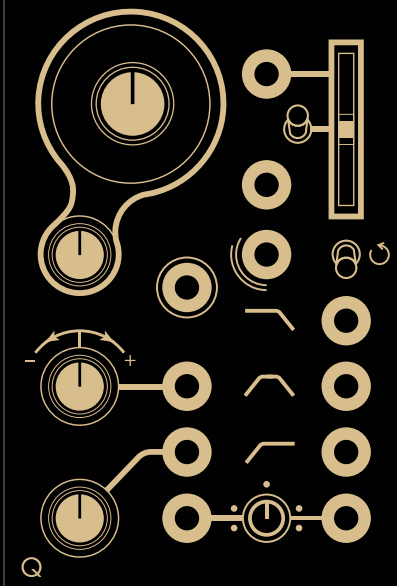
INSTRUŌ | SPECIALIST SYNTHESIZERS



I-ō47

Multimode Resonator / Filter

User Manual

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Description

I-ō47 Multimode Resonator/Filter is a modern take on a vintage circuit design inspired by the classic synthesisers from the early 1970s. Unlike many multimode filters, **I-ō47** has a steep -18dB/oct slope with interpolating inputs and tameable resonance.

Although inspired by the past, this module was designed with new ideas, new features, and most importantly - new quirks. A hybrid design of matched transistor pairs and precision op-amps was used to create the circuit's semi-discrete VCAs, making the **I-ō47** a beast of its own variety.

With on-board limiter/waveshaper, exponential frequency modulation, pingable resonance, inverted input, and crossfading and mixing capabilities, **I-ō47** fits in every patch.

Features

- Simultaneous low pass, high pass, band pass, and notch filter types
- Self-oscillating resonance with feedback toggle
- 1V/Oct tracking
- Strike input for pingable resonance
- Notch offset with CV control
- Limiter/waveshaper
- Inverting input

Installation

1. Confirm that the Eurorack synthesizer system is powered off.
2. Locate 4 HP of space in your Eurorack synthesizer case.
3. 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 power cable is connected to -12V.
4. 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.
5. Mount the Instruō **I-ō47** in your Eurorack synthesizer case.
6. 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: 14 HP
- Depth: 27mm
- +12V: 50mA
- -12V: 50mA

I-ō47 | ʌɪ-əʊ-ˈfɔːti-ˈsɛv(ə)n | **noun** (signal processing) the in's and out's of a classic multimode filter/resonator



Key

1. Input
2. Limiter Toggle
3. Gain
4. Inverting Input
5. Low Pass Output
6. Band Pass Output
7. High Pass Output
8. Notch Output
9. Course
10. Fine
11. FM Input
12. FM Attenuverter
13. 1V/Oct Input
14. Notch
15. Notch CV Input
16. Q
17. Q CV Input
18. Feedback Toggle
19. Strike Input

Input & Output

Input: Audio input of the filter.

- The signal present at the **Input** will output from all filter types simultaneously.

Limiter Toggle: The **Limiter Toggle** sets a fixed level tanh[3] circuit. Limiting is only applied to the signal present at the **Input**.

- When the toggle is in the up position, limiting/waveshaping is bypassed.
- When the toggle is in the down position, limiting/waveshaping is enabled.

Gain: The **Gain** fader affects the signal present at the **Input**.

- If the fader is in the up position, the signal present at the **Input** will be at its full scale amplitude.
- If the fader is in the down position, the signal present at the **Input** will be fully attenuated.
- If limiting is enabled, the centre position of the **Gain** fader is optimised as a "sweet spot" for versatile general purpose use.

Inverting Input: Inverting audio input of the filter.

- The signal present at the **Inverting Input** is inverted and will output from all filter types simultaneously.
- The level of the signal present at the **Inverting Input** is inversely proportional to the level of the **Q** parameter. As resonance increases, the signal present at the **Inverting Input** decreases.
- This functionality can be used for dynamic signal blending.

Low Pass Output: Low pass filter output.

- Any harmonics above the cutoff frequency are attenuated.

Band Pass Output: Band pass filter output.

- Any harmonics above or below the centre frequency are attenuated.

High Pass Output: High pass filter output.

- Any harmonics below the cutoff frequency are attenuated.

Notch Output: Notch filter output.

