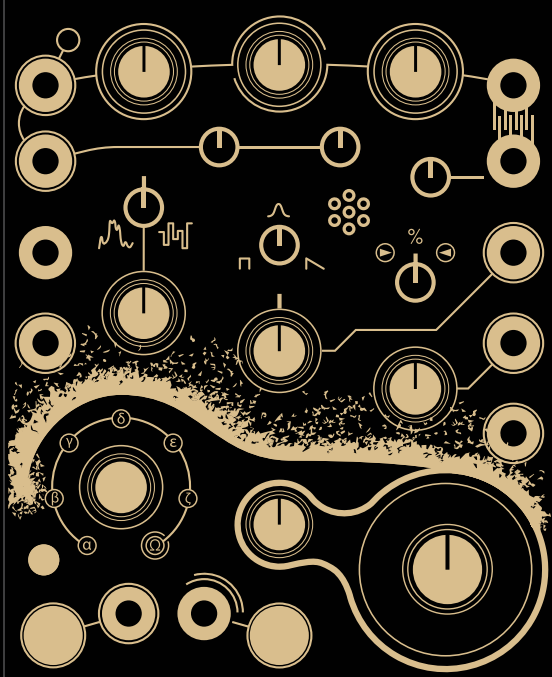
INSTRUO | SPECIALIST SYNTHESIZERS



# arbhar

## Granular Audio Processor

## User Manual

## (Firmware 1.6)

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## Description

**arbhar** heralds a new generation of granular processing in Eurorack. Sampled audio can be chopped into tiny grains, scattered, shaped, re-pitched, reversed, and layered for an endless range of audio manipulation from seamless frozen tones to mutated acousmatic madness. Each grain sounds with its defined specifications. When modulation is used, the "per-grain parameter" definition allows for true polyphonic layering.

Featuring a condenser microphone set into the front panel, built-in audio analysis for automatic sampling, and internal modulation over various parameters; this is truly a granulator like no other.

Meet the **Lexer Method.**

## Features

- 44 polyphonic grains between two granular engines
- Six 10 second individual and consecutive audio buffers
- 1V/Oct pitch tracking
- On-board random pitch deviation and grain direction probability
- Scan mode, Follow mode, and Wavetable mode
- Stereo pan, delay, and reverb configurations
- Built-in condenser microphone
- Dedicated analogue input pre-amplifier
- USB import & export functionality
- Audio analysis with onset detection for automatic audio capture
- Includes 2 HP passive CV expansion module & 4GB USB flash drive.

## Installation

1. Confirm that the Eurorack synthesizer system is powered off.
2. Locate 18 HP of space in your Eurorack synthesizer case for the module.
3. Locate an additional 2 HP of space in your Eurorack synthesizer case for the optional CV expansion module.
4. Connect the 10 pin side of the IDC power cable to the 2x5 pin header on the back of the module, confirming that the red stripe on the IDC power cable is connected to -12V, indicated with a white stripe on the module.
5. Connect the 16 pin side of the IDC power cable to the 2x8 pin header on your Eurorack power supply, confirming that the red stripe on the power cable is connected to -12V.
6. Optional: To install the CV Expander module, connect the included 12 pin IDC cable to both modules. Ensure that the red strip of the IDC cable matches the white stripe on each module.
7. Mount the Instruō **arbhar** in your Eurorack synthesizer case.
8. Power your Eurorack synthesizer system on.

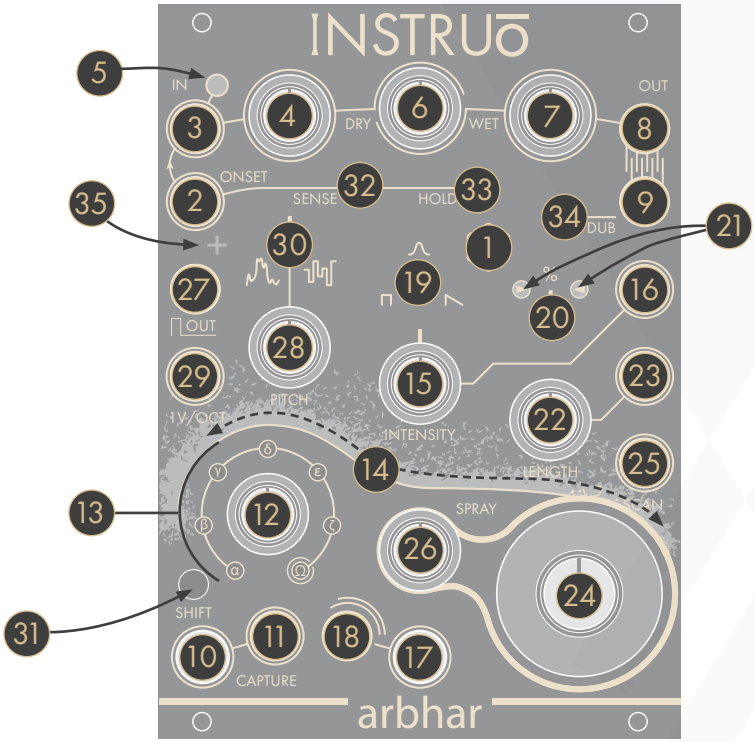
### Note:

This module has reverse polarity protection.
Inverted installation of the power cable will not damage the module.

## Specifications

- Width: 18 HP Module + 2 HP CV Expansion Module
- Depth: 42mm
- +12V: 250mA
- -12V: 30mA
- Sample Rate: 64kHz
- Bit Depth: 32 Bit

**arbhar** | ˈarˠuːrˠ | **noun** (agricultural) a grain, a very small amount of a particular quantity, natural patterns or lines in the surface of wood or cloth




## Key

1. Condenser Microphone
2. Onset Input
3. Input
4. Input Level
5. Input Indicator
6. Dry/Wet Mix
7. Output Level
8. Output 1
9. Output 2
10. Capture Button
11. Capture Gate Input
12. Layer
13. Layer Indicators
14. Granular Stream
15. Intensity
16. Intensity CV Input
17. Strike Button
18. Strike Input
19. Grain Window
20. Grain Direction
21. Grain Direction Indicators
22. Length
23. Length CV Input
24. Scan
25. Scan CV Input
26. Spray
27. Gate Output
28. Pitch
29. 1V/Octave Input
30. Pitch Deviation
31. Shift Button
32. Sensitivity
33. Hold
34. Dub
35. Onset Indicator

# CV Expansion Module




## Key

1. Spray CV Input
2. Layer CV Input
3. Grain Direction CV Input
4. Grain Window CV Input
5. Pitch Deviation CV Input
6. Dub CV Input
7. Mod CV Input
8. Dry/Wet Mix CV Input

## I/O & Capture

**Condenser Microphone:** The **Condenser Microphone** located on the front panel can be used for capturing audio. It is normalled to the **Onset Input** when no cables are patched to the **Onset Input** jack.

- The **Onset Input** is normalled to the **Input**. When no cables are connected to either input, the **Condenser Microphone** will normal through the **Onset Input** and to the **Input**.

**Input:** AC coupled audio input.

**Normalised Signal Path:**



Microphone

ONSET
Signal to be Analysed

IN
Signal to be Recorded

**Input Level:** The **Input Level** knob sets the level of the signal present at the **Input**. This includes the level of the normalled **Condenser Microphone** signal. The input stage incorporates analogue limiting. This allows **arbhar** to saturate rather than digitally clip when high amplitude signals are used.

- If the knob is at its 10:00 position, the signal present at the **Input** is approximately at unity gain. If the knob exceeds the 10:00 position, **arbhar** drives the signal through the input pre-amplifier. Analogue limiting will prevent signals from digitally clipping at the **Input**.
- The knob can be used to increase line level signals to modular level.

**Input Indicator:** The **Input Indicator** will illuminate amber when a signal is present at the **Input**. The brightness of the LED indicates the amplitude of the input signal.

**Dry/Wet Mix:** The **Dry/Wet Mix** parameter will equal power crossfade between the dry signal and the granular engine.

**Output Level:** The **Output Level** knob sets the level of the signal present at the **Outputs**.

**Outputs:** By default, grains are randomly distributed between the two **Outputs** using coin toss logic.

- **Output 2** is normalised to **Output 1**. For mono playback, monitor from **Output 1**
- Connecting **Output 2** enables stereo imaging and independent effect processing for each output (See **Hardware Configuration** for more information).

**Capture Button:** The **Capture Button** activates recording of the signal present at the **Input**.

- Each capture activation will start recording from the start of the layer.
- Once the recording has started, the button will illuminate amber and recording will continue until the layer is filled, even if the currently selected layer is being changed.
- The recording will automatically stop once the layer is filled. This is indicated by an unilluminated **Capture Button**.
- Pressing the **Capture Button** while capture is activated will stop recording.
- **arbhar** automatically saves recordings and will retain recordings between power cycles (See the **Save & Load** section for more information).

