



Digital Meets Analog.

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Foreword

Nebulae has always been a unique piece of kit. Both the v1 and v2 provide ways of manipulating sound that set it apart from most audio processors; even those with a granular bent. According to Darwin Grosse from the Art+Music+Technology podcast, Nebulae “Changed the sound of modular” when it first came out. Hearing these words from a visionary such as Darwin, caused me to examine the module in a different light.

The magic, to me, comes from a combination of disparate processing techniques which coalesce into something more meaningful when experienced together. It isn't just a granular processor, or just a phase vocoder, even though both of these topics could justify an entire instrument dedicated to them. The appeal for Nebulae stems from the combination of time stretching, granular synthesis, and sampling. The audio equivalent of peanut butter and jelly I suppose.

The Nebulae design will be 10 years old in 2023. Even after all of these years, I find myself discovering new sounds in every session. Whether it's new control combinations that reveal hidden aspects of audio buffers, or applying old techniques to new source material, I never fail to walk away with something inspiring.

If this is your first patch with the Nebulae, or the 100th, I hope it does the same for you.

Happy Patching,
Andrew Ikenberry
Founder & CEO



The original Nebulae v1 prototype, complete with a beautiful cardboard front panel.

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 accept 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

Module Installation

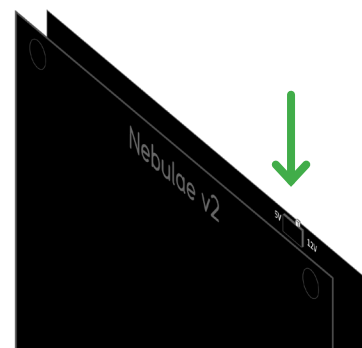
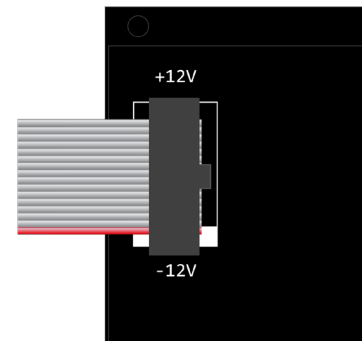
To install, locate 20HP of space in your Eurorack case and confirm the positive 12 volts and negative 12 volts sides of the power distribution lines.

Plug the connector into your case's power supply unit, 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 module with the red band facing the bottom of the module.

5V Power Switch

To power Nebulae from your PSU's 5V rail, toggle the 5V switch on the control PCB panel, just behind the "Nebulae" text on the front panel.



Technical Specifications

General

- Width: 20HP
- Depth: 36mm
- Power Consumption: +12V=318mA, -12V=7mA, +5V=0mA
- Power Consumption (Powered by +5V): +12V=47mA, -12V=7mA, +5V=271mA

Audio

- Sample Rate: 48kHz
- Bit-depth: 24-bit
- True Stereo Audio IO

Controls

- Knobs
 - Resolution: 12-Bit (4,096 distinct values)
- CV Inputs
 - Resolution: 12-Bit (4,096 distinct values)

File Formats

- Audio File Formats: wav, flac, aif
- Sample-rate/bit-depth: any
- Maximum file storage: 75MB
- Instrument file formats: CSound (.instr), Pure Data (.pd)

Require additional compilation

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

Recommended Listening

Curtis Roads (1999-2003) - *Point Line Cloud*

Bio Excerpt: Curtis Roads creates, teaches, and pursues research in the interdisciplinary territory spanning music and sound technology. His pedagogical pedigree includes Harvard University, Université Paris, MIT, and more, and he also co-founded the International Computer Music Association.

A pioneer in the development of granular synthesis (1974), Roads has been at the forefront of experimental audio analysis and sound design. Among his published books are a multitude of computer music based texts, including the prolific *Microsound*, which dives into compositional techniques using sound particles.

Barry Truax (1986) - *Riverrun*

Professor Emeritus of Simon Fraser University, Barry Truax is a Canadian composer credited with the first ever implementation of real-time granular synthesis, which can be heard in his 1986 composition, *Riverrun*. Additional Listening: *Wings of Nike* (1987)

Trevor Wishart (1979-1986) - *Vox 5, Vox Cycle*

York based Trevor Wishart is a pioneer of digital audio media composition and prolific author on the subject of "sonic art." Wishart's compositional interests mainly involve the human voice, and the transformation and interpolation between the human voice and natural sounds.

Alongside his compositional work, Wishart was crucial in the development of the Composers Desktop Project, and international cooperative whose open-source sound transformation software under the same name hosts powerful DSP transformation tools.

Recommended Reading

Microsound - Curtis Roads

[MIT Press](#)

Formalized Music: Thought and mathematics in composition - Iannis Xenakis

[PDF](#)