- This is also known as a **Band Stop Filter** or a **Band Rejection Filter**.
- Any harmonics within the stop band are attenuated.

Frequency Modulation

Coarse: The **Coarse** knob controls the cutoff frequency of the low pass and high pass filters and the centre frequency of the band pass and notch filters.

- The cutoff frequency is the point at which the filtered signal is reduced by 3dB in amplitude.
- The centre frequency is the midpoint between the cutoff frequencies set by the low pass and high pass filters.
- Turning the knob clockwise will increase the cutoff/ centre frequency.
- Turning the knob anticlockwise will decrease the cutoff/ centre frequency.
- If **I-ō47** is used as an oscillator, the knob controls the fundamental frequency of the oscillator.
- Range: ~16Hz - 16KHz.

Fine: The **Fine** knob is used for minute control of the cutoff frequency of the low pass and high pass filters and the centre frequency of the band pass and notch filters. Fine tuning is relative to the value set by the **Coarse** knob.

- Turning the knob clockwise will increase the cutoff frequency.
- Turning the knob anticlockwise will decrease the cutoff frequency.
- If **I-ō47** is used as an oscillator, the knob controls the fundamental frequency of the oscillator.

FM Input: The **FM Input** is a bipolar control voltage input for the cutoff/ centre frequency and applies exponential frequency modulation.

- Control voltage is scaled by the **FM Attenuverter** and sums with the level set by the **Coarse** and **Fine** knobs.
- If **I-ō47** is self-oscillating, the **FM Input** can be used for exponential frequency modulation of the generated sine waveform.

FM Attenuverter: The **FM Attenuverter** determines the depth of frequency modulation applied to the cutoff/centre frequency.

- Turning the knob clockwise will increase the depth of exponential frequency modulation.
- Turning the knob anticlockwise will increase the depth of exponential frequency modulation with inverted polarity.
- Centring the knob will attenuate the control voltage signal.

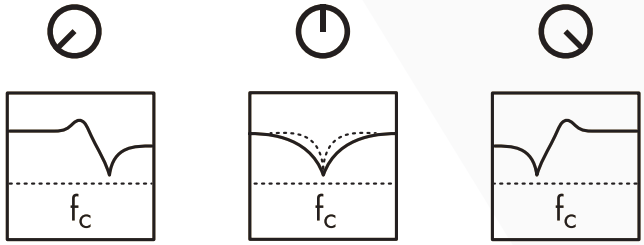
1V/Oct Input: The **1V/Oct Input** is a bipolar control voltage input for the cutoff/centre frequency.

- This is a dedicated exponential frequency control input which can be used for precise frequency modulation such as 'keyboard tracking'.
- If **I-ō47** is self-oscillating, the **1V/Oct Input** can be used for consistent pitch tracking of the sine waveform, effectively making **I-ō47** a quadrature sine waveform oscillator.
- Control voltage is summed with the level set by the **Coarse** and **Fine** knobs.

Notch: The **Notch** knob controls the centre frequency offset of the notch response output. This parameter affects the **Notch Output** only.
The numbers surrounding the **Notch** knob depict a multiplier indicating an approximate octave offset from the centre frequency.

- ¼ = 0.25 x centre frequency (-2 octave offset). [towards high pass response]
- ½ = 0.5 x centre frequency (-1 octave offset). [towards high pass response]
- 1 = centre frequency (0 octave offset). When the knob is set to 1, the **Notch Output** is a traditional symmetrical notch filter.
- 2 = 2 x centre frequency (+1 octaves offset). [towards low pass response]
- 4 = 4 x centre frequency (+2 octave offset). [towards low pass response]

- At the outer extremities of the **Notch** knob the **Notch Output** will duplicate the **Low Pass Output** (anti-clockwise) or the **High Pass Output** (clockwise).



Notch CV Input: The **Notch CV Input** is a bipolar control voltage input for the **Notch** parameter. Signal present at the **Notch CV Input** will affect the **Notch Output** only.

- Control voltage is summed with the knob position.
- Input range: 0V - 5V

Resonance

Q: The **Q** knob determines the level of feedback from the filter's output to its input.

- This is also known as the **Resonance**, **Emphasis**, or **Feedback**.
- With resonance introduced, the cutoff frequency of the low pass and high pass filters accentuate while the centre frequency of the band pass and notch filters inversely scales in amplitude.
- Turning the knob clockwise will increase resonance.
- Turning the knob anticlockwise will decrease resonance.