**Capture Gate Input:** Recording and overdubbing is activated when a gate signal is present at the **Capture Gate Input**.

The **Capture Gate Input** can be set to latching or momentary by pressing the **Shift Button** and the **Capture Button** and moving the **Dub** knob fully anticlockwise (momentary, default) or fully clockwise

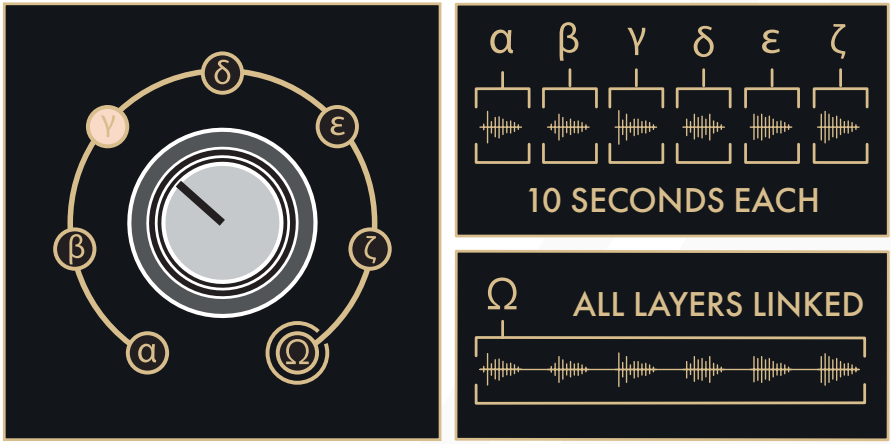
(latching). When set to momentary, capturing will be activated for as long as a gate signal is held high. When set to latching, capturing toggles on and off with each successive rising edge signal.

This behaviour can also be adjusted in the arbhar_config.txt file (See the arbhar_config.txt section of the manual for more information).

**Layer:** The **Layer** knob sets the currently selected layer. There are six layers which can store up to 10 seconds of audio each.

- They are referred to as alpha, beta, gamma, delta, epsilon, and zeta.
- Layer content is set at the beginning of each grain and remains unchanged for the duration of the grain.
- When the knob is fully clockwise and the omega **Layer Indicator** is illuminated, all layers are consecutively available via the **Scan** parameter.
- To ensure the absence of audio drop outs at extreme **Scan** parameter positions, **arbhar** will record for an extra 2 seconds at the end of each layer.

**Layer Indicators:** The **Layer Indicators** will illuminate around the **Layer** knob to indicate the currently selected layer.



- When the knob is fully clockwise and the omega **Layer Indicator** is illuminated, the currently selected layer is determined by the position of the **Scan** parameter and indicated by the corresponding **Layer Indicator**.

**Granular Stream**: The **Granular Stream** display will change colour to indicate the currently selected layer. The **Granular Stream** display will also illuminate from left to right, indicating the amplitude of the granular stream.

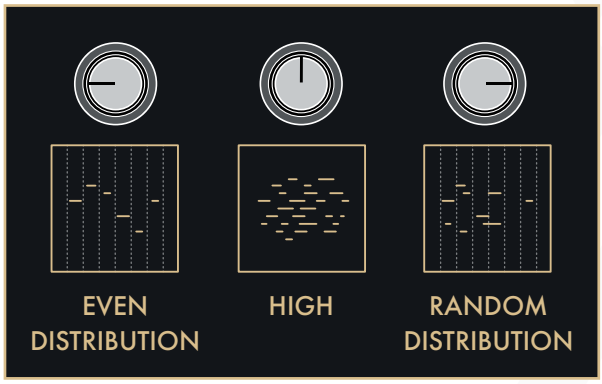



- The alpha layer is indicated by the colour blue.
- The beta layer is indicated by the colour magenta.
- The gamma layer is indicated by the colour amber.
- The delta layer is indicated by the colour yellow.
- The epsilon layer is indicated by the colour turquoise.
- The zeta layer is indicated by the colour violet.
- The omega layer is a combination of all layers, therefore it is indicated by a combination of all colours based on the current **Scan** parameter position.

## Granular Synthesis

There are two separate granular engines within **arbhar**. The **Continuous Granular Engine** is controlled by the **Intensity** parameter. The **Strike Granular Engine** is controlled by the **Strike Input** and **Strike Button**. By default, 24 grains can be generated polyphonically from the **Continuous Granular Engine** and 20 grains can be generated polyphonically from the **Strike Granular Engine**. A total of 44 grains can be played polyphonically between both granular engines.

**Intensity:** The **Intensity** parameter sets the amount of generated grains from the **Continuous Granular Engine**.




- The maximum number of grains are generated when the knob is in its centre position.
- Turning the knob anticlockwise from its centre position will decrease the number of grains. Any knob setting anticlockwise of its centre position will generate grains at the same amplitude and set a synchronous grain generation pattern.
- Turning the knob clockwise from its centre position will decrease the number of grains. Any knob setting clockwise of its centre position will generate grains at random amplitudes and set asynchronous grain generation. Random amplitude and asynchronous grain

generation settings can be adjusted in the arbhar_config.txt file (See the arbhar_config.txt section of the manual for more information).

- Turning the knob to either of its extreme settings will turn off the **Continuous Granular Engine**. In these settings, the **Strike Button** and **Strike Input** can be used for time-synchronized grain generation via the **Strike Granular Engine**.
- When changing the **Intensity** parameter, all currently generated grains will remain uninterrupted. It is therefore possible that the change of the **Intensity** parameter may not have an immediate audible effect in relation to the value set by the **Length** parameter.
- The rate of grain generation from the **Continuous Granular Engine** is set by both the **Intensity** and **Length** parameters.
- Double press and hold the **Shift Button** to engage **arbhar's** 'track and hold' mode (See the Track & Hold Mode section for more information.

**Intensity CV Input:** The **Intensity CV Input** is a bipolar control voltage input for the **Intensity** parameter.

- Control voltage is summed with the knob position.
- Input range: 10V. e.g. a voltage difference of 10V is needed to control from the minimum to maximum knob position. If the knob is at its centre position, the accepted input range is -/+5V.

**Strike Button:** Pressing the **Strike Button** will generate a single grain at the **Outputs**.

- The grains generated by the **Strike Granular Engine** are 15% louder than those of the **Continuous Granular Engine**. This allows the triggered grains to act as accents within dense granular textures.
- If only triggered grains are desired, set the **Intensity** knob to either of its extreme positions to disable the **Continuous Granular Engine** and use the **Strike Input** or **Strike Button** to access the **Strike Granular Engine**.

**Strike Input:** A single grain is generated when a trigger or gate signal is present at the **Strike Input**.

**Grain Window:** The **Grain Window** parameter sets the amplitude envelope of the grains.

- If the knob is in the centre position, the grain window is set to a **Gaussian** shape. The Gaussian shape is suitable for smooth drones and textures.
- Turning the knob towards anticlockwise from the centre position morphs the grain window to a **Square** shape. The square shape is suitable for sharper textures and can be used for loop effects with low **Intensity** parameter settings.
- Turning the knob towards clockwise from the centre position morphs the grain window to a **Sawtooth** shape. The sawtooth shape is suitable for percussive textures.
- Double press and hold the **Shift Button** to engage **arbhar's** 'track and hold' mode (See the Track & Hold Mode section for more information.

**Grain Direction:** The **Grain Direction** parameter sets the probability percentage of the playback direction of each grain.

- If the knob is in its centre position, grain direction probability is set to 50% forward playback and 50% reverse playback.
- If the knob is fully anticlockwise, grain direction probability is set to 100% forward playback.
- If the knob is fully clockwise, grain direction probability is set to 100% reverse playback.
- **Grain Direction** values are applied at the beginning of each grain and remain unchanged for the duration of the grain. It is therefore possible that the change of the **Grain Direction** parameter may not have an immediate audible effect in relation to the value set by the **Intensity** and **Length** parameters.

**Grain Direction Indicators:** The **Grain Direction Indicators** will illuminate to indicate the playback direction of the currently generated grain.

- If the left **Grain Direction Indicator** is illuminated, forward playback direction is set for the current grain.
- If the right **Grain Direction Indicator** is illuminated, reverse playback direction is set for the current grain.
- Grains from the **Continuous Granular Engine** are indicated by white LED illumination.
- Grains from the **Strike Granular Engine** are indicated by amber LED illumination.
- Both **Grain Direction Indicators** will illuminate amber when **arbhar** is set to **Wavetable Mode** (See the **Wavetable Mode** section for more information).

**Length:** The **Length** parameter sets the duration of each grain ranging from ~40ms - 3s. This parameter is crucial to the granular texture. Grain length is shown on the **Granular Stream** display.

- Length values are applied at the beginning of each grain and remain unchanged for the duration of the grain.
- The rate at which grains are generated is set by both the **Intensity** and **Length** parameters.