The Computer Music Tutorial - Curtis Roads

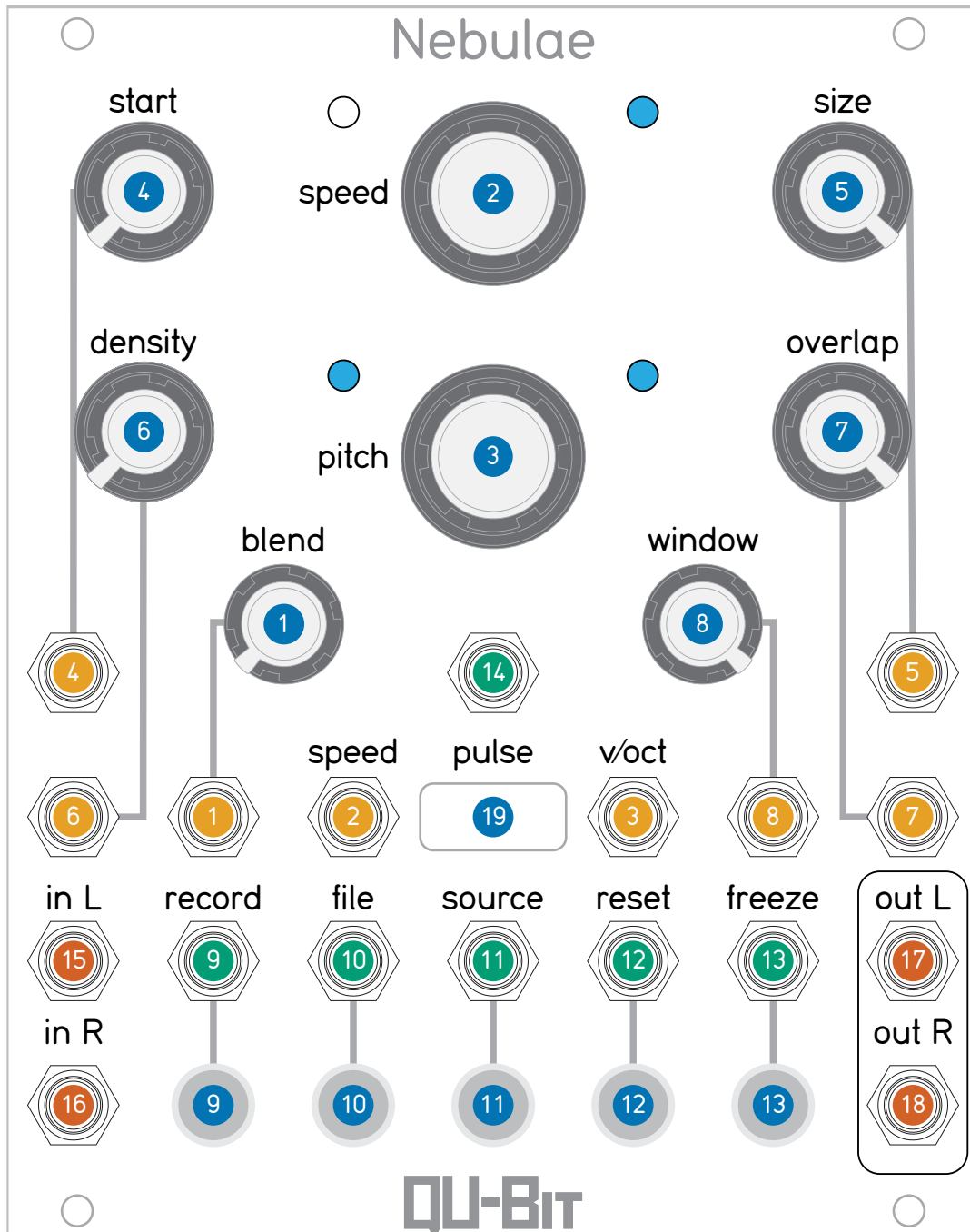
[MIT Press](#)

Phase Vocoder - J.L. Flanagan and R.M. Golden

[PDF](#)

Front Panel

Front Panel Diagram links to Primary Functions. For Secondary Functions, [head to page 15.](#)



Functions: Granular Looper

The Functions section covers the default instrument on Nebulae v2, the Granular Looper. For information on the factory alternate instruments and their functions, skip down to the [Alternate Instrument section \(p. 24\)](#).

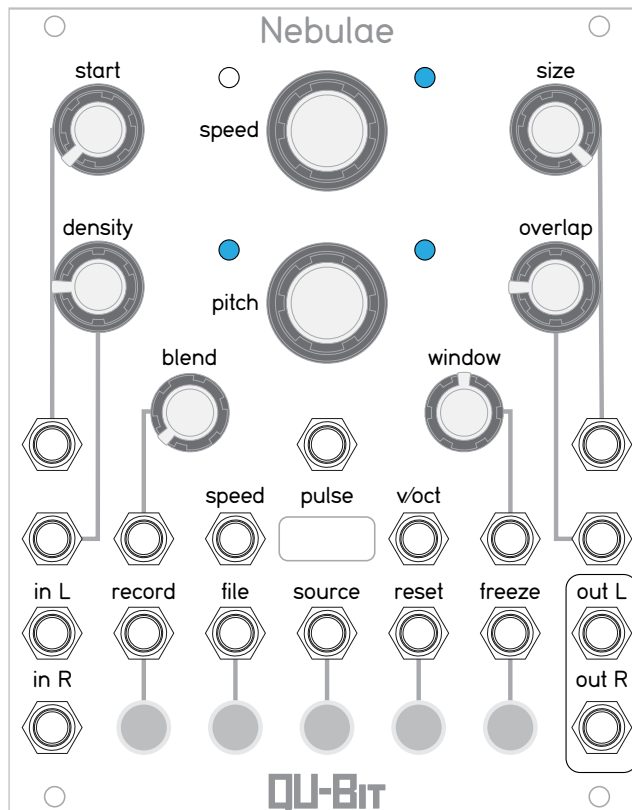
Boot Animations

The boot animation rotates the RGB LEDs in a circle during boot up, 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.

- White LED: Nebulae is booting up.
- Blue LED: Nebulae is loading firmware files.
- Aqua LED: Nebulae is loading USB files (alt. instruments, samples, and firmware updates).
- Green LED: Nebulae is updating the firmware.
- Red LED: Nebulae update has failed.

Initial Position

If you are looking to use this manual alongside learning Nebulae, then we recommend starting with the below initial knob positions and button states. This will ensure that Nebulae is playing a sample to its full length, with no manipulations happening.



Functions: Granular Looper

1. Blend

Primary Function

- Blend mixes between the two main engines comprising Nebulae: the phase vocoder and the granular processor. Though the knob behaves differently between the File Mode and the Live Mode, the general knob layout is the same. Only the phase vocoder is present when the knob is fully CCW, and only the granular processor is present when the knob is fully CW.



Note: In Live Mode, an audio loop must be recorded first before the two engines can process the audio. Without a recorded loop, Nebulae will mix into silence on both ends of the knob.

How to change between File and Live modes.

Pressing the Source button will change between File Mode (LED off) and Live Mode (LED on). Learn more about the source button in the [Source section of the manual \(p. 14\)](#).

What is a Phase Vocoder?

A phase vocoder is an algorithm which analyzes an incoming audio signal and then separates the time and frequency components into two separate signals. These two signals can then be manipulated independently of each other, and then converted back to the time domain for playback.

This technology is what provides the powerful transformations that Nebulae is capable of such as time stretching, spectral freezing, and independent control over pitch and playback speed.

What is a Granular Processor?

A granular processor takes incoming audio and splits it into small pieces called grains. These grains can be played back at varying speeds, pitches, and layered on top of one another to create varying timbres.