Q CV Input: The **Q CV Input** is a bipolar control voltage input for **Q**.

- Control voltage is summed with the knob position.
- Input range: -/+ 8V.

Feedback Toggle: The **Feedback Toggle** enables and disables internal routing of the **Band Pass Output** to **I-ō47** input. When enabled, increasing **Q** can result in self-oscillation.

- If the toggle is in the up position, feedback is enabled.
- If the toggle is in the down position, feedback is disabled.
- If the **Q** knob is at its maximum value and there is no input signal, **I-ō47** will self-oscillate as a stable sine waveform.

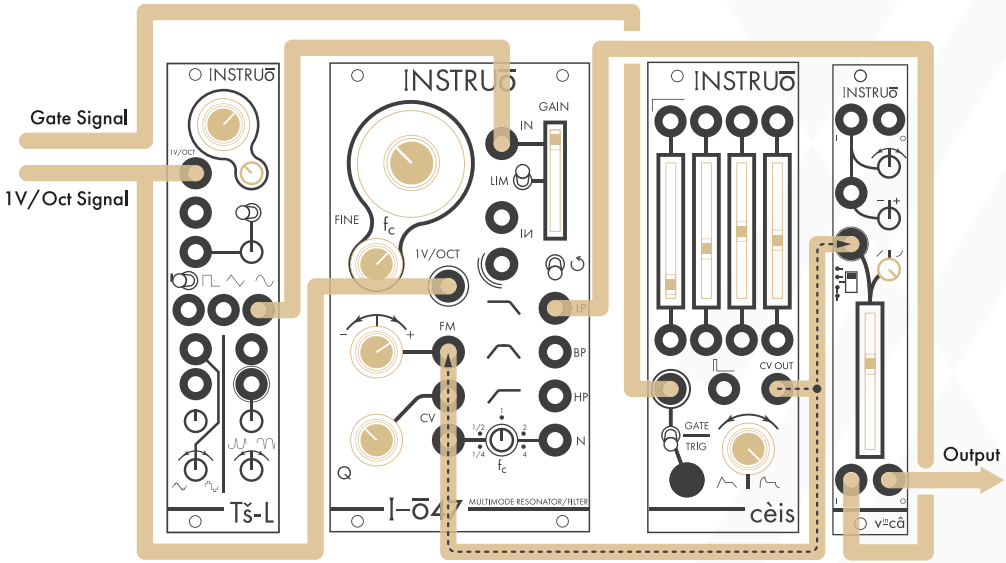
Strike Input: Rising edge signals present at the **Strike Input** excite the resonance of **I-ō47**.

- Gate and trigger signals present at the **Strike Input** will ping the resonance.
- Audio rate waveforms present at the **Strike Input** result effects similar to hard synchronisation.
- It's important to note that the **Strike Input** is not a low pass gate input and will not affect the cutoff frequency. Only the resonance is affected.

Patch Examples

East Coast Synth Voice:

Summary: The sequencer or keyboard sends voltages to the oscillator while simultaneously triggering the envelope generator. The CV output of the envelope generator opens **I-ō47** and the VCA, allowing the oscillator signal to pass through. More traditional East Coast patches would incorporate separate envelope generators for **I-ō47** and the VCA.



Audio Path:

- Connect the desired waveform of an oscillator to the **Input** of **I-ō47**.
- Connect the **Low Pass Output** of **I-ō47** to the audio input of a VCA.
- Monitor the audio output of the VCA.
- Set the fundamental frequency of the oscillator to a desired position.
- Set the **Gain** fader to its maximum setting.
- Set the **Coarse** and **Fine** knobs to desired positions.