**Length CV Input:** The **Length CV Input** is a bipolar control voltage input for the **Length** parameter.

- Control voltage is summed with the knob position.
- Input range: 10V. e.g. a voltage difference of 10V is needed to control from the minimum to maximum knob position. If the knob is at its centre position, the accepted input range is -/+5V.

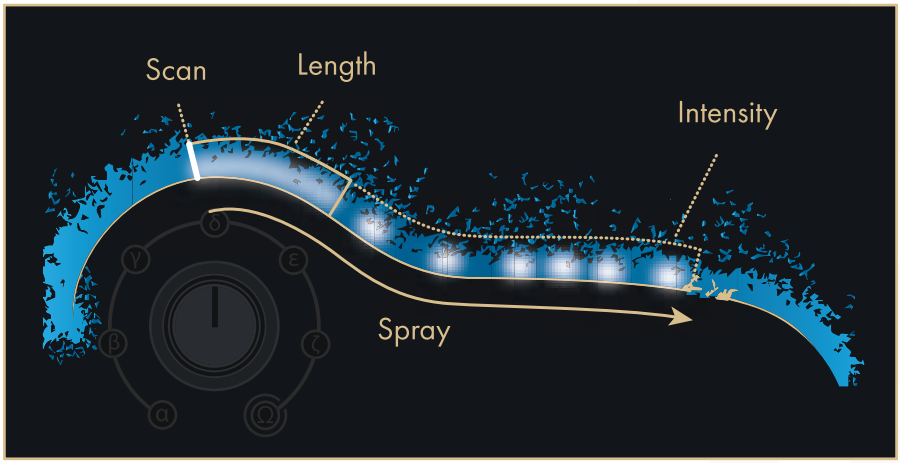
**Scan:** The **Scan** parameter sets the point of grain generation within the layer. The position of the **Scan** parameter is shown on the **Granular Stream display**.

- The start position is set at the start of each grain and remains unchanged for the duration of the grain.

**Scan CV Input:** The **Scan CV Input** is a bipolar control voltage input for the **Scan** parameter.

- Input range: -/+5V.

**Spray:** The **Spray** parameter controls a random deviation of the grain start position. The amount and location of start position deviation is shown on the **Granular Stream** display.




- **Spray** functionality will deviate from the current **Scan** position to the right of the layer. The **Spray** parameter is biased towards the current **Scan** position, in order to create a sense of moving through the recording if the **Scan** position is changed.
- The start position is set at the start of each grain and remains unchanged for the duration of the grain.
- If the value of the **Spray** parameter is greater than the duration available from the **Scan** position to the end of the layer, the **Spray** parameter will extend to include the time in front of the set **Scan** position.
- If the **Spray** parameter is set to its maximum value, the start position

for the grains will be completely random positions within the entire layer.

**Gate Output:** The **Gate Output** generates gate signals. The generation of the gate signals are dependent on the selected **Onset Control Mode** (See the **Onset Control Modes** section for more information).

- Output range: +5V.
- Duty cycle: 12ms.

## Pitch

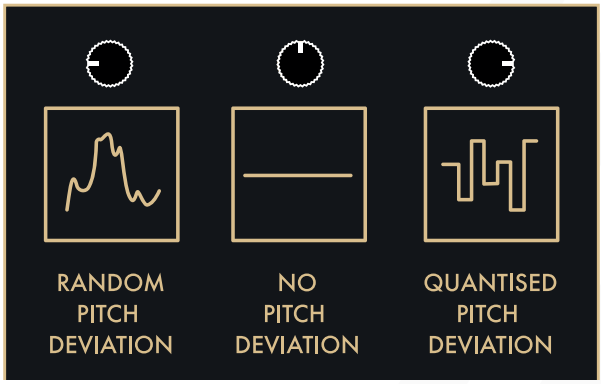
**Pitch:** The **Pitch** knob will change the pitch of the grains.

- Pitch values are applied at the beginning of each grain and remain unchanged for the duration of the grain. It is therefore possible that by modulating the **Pitch** parameter, **arbhar** can generate polyphonic overlapped grains. Decreased **Intensity** and **Length** parameters will result in more immediate **Pitch** parameter changes.

**1V/Octave Input:** The **1V/Octave Input** is a bipolar control voltage input for the **Pitch** parameter.

- Control voltage is summed with the knob position.
- Input range: 10V. e.g. a voltage difference of 10V is needed to control from the minimum to maximum knob position. If the knob is at its centre position, the accepted input range is -/+5V.

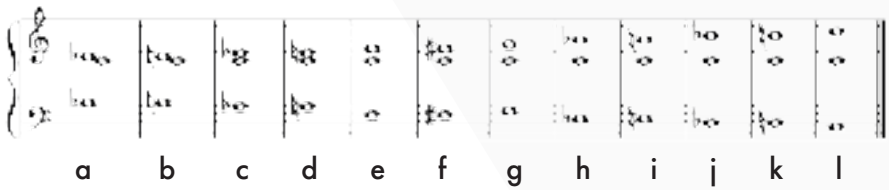
**Pitch Deviation:** The **Pitch Deviation** knob applies an intervallic voltage offset to the pitch of each grain.




- If the knob is at the centre position, no pitch deviation is applied.
- Turning the knob anticlockwise from its centre position applies bipolar unquantized random pitch deviation.
- Turning the knob clockwise from its centre position applies bipolar quantized random pitch deviation of increasing intervals for each

grain. The intervallic voltage offset increases as the knob is moved clockwise.

- Pitch deviation values are applied at the beginning of each grain and remain unchanged for the duration of the grain. It is therefore possible that by modulating the **Pitch Deviation** parameter, **arbhar** can generate polyphonic overlapped grains. Decreased **Intensity** and **Length** parameters will result in more immediate **Pitch Deviation** parameter changes.
- Measured in semitones, the following intervallic pitch deviations are available.
- Double press and hold the **Shift Button** to engage **arbhar's** 'track and hold' mode (See the Track & Hold Mode section for more information




a



-2 / 0 / +1

b



-1 / 0 / +2

c



-4 / 0 / +3

d



-3 / 0 / +4

e



-7 / 0 / +5

f



-6 / 0 / +6

g



-5 / 0 / +7

h



-9 / 0 / +8

i



-8 / 0 / +9

j



-11 / 0 / +10

k



-10 / 0 / +11

l



-12 / 0 / +12

## Shift Button

- The **Shift Button** is used for secondary features, modes, and controls (See the **Erase & Undo**, **Layer Record Destination Lock, Onset Control Modes, Scan Mode & Follow Mode, Save & Load**, and **Import & Export** sections for more information).
- If the **Shift Button** is held down, the colour of the **Granular Stream** display illuminates red with white illumination on either side.

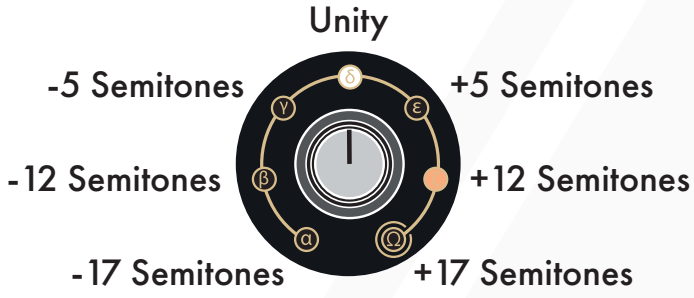
## Track & Hold Mode

Double press and hold the **Shift Button** to activate **Track & Hold Mode**. This forces certain specific parameter changes to only engage on the release of the **Shift Button**. When **Track & Hold Mode** is activated, the **Granular Stream will be illuminated green**.

The parameters that get held are:

- Window
- Pitch - The **Layer Indicators** will display when the pitch is set to a fifth or an octave. (See diagram below)
- Pitch Deviation
- Intensity

**Note:** Pitch change will be illuminated amber by the **Layer Indicators.**



## Erase & Undo

**Erase:** If a new recording has been captured into an empty layer, press and hold the **Shift Button** and then press the **Strike Button** to perform the **Erase** function.

**Undo:** If audio replacement or a sound-on-sound overdub has been recorded into an existing layer, one **Undo** function is accessible. In this case, press and hold the **Shift Button** and then press the **Strike Button** to perform the **Undo** function. The **Undo** function will always return back to the last manually captured or loaded layer.

If audio has been captured into the currently selected layer, the **Strike Button** will pulse amber when the **Shift Button** is held down, indicating that there is audio to **Erase** and/or **Undo**. Once the **Undo** function has been performed, the **Strike Button** will pulse white, indicating that there is still audio captured into the currently selected layer that can be **Erased**.




To undo an overdub hold 1, press 2. When pulsing orange the action will undo.



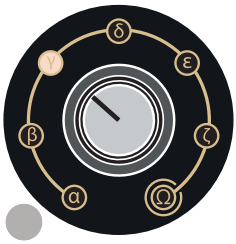

Doing this a second time will erase the buffer completely. When pulsing white the action will erase.