- Blend CV input range: -5V to +5V

Did You Know? Blend, along with the other knobs on Nebulae, has a secondary function! Head to the Secondary Functions section to find out all the secondary functions found on Nebulae.

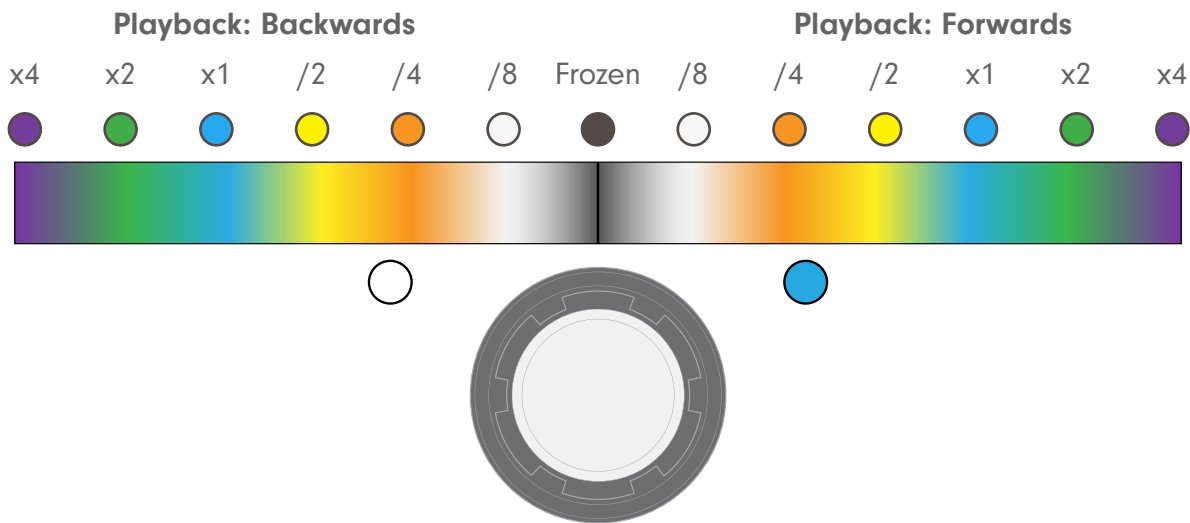
Functions: Granular Looper

2. Speed

Primary Function

- The Speed encoder adjusts the playback speed of the audio sample (File Mode), or recorded buffer (Live Mode) independent from the audio's pitch. This effect is commonly referred to as "time-stretching," letting you transform audio into droning beds of sonic texture while staying in key the entire time.

The speed range is 4 times slower to 4 times faster than the original playback speed. Turning the encoder CW will increase the speed, while turning the encoder CCW will decrease the speed. See the speed LED color indication graphic below for further reference:



Resetting the Speed to the default playback: To reset the playback speed to default (x1 forward), press the encoder down to jump back to the default position. You will know you are in the default position when the right Speed LED is a bright blue.

Fun Fact! When set to the default playback speed (x1), Nebulae can quickly jump to reversed audio playback by clicking down the Speed encoder. Clicking down the encoder again will bring Nebulae back to the default playback speed.

Entering the instrument selection menu: To enter the instrument selection menu, hold the Speed encoder down for 3 seconds. You can find out more about using alternate instruments in the [Alternate Instrument section \(p. 24\)](#).

- Speed CV input range: -5V to +5V

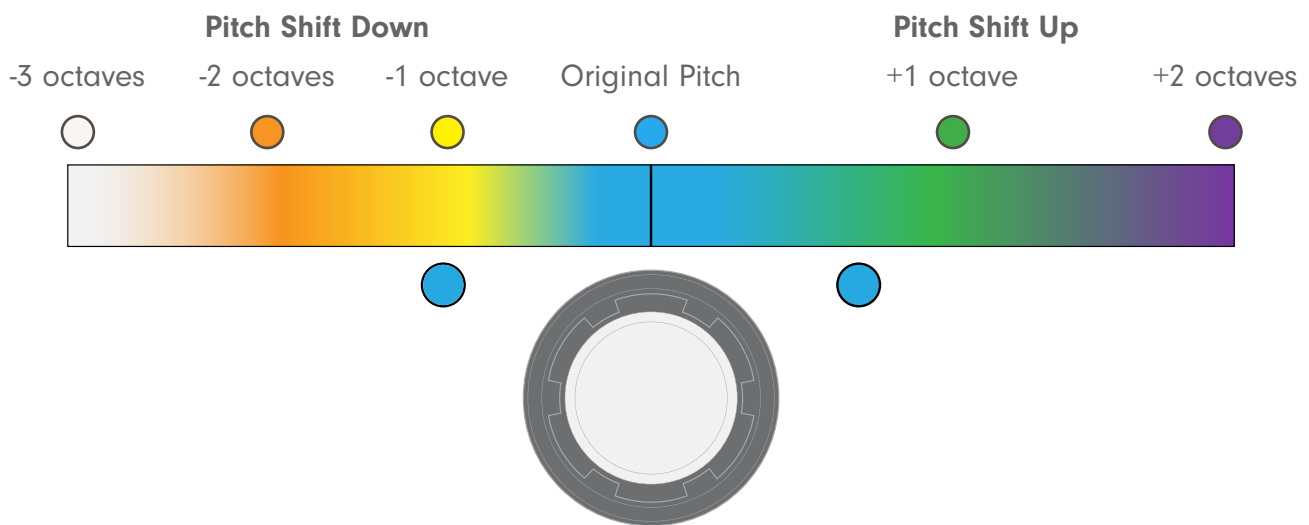
Functions: Granular Looper

3. Pitch

Primary Function

- The aptly named Pitch encoder adjusts the audio sample's or recorded buffer's frequency independently from the playback speed. This means you can tune a vocal sample or pitch shift a percussion loop while staying in tempo with the rest of the patch!

The pitch range is -3 octaves to +2 octaves from the original pitch. Turning the encoder CW will increase the pitch, while turning the encoder CCW will decrease the pitch. See the graphic below for further reference:



Resetting the Pitch to the default frequency: To reset the pitch to default (0 octaves), press the encoder down to jump back to the default position. You will know you are in the default position when both Pitch LEDs are bright blue.