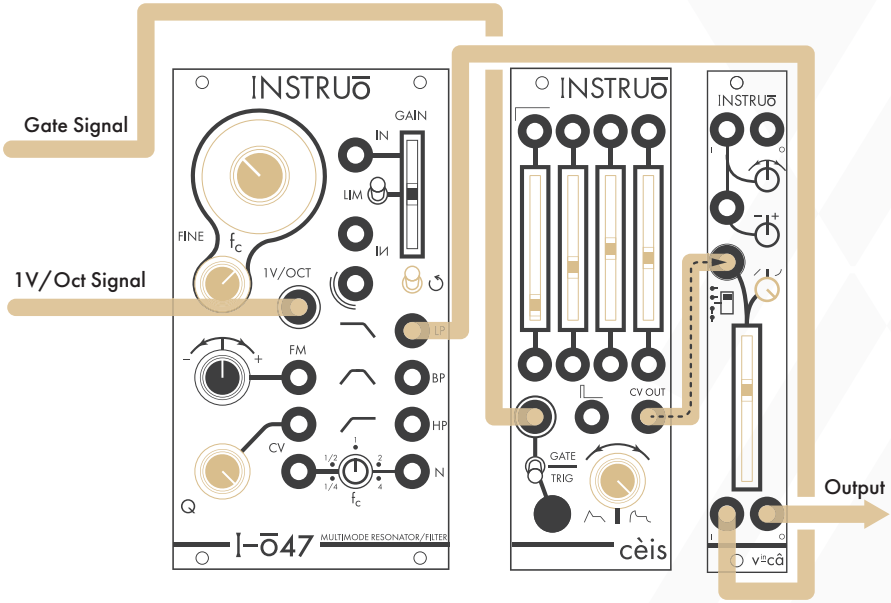
- Set the **Q** knob to a desired position.
- Set the level of the VCA to a desired position.

Control Path:

- Connect the 1V/Oct output of a sequencer or keyboard to a buffered multiple.
- A buffered multiple will keep the signal from dropping voltage when split.
- Connect two copies of the 1V/Oct CV signal to the 1V/Oct input of the oscillator and the **1V/Oct Input** of **I-ō47**. This is known as **Keyboard Tracking** and allows **I-ō47** to track the sequencer or keyboard voltage. As higher voltages are generated, the cutoff frequency increases.
- Connect the gate output of the sequencer or keyboard to the trigger input of an envelope generator.
- Connect the CV output of the envelope generator to a multiple.
- Connect one copy of the envelope generator CV signal to the **FM Input** of **I-ō47** and set the **FM Attenuverter** to a desired positive position.
- Connect a second copy of the envelope generator CV signal to the CV input of the VCA and set the corresponding CV attenuator to a desired position.
- Set the envelope stages to desired positions.

Sine Wave Generator:

Summary: With feedback enabled, peaking the resonance of **I-ō47** forces it to self-oscillate as a pure sine waveform. Once the waveform is generated, it can then be patched through a VCA as a simple synth voice patch. This was often the technique to create sine waveforms in the early days of electronic synthesiser music. In the simplest of contexts, a second filter in the audio path is not needed, because a sine waveform only loses amplitude when patched through a filter. This is because there are no other harmonics to attenuate, only the fundamental.



Audio Path:

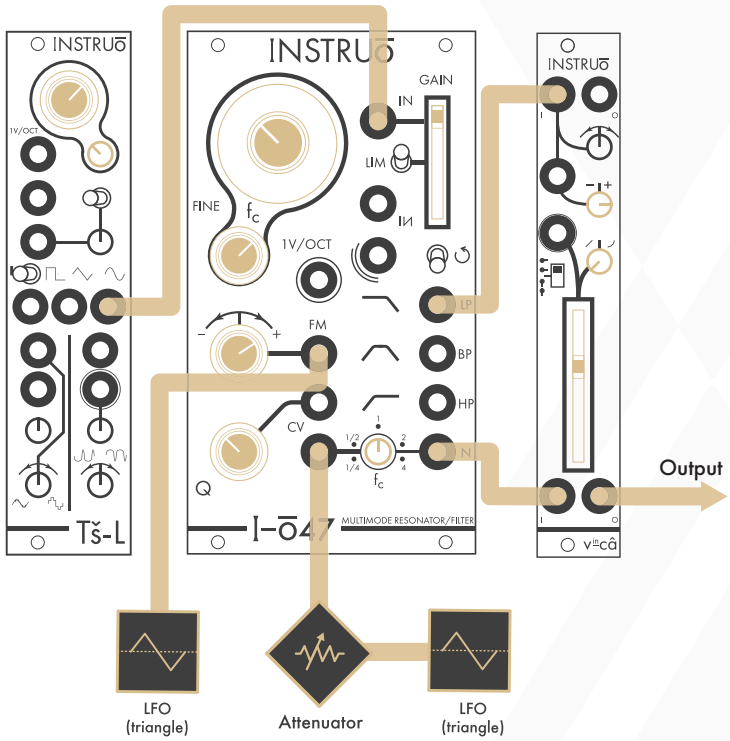
- Connect the **Low Pass Output** of **I-ō47** to the audio input of a VCA.
- Enable feedback by setting the **Feedback Toggle** to its up position.
- Set the **Q** knob fully clockwise. Without an input signal, **I-ō47** resonantes as a pure sine waveform.
- Set the **Coarse** and **Fine** knobs to desired positions. In this patch, the **Coarse** and **Fine** knobs are frequency (pitch) controls.
- Set the level of the VCA to a desired position.

