Aurora

warp

time

blur

reverse

freeze

reflect

time

mix

shift

atmosphere

left

warp

reflect

left

right

blur

atmos

right

QU-BIT

Digital Meets Analog.

Table of Contents

This manual covers Aurora firmware v1.4.4

Foreword

What does a spectral reverb sound like?

That's the question I asked the Qu-Bit team more than 3 years ago. Everyone seemed to have their own interpretation. As I listened to the answers: time stretching, spectral blurring, and even Aphex Twin, I soon realized that we were in for quite a journey.

And what a journey it was. Four hardware revisions, one global pandemic, and more than 10,000 lines of code have gone into this device. Not to mention the countless hours of patching, testing, and pondering.

Along the way, we discovered many things. We learned the pros and cons of various FFT algorithms, the limits of ARM cortex M7 CPUs, and how to dial in the perfect blend of transient preservation versus pitch accuracy. But most importantly, we discovered a musical process which expands the sonic palette of the Eurorack environment.

I hope you feel the same sense of discovery while patching with Aurora that we did while designing it.

Happy patching,

Andrew Ikenberry
Founder & CEO

Description

Welcome to Aurora, a spectral reverb capable of a wide palette of sounds: from icy shimmers and whale songs, to alien textures and sounds you've never heard before. And likely, will invoke a hunger for exploration you felt when you first touched a modular synthesizer.

Whether you're creating beautiful time-stretched tails, or cybernetic metallic effects, Aurora gives you control over how far from reality you want to be. By blurring these signals we can achieve cavernous reverberations and spectral artifacts.

Since Aurora's sonorous response is entirely dependent on the input signal, no two patches will sound alike, lending itself to an infinite world of surprise and discovery.

Discovery. It's why we are all here.

- Spectral reverb with true stereo audio IO
- Phase vocoder audio engine running at 48kHz, 24-bit
- Time stretched tails, icy shimmers, and voltage controlled whale songs
- Front panel USB port provides easy firmware updates, user options, and more
- Powered by the Daisy Audio Platform

Tech Specs
Width: 12HP
Depth: 22mm
Power Consumption: +12V=215mA, -12V=6mA, +5V=0mA

USB Port
Type: A
Power Draw: Up to 500mA (for powering external devices). Please note that power drawn from the USB port must be considered a part of the total PSU current consumption.

Module Installation

To install, locate 12HP 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.

+12V

-12V
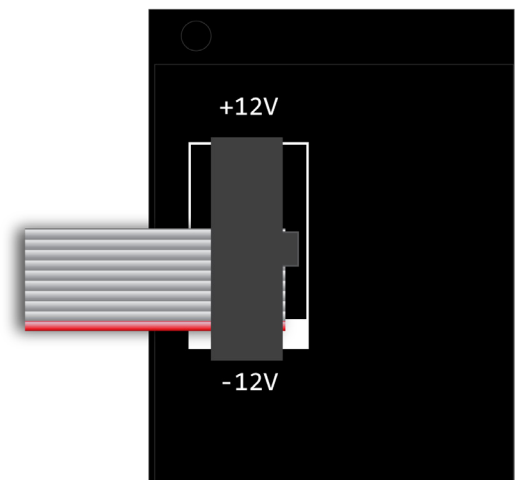
What is Spectral Processing?

Spectral processing is a way of manipulating an audio signal in the frequency domain, rather than the traditional time domain representation.

This is accomplished by using a phase vocoder to analyze an incoming signal, convert it to the frequency domain, manipulate it, and transform it back into the time domain.

It allows us to perform unique musical tasks such as time stretching, frequency blurring, and harmonization.

WTF Is FFT?

Jean-Baptiste Joseph Fourier

The most common way to create a phase vocoder for audio applications is the Fast Fourier Transform(FFT). This algorithm gets its name from the French mathematician Joseph Fourier (1768-1830), who theorized that any complex sound could be recreated using a sum of individual sine waves.

The FFT algorithm separates the time and pitch domain aspects of an input signal. Once in this form, we can change the pitch data without affecting time, and vice versa.
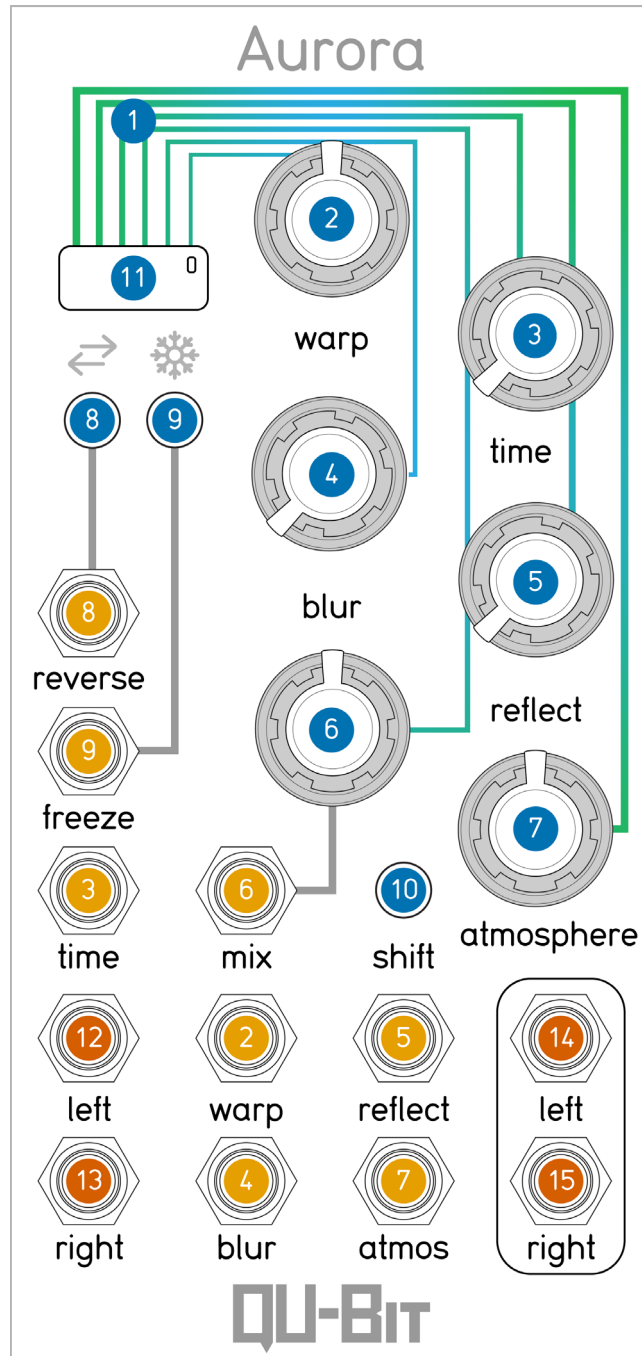
Fun Fact: Joseph Fourier is credited with the discovery of the "greenhouse effect" in the 1820's!