Jumping Octaves: The Pitch encoder can quickly jump octaves relative to your pitch position.

To jump octaves, hold down the Pitch encoder. Then, while holding the encoder down, turn the encoder to scroll through the available octaves. This technique can be useful for quickly jumping to a different pitch on the fly!

- Speed CV input range: -5V to +5V

Functions: Granular Looper

4. Start

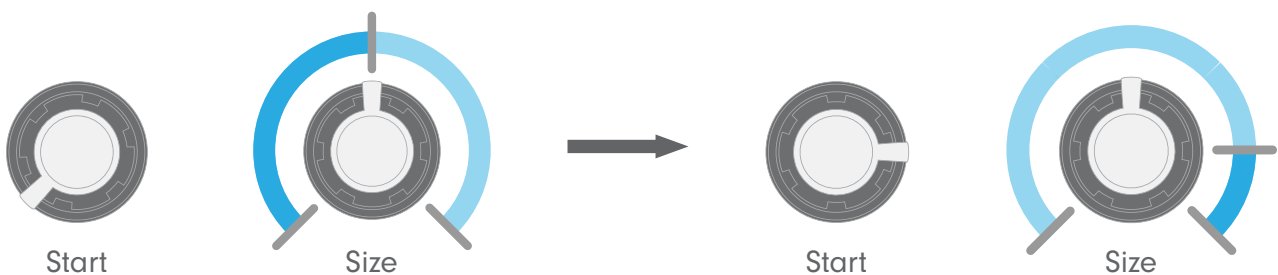
Primary Function

- The Start knob controls the start position of the loaded audio file, or recorded buffer. The Start knob is an offset, with the beginning of the audio loop at the fully CCW position, and the end of the loop at the fully CW position. Each time the audio loop reaches its end, it will replay at the current Start setting.
- Start CV input range: -5V to +5V

5. Size

Primary Function

- The Size knob controls the overall size of the audio loop. The Size is relative to the original sample length, and is a fixed length that can then be moved around with the Start parameter. See the illustration below for reference:



Note how the playback size (solid blue section) is smaller on the right than on the left.

Since the selected playback size is longer than the available audio between the new start point and the end of the audio sample, Nebulae will only loop between the start point and the end of the sample.

This results in the playback size getting smaller regardless of the knob/CV position as Start is turned CW.

- Start CV input range: -5V to +5V

Functions: Granular Looper

6. Density

Primary Function

- The Density knob controls the grain density within the granular processing engine on Nebulae. When the knob is fully CCW, a single grain will trigger every few seconds. As the knob turns CW, the grain density increases, filling the negative space with tiny bits of the audio loop. At the maximum, the grain density is at audio rate, creating a sample-reduced copy of the audio loop.

There are multiple ways to manipulate these grains, which you will discover further into this manual, if you'd like to jump ahead, here are some recommended sections for reading:

[Overlap](#)

[Window](#)

[Random Grain Trigger](#)

[Random Grain Size](#)

[Random Grain Muting](#)

- Start CV input range: -5V to +5V

7. Overlap

Primary Function

- The Overlap knob is a dual function parameter. Turning the knob adjusts the size of the grains, as well as adjusts the amount of overlap between successive grains. As the grain size becomes larger than the space between grains assigned by Density, the individual grains begin to overlap.

The grain size ranges from 1% of the grain rate, to 600% of the grain rate.

Note: 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.

- Start CV input range: -5V to +5V

Experiment: By adjusting the Overlap knob when the Density is on the right side of the knob (high grain density), Nebulae can emulate a down-sampled version of the audio loop, since the grains begin to act as the sample-rate of the audio loop! This is a great setting to add some digital grit or lo-fi qualities to your audio loop.

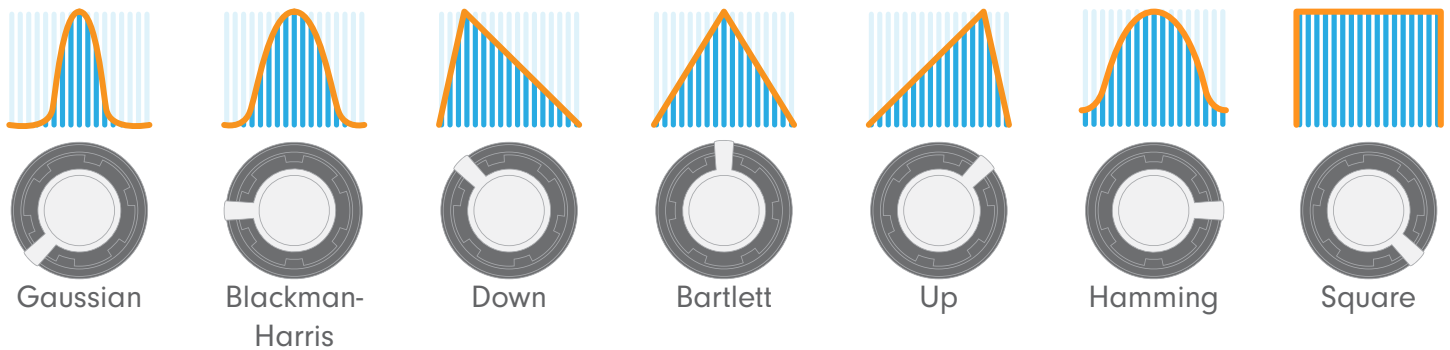
Functions: Granular Looper

8. Window

Primary Function

- The Window knob adjusts the amplitude envelope applied to each grain. By applying a window to each grain, Nebulae determines how “hard” or “soft” the edges of the grain are.

The knob blends between 7 different window types, with the softer windows on the left side of the range and the harder windows on the right. Use the graphic below as a reference for the available window types on Nebulae:



- Window CV input range: -5V to +5V

9. Record

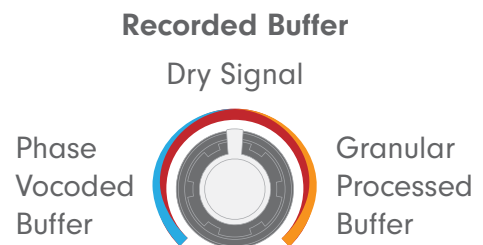
Primary Function

- The Record button is used to record either a portion of the current sample (File Mode), or a portion of the inputted audio signal (Live Mode). Once a buffer is recorded, Nebulae will process the recorded buffer with both the phase vocoder and granular processor.