## Layer Record Destination Lock

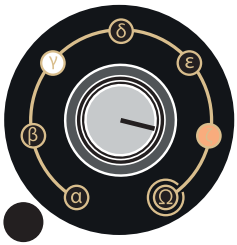
Audio can be captured into a layer while a different layer is being monitored. This can be done by decoupling the recording destination from the **Layer** parameter.

To set a **Layer Record Destination Lock**, press and hold the **Shift Button** and then turn the **Layer** knob. The **Layer Record Destination Lock** is indicated by an amber **Layer Indicator**. The monitored layer is indicated by a white **Layer Indicator**.

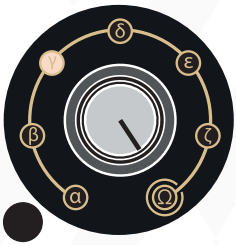
To recouple the recording destination and the **Layer** parameter, press and hold the **Shift Button** and then set the **Layer** knob to the omega layer.




Move layer knob to desired location to select record and playback layer (illuminated off white).




Holding shift and moving the layer knob will decouple record layer (illuminated amber) from playback layer (illuminated white).




Holding shift and moving layer knob to 'omega' will recouple the layers.

## Audio Analysis & Onset Detection

**Onset Input:** The **Onset Input** is an AC coupled audio input for the audio analysis section of **arbhar**.

- The **Onset Input** is normalised to the **Input**.
- Depending on the currently selected mode, signals present at the **Onset Input** will activate capture. This is the default functionality.

**Onset Indicator:** The **Onset Indicator** shows when onset detection is armed. If the indicator is illuminated, onset detection is armed. If the indicator is unilluminated, an onset was detected and will remain unarmed for the duration of time set by the **Hold** parameter. The **Onset Indicator** relates to the **Onset Control Modes** and is dependent on the **Sensitivity** and **Hold** parameters.

- In the alpha and beta **Onset Control Modes**, the **Onset Indicator** illuminates amber to show that a detected onset will activate capture.
- In the gamma and delta **Onset Control Modes**, the **Onset Indicator** illuminates white to show that the detected onset will generate gate signals at the **Gate Output**.
- Once an onset is detected, the **Onset Indicator** will be unilluminated for the duration of time set by the **Hold** parameter.
- When the **Onset Indicator** illuminates again, **arbhar** is waiting for another onset to detect.
- In the gamma **Onset Control mode**, onset-derived gate signals will be mixed with the gate signals generated by the **Continuous Granular Engine**.
- In the delta **Onset Control Mode**, the onset-derived gate signals are solely dependent on the detected onset.
- In the delta **Onset Control Mode**, it can be useful to connect the **Gate Output** to the **Capture Gate Input**, and set the **Hold** parameter to have a time duration as long as the capture duration.

**Sensitivity:** The **Sensitivity** parameter sets the responsiveness of the **Onset Input**.

- Turning the knob clockwise increases the responsiveness of the **Onset Input**.
- Turning the knob anticlockwise decreases the responsiveness of the **Onset Input**.

**Hold:** The **Hold** parameter changes functionality based on the selected **Onset Control Mode**.

- If capture is triggered by onset detection, the **Hold** parameter sets the minimum capture time when capture is activated.
- If gate signals are generated at the **Gate Output** upon onset detection, the **Hold** parameter sets minimum time between gate signals.
- See the **Onset Control Modes** section for more information.

**Dub:** The **Dub** parameter is used for audio replacement and sound-on-sound recording. It sets the level of the existing audio within the layer and the audio of the new capture.

- If the knob is fully anticlockwise, the new capture will replace the current capture in the currently selected layer.
- If the knob is in the centre position, the existing capture at half amplitude is mixed with the new capture at half amplitude.
- If the knob is fully clockwise, the existing capture at full amplitude is mixed with new capture at full amplitude. This setting is great for accumulating audio layers.




New audio capture destructively replaces previous audio.




Previous audio will be attenuated by 50% and summed with new audio.

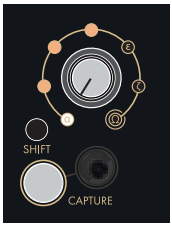



New audio will sum with previous audio at full amplitude.

## Onset Control Modes

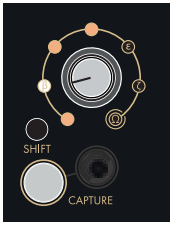
**arbhar** features four different **Onset Control Modes** that determine how the internal audio analysis functions.

With the **Shift Button** and the **Capture Button** held down, turn the **Layer** knob to set the **Onset Control Mode**:



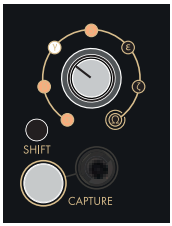

**Alpha:** The alpha setting will activate capture upon onset detection.

In this mode, a gate signal will generate from the **Gate Output** at the beginning of each grain.



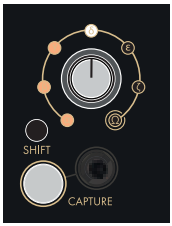

**Beta:** The beta setting will activate capture upon onset detection.

In this mode, a gate signal will generate from the **Gate Output** upon each onset detection and is set high for the duration of time set by the **Hold** parameter.




**Gamma:** The gamma setting will not activate capture upon onset detection.

In this mode, a gate signal will generate from the **Gate Output** at the beginning of each grain.




**Delta:** The delta setting will not activate capture upon onset detection.

In this mode, a gate signal will generate from the **Gate Output** upon each onset detection and is set high for the duration of time set by the **Hold** parameter.

## Scan Mode & Follow Mode

To change between **Scan Mode** and **Follow Mode**, press and hold the **Shift Button** and the **Capture Button,** then turn the **Scan** knob to either of the two extreme values. Double turning the **Scan** knob to the minimum or maximum position will toggle between **Scan Mode** and **Follow Mode**. The **Strike Button** will be unilluminated when **Scan Mode** is selected and will illuminate white when **Follow Mode** is selected.




1) Shift Button
2) Capture Button
3) Scan Knob
4) Strike Button

**Scan Mode: Scan Mode** is the factory default mode. In **Scan Mode**, the user can manually scan through the recorded buffer, setting the **Scan** parameter at any position to freeze audio playback.

**Follow Mode:** In **Follow Mode**, audio playback is triggered and directed internally.

Pressing the **Capture Button** or sending a gate or trigger signal to the **Capture Gate Input** will start recording and simultaneously trigger the playback from the start of the layer at the speed set by the **Scan** knob.

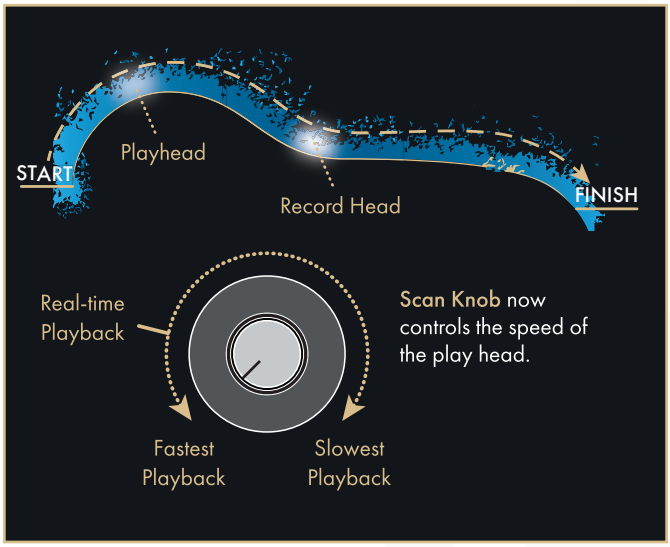
Pressing the **Capture Button** or sending a gate or trigger signal to the **Capture Gate Input** will start recording and simultaneously trigger the playback from the the start of the layer at the speed set by the **Scan** knob.

Pressing the **Strike Button** or sending a gate or trigger signal to the **Strike Input** will start playback from the start of the layer. Playback speed is set by the **Scan** knob.

If the **Onset Control Mode** is set to alpha or beta, onset detection will capture audio and trigger playback simultaneously.

If the **Onset Control Mode** is set to gamma or delta, the onset detection will only restart playback. In this case, the **Capture Button** and **Capture Gate Input** are used to record audio into the layer.

In **Follow Mode**, the playback is still a composite of the number of grains selected (**Intensity**), grain length (**Length**) and random deviation of the position (**Spray**). However, the **Spray** parameter randomises the start position of the grain with the audio prior to the current play head position. Therefore, in the instance of a new playback or capture trigger, the value of the **Spray** parameter will increase from 0 to the set **Spray** parameter value as the play head or record head progresses.




In the arbhar_config.txt file, the **Scan CV** can be definied to either control the **Playback Speed**, or alternatively to control an offset in the position between record head and playhead. (See the arbhar_config.txt section of the manual for more information).

