularized, and mangled to no end. With independent control over pitch and speed, and granular controls such as overlap, window, and density, finding new sonic territory is only a knob turn away. Nebulae can use live audio input, a recorded buffer, or audio files as the source material for its powerful audio manipulations. The live input buffer can record up to five minutes of stereo audio at 48kHz, 24 bit. In addition, up to 75 MB of stereo audio can be loaded simultaneously through the USB port. No naming convention or special formatting necessary; just plug and play.

Nebulae lives a double life as an open source DSP platform with an extensive library of off the shelf alternate instruments. You can turn the module into a lush reverb, spectral delay, or tape-style looper simply by loading a new file onto the flash drive. Do you want to tweak one aspect of an existing instrument, even the default functionality? No problem. No prior coding knowledge is necessary to tweak and refine existing firmware to your liking or start with one of our templates. Alternate firmware files can be written with Pure Data, Csound, SuperCollider, and even bare-bones C programs.

- Granular sampler with time stretching capabilities

- 5 minute stereo recording buffer at 48kHz, 24 bit (In addition to file playback buffer)

- No naming convention or special formatting necessary for file playback

- Supports Pure Data, Csound, and SuperCollider alternate instrument files

- Ships with loaded USB flash drive ready to use

- Black aluminum front panel

Contents

General

Specs

Audio Quality

- 24-bit, 48kHz Stereo Audio Input/Output

Depth

- 34mm

Width

- 20hp

Current Consumption

Powered by +12V

- +12V: 318mA
- -12V: 7mA

Powered by +5V

- +12V: 47mA
- -12V: 7mA
- +5V: 271mA

Installation

To install, locate 20 HP of space in your Eurorack case and confirm the positive 12 volts and negative 12 volts sides of the power distribution lines. Plug the connector into the power distribution board of your case, keeping in mind that the red band corresponds to negative 12 volts. In most systems, the negative 12 volt supply line is at the bottom. The power cable should be connected to the Nebulae with the red band facing the bottom of the module.

To power the the module from Eurorack +5V position the switch behind the Positive Speed LED to the +5V position.

Boot Animations

The boot animation rotates the RGB LEDs in a circle during bootup, and when reloading files or instruments.

To give useful visual feedback there are a number of different colors used during this animation.

The white booting animation will start 10 seconds after powering the module.

Color	Status
White	Booting
Blue	Loading Files
Aqua	Loading Files from USB
Green	Firmware Update
Red	Error

Marked Diagram

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Granular Looper

The granular looper plays back an audio file or a recorded buffer and loops it. It is run through a phase vocoder to allow for the independent pitch and speed control. The output is then run in parallel with a granular processor that the user can mix between.

Primary Controls

1. Speed

Turning the encoder will increase/decrease the playback speed of the audio sample, or recorded buffer independently of pitch.

CV input responds to +/- 5V, and is added to current knob position.

Speed ranges from 4x playing backwards to 4x playing forwards .

The illuminated LED will correspond to the direction in which the file is playing back. (Left is backward, right is forward).

The LED will illuminate twice as bright when you're set to an even factor of speed.

Positions between speed factors are indicated by a blend of the colors of the surrounding factors.

Speed	Color
1/8	White
1/4	Orange
1/2	Yellow
1 (original speed)	Blue
2	Green
4	Purple

Holding this encoder for 2 seconds will enter the instrument selector menu.

When recording, the speed is used to determine the new maximum size of the buffer, and is locked.

During circular recording, this lock is disabled, and speed can move freely. The buffer will remain the same size no matter what..

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2. Pitch

Turning the encoder will increase/decrease the pitch of the audio sample, or recorded buffer independently of play-back speed.

CV input tracks 1V/Octave, accepts 0-5V unipolar, and is added to the knob position.

Pitch ranges from -3 octaves to +2 octaves.

When set to original pitch, both pitch LEDs will be blue.

The LEDs will illuminate twice as bright when set to any octave that is above or below original pitch.

Positions between octaves are indicated by a blend of the colors of the surrounding octaves.

Octave	Color	Side (left/right)
-3	White	Left
-2	Orange	Left
-1	Yellow	Left
0 (original pitch)	Blue	Both
+1	Green	Right
+2	Purple	Right

3. Start

Controls the start position of either the loaded file or the recorded buffer.

CV input responds to +/- 5V, and is added to the knob position.