How To Record: To begin recording, either press the Record button or send a gate signal to the Record gate input. The Record button will turn red indicating it is recording a new buffer.

Nebulae can record up to 5 minutes of audio, and the recording will end either when the Record button is pressed a second time, the Record gate input is re-triggered, or Nebulae maxes out the 5 minute limit. To accurately calculate the anticipated size of a new buffer, the speed, start and size controls are locked during normal recording.

The Blend knob will mix between these 3 available signals: the phase vocoded buffer, the dry signal (audio sample in File mode, inputted audio in Live Mode), and the granular processed buffer.



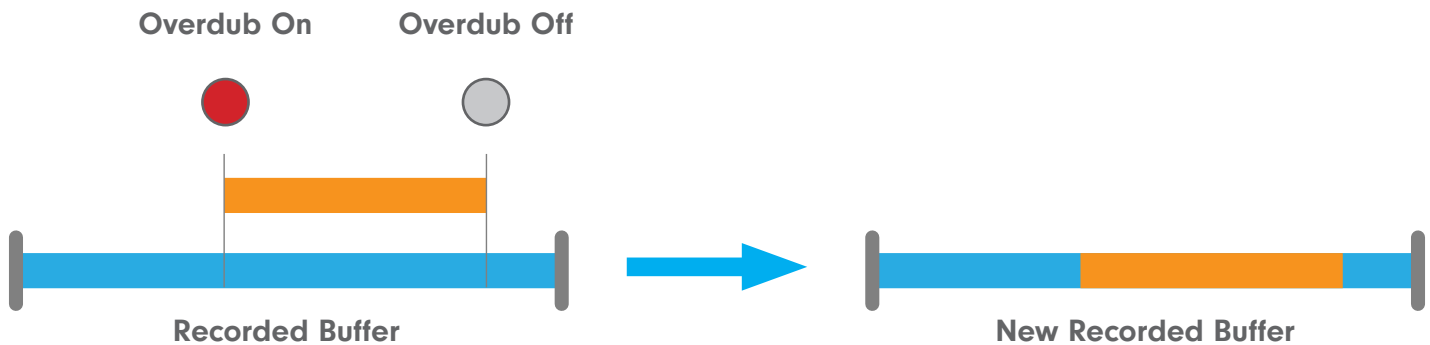
Read more about Record on the next page...

Functions: Granular Looper

9. Record Cont.

Overdubbing: Once a buffer is recorded, the buffer length is set, and re-recording from either the File source or the Live source will overdub the existing audio when recording is on. Punch in at any time to record reversed, granulated, pitch shifted, or any other manipulated variations of audio.

Each time an overdub is completed, the Speed and Pitch encoders will jump back to the default positions so the buffer plays back as heard during the recording. Recording will automatically deactivate when it has completed a full overdub pass.



Clearing The Buffer: To clear the buffer, hold the File button down, then press Reset. This will remove all audio from the buffer.

Saving The Buffer To USB: To save your recorded buffer to your USB drive, hold the File button and press Freeze button. This will save the buffer to your USB drive as a .wav file, allowing you to revisit the buffer in File mode, or export it to use in a DAW or other audio playback device.

Did You Know? There's a recording mode that is fully unhinged, letting you constantly record over the buffer! Head to the [secondary functions section for Record](#) to find out more.

- Record gate input threshold: 0.4V

10. File

Primary Function

- The File button cycles through the available audio samples on Nebulae. Each time the File button is pressed or the File gate input is sent a gate signal, Nebulae will immediately advance from the current audio sample to the next. The default file order is sequential through the audio files (which are sorted alphabetically).

Did You Know? You can change the order which File cycles through the available audio samples! Head to the [secondary functions section for File](#) to learn more.

- File gate input threshold: 0.4V

Functions: Granular Looper

11. Source

Primary Function

- The Source button switches Nebulae between File and Live modes. When the Source button LED is on, Nebulae is in Live mode. When the LED is off, Nebulae is in File mode. Holding the Source button grants access to the secondary functions found across Nebulae.

Pro tip: Changing between File and Live modes requires a swift tap, bouncing off the button. This is to avoid accidentally entering the secondary functions menu.

- Source gate input threshold: 0.4V

12. Reset

Primary Function

- Pressing the Reset button or sending a signal to the Reset gate input will reset the playback position back to the currently selected start point. The Reset LED will flash each time Nebulae reaches the loop point of the audio buffer.
- Reset gate input threshold: 0.4V

13. Freeze

Primary Function

- Pauses the current playback position while retaining the spectral characteristics of the audio. This is a latching control. The Button LED will be illuminated when the buffer is frozen.
- Freeze gate input threshold: 0.4V

14. Pulse

Primary Function

- Outputs a 5V gate signal whenever the loop resets. This is useful for syncing other points in your patch to the audio loop on Nebulae.
- Pulse gate input threshold: 0.4V

Functions: Granular Looper

Secondary Functions

Now that we covered the primary functions of Nebulae's front panel controls, we can dive into the secondary functions, which open up a host of customizable features for more in depth sound designing.

Hold down the Source button to access the secondary functions menu. When the Source button is released, Nebulae's controls will return to their primary functions.

1. Blend

Secondary Function: Granular FM

- Controls the modulation index of FM applied to each grain. The FM is applied directly to the grain, and does not affect the phase vocoded sound. This is disabled when density is set fully counter-clockwise or when set to live source.

2. Speed

Secondary Function: Input Level

- Holding down Source and turning Speed will adjust the audio input level on Nebulae. By turning the encoder CW, Nebulae can increase the input level to accept line level signals, letting you incorporate external gear with your modular, or record loops with your external gear to manipulate with your modular. To return to modular level, click the encoder while holding Source.

3. Pitch

Secondary Function: Pitch Fluctuation

- Holding down the Source button and turning the Pitch encoder will add a random amount of pitch deviation to the audio loop. The maximum range is -2 to +2 octaves, and the Pitch LEDs will flash purple when the encoder has reached the maximum.

Restoring Secondary Settings: While holding the Source button, clicking the Pitch encoder down will restore all secondary settings to their default values. This is a great way to get back to square one if you aren't quite sure where you ended up!