## Wavetable Mode

Turning the **Length** knob fully anticlockwise forces **arbhar** to crossfade into a **Wavetable Synthesis Engine**. The wavetable is derived from a single-cycle loop of the captured content within the layer.

- Both **Grain Direction Indicators** are illuminated amber when this mode is active.
- The pitch of the **Wavetable Synthesis Engine** is calibrated to produce a C note when the **Pitch** knob is set to its centre position.
- The **Pitch Deviation** parameter functions in its normal manner.
- The **Scan** and **Spray** parameters will change the position in the layer from which the wavetable is derived.
- The **Intensity** parameter changes in functionality to be an update rate control for the wavetable content (**Scan**, **Spray**, and **Pitch Deviation**). The fastest update rate is found when the **Intensity** knob is at its centre position.
- Moving the **Intensity** knob to either of its extreme positions will disable its continuous oscillation. In either of these extreme positions, the **Strike Button** and **Strike Input** can be used to trigger a short note via the **Strike Granular Engine**. These notes are 15% louder than the continuous oscillation and can be used to accentuate continuous oscillation.
- The centre frequency of the wavetable can be defined in Hz. within the arbhar_config.txt file. Default is C2 (C below middle C) at 130.813Hz (See the arbhar_config.txt section for more information).

## Phase Switching

The second output of **arbhar** is phase-inverted in order to ensure that no phase cancellation occurs when the second output is normalised to first output when monitored in mono. When monitoring in stereo, however, the user might experience that the dry input signal of the arbhar is cancelled out further down the signal chain (i.e. summing a stereo signal to a mono signal some stereo effects, like reverb, that actually process a summed stereo input).

This can be avoided by leaving the **Dry/Wet Mix** knob fully wet and mixing in the dry signal separately or by engaging the phase switch for the second output.

To do this, press and hold the **Shift Button** then the **Capture Button** and turn the **Hold** knob fully clockwise for stereo patching. For mono patching, press and hold the **Shift Button** then the **Capture Button** and turn the **Hold** knob fully anticlockwise. This is the default state.

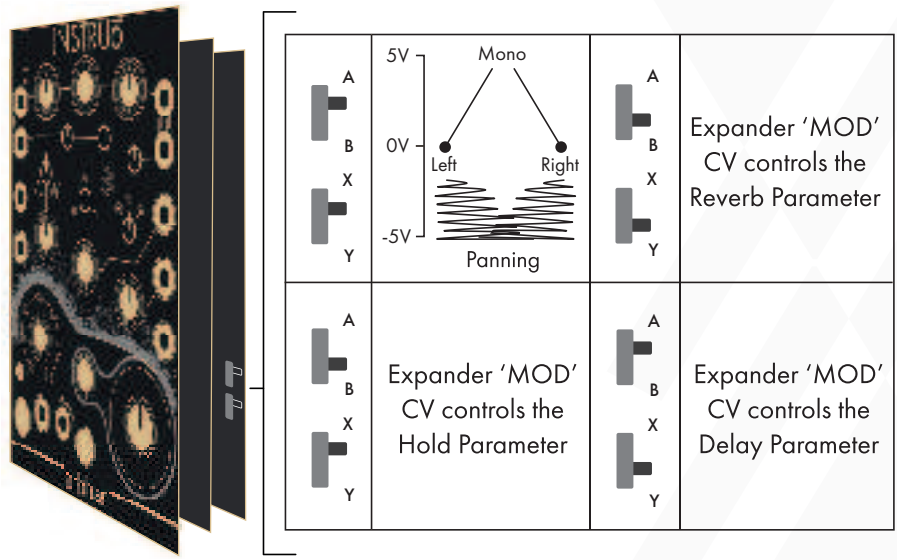
This setting can also be changed in the arbhar_config.txt file (See the arbhar_config.txt section for more information).

It is important to  note that if the **arbhar** is patched in mono and the phase switch is engaged, the dry signal will cancel out. This can actually be used to simulate a VCA for the granulated sound when the **arbhar** is in **Stereo Panning Configuration**. Just patch a CV signal into the **Mod Input**. At 0V all grains are heard. At +5V all grains are panned to mono and cancel out.

## Hardware Configurations

**arbhar** can be set to four different configurations using the **Hardware Configuration Switches**, **AB** and **XY**, found at the right side of the back circuit board. The value of the parameters determined by the **Hardware Configuration Switches** are set by the **Mod CV Input** on the **CV Expansion Module**.

**Note:** It is recommended to change these settings while the module is powered down.




### Stereo Panning Configuration:

**Hardware Configuration Switch** Position: A-X.

Two granular engines (24 grains + 20 grains) and **Wavetable Mode**.

The **MOD CV Input** on the **CV Expansion Module** sets the amount of stereo panning.

- At 0V, **arbhar** distributes the grains in the default coin toss method.
- With positive voltage, additional to the coin toss method, the stereo spread is reduced. At +5V, stereo spread reduces to a fully mono mix.
- With negative voltage, additional to the coin toss method, a random deviation from the left and right extremes creates a more active equal power stereo distribution. At -5V, the grains have a fully random equal power stereo distribution.

## Hold CV Configuration:

**Hardware Configuration Switch** Position: B-X.

Two granular engines (24 grains + 20 grains) and **Wavetable Mode**.

The **MOD CV Input** on the **CV Expansion Module** modulates the **Hold** time

- Positive voltage increases the set **Hold** time.
- Negative voltage decreases the set **Hold** time.

## Stereo Reverb Configuration:

**Hardware Configuration Switch** Position: B-Y.

Two granular engines (20 grains + 20 grains) and **Wavetable Mode**.

The **MOD CV Input** on the **CV Expansion Module** controls curated parameters of the stereo reverb.

- Positive voltage controls reverb parameters mixed with the dry signal. The reverb freezes at +5V.
- Negative voltage omits the dry signal and only allows the wet signal to pass. The reverb has additional shimmering modulation.
- The stereo spread of the dry signal can be defined in the arbhar_config.txt file (in %).

**Note:** When **arbhar** is set to the **Stereo Reverb Configuration**, the module will run at a reduced sample rate and bit depth of 48kHz / 32 Bit.

## Feedback/Delay Configuration:

**Hardware Configuration Switch** Position: A-Y.

Two granular engines (24 grains + 20 grains) and **Wavetable Mode**.

The **MOD CV Input** on the **CV Expansion Module** controls curated parameters of the feedback/delay.

- A summed dry and wet signal will generate from **Output 1** if it's the only **Output** connected.
- **Output 1** generates the dry signal when both outputs are connected.
- **Output 2** generates the wet signal only.
- Positive voltage controls delay times between 80ms - 1000ms with a fixed feedback level of 67% for a more standard echo effect.
- Negative voltage controls delay times between 25ms - 1ms with a fixed feedback level of 99% for some shimmering Karplus-Strong effects.

## Save & Load

Loading a saved recording from memory after it has been erased allows for non-destructive experimentation of recording/overdubbing source material.

**Save:** To save a recording within the currently selected layer, press and hold the **Shift Button** and the **Capture Button** and then press the **Strike Button** for less than (<) 2 seconds. The **Strike Button** will flash indicating that the layer has been saved to memory.

**Load:** To reload a saved recording after its been erased, press and hold the **Shift Button** and then press the **Strike Button** for less than (<) 2 seconds. The **Strike Button** will pulse white indicating that the layer has been loaded from memory.

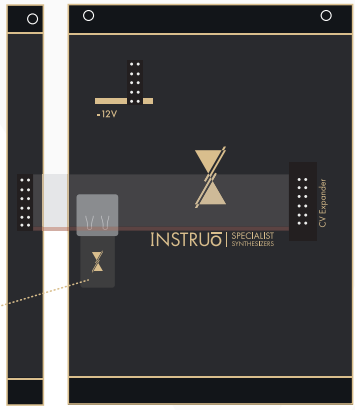
**Note:** Save and Load refer to internal memory functions. In order to save and load via the USB drive, please consult **Import & Export** section. (**Page 33**).

## USB Flash Drive

**arbhar** includes a 4GB USB flash drive.

Three folders are automatically created when the USB flash drive is connected to **arbhar**:

- _usersaved
- _toConvert




Upon power up, **arbhar** checks the **_toConvert** folder. The first 13 seconds of each of the first six audio files are converted into an **arbhar** friendly format.

These converted files are automatically copied into the internal file system of **arbhar**.

This conversion ensures that the files will play at the correct pitch. It also ensures that the file is cropped to a size that **arbhar** is able to import.

All files placed into the **_toConvert** folder will remain there unchanged.

- Make sure that only files with conventional uncompressed audio formats are used (.wav, .aiff files).
- All sample rates and bit depths are considered.
- Only the left channel of stereo files are converted.