4. Size

Controls the size of the currently selected loop.

CV input responds to +/- 5V, and is added to the knob position.

5. Density

Controls the rate of grain generation.

Ranges from .120Hz(8.3s) to 2.5kHz(400us).

When the secondary Freeze control is enabled, turning the density knob all the way down disables internal grain generation.

CV input responds to +/- 5V, and is added to the knob position.

6. Overlap

Controls the amount of overlap between successive grains as well as the size of individual grains.

Ranges from 1% to 600% of grain rate.

When the Secondary Freeze control is enabled, and the density control is all the way down, overlap will control the grain size across a fixed range from 500us to 2 seconds.

CV input responds to +/- 5V, and is added to the knob position.

7. Blend

File Source

When the knob is fully counter-clockwise only the phase vocoded loop will output.

When the knob is fully clockwise only the granular loop will output.

Live Source

When Source is illuminated this controls the blend of the phase vocoder, granular stream, and dry input signal.

When the knob is set to the middle, only the dry signal will output.

When the knob is set fully counter-clockwise, only the phase vocoded loop will output.

When the knob is set fully clockwise, only the granular loop will output.

CV input responds to +/- 5V, and is added to the knob position.

8. Window

Changes the window shape of the grains being generated.

This control blends through each of the following hammer shapes in this order.

1. Gaussian .
2. Blackman-Harris .
3. Down.
4. Bartlett .
5. Up.
6. Hamming.
7. Square.

CV input responds to +/- 5V, and is added to the knob position.

9. Audio Inputs

Stereo Audio Inputs. When nothing is connected to the right input, the left input will normal to the right input.

When set to file source this is used as an FM Input for the grains being generated.

10. Audio Outputs

Stereo Audio Output.

10Vpp.

11. Record

Pressing record for the first time creates a new buffer that ends when record is disabled or 5 minutes have passed (You can make this initial recording from a live input source or from a file). The input to the buffer is controlled by the blend control, and will be filled with the audio that is heard at the time of recording. This includes all knob turns and CV controls, excluding speed, start, and size.

Once the buffer is looping it's possible to punch in at any moment and record the output back into the buffer, replacing the existing material (Record your loop backwards with no additional input to have it play backward when set to original speed).

Once an overdub has completed, original pitch and speed will reset, guaranteeing that you hear what you were just recording.

Recording will automatically disable itself at the end of a full overdub pass.

To clear the buffer hold file and press reset.

To accurately calculate the anticipated size of a new buffer, the speed, start and size controls are locked during normal recording.

12. File

This advances the currently selected audio file to the next audio file.

The order of succession is defined by the File Selection Mode in the secondary controls menu.

This control is inactive when set to Live Source.

13. Source

Switches between File Source and Live Source.

Holding this button provides temporary access to the Secondary Control Menu.

14. Reset

Resets the playback position to the currently selected loop start point.

15. Freeze

Pauses the current playback position while retaining the frequency and spectral characteristics of the audio.

This is a latching control.

The Button LED will be illuminated when the buffer is frozen.

16. Pulse

A 5V gate emits from this output whenever the loop resets.

Edit Functions

These commands are executed when holding the File button and pressing another button.

Reload Files

Reload files by holding File and pressing Source. (Note: Source is a falling edge sensitive button) .

Reload files from a USB drive and restart the currently selected instrument file.

Buffer Erase

Erase the buffer by holding file and pressing reset.

Upon erasing the buffer the reset LED will blink five times to indicate that the buffer has been cleared.

Secondary

A secondary set of controls is accessible when holding down the source button.

Once the source button has been held for 250 ms, the LEDs will shift to display the state of the secondary settings.

With source pressed down, pressing any of the other buttons or turning the knobs will affect the secondary controls.

Releasing the source button returns the controls back to their primary functions.

CV and gate inputs will continue to affect the primary controls even while source is being held.

2. Pitch

This control sets the amount of random pitch deviation. Range: +/- 2 octaves.

The purple LED indicators will blink when trying to turn the encoder past the minimum or maximum.

Clicking this encoder from the secondary control menu will restore all secondary controls to their default positions.

3. Start

Random Grain Position.

This will add random deviation to the playback position that new grains are generated from.

At its minimum value, all grains are generated from the current playback position.

At its maximum value, all grains are generated from a random position within the file or buffer.

4. Size

Controls the amount of random panning applied to the generated grains.