4. Start

Secondary Function: Grain Position

- Holding down the Source button and turning the Start knob will add random probability to where new grains are generated from.

When the knob is fully CCW, new grains will only generate from the playback position. As the knob is turned CW, the chance increases for new grains to generate from a random position in the audio loop. When the knob is fully CW, all grains are generated from a random position in the file or buffer.

Functions: Granular Looper

5. Size

Secondary Function: Grain Panning

- Holding down the Source button and turning the Size knob adjusts the amount of random panning applied to the grains.

When the knob is fully CCW, no panning is applied to the grains. When the knob is fully CW, each grain is randomly panned within the stereo field.

6. Density

Secondary Function: Grain Displacement

- Holding down the Source button and turning the Density knob adjusts the amount of random time displacement between the grains. When the knob is fully CCW, no displacement will occur between the grains. While the knob is turned CW, random time displacement will be added between grains. At the maximum CW position, each grain will be randomly displaced.

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.

7. Overlap

Secondary Function: Grain Size

- Holding down the Source button and turning the Overlap knob controls the amount of random deviation applied to each grain size. When the knob is fully CCW, no random deviation is applied to the grain size. As the knob turns CW, the probability and amount of random deviation to grain size increases for each grain. When the knob is fully CW, each grain receives a random length adjustment of $\pm 100\%$.

This adjustment is applied to the grain size set by Overlap's primary knob position. Each adjustment is calculated independently for the left and right channels.

8. Window

Secondary Function: Grain Muting

- Holding down the Source button and turning the Window knob adjusts the chance that Nebulae will randomly mute an individual grain.

When the knob is fully CCW, no grains will be muted. When the knob is at the middle position, half of all grains will be muted. When the knob is fully CW, 99% of all grains will be muted. The stochastic masking calculation (chance for random muting) is independently performed for the left and right channels.

9. Record

Secondary Function: Circular Recording

- Holding down the Source button and pressing the Record button activates the Circular Recording mode. In this mode, Nebulae will continuously record audio into the buffer. Creating the initial buffer and overdub recording work the same in this mode as in the default recording mode. The key differences are:
 - 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.

Blend Behavior When Circular Recording: When recording audio into Nebulae, the Blend knob acts as an input level control for the audio input.

When the knob is at 12 o'clock, or the fully dry position, the audio input is silent. As the knob is turned CCW, the input level into the phase vocoder is increased. When turning the knob CW, the input level into the granular engine is increased.

11. File

Secondary Function: File Order

- Holding down the Source button and pressing the File button will change the order that File advances through the available audio samples. The table below describes the 3 different orders available:

Order #	Order Direction	Indicator
1	Forward	File LED fades from OFF to ON
2	Backward	File LED fades from ON to OFF
3	Random	File LED blinks between random levels of brightness

Pressing the File button will advance through the available orders, and will wrap around at the end.

13. Freeze

Secondary Function: Grain Trigger

- Holding the Source button and pressing Freeze changes the source gate input into a grain trigger input. When active (you'll know when it's active when the Freeze LED is on while holding Source down) the source input no longer changes Nebulae between File and Live modes.

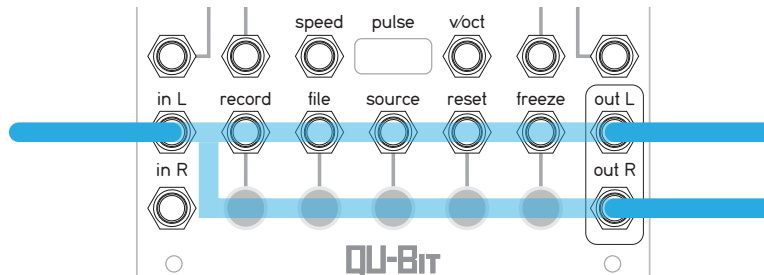
When this setting is enabled, turning the density knob all the way down will disable the internal generation of grains, deferring all grain generation to the source gate input. With Grain Trigger enabled, grains can now be triggered with external gate sequencers for rhythmic complexity, burst generators for rapid explosions of sound, and more. If Density is up, the gate trigger input will still fire grains between the internally triggered grains.

Did You Know? When the density control is at its minimum, the overlap control operates on a fixed range of grain sizes from 500us to 2 seconds.

Functions: Granular Looper

15. Audio In Left

- Audio input for Nebulae's left channel. When no cable is present in the right input, the left channel normals to the right channel. See the graphic below for reference:



Input range: 10Vpp, AC-coupled (input level adjustable via Source+Speed)

16. Audio In Right

- Audio input for Nebulae's right channel.
Input range: 10Vpp, AC-coupled (input level adjustable via Source+Speed)

17. Audio Out Left

- Audio output for Nebulae's left channel.
Output range: 10Vpp

18. Audio Out Right

- Audio output for Nebulae's right channel.
Output range: 10Vpp

19. USB

- The USB is Nebulae's means of importing and exporting files, from audio files to alternate instrument files, firmware updates, and system logs. The USB drive does not need to be in Nebulae for the module to operate.

USB Formatting

Nebulae can use any USB drive that is formatted to FAT32. If you want to use a different USB drive from the one shipped with Nebulae, but need to reformat, you can find the instructions to do so below:

Mac OS X

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.

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

19. USB

Sample Formatting

Nebulae accepts samples with multiple file types and audio fidelities. See the list below for acceptable audio file formats.

Nebulae Sample File Types

- .wav
- .flac
- .aif/.aiff

Sample Rate & Bit Depth

Nebulae accepts audio files of any bit-depth/sample rate. However, the module runs at 48kHz and will play back all files at this sample rate (the main instrument will compensate for the difference between file sample rate and the system sample rate).

Alt. Instrument/Program Formatting

Nebulae accepts multiple file types for alternate instruments and program files, however some will load from the USB automatically while others require additional steps. See the lists below for reference.

Files that load automatically

- CSound Instruments (.instr)
- Pure Data Patches (.pd)

Files that require additional compilation

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

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

19. USB

Loading Files Onto Nebulae

Nebulae will automatically load files at boot up. During the boot up process, the Nebulae LEDs will illuminate as cyan when loading new files onto Nebulae. If the files on the USB are not new, Nebulae will not reload the files and illuminate blue.