## Import & Export

**Import:** Files can be imported into a layer from the USB flash drive.

- Insert a USB flash drive into the computer.
- Drag and drop the desired file to the **_toConvert** folder of the USB flash drive.
- Ensure that there are no spaces within the file names - 'my sample.wav' should be 'mySample.wav' or 'my_sample.wav'.
- The first 13 seconds of the first six files in alphabetical order will be converted into the optimal format for **arbhar**.
- Once the files have loaded, eject the USB flash drive from the computer.
- With **arbhar** powered off, insert a USB flash drive into the USB port on the back of **arbhar**.
- Once the USB flash drive has been inserted, power **arbhar** on.
- Once **arbhar** has fully booted, press and hold the **Shift Button** and then press the **Strike Button** for at least (>=) 2 seconds.

**Export:** Files can be exported from a layer to the USB flash drive.

- With **arbhar** powered off, insert a USB flash drive into the USB port on the back of **arbhar**.
- Once the USB flash drive has been inserted power **arbhar** on.
- Capture audio into a layer.
- Press and hold the **Shift Button** and the **Capture Button** and then press the **Strike Button** for at least (>=) 2 seconds.
- The layer will export to the **_usersaved** folder of the USB flash drive. as a 48kHz / 24 Bit .wav file. Files saved to the USB flash drive are not available to load back into **arbhar**, unless they are moved into the **_toConvert** folder of the USB flash drive.
- If the **Export** feature is used while the omega layer is selected, all layers will export simultaneously.
- It is important to note that **Importing** and **Exporting** is only possible on a per layer basis.

## CV Expansion

**Spray CV Input:** The Spray CV Input is a bipolar control voltage input for the **Spray** parameter.

- Control voltage is summed with the knob position.
- Input range: 10V. e.g. a voltage difference of 10V is needed to control from the minimum to maximum knob position. If the knob is at its centre position, the accepted input range is -/+5V.

**Layer CV Input:** The **Layer CV Input** is as bipolar control voltage input for the **Layer** parameter.

- More than 360 degrees of movement is accessible via positive and negative control voltage.
- Input range: -/+5V.
- Modulating the **Layer** parameter between 0V and 5V with external control voltage will enable two clockwise cycles through all six layers from the currently selected layer.
- Modulating the **Layer** parameter between 0V and -5V with external control voltage will enable two anticlockwise cycles through all six layers from the currently selected layer.

**Grain Direction CV Input:** The **Grain Direction CV Input** is a bipolar control voltage input for the **Grain Direction** parameter.

- Control voltage is summed with the knob position.
- Input range: 10V. e.g. a voltage difference of 10V is needed to control from the minimum to maximum knob position. If the knob is at its centre position, the accepted input range is -/+5V.

**Grain Window CV Input:** The **Grain Window CV Input** is a bipolar control voltage input for the **Grain Window** parameter.

- Control voltage is summed with the knob position.
- Input range: 10V. e.g. a voltage difference of 10V is needed to control from the minimum to maximum knob position. If the knob is at its centre position, the accepted input range is -/+5V.

**Pitch Deviation CV Input:** The **Pitch Deviation CV Input** is a bipolar control voltage input for the **Pitch Deviation** parameter.

- Control voltage is summed with the knob position.
- Input range: 10V. e.g. a voltage difference of 10V is needed to control from the minimum to maximum knob position. If the knob is at its centre position, the accepted input range is -/+5V.

**Dub CV Input:** The **Dub CV Input** is a bipolar control voltage input for the **Dub** parameter.

- Control voltage is summed with the knob position.
- Input range: 10V. e.g. a voltage difference of 10V is needed to control from the minimum to maximum knob position. If the knob is at its centre position, the accepted input range is -/+5V.

**Mod CV Input:** The **Mod CV Input** is a bipolar control voltage input for the **Hardware Configuration** set by the **Hardware Configuration Switches** (See the **Hardware Configurations** section for more information).

- Input range: -/+5V.

**Dry/Wet Mix CV Input:** The **Dry/Wet Mix CV Input** is a bipolar control voltage input for the **Dry/Wet Mix** parameter.

- Control voltage is summed with the knob position.
- Input range: 10V. e.g. a voltage difference of 10V is needed to control from the minimum to maximum knob position. If the knob is at its centre position, the accepted input range is -/+5V.

## arbhar_config.txt

These are the settings that can be changed in the arbhar_config.txt file.

| | |
|---|---|
| capture_cv gate | gate (momentary) / trigger (latching) |
| grain_trigger all | all / first |
| phase_switch mono | mono / stereo |
| strikeButtonToTrigger off | off / on |
| strikeCvLatency high | high / low |
| strikeCvDelay 18 | number in ms |
| delete_on_omega disabled | disabled / enabled |
| wavetabelCentreFreq 130.813 | define number in Hz |
| randomAmpWithRandomIntensity disabled | disabled / enabled |
| randomTimingWithRandomIntensity enabled | disabled / enabled |
| grainPanningInReverbMode 25 | define number in % |

From version 1-6-b onwards:

| | |
|---|---|
| followFadeInTime 1000 | define duration in ms* |
| followModeScanCv speed | speed / offset ** |

* this is the duration of grains fading in after capture triggered new recording in Follow Mode

** this is to repurpose the ScanCV input to control an offset between playhead and record head when in Follow Mode

## Update Firmware

For information and assets pertaining to **arbhar** firmware updates, visit: www.instruomodular.com/support.

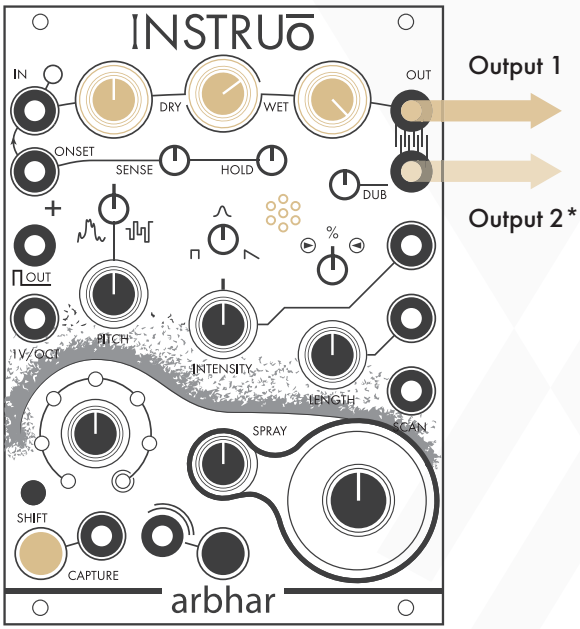
## Factory Reset

Press and hold the **Shift Button** and then press the **Capture Button** seven times to perform a factory reset. A factory reset will clear all audio recordings (except folders on the USB flash drive) and reset all modes, except the configurations set by the **Hardware Configuration Switches**.

## Patch Examples

### Basic Granular Processing:

**Summary:** Audio is captured, granulated, and then monitored.




### Audio Path:

- Connect any audio signal to the **Input**.
- Set the **Input Level** to a desired position and set the **Output Level** fully clockwise.
- Set the **Dry/Wet Mix** knob to a desired position. If the **Dry/Wet Mix** knob is fully clockwise (fully wet), then audio will not be heard until audio has been captured.
- Monitor **Output 1** for mono playback. Monitor **Output 1** and **Output 2** panned hard left and hard right for stereo playback.
- Set the **Layer** knob to the desired target layer.

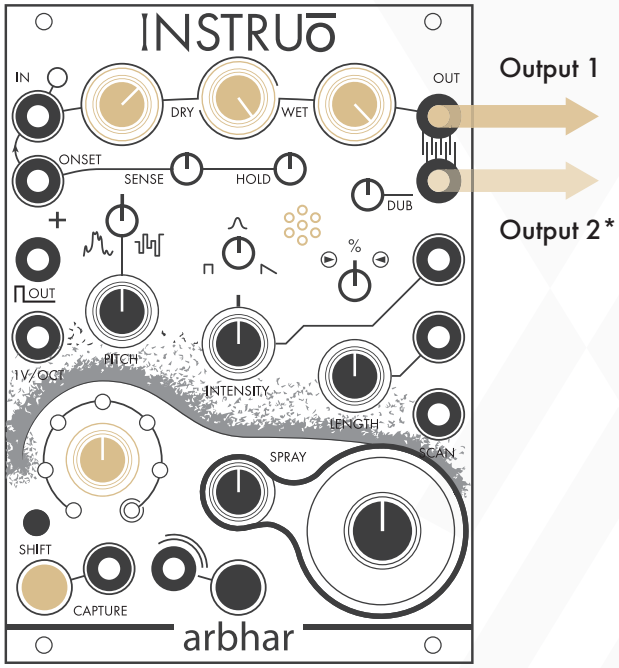
- Press the **Capture Gate Button** or connect a gate signal to the **Capture Gate Input** to start capturing audio.
- Capture will be activated until the maximum layer duration has been met. If the **Capture Gate Button** is pressed while capture is activated, or if the gate signal present at the **Capture Gate Input** is low, recording will be stopped.
- Once capture has deactivated, turn the **Input Level** fully anticlockwise. This effectively turns down the **Condenser Microphone** input signal.
- Experiment with all granular and pitch knobs to find desired effects and sweet spots.