Effects of FFT Size

Whenever processing audio with an FFT, there is a tradeoff between time or frequency resolution. This is controlled with the "FFT Size" parameter which is the number of samples per analysis/resynthesis phase. Larger FFT sizes will exhibit more accurate frequency response, and lower FFT sizes will exhibit more accurate transient response.

Aurora

warp

time

blur

reflect

reverse

freeze

atmosphere

time   mix   shift

left   warp   reflect   left

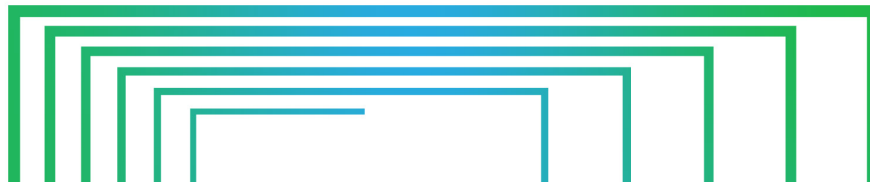right   blur   atmos   right

QU-BIT

Tactile Controls
& Interfaces

CV/Gate Inputs

Audio IO

Functions

1. LEDs

The LED user interface is the primary visual feedback between you and Aurora. It mediates a host of settings in real time to keep you in your patch, including pitch data, input level, audio direction, and timbral filtering. One constant feature of the LED UI is the audio input color, which is green. Each LED indicator will be outlined within their respective function section below.

2. Warp

● Warp adjusts the frequency domain pitch shifting from 3 octaves down to 3 octaves up. No pitch shifting occurs when the Warp knob is at 12 o'clock. When Warp is on an octave, the LEDs are green and blue. When Warp is off an octave, the LEDs are green and purple.

-3 Octaves	-2 Octaves	-1 Octave	+0 Octaves	+1 Octave	+2 Octaves	+3 Octaves

On Octave   Off Octave
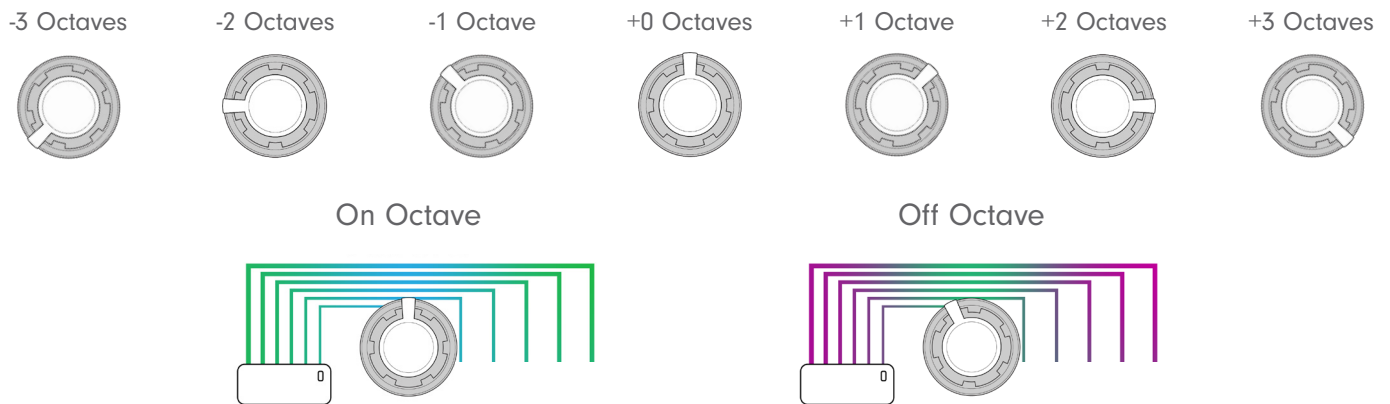
With 1V/oct tracking, Warp can easily transform Aurora into a second voice, adding intrigue and complexity to your spectral content.

● Warp 1V/Oct CV input. Range: -5V to +5V

Functions

Spectral Blurring

Blurring Off

Blurring On

3. Time

- The Time knob blurs the amplitude component of the incoming audio signal. This is your clean spectral manipulation that creates smeared, beautiful tails from your audio. The resulting sound is similar to a traditional decay, but is constantly responding to the input signal.