Note: All files must be in the USB's root directory (not in a folder) in order to load onto Nebulae. Any additional files can be stored in folders on the USB drive, and will not affect Nebulae in any particular way.

Loading New Files While Nebulae Is On: To load new files while Nebulae is powered on, hold down the File button, and press the Source button. Nebulae will search the USB for new files, and upload them into the instrument in real time, instantly changing over while the module is still running.

Maximum Amount of Files: Nebulae can load an unlimited number of sample files and instrument files, so long as they are under the maximum storage amount. Nebulae will load the first 75MB of files from the USB drive before booting up the instrument. Any additional files will not be loaded, but will still exist on the drive.

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

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

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 file system is read-only most of the time, which doesn't allow it to keep an accurate calendar.

19. USB

How To Update Firmware

Follow the instructions below for updating your Nebulae's firmware via the USB drive. Nebulae must be powered during the entirety of the update.

Note: If you have the most recent hardware revision of Nebulae (Pi 4, indicated by a USB-C port on the back of the module), you do not need to update.

What You Need

- A USB drive (FAT32)
- a neb_update.zip firmware file, the most recent version is v2.1.2.

[Download v2.1.2](#)

The Update Process

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

Reverting To Factory Firmware

Adding a "[revert to factory firmware](#)" file 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, and is essentially just acting as a command for Nebulae to read.

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

Alternate Instruments

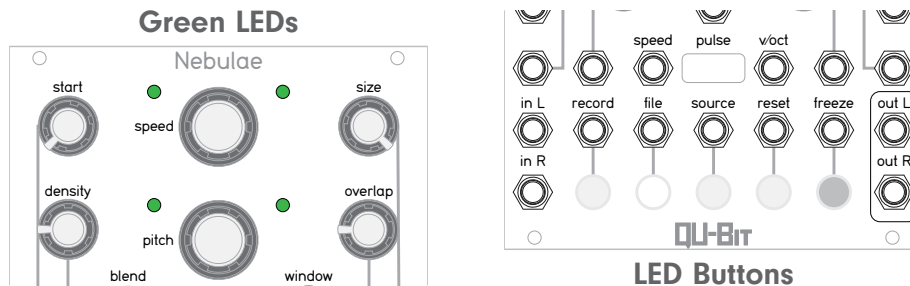
Nebulae is more than just its powerful granular looper processor. It is a DSP platform, and can be an infinite number of different instruments and effects, thanks to the .instr file.

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 an instrument file (.instr) itself.

How To Change Instrument Files

Entering The Instrument Selector: 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. An off button LED indicates that there is no file present.



Selecting & Loading an Instrument: To select an instrument, you first have to choose which instrument bank to work with. You can change the bank by rotating the speed encoder. There are 3 banks to choose from, listed below:

- The Instrument Files Bank (.instr, Negative Speed LED is lit)
- The Factory Files Bank (both Speed LEDs are lit)
- The Pure Data Files Bank (.pd, Positive Speed LED is lit)

Once the bank is selected, press one of Nebulae's five LED buttons to illuminate/select an instrument. Files are organized alphabetically from left to right across the buttons.

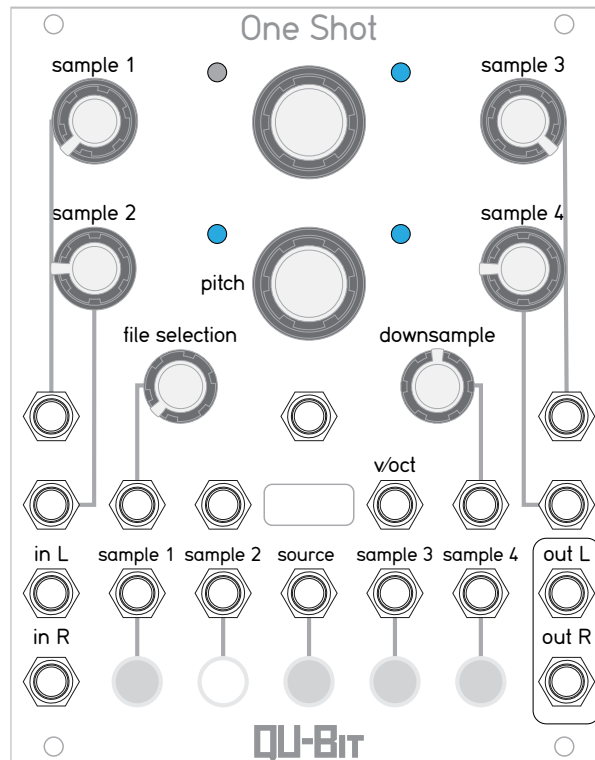
Now that an instrument is selected, clicking the Speed encoder will load the selected instrument, and check for a USB drive/reload files. Clicking the Pitch encoder from this menu will return to the primary control menu without changing instruments.

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.

Alternate Instruments: Factory Bank

One Shot Polyphonic Sampler



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. Press the File button in the Instrument Selector factory bank to choose One Shot.

Primary Controls

Start: varispeed pitch control for sample 1
Density: varispeed pitch control for sample 2
Size: varispeed pitch control for sample 3
Overlap: varispeed pitch control for sample 4
Pitch: global varispeed pitch offset control

Blend: selects between groups of 4 samples for playback

Record: trigger source for sample 1
File: trigger source for sample 2
Reset: trigger source for sample 3
Freeze: trigger source for sample 4

Source: Trigger Choke/Secondary menu access

Secondary Controls (Hold Source To Access)