Control Path:

- Apply control voltage to any of the CV inputs of **arbhar**.

## Feedback Capture:

**Summary:** The monitored output is fed back to the **Condenser Microphone**. Feedback is captured, granularised and then monitored.
**CAUTION:** This patch could harm monitoring systems if feedback is too loud. **Patch at your own risk.**




## Audio Path:

- Ensure that no cables are connected to the **Input** or **Onset Input**. This ensures that the **Condenser Microphone** is active.
- Turn on your monitoring system (speaker, headphones, etc.) so that they are able to feedback into the **Condenser Microphone**.
- Set the **Input Level** to a desired position and set the **Output Level** fully clockwise. The **Input Level** controls the amount of feedback.

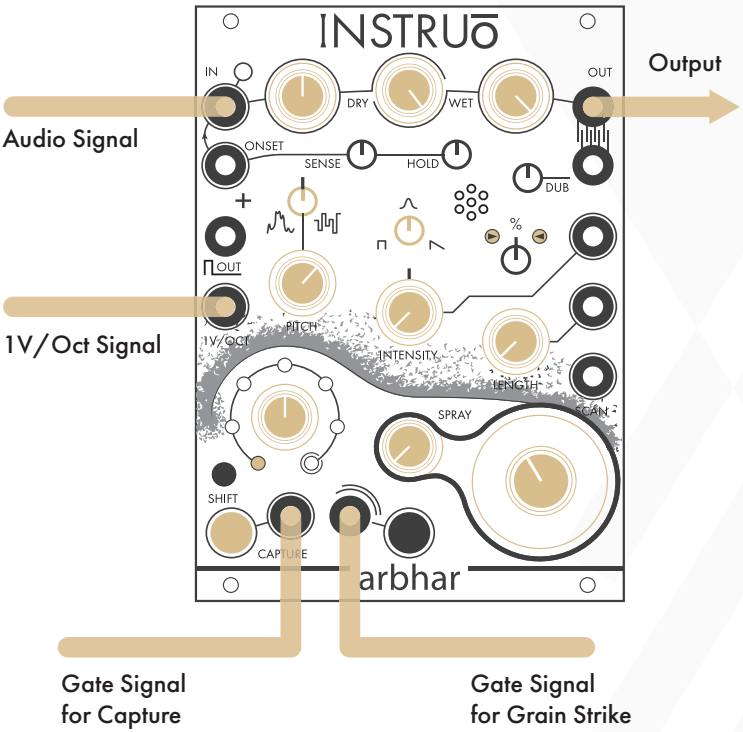
- Set the **Dry/Wet Mix** knob to fully clockwise. Audio will not be heard until audio has been captured.
- Monitor **Output 1** for mono playback. Monitor **Output 1** and **Output 2** panned hard left and hard right for stereo playback.
- Set the **Layer** knob to the desired capture location.
- Press the **Capture Button** or connect a gate signal to the **Capture Gate Input** to start capturing audio.
- Capture will be activated until the maximum layer duration has been met, if the **Capture Button** is pressed while capture is activated, or if the gate signal present at the **Capture Gate Input** is low.
- Once capture has deactivated, turn the **Input Level** fully anticlockwise. This effectively turns down the **Condenser Microphone** input signal.
- Set all granular and pitch knobs to desired positions.

Audio Path:

- Apply control voltage to any of the CV inputs of **arbhar**.

## Wavetable Synth Voice:

**Summary:** A wavetable is derived from captured audio. This wavetable can be triggered and pitch tracked and has a variable amplitude envelope.




## Audio Path:

- Connect any audio signal to the **Input**.
- Set the **Input Level** to a desired position and set the **Output Level** fully clockwise.
- Set the **Dry/Wet Mix** knob to a fully clockwise.
- Monitor **Output 1** for mono playback.
- Set the **Layer** knob to the desired target layer.

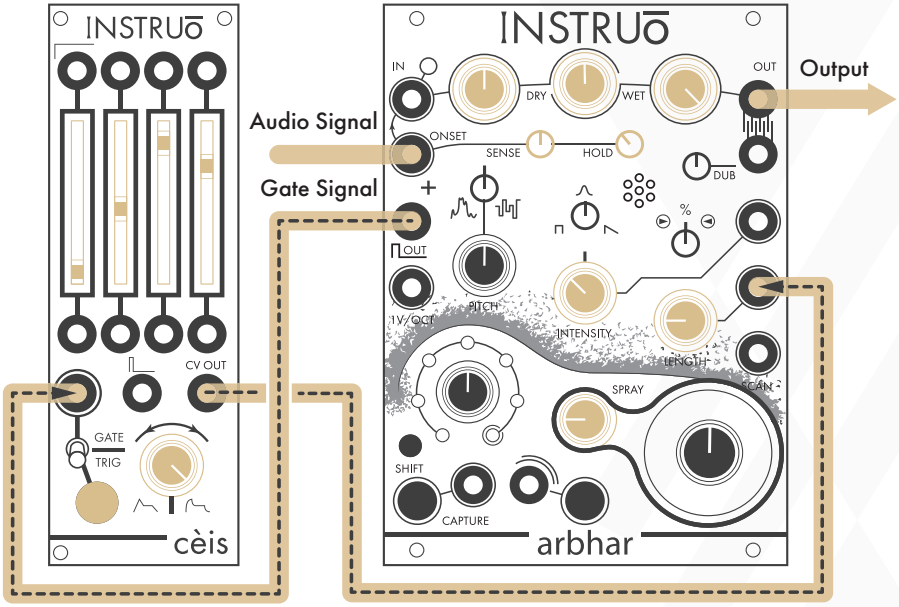
- Press the **Capture Button** or connect a gate signal to the **Capture Gate Input** to start capturing audio.
- Capture will be activated until the maximum layer duration has been met. If the **Capture Button** is pressed while capture is activated, or if the gate signal present at the **Capture Gate Input** is low, recording will be stopped.
- Set the **Length** knob fully anticlockwise to enable **Wavetable Mode**. This is indicated by two amber illuminated **Grain Direction Indicators**.
- With the **Intensity** knob in its centre position, use the **Scan** knob to set the desired wavetable.
- Once the wavetable has been chosen, set the **Intensity** knob either fully clockwise or fully anticlockwise to disable the **Continuous Granular Engine.**
- Set the **Grain Window** knob to a desired position. This will determine the amplitude envelope.
- Set the **Pitch** knob to a desired position.
- Set the **Pitch Deviation** knob to its centre position. This ensures that no pitch deviation is applied to the **Pitch** parameter.
- Set the **Spray** knob fully anticlockwise. This ensures that the chosen wavetable is unaltered.

Control Path:

- Connect the 1V/Oct output of a sequencer or keyboard to the **1V/Octave Input**.
- Connect the gate output of the sequencer or keyboard to the **Strike Input** to activate the **Strike Granular Engine**.

## Onset Triggered Modulation:

**Summary: Onset Control Mode** is set to delta so that a gate signal will generate from the **Gate Output** upon each onset detection. The **Gate Output** triggers an envelope which is used to modulate the **Length** parameter of **arbhar.**




## Audio Path:

- Connect any audio signal to the **Onset Input**.
- Set the **Input Level** to a desired position and set the **Output Level** fully clockwise.
- Set the **Dry/Wet Mix** knob to a desired position. If the **Dry/Wet Mix** knob is fully clockwise (fully wet), then audio will not be heard until audio has been captured.
- Monitor **Output 1** for mono playback.
- Set the **Sensitivity** parameter to its centre position.
- Set the **Hold** parameters to its 10:00 position.

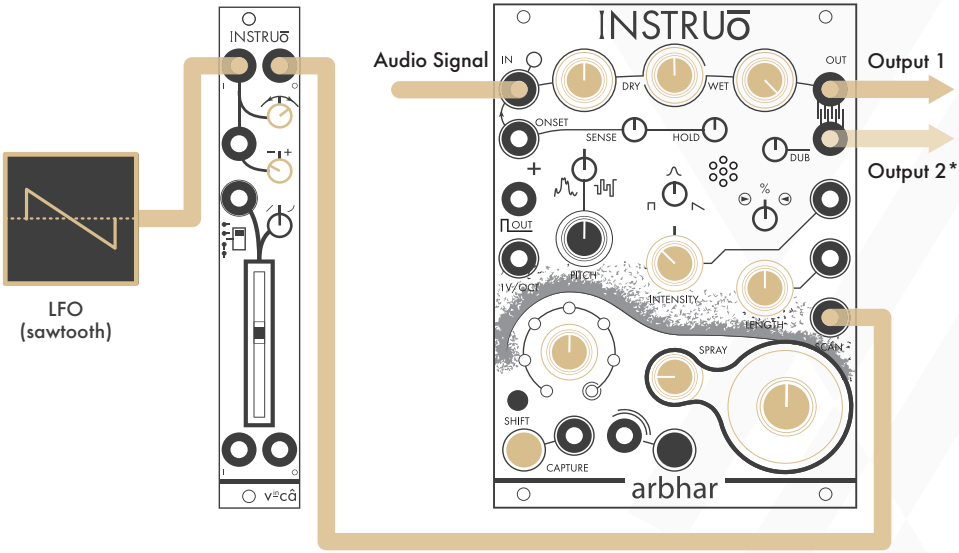
- Set the **Intensity** parameter to its 10:00 position.
- Set **Length** parameter to its 9:00 position.
- Set the **Spray** parameter to its 9:00 position.
- The **Onset Detection** will trigger capture.