When fully counter-clockwise, there will be no random panning of grains.

When fully clockwise, each grain will be panned to a random location between both outputs.

5. Density

Controls the amount of random time displacement for grains.

The grains will still be created at the same rate as before, but they will be displaced up to a maximum of 10 seconds. When the grain plays it will have the same pitch, window shape, and size that it had when it was generated.

These random displacements are calculated independently for the left and right channels.

6. Overlap

Sets the amount of random deviation in grain size. The control is +/- 100% at maximum, and the deviation is added to the overlap setting.

These random grain sizes are calculated independently for the left and right channels.

7. Blend

Controls the modulation index of FM applied to each grain.

This is disabled when density is set fully counter-clockwise or when set to live source.

This applies FM directly to the grains, and has no effect on the phase vocoded sound.

8. Window

Stochastic grain masking.

Increasing this control will mute random grains.

The stochastic masking is calculated for left and right channels separately.

When set fully counter-clockwise, no grains will be muted.

When set to the middle, half of all grains will be muted.

When set fully clockwise, 99% of all grains will be muted.

11. Record

This enables Circular Recording, continuously recording new content to the buffer.

Creating a buffer and overdub recording work the same way that the normal behavior does.

The key differences are that:

- recording is not disabled at the loop point.
- original pitch/speed are not reset by the end of a recording.
- the locks on speed, start, and size are disabled.

12. File

This changes the order in which the file button progresses through the files.

Pressing the button will advance through the following options, wrapping at the end of the list.

Option Number	Playback Order	Indicator
1 (default)	Forward	LED fades from dark to light
2	Backward	LED fades from light to dark
3	Random	LED blinks between random brightness

13. Source

Holding this button provides temporary access to all of the secondary controls while it is held.

15. Freeze

Configures a grain trigger out of the source gate input.

When active, the source gate input no longer switches between live and file sources.

When this setting is enabled, turning the density knob all the way down will disable the internal generation of grains, deferring all grain generation to the source gate input.

When the density control is at it's minimum, the overlap control operates on a fixed range of grain sizes from 500us to 2 seconds.

Instr Selector

The Nebulae can be an infinite number of different instruments, thanks to the .instr file. This allows an independent chunk of Csound or Pure Data code to run with access to all files, and controls that our main granular looper uses. The granular looper is actually a .instr file itself.

For more information on .instr files see the instrument reference document.

The selector can be entered when the module is running by pressing and holding the speed encoder. After two seconds, the pitch and speed LEDs will illuminate green, and one of the five button LEDs will illuminate as well.

A fully illuminated button LED indicates the selected instruments.

A dimly illuminated button LED indicates that there is an instrument present in that position.

A unilluminated button LED indicates that there is no file present.

Clicking the Speed encoder from this menu will load the selected instrument, and check for a USB drive/reload files.

Clicking the Pitch encoder from this menu will return to the primary control menu without changing instruments.

The Speed LEDs will indicate whether you're selecting from the factory bank of instrument files or the user bank.

You can change the bank by rotating the speed encoder.

If the Negative Speed LED is illuminated, the user bank of .instr files is selected.

If both Speed LEDs are illuminated, the factory bank of .instr files is selected.

If the Positive Speed LED is illuminated, the user bank of Pure Data files selected.

The five LEDs at the bottom signify the selection of an instrument file. Selecting one of the five, and then pressing the speed encoder, will restart the Nebulae with the new instrument loaded.

If there are more than 5 instrument files in the bank:.

- The far left and/or far right buttons will blink between dim and off to indicate that there are more files in that direction.

- The far left or far right button will blink between dim and fully illuminated to indicate that the selected instrument file is in that direction.

- The pitch encoder can be rotated to scroll through the visible instrument files.

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Factory Instr Files

Currently the following factory instruments are loaded in the following positions from left to right:.

1. a_granularlooper.instr - Granular looper with phase vocoder audio engine.
2. b_oneshot.instr - A 4-channel one shot sampler with varispeed.
3. c_synth.instr - Synth voice, Morphable Waveform, Sub, and an LPF.
4. d_effects.instr - Multi-Effects processor - Delay, and Reverb.
5. e_testio.instr - A simple instrument that passes the audio input to the audio output. A good template.

Each instrument file has an overview of it's controls below.