    When the knob is fully CCW, minimal amplitude blurring is present. When the knob is fully CW, full amplitude blurring occurs on the wet signal.

- Time CV input. Range: -5V to +5V

4. Blur

- The Blur knob is the other side of the spectral coin to Time. Blur smears the frequency component of the incoming audio signal. This is the alien, experimental side of spectral processing, creating digitally stretched spectral effects.

    When the knob is fully CCW, no frequency blurring is present. When the knob is fully CW, full frequency blurring occurs on the wet signal.

- Blur CV input. Range: -5V to +5V

Learn how Aurora's blur effect works by reading our What is Spectral Processing and FFT sections above!

5. Reflect

● The Reflect knob morphs between different multi-delay time zones, with varying results across the knob. When the knob is fully CCW, there is no additional delay on the inputted signal. When the control is increased via knob or CV, delay lengths are increased. Earlier zones sound like short early reflections while higher settings create interesting rhythmic combinations. Each stereo output is mapped with complementary delay lengths to create interesting results.

Experiment: Send a quarter note chord stab to Aurora with Blur and Time down. Slowly turn the Reflect knob to hear the varying time zones. Once you've found a desirable time zone, add Blur and Time to build out your spectral reverb. Reflect, in combination with spectral blurring, can create extremely long tails even from the shortest sounds.

● Reflect CV input. Range: -5V to +5V

6. Mix

● The Mix knob blends between the dry and wet signal. When the knob is fully CCW, only the dry signal is present. When the knob is fully CW, only the wet signal is present.

● Mix CV input Range: -5V to +5V

7. Atmosphere

● Controls a combination of spectral and time domain filters to shape the sonic character of your sound.

When set to the middle there is no effect before going through the spectral processes.

Decreasing the control below center results in a spectral filtering that can result in spectral whalesongs, and underwater organs.

Increasing the control above center results in additional high frequency content creating icy textures, before giving way to a high pass filter to carve out space for busier sound sources.
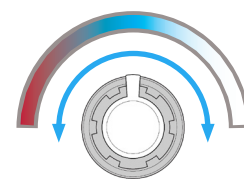
● Atmosphere CV input. Range: -5V to +5V

Atmosphere Quick Tip: Atmosphere's knob position is indicated via the LEDs! See the graphics to the right for the LED states.
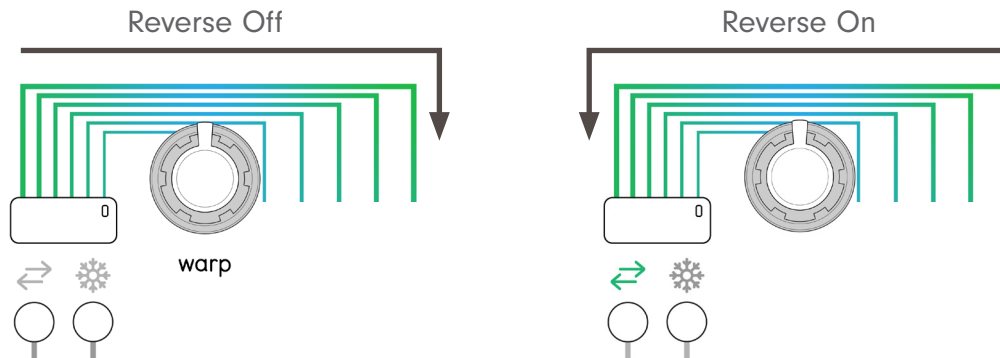
Atmosphere Down

Atmosphere Up

LED color intensifies at far ends of the knob

7

Functions

8. Reverse

● Reverse plays the input audio backwards. While active, the Reverse LED is lit green, and the LED UI's pulse flows from right to left, rather than left to right. The reverse state is saved between power cycles. See graphic below for reference:

Reverse Off   Reverse On

warp

● Reverse Gate input. Threshold: 0.4V

9. Freeze

● The Freeze button will lock onto the current spectral characteristics of the input signal and sustain it until the control is deactivated. The below functions are still able to be manipulated while your audio is frozen:

- Warp
- Time
- Blur
- Atmosphere
- Mix

Frozen Audio will not transfer when changing FFT sizes, so you will need to refreeze audio if you are looking to change your FFT size.

● Freeze Gate input. Threshold: 0.4V

Experiment: With Aurora patched up, freeze your signal. While frozen, turn up Time and Blur to the higher end of the knob, and then sweep Warp back and forth slowly. The result is a "spectral tear," which is a complex combination of timey-wimey frequency cacophony.

10. Shift

● The shift button provides access to the secondary functions found on the Reverse, Freeze, and Mix parameters.

To change a shift parameter, hold down shift, and adjust the knob or button for the desired shift control. Once the adjustment is made, you can let go of shift. Below is each command and their description:

Shift+Mix: Input Level

Holding Shift and turning Mix will adjust Aurora's audio input level. This function is useful for adjusting your sound source to an ideal level with Aurora's internal framework.

By turning the input level CW, you can increase the level to 4x the default level. This allows for line level gear to patch directly into Aurora. Turning the input level fully CCW will attenuate the input by half.

The default level is indicated by blue LEDs, and with custom levels showing white LEDs.
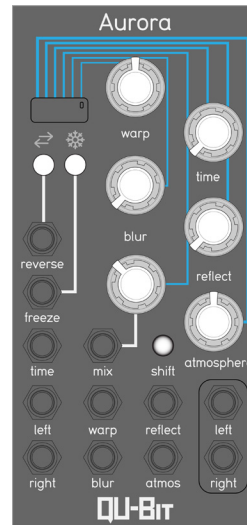
Default Input Level   Custom Input Level

Range: -6dB to +12dB

Shift+Freeze: Reload USB Files

Aurora will automatically update its configurable settings when it detects a change on the USB drive, and will indicate the update with a white LED flash directly above the USB drive. Firmware updates can only be updated at boot up.