Control Path:

- Connect the 1V/Oct output of a sequencer or keyboard to the **1V/Oct Input** of **I-ō47**.
- Connect the gate output of the sequencer or keyboard to the trigger input of an envelope generator.
- Connect the envelope generator CV output to the CV input of the VCA and set the corresponding CV attenuator to a desired position.
- Set the envelope stages to desired positions.

Set Phaser To Stun:

Summary: One bipolar LFO modulates the cutoff frequency of the low pass filter while a second bipolar LFO modulates the centre frequency of the notch filter. A gate or trigger signal can be used to reset the cycle of the LFOs. LFOs can be free running, or in synchronized patterns, such as fixed quadrature, phase shifted, or multiplied/divided.



Audio Path:

- Connect the desired waveform of an oscillator to the **Input** of **I-ō47**.
- Connect the **Low Pass Output** of **I-ō47** to an audio input of a mixer.
- Connect the **Notch Output** of **I-ō47** to a second audio input of a mixer.
- Monitor the audio output of the mixer.

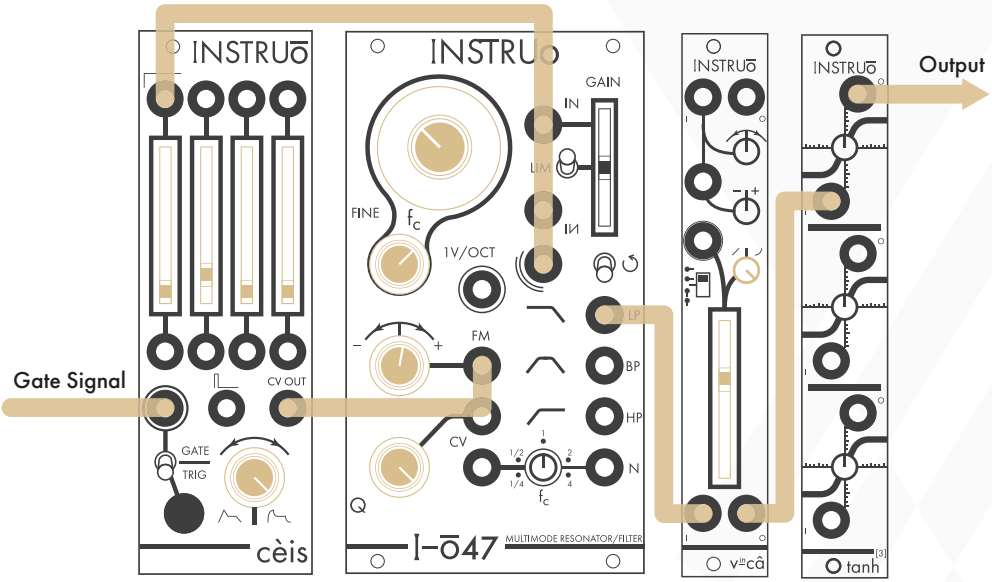
- Set the fundamental frequency of the oscillator to a desired position.
- Set the **Gain** fader to its maximum setting.
- Set the **Coarse** and **Fine** knobs to desired positions.
- Set the **Q** knob to a desired position.
- Set the **Notch** knob to 1, its centre position.
- Set the level of both channels of the mixer to be equal.

Control Path:

- Connect a bipolar LFO to the **FM Input** and set the **FM Attenuverter** to a desired position.
- Connect a second attenuated bipolar LFO to the **Notch CV Input**.