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One-Shot Polyphonic Sample Player

The one shot sampler allows for simultaneous playback of four samples at a time.. Each with their own pitch control, and trigger input. . This instr is accessed from the file button in the instr selector in the factory instrument bank. .

Primary Controls

2. Pitch

Global Varispeed offset.

3. Start

Varispeed control of Sample 1.

CV input responds to +/- 5V, and is added to the pot position..

4. Size

Varispeed control for Sample 3.

CV input responds to +/- 5V, and is added to the pot position..

5. Density

Varispeed control for Sample 2.

CV input responds to +/- 5V, and is added to the pot position..

6. Overlap

Varispeed control for Sample 4.

CV input responds to +/- 5V, and is added to the pot position..

7. Blend

Offset for file selection..

When fully counter-clockwise, the first four samples loaded on the Nebulae will be played.

When fully clockwise, the last four sample loaded on the Nebulae will be played.

11. Record

Trigger for sample one.

12. File

Trigger for sample two.

13. Source

Kill All Trigger/Button.

Chokes all the inputs.

Holding this accesses the secondary control menu..

14. Reset

Trigger for sample three.

15. Freeze

Trigger for sample four.

Secondary Controls

3. Start

Length control of sample one.

4. Size

Length control of sample three.

5. Density

Length control of sample two.

6. Overlap

Length control of sample four.

8. Window

Controls the amount of downsampling..

11. Record

Kills only the first channel's sample.

12. File

Kills only the second channel's sample.

14. Reset

Kills only the third channel's sample.

15. Freeze

Kills only the fourth channel's sample.

Synth Voice

Subtractive synth voice, featuring waveform blend, controllable sub-oscillator amount, and a 24 dB ladder filter.

Primary Controls

2. Pitch

Frequency of the Oscillator.

Five octave range.

5. Density

Cutoff frequency of low pass filter.

6. Overlap

Resonance of low pass filter.

7. Blend

Waveform blend.

When the control is fully counter-clockwise, the waveform is a square wave.

When the control is fully clockwise, the waveform is a sawtooth wave.

8. Window

Sub-Oscillator Amount.

Controls the amplitude of a sine wave oscillator one octave below the currently set frequency.

When the control is fully counter-clockwise, there is no sub-oscillator signal.

When the control is fully clockwise, the sub-oscillator is the same amplitude as the primary waveform signal.

10. Audio Outputs

Audio output. Both outputs are identical

Secondary Controls

No Secondary Controls have been implemented yet.

World of Echo

Multi-fx instrument featuring delay, and reverb.

Primary Controls

3. Start

Delay Time (2 second maximum)

4. Size

Feedback Amount

5. Density

Reverb Time

6. Overlap

Reverb Filtering control

7. Blend

Dry/Wet for the Delay mix

8. Window

Amount of post-delay signal to send to the reverb bus.

9. Audio Inputs

Stereo Inputs. The Left input will normal to the right input when nothing is connected to it.

10. Audio Outputs

Processed Stereo Audio Outputs

13. Source

Mutes the audio input.

Secondary Controls

No Secondary Controls have been implemented yet.

Test I/O

This instrument file can be used to verify audio pass through, and see the amplitude of completely unprocessed sources.

The Source button acts as a latching mute control.

This is also a nice instrument file to use to get started building alternate instruments.

Secondary Controls

1. Speed

Controls the hardware ADC level for the audio inputs.

When the Positive Speed LED is green the level is set for modular level input.

If the Positive Speed LED is illuminated, the gain is higher. At maximum line in level signals are usable.

If the negative Speed LED is illumintated the gain is lower. .

This is not a smooth control, the user may hear a few clicks, as the controls are in multiple dB per step..

Clicking the control resets it to 0dB gain.

This can be used in any alternate instrument. .

Formatting a New USB Drive

The Nebulae expects a USB drive formatted as FAT32.

Mac OS X

On recent releases of Mac OS X there is an issue with disk utility that requires additional steps for formatting.

To format, follow these steps:.

1. Insert USB drive into the computer.
2. Open Disk Utility.
3. Select the Drive from the menu on the left (Select the actual drive, and not the partition within the drive).
4. Select Erase, and choose the MS-DOS (FAT32) option from the drop down.
5. If it fails continue to steps 6-7.
6. Repeat steps 3 and 4 again.
7. It will succeed, and your drive will be properly formatted. (The name of the device may be changed in this process).