This allows for users to "hot swap" the USB drive, changing configurable settings, and the like without power cycling the module. This occurs without using the button combination, and the combination is typically reserved for reloading the options.txt file after a factory reset.

White LED: Update Successful!
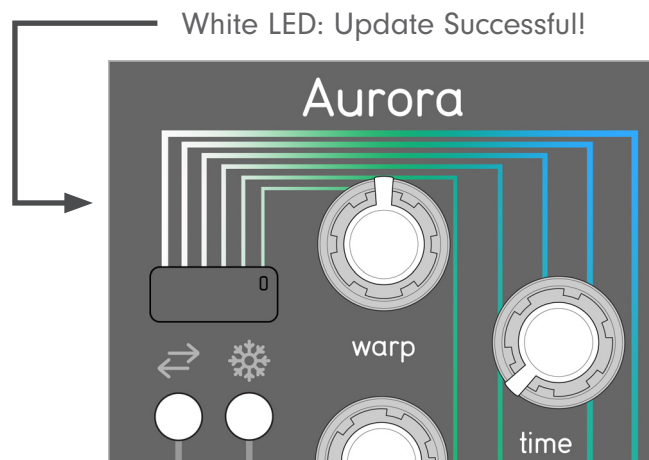
Functions

Shift+Reverse: FFT Size

Holding Shift and pressing Reverse cycles through the 4 available FFT settings. If you haven't yet, we recommend reading the "WTF is FFT?" section above for further clarification on what is happening with this core component of Aurora.

FFT Size affects the sonic characteristics, latency, and timbre of the spectral effects. The highest settings will result in lush spectral modulations with clean pitch shifting at the cost of some additional latency. The lowest settings will result in very little latency, and evoke alien-like timbres within a low-resolution spectral field. Each size can be used on the same sound to create drastically varying outputs, and different sounds complement the FFT sizes in unique ways.

FFT Size	Reverse LED Color	How It Sounds	Fun Sound Sources
4096 (Default)	Blue	Lush And Clean	Physical Modeling Voice, Synth Pads
2048	Green	Best Of Both Worlds	Wavetable Synths, Samples
1024	Cyan	Comb-like Timbres	Synth Drums, Simple Waveforms
512	Purple	Aliens Are Inside My Module	Vocals For Craziness, Drums

The FFT setting is stored between power cycles. For single-path patches where timing is critical (perhaps when disabling the ALWAYS_BLUR optional setting, and/or using drums as the input), the LATENCY_COMP setting can be enabled to delay the input signal by the same amount to remove the apparent latency. See our USB section to learn how to change configurable software settings.

Shift+Reverse, Hold 2 Seconds: Factory Reset

Holding down both Shift and Reverse for 2 seconds will perform a factory reset for your Aurora. This will restore the UI-editable features to their defaults:

- FFT size will restore to 4096 (Blue Reverse LED)
- Reverse will disable
- Input level will go to 1x

This also non-destructively resets all "options.txt" parameters to their defaults. Settings from a USB drive can be reloaded using the reload USB function.

Aurora will confirm that the factory reset is complete with a white LED animation across the top section of the module.

## Shift+Reflect: Stereo Enhancement

Holding Shift and turning Reflect adjusts the wet signal's stereo width. When the knob is fully CCW, no stereo enhancement is present. When fully CW, stereo enhancement is at 100%. Crank the width for ear-candy stereo goodness.

The stereo width state is indicated by the right side of the LED interface, increasing in size and intensity across the knob. The default stereo enhancement (75%) is indicated by blue LEDs.

0% Stereo Enhancement　　　　　　　100% Stereo Enhancement
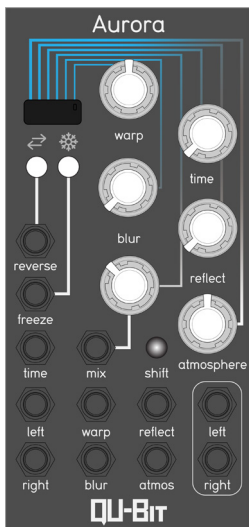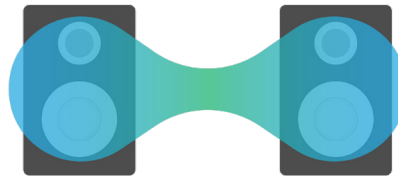
0% Stereo Enhancement　　　75% Stereo Enhancement　　　100% Stereo Enhancement
　　　　　　　　　　　　　　　　(Default)

11. USB

● Aurora's USB port and included USB drive are used for firmware updates, alternate firmwares, and additional configurable settings. The USB drive does not need to be inserted in Aurora for the module to operate. Any USB-A drive will work, as long as it is formatted to FAT32.

Configurable Settings

Configurable Settings are available via the options.txt file on the USB drive. If an option is set to 1, it is active. If the option is set to 0, it is inactive:

Option	Default	Description
DSP_ORDER	1	Changes the DSP order within Aurora. 0=OFF (Spectral Domain into time domain), 1=ON (Time domain into spectral domain).
FREEZE_WET	0	When Mix is fully dry, Freeze forces the mix setting to full wet when engaged. 0=OFF, 1=ON
LATENCY_COMP	0	Adds an internal delay on FFT SIZE samples to keep the FFT and the dry signal in sync. 0=OFF, 1=ON
ALWAYS_BLUR	1	Determines if Aurora is constantly blurring the wet signal or not. 0=OFF (no blurring on wet signal when Time and Blur are fully CCW). 1=ON (blurring always occuring to some extent on Time and Blur).
QUANTIZE_WARP	1	Quantizes Warp to Semitones. 0=OFF, 1=ON knob, 2= ON knob and CV
WARP_DEADZONES	1	Sets the octave zone size on Warp. 0=OFF (ideal for unquantized Warp sweeps with no stepping), 1=On (creates deadzones to easily hit octaves when turning the knob).