Kick Drum:

Summary: A gate or trigger signal triggers cèis.The attack gate output of cèis pings the resonance of **I-ō47** via the **Strike Input.** The CV output of cèis modulates the cutoff frequency of **I-ō47**.



Audio Path:

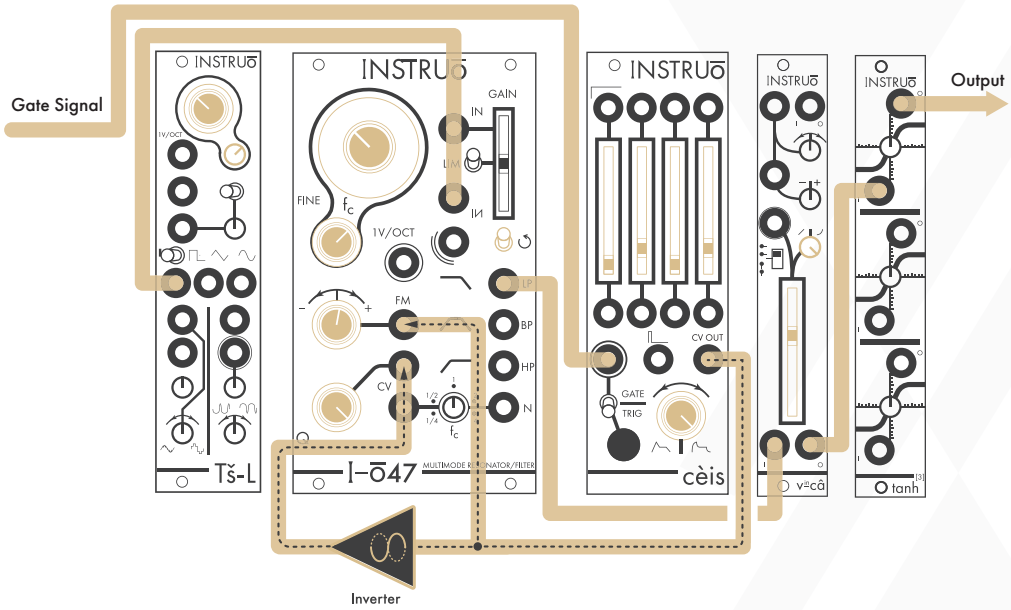
- Monitor the **Low Pass Output** or **Band Pass Output**.
- Set the fundamental frequency of the kick drum sound using the **Coarse** and **Fine** knobs.
- Disable feedback by setting the **Feedback Toggle** to its down position.
- Set the **Q** knob to a desired position. This sets the decay time of the amplitude for the kick drum sound.
- For a more aggressive kick drum sound, connect the **Low Pass Output** or the **Band Pass Output** of **I-ō47** to the input of **tanh[3]**. Monitor the output of **tanh[3]**.

Control Path:

- Connect a gate or trigger signal source to the gate/trig input of cèis.
- Connect the attack gate output of cèis to the **Strike Input**.
- Connect the CV output of cèis to the **FM Input** and set the **FM Attenuverter** just to the right of its centre position. This sets the amount of pitch modulation for the kick drum sound.
- Set the shape knob of cèis to a logarithmic/exponential response curve.
- Set the attack, sustain, and release faders of cèis to their minimum positions.
- Set the decay fader of cèis to a short decay. This sets the decay time of the pitch modulation for the kick drum sound.

Kick Drum 2:

Summary: A gate or trigger signal source triggers cèis.The attack gate output of cèis pings the resonance of **I-ō47** via the **Strike Input**. The CV output of cèis modulates the cutoff frequency of **I-ō47**. An inverted copy of the CV output of ceis decreases the amount of resonance of **I-ō47**, crossfading between the oscillator and silence.



Audio Path:

- Connect a square waveform of an oscillator to the **Inverting Input** of **I-ō47**.
- Monitor the **Low Pass Output**.
- Set the fundamental frequency of the oscillator to a desired position.
- Set the fundamental frequency of **I-ō47** to match the fundamental frequency of the oscillator using the **Coarse** and **Fine** knobs (some detuning is encouraged and will result in different tonal resonances).
- Disable feedback by setting the **Feedback Toggle** to its down position.