Windows

1. Insert USB Drive into the computer.
2. Right-click the USB Drive in the computers file-browser.
3. Select the "Format" option.
4. Choose FAT32 from the formatting options.
5. Click Format

Linux.

1. Insert USB Drive into the computer.
2. Right-click the USB Drive in the computers file-browser.
3. Select the "Format" option.
4. Choose FAT32 from the formatting options.
5. Click Format

Loading Files

Files are automatically loaded and sorted at boot up, but can also be reloaded at anytime by holding file, and pressing source from any instrument's primary control page.

The LED animation has two different behaviors when loading files.

If there is a USB drive detected and files are being copied from it, the LEDs will be aqua.

If there is no USB drive detected and the existing files are being reloaded, the LEDs will cycle blue.

At this time, files cannot be reloaded while running a Pure Data instrument..

File Types

The following files are loaded from USB automatically.

- Audio Files.
    - .wav.
    - .aif/.aiff.
    - .flac.
- Csound instruments (.instr).
- Pure Data patches (.pd).

The following files are able to be loaded and executed, but may require separate compilation and/or accessing the module through SSH.

- Shell scripts (.sh).
- SuperCollider synths (.scd).
- Bare-bones C programs (.c).
- Python scripts (.py).

Sample Rate and Bit Depth

Audio Files may be of any bit-depth/sample rate. However, the module runs at 48kHz and will playback all files at this sample rate (the main instrument will compensate for the difference between file sample rate and the system sample rate).

Persistence of Memory

When files have been loaded into the module, they will remain there after the USB flash drive has been removed as well as between power cycles.

They will only be replaced when new files are present on the flash drive when files are loaded. (It should be noted that loading new audio files does not replace .instr files and vice versa).

For example, if the user loads foo.wav from a USB drive, removes the USB drive, and power cycles the Nebulae. foo.wav will remain on the Nebulae. If you reload the USB drive with foo_2.wav, foo.wav will be removed from the Nebulae, and foo_2.wav will be added.

This behavior is based on the file type. So you could load a Pure Data instrument once, and never put another Pure Data instrument on a USB drive, and the original instrument will remain on the Nebulae indefinitely.

Addditional Considerations

While as many files as will fit on the Raspberry Pi will be copied, only the first 75MB of audio files (alphabetically) will be loaded into the currently playing instrument.

Pure Data can still access these files at /home/alarm/audio.

If a file exceeds the 75MB limit, smaller files that appear after the large file alphabetically will still be loaded into the instrument until the 75MB limit is reached.

Neb Log

A neb_log.txt file is added to the USB flash drive after booting up the Nebulae.

This reports the current firmware version along with a check for mandatory files, and other useful information at the time of boot up.

This file can be deleted at any time without issue. It will be regenerated upon boot up.

The dates are likely incorrect as the Nebulae's filesystem is read-only most of the time, which doesn't allow it to keep an accurate calendar..

Firmware Update

Welcome to the guide on updating the firmware for your Qu-Bit Nebulae.

This guide illustrates updating the firmware via the USB drive on the front of the module.

What You Need

- A USB Drive
- A neb_update.zip firmware update file

The process

- Add the neb_update.zip to the root directory of the USB drive.
- Insert the USB drive into the Nebulae.
- Make sure that no CVs are present at the control inputs. (The module performs a self-calibration after firmware updates)
- Power on the Nebulae
- After the typical boot time, the LEDs will begin to cycle green indicating the firmware is updating successfully.
- The update will take up to 90 seconds.
- Once the update is complete the LEDs will stop rotating, and will remain green while the Nebulae performs a software reboot.
- The LEDs will begin cycling white to indicate the boot sequence, and subsequently aqua when it begins to load files.
- Once the module is running we recommend power cycling the module (with 5 seconds between turning the module off and turning it back on).

It is recommended that the Nebulae not be powered down during a firmware update, or when loading files.

Reverting to the Factory Firmware

Adding a file "revert_to_factory_firmware" to the root directory of your USB drive will cause the Nebulae to revert to the factory firmware.

The file can be empty, and will be deleted after the reversion has been complete.

If something goes wrong with a firmware update, performing this or another firmware update will likely resolve the issue.

This will always revert to v1.0.0 of the Nebulae Firmware.

After booting the module up with the revert_factory_firmware file on the USB drive, it may take longer than normal to enter the boot sequence.

Release Notes