Follow the instructions below to access and use your configurable settings:

1. Insert the Aurora USB drive into your computer.
2. Open the options.txt file inside the USB drive. Usually a double-click does the trick!
3. Set your settings to your desired configuration. Simply change the setting's adjacent number to either 1 (ON) or 0 (OFF)
4. Save the options.txt file
5. Safely eject the USB drive, then remove it from your computer
6. Insert the USB drive into Aurora.
7. Your Aurora will now read and update the settings determined by the options.txt file. The LED above the USB port will turn white, indicating a successful update.

Sample Default Text

Download this options.txt file for the default state on the product page.

Firmware Updates/Alternate Firmware

To update the firmware on your Aurora, simply drag the update ".bin" file onto the USB drive and power up your module with it inserted. To guarantee that the desired file is loaded, make sure that only one .bin file is present on your USB drive.

At bootup the Aurora will always write an "Aurora_Version.txt" file that contains the current release firmware version name if there is a USB drive present. You can confirm that the update was successful by checking that the file mentioned above says the correct version. "Aurora_Version.txt" is only written by official aurora firmware. Custom firmware, etc. may not comply with this. The dsy_boot_log.txt file is always written.

In addition, the "daisy_boot_log.txt" file will keep a log of all updates and errors that occur during the update process. However, this file is only created or updated when an actual update takes place. So keeping the same bin file on the USB drive will not result in this file getting larger.

There is no need to remove the .bin file from your flash drive afterwards. Aurora will only update to a new .bin file if it is different than the currently installed firmware.

12. Audio Input Left

● Audio input for Aurora's left channel. The left input normals to both channels when no cable is present in Audio input Right.

Input Range: 10Vpp AC-Coupled (input level configurable via Shift+Mix function)

13. Audio Input Right

● Audio input for Aurora's right channel.

Input Range: 10Vpp AC-Coupled (input level configurable via Shift+Mix function)

14. Audio Output Left

● Audio output for Aurora's left channel.

Input Range: 10Vpp

15. Audio Output Right

● Audio output for Aurora's right channel.

Input Range: 10Vpp

Calibration

Aurora is calibrated in our factory using precise laboratory grade equipment and we do not recommend recalibrating unless you have found a tracking mismatch between it and another module. However, should you need to recalibrate your module for whatever reason, the steps are listed below:

1. Hold down Reverse, and boot up Aurora. Hold the button down until the Freeze LED pulses white.
2. With no other CV/Gate inputs present in the module, patch in 1V (1 octave up from root on your sequencer) to the Warp CV input.
3. Press Freeze. The LED above the USB port will now illuminate green.
4. Patch 3V (3 octaves up from root on your sequencer) into the Warp CV input.
5. Press Freeze. Your module is now calibrated to 1V/oct and is in normal operating mode.

For different voltage standards (such as Buchla's 1.2V) adjust the CV inputs accordingly.

To discard your recalibration and revert to the original calibration settings, press the Shift button to exit the mode.
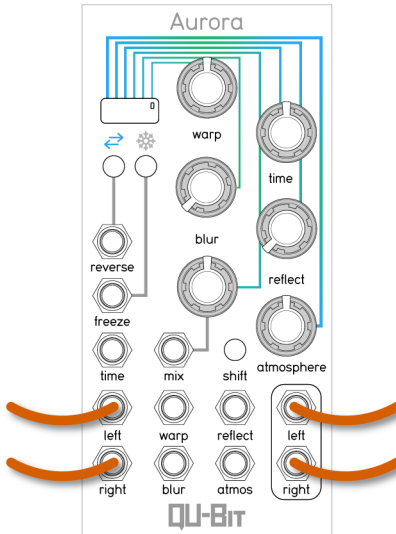
Initial Knob Positions
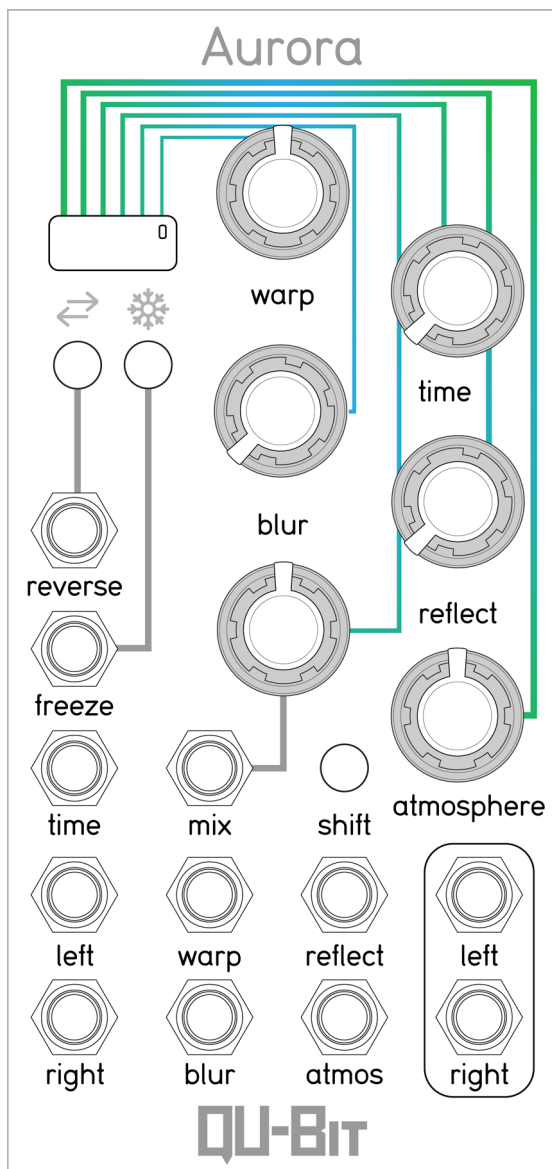
*These are the recommended initial knob positions, but who are we to pigeonhole you. It's your party, throw it how you want it!