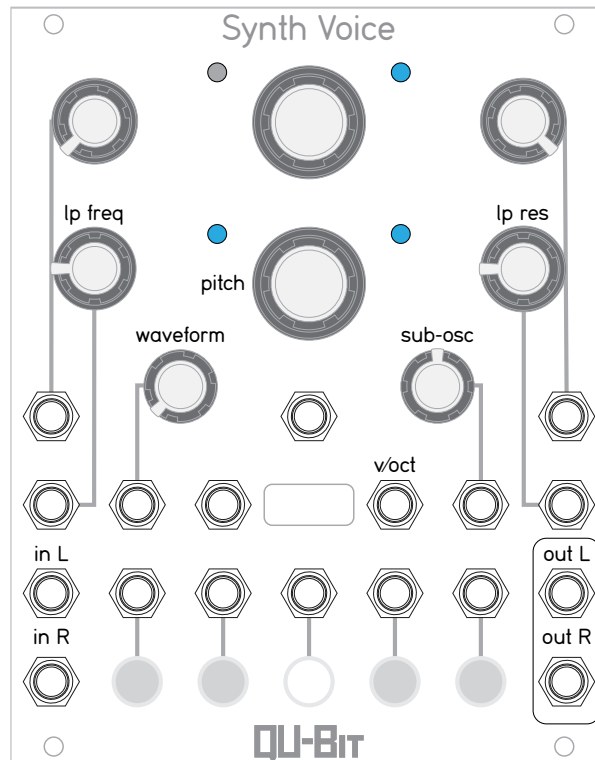
Start: adjust length for sample 1
Density: adjust length for sample 2
Size: adjust length for sample 3
Overlap: adjust length for sample 4

Window: global down-sampler

Record: trigger choke for sample 1
File: trigger choke for sample 2
Reset: trigger choke for sample 3
Freeze: trigger choke for sample 4

Alternate Instruments: Factory Bank

Synth Voice



Our subtractive synth voice features waveform blend, controllable sub-oscillator amount, and a 24 dB ladder filter. To choose Synth Voice, press the Source button in the Instrument Selector factory bank.

Primary Controls

Pitch: oscillator frequency, 5 octave range

Density: lowpass filter cutoff frequency

Overlap: lowpass filter resonance control

Blend: oscillator waveform selector. When fully CCW, the oscillator is a square wave. When fully CW, the oscillator is a sawtooth wave.

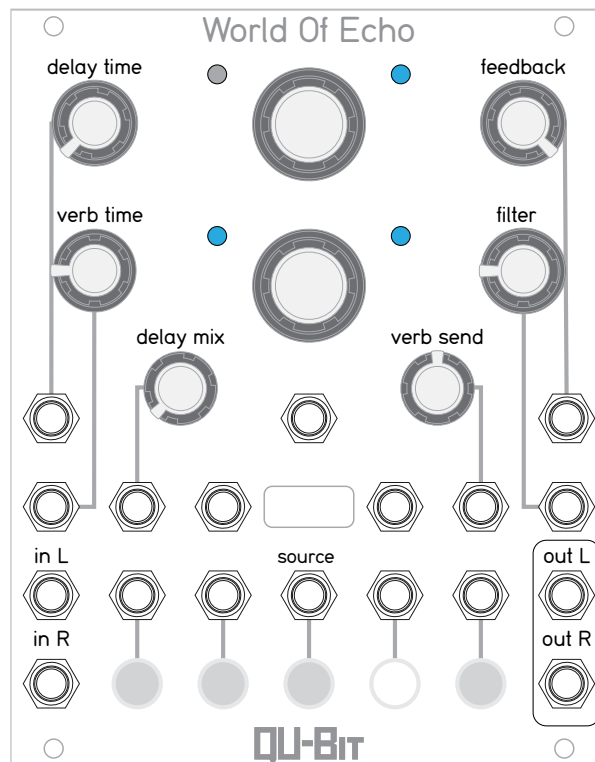
Window: sub-oscillator mixer

Secondary Controls

There are no secondary controls for Synth Voice.

Alternate Instruments: Factory Bank

World Of Echo



World Of Echo is a multi-fx instrument featuring delay, and reverb. To choose World Of Echo, press the Reset button in the Instrument Selector factory bank.

Primary Controls

Delay

Start: delay time control. Range: comb to 2s

Size: delay feedback amount. Range: 1 repeat to infinite

Blend: delay dry/wet mix. Linear mix curve.

Reverb

Density: reverb time control

Overlap: reverb lp filter control

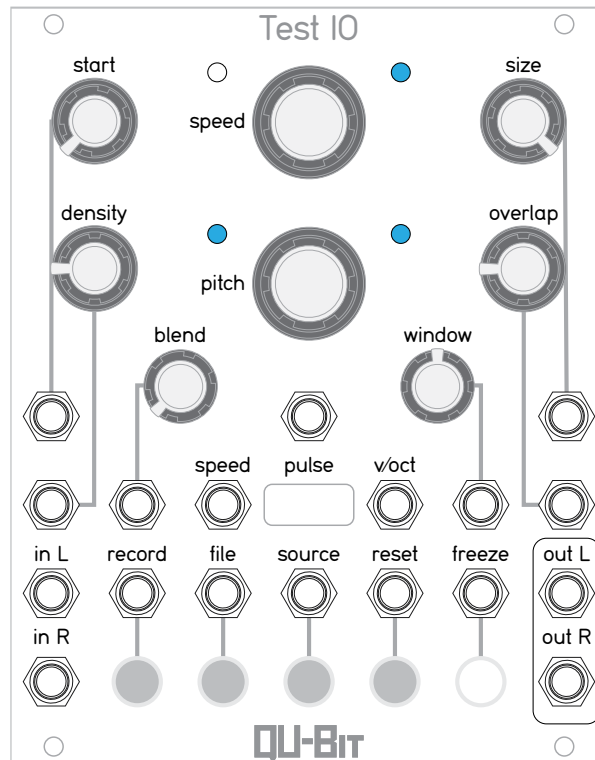
Window: post-delay signal reverb send

Secondary Controls

There are no secondary controls for World Of Echo.

Alternate Instruments: Factory Bank

Test IO



Test IO is an audio pass through example with input level adjustment. This is also a great instrument to use as a template for your own alternate instrument creations. To choose Test IO, press the Freeze button in the Instrument Selector factory bank.

Primary Controls

Speed: controls the audio input level, from modular to line level. Turning the encoder CW increases amplitude, while turning CCW decreases the amplitude.

Source: acts as a latching mute control.

Changelog

Firmware Version	Notes
v1.0.0	<ul style="list-style-type: none">• release firmware
v2.1.2	<ul style="list-style-type: none">• new feature: Live buffer can now be saved to the USB drive via File+Freeze button combo• new feature: pressing and holding the Pitch encoder will jump octaves when turning the encoder at the same time• Nebulae now boots up whichever instrument file was last used• secondary settings now saved between power cycles• PD files now loadable directly from the main granular instrument