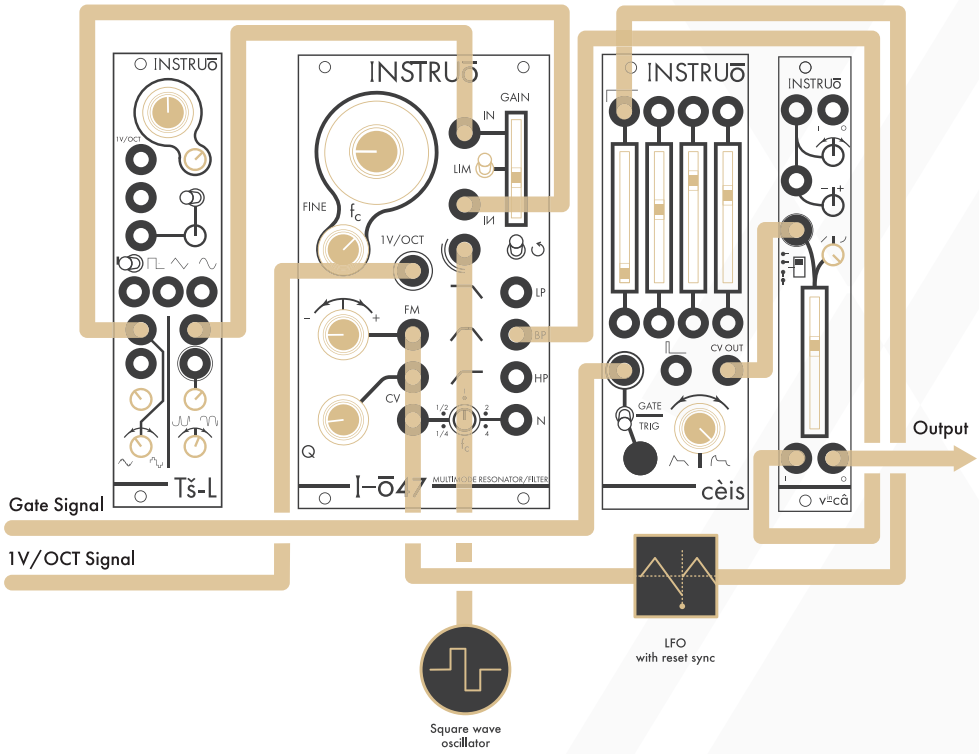
- Set the **Q** knob to its maximum position. This allows for the monitoring of the **Inverting Input**.
- For a more aggressive kick drum sound, enable feedback by setting the **Feedback Toggle** to its up position and connect the **Low Pass Output** of **I-ō47** to the input of **tanh[3]**. Monitor the output of **tanh[3]**.

Control Path:

- Connect a gate or trigger signal source to the gate/trig input of cèis.
- Connect the attack gate output of cèis to the **Strike Input**.
- Connect the CV output of cèis to a multiple.
- Connect one copy of the cèis CV signal to the **FM Input** and set the **FM Attenuverter** just to the right of its centre position. This sets the amount of pitch modulation for the kick drum sound.
- Connect a second copy of the envelope generator CV signal to an full scale inverter.
- Connect the output of the inverter to the **Q CV Input**.
- Set the shape knob of cèis to a logarithmic/exponential response curve.
- Set the attack and sustain faders of cèis to their minimum positions.
- Set the decay and release faders of cèis to a short decay and short release.

Filter Morph Voice:

Summary: The fold and PWM outputs of Tš-L are mixed/interpolated via the **Input** and **Inverted Input** of **I-ō47** and then sent to vincâ via the **Band Pass Output**. A sawtooth waveform LFO modulates **I-ō47** while a sub square waveform from Cš-L pings the resonance of **I-ō47**. The sequencer sends voltages to the 1V/OCT of the **I-ō47** while simultaneously triggering cèis. The CV output of cèis opens **vincâ**, allowing the final signal to pass through.



Audio Path:

- Connect the fold output of Tš-L to the **Input** of **I-ō47**.
- Connect the PWM output of Tš-L to the **Inverted Input** of **I-ō47**.

- Connect the **Band Pass Output** to the input 2 of vincâ and set the amplitude/CV attenuator of vincâ to a desired position.
- Monitor the output of **vincâ**.
- Set the fundamental frequency of Tš-L to a desired position.