Patch Examples

Basic Reverb

Modules Used:

- Aurora
- Any sound source you'd like!

From the initial knob positions, turn up Time to 50% for a basic time-stretched reverb. If you are using a shorter sound and want a longer tail, turn up Reflect for the desired multi-tap delay time-zone of your choice to lengthen your tail. For harsher reverbs, try changing the FFT size by holding Shift and pressing Reverse to cycle through the options!
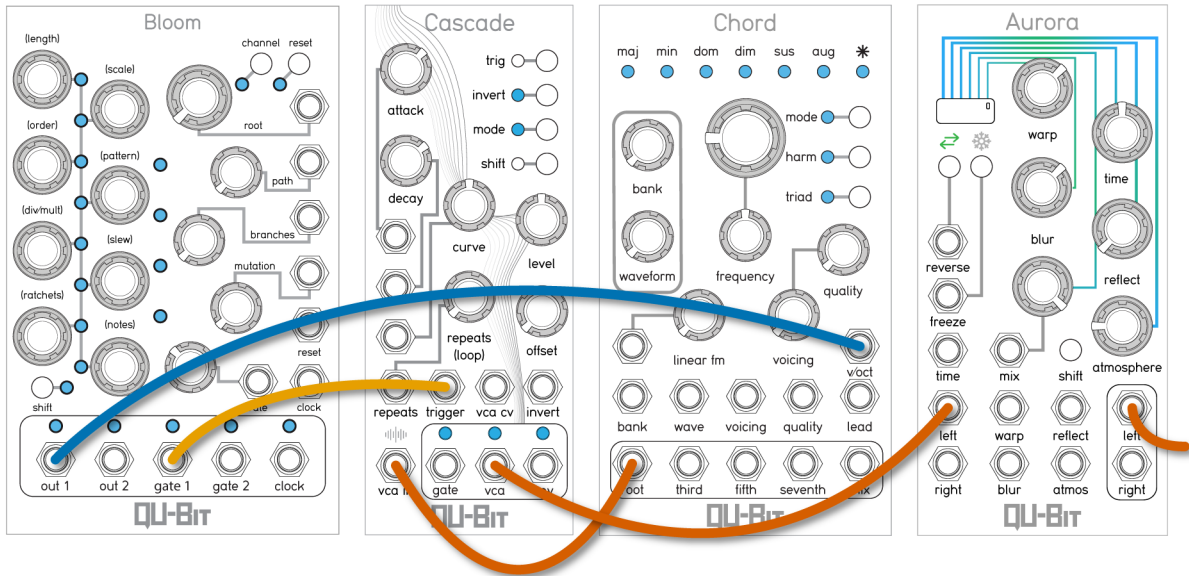
Patch author is Michael Corell, who performed an immense amount of Aurora-related research to dial in this patch.

Aurora Settings:

- FFT Size: Blue
- Warp: 50%
- Time: 50%
- Blur: 0%
- Reflect: 0-100%
- Mix 50%
- Atmosphere: 50%

Whale Songs

Modules Used:
- Aurora
- Sound Source (Chord v2)

Spectral whale songs emanate from the depths with Chord and Aurora! Patch a slow and low Chord sine wave into Aurora, and crank the mix to fully wet. Turn down Atmosphere to remove the frequencies only found at sea level, and turn up Warp for variation in whale song pitch. Blur and Time are key here, transforming a pure sine wave into a harmonically interesting reiteration.
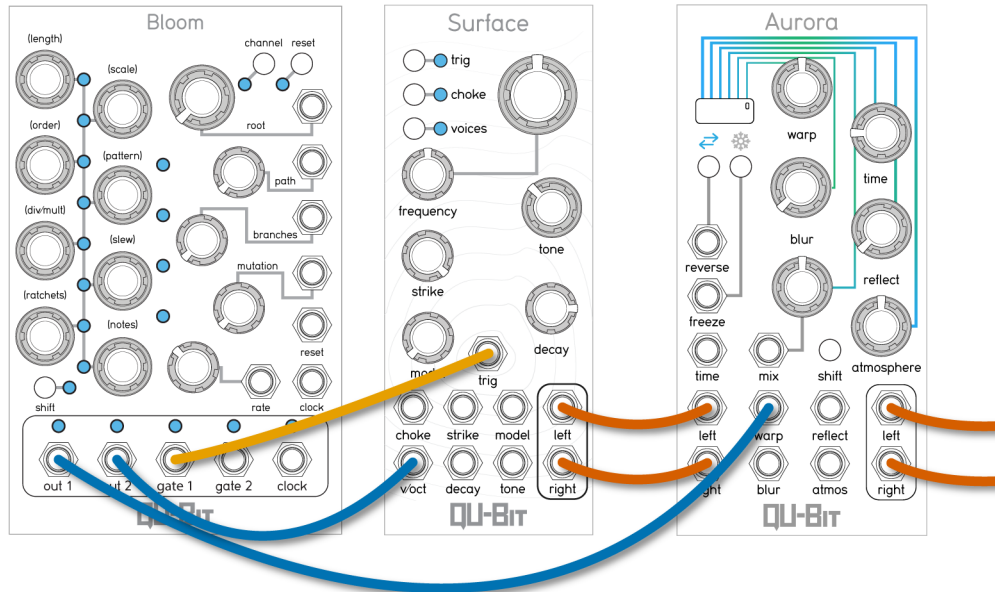
This patch was curated by Andrew Ikenberry, who has a deep passion for the ocean and its inhabitants.