Control Path:

- Connect the **Gate Output** to the gate/trig input of an envelope generator.
- Connect the CV output of the envelope generator to the **Length CV Input**.
- Set the envelope settings to a desired positions. For more obvious effects use longer attack and release stages.

## Looping Granular:

**Summary:** A scaled and offset sawtooth waveform is used to modulate the **Scan** position of **arbhar** for looping granular playback. Scaling sets the length, inversion sets the direction and the LFO frequency sets playback speed.




## Audio Path:

- Connect any audio signal to the **Input**.
- Set the **Input Level** to a desired position and set the **Output Level** fully clockwise.
- Set the **Dry/Wet Mix** knob to a desired position. If the **Dry/Wet Mix** knob is fully clockwise (fully wet), then audio will not be heard until audio has been captured.
- Monitor **Output 1** for mono playback. Monitor **Output 1** and **Output 2** panned hard left and hard right for stereo playback.
- Set the **Layer** knob to the desired target layer.
- Press the **Capture Button** or connect a gate signal to the **Capture Gate Input** to start capturing audio.

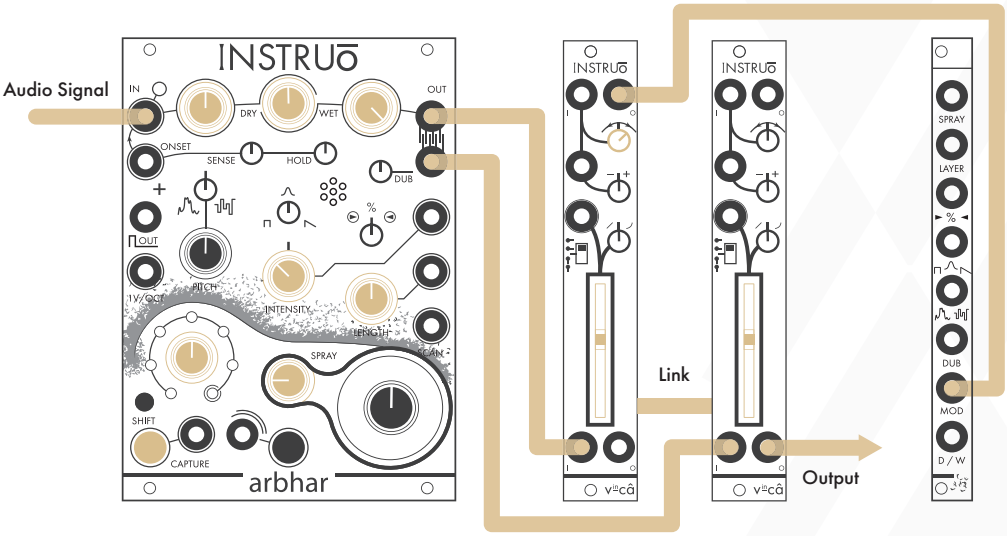
- Capture will be activated until the maximum layer duration has been met. If the **Capture Button** is pressed while capture is activated, or if the gate signal present at the **Capture Gate Input** is low, recording will be stopped.
- Once capture has deactivated, turn the **Input Level** full anticlockwise.
- Experiment with all granular and pitch knobs to find desired effects and sweet spots.

Control Path:

- Patch a sawtooth waveform LFO into a scale and offset module. Set scale and offset parameters to desired positions.
- Set LFO rate to a desired frequency.
- Patch the scaled and offset sawtooth waveform LFO into the **Scan CV Input**.

## Delay Mode Dry/Wet Mix:

**Summary: arbhar** is set to it's **Feedback/Delay Hardware Configuration** (See the **Hardware Configurations** section for more information). When both **Output 1** and **Output 2** are connected, **Output 1** generates the dry signal only and **Output 2** generates the wet signal only. Patching the outputs to two attenuators allows for level control over the dry/wet mix separately. The dry and wet outputs are summed together and monitored. Sending CV to the **MOD CV Input** controls **arbhar**'s curated **Feedback/Delay** parameter.




## Audio Path:

- Connect any audio signal to the **Input**.
- Set the **Input Level** to a desired position and set the **Output Level** fully clockwise.
- Set the **Dry/Wet Mix** knob to a desired position. If the **Dry/Wet Mix** knob is fully clockwise (fully wet), then audio will not be heard until audio has been captured.
- Connect **Output 1** to the input of a VCA for attenuated level control of the dry signal. Set to a desired amount.

- Connect **Output 2** to the input of a VCA for attenuated level control of the wet signal. Set to a desired amount.
- Set the **Layer** knob to the desired target layer.
- Press the **Capture Button** or connect a gate signal to the **Capture Gate Input** to start capturing audio.
- Capture will be activated until the maximum layer duration has been met. If the **Capture Button** is pressed while capture is activated, or if the gate signal present at the **Capture Gate Input** is low, recording will be stopped.
- Once capture has deactivated, turn the **Input Level** fully anticlockwise.
- Monitor the summed output (In the graphic above the summing is achieved by linking two v[in]câ's via their back jacks).

Control Path:

- Ensure the **CV Expansion Module** is connected to **arbhar** via the 12 pin IDC ribbon cable.
- Apply control voltage to the **MOD CV Input** to control **arbhar**'s curated **Feedback/Delay** parameter

## History of The Lexer Method

Granulation is a central part of the **piano+** performance system, originally developed in Max/MSP between 2000 – 2012 to augment an acoustic grand piano with electroacoustic processes[1] and extensively used in my musical work over the past 20 years. Granular processes enable working within the ambiguities of acoustic and electronically modified sound. I always found it fascinating for electronically sustained drones to emerge from a sound produced on an acoustic instrument. I wanted a system that allowed me to play with aspects of the processing taking control data from the acoustic playing, rather than playing along with the electronics. It all seemed possible when first encountering Nobuyasu Sakonda's Granular 2.5 Max patch[2] – the first time I experienced independent playback speed and pitch controls – and Miller Puckette's FFT based audio analysis tools[3].

So rather than following the approach thought of and pioneered by Xenakis[4] and Curtis Roads[5], to see granulation as a synthesis tool to create new sonic textures from the tiny fragments of recorded sound, I was inspired to extend the sonic parameters of acoustic instruments as a starting point for my artistic practice.

The fundamental approach for **arbhar** utilises granulation techniques on audio captured in real-time in response to the sounds produced by the acoustic instrument or sound source. Playing back multiple instances of grains which are out of phase with one another to create the illusion that the sound is continuous. As few as eight grains of approximately 80ms length are sufficient to create convincing results retaining an acoustic resemblance to the original. As the sample position and pitch of the playback can be independently controlled, the user has the possibility of 'tuning' into selected fragments using any controller, random or sequenced source, considered appropriate. Aspects of random deviation of parameters – a feature that has proven far more important than grain count to achieve convincing organic sounding granular textures – allow further adaptation to create organic sounding drones and textures, but

most interestingly of all, it can be the basis to zoom in and out of the recognised source and its endless sonic modulations.

For example, setting the playback position of a captured piano note shortly after the attack phase, with a grain length of approximately 300ms with a gaussian shaped texture and a slight spray will produce a very convincing piano drone, especially when using a more modest grain count, as the spray will ensure that not one grain is exactly like another. In contrast, reducing density to a single grain, changing the texture to sawtooth or pulse and reducing the spray will be like a stutter or beat repeat effect where the length will decide on the speed.

After years of excitement and frustrations working with the software based **piano+** system, I am now delighted to see these processes available in a Eurorack module. With Jason Lim's technical expertise and interface design, informed by his musicality and instrumental talent, **arbhar** became so much more than I had initially imagined.

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[1] http://research.gold.ac.uk/8005/
[2] http://formantbros.jp/sako/download.html
[3] http://msp.ucsd.edu/Publications/icmc98.ps
[4] Xenakis, Iannis, Formalized Music, 1992.
[5] Roads, Curtis, Microsound, 2001

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CE This device meets the requirements of the following standards: EN55032, EN55103-2, EN61000-3-2, EN61000-3-3, EN62311.