Aurora Settings:
- FFT Size: Green
- Warp: 65%
- Time: 50%
- Blur: 65%
- Reflect: 0%
- Mix 100%
- Atmosphere: 30%

Arpeggiating Reverb

Modules Used:

- Aurora
- Sequencer (Bloom)
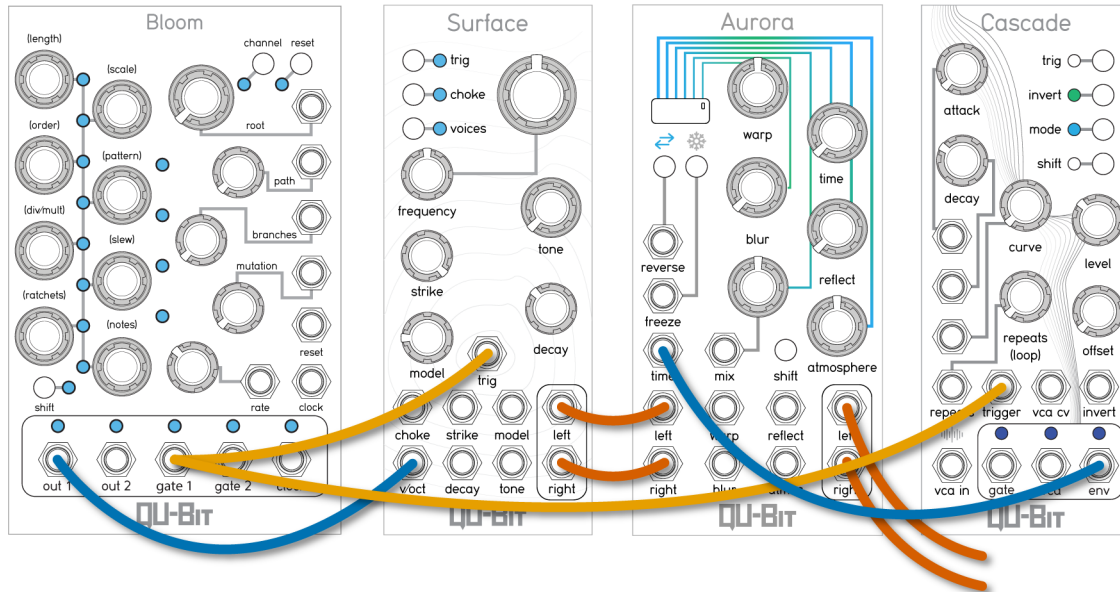- Sound Source (Surface)

Take advantage of Warp's 1V/oct tracking with this simple melodic patch! Bloom is sending CV outs both to Aurora (the arpeggio) and Surface (for transposition). Bloom's Gate 1 is driving the sequence, leading Surface and Aurora into a sparkling dance with one another. Take Aurora for a spin by throwing the input signal in reverse, or setting Warp to different intervals! This patch was created by Stephen Hensley.

Aurora Settings:

- FFT Size: Blue
- Warp: 50%
- Time: 0%
- Blur: 0%
- Reflect: 0%
- Mix 50%
- Atmosphere: 50%

Patch Examples

Note Extender

Modules Used:

- Aurora
- Sequencer (Bloom)
- Sound Source (Surface)
- Inverted Envelope (Cascade)

Stretch the shortest notes ad infitum with time-domain blurring! Here we trigger both our sound source and an inverted envelope from Cascade at the same time. The inverted envelope is patched into Aurora's Time CV input, which is used to capture and extend the inputted audio, resetting every trigger.

The key for dialing in the time-stretching is adjusting the envelope decay and amplitude to capture the harmonically rich portion of the sound, while avoiding potential noise from transients. This varies from sound to sound, so make sure to experiment! This patch was curated by Stephen Hensley.

Aurora Settings:

- FFT Size: Blue
- Warp: 50%
- Time: 0%
- Blur: 0%
- Reflect: 0%
- Mix 50%

Patch Examples

Polyrhythm Percussion
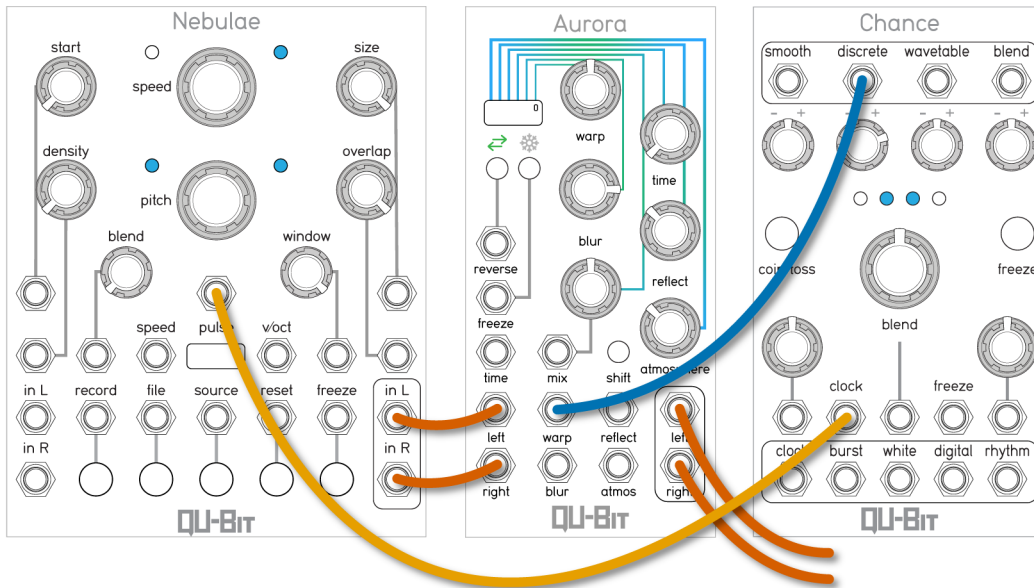
Modules Used:
- Aurora
- Modulation (Chance)
- Sound Source (Nebulae)

Turn simple percussion into a polyrhythm powerhouse. In this example, we're using a drum loop on Nebulae, but this would work with any percussion input. The Pulse output from Nebulae is clocking Chance, which is delivering the "Discrete" CV output to the "Warp" CV on Aurora.
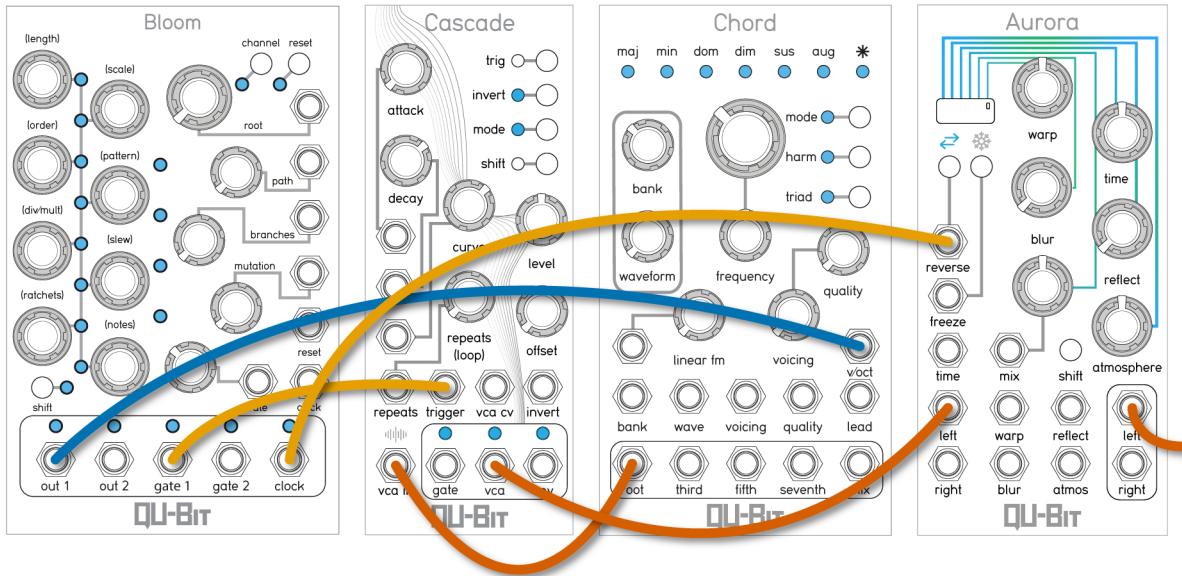
Dial the Reflect knob to taste! This patch was meticulously curated by Johno Wells.

Aurora Settings:
- FFT Size: Green
- Warp: 50%
- Time: 0%
- Blur: 75% (3 o'clock)
- Reflect: 40% (11 o'clock)
- Mix 50%
- Atmosphere: 40% (11 o'clock)

Reversed Swells

Modules Used:
- Aurora
- Sound Source (Chord v2)
- Sequencer (Bloom)
- Clock Divider/Multiplier

Build ebb and flow into your patch with reverse reverb swells! Here we send a simple Chord stab into Aurora at the basic time-stretched reverb settings. To create the swells, send a gate signal running 2x the rate of the sound source trigger. You can use a clock multiplier to acheive this, but here we set the ratio internally on Bloom, setting the sequence to /2 the clock rate. The result is a reverberating boomerang effect, pushing and pulling your reverb with every Chord hit.

This patch was curated by Stephen Hensley.

Aurora Settings:
- FFT Size: Blue
- Warp: 50%
- Time: 50%
- Blur: 0%
- Reflect: 0%
- Mix 50%
- Atmosphere: 50%

Qu-Bit Lifetime Repair Warranty

No matter how long you've owned your module, or how many people have owned it before you, our doors are open to any and all Qu-Bit modules needing repair. Regardless of circumstances, we will continue to provide physical support for our modules, with all repairs being completely free of charge.*

Learn more about the lifetime repair warranty.

*Issues that are excluded from the warranty, but do not void it includes scratches, dents, and any other user-created cosmetic damage. Qu-Bit Electronix holds the right to void warranty at their own discretion and at any time. Module warranty may be voided if any user damage is present on the module. This includes, but is not limited to, heat damage, liquid damage, smoke damage, and any other user-created critical damage on the module.

Changelog

Firmware Version	Notes
v1.7.2	• release firmware
v1.7.3	• Added USB power draw section to Tech Specs
v1.7.4	• Updated input level range: -6dB to +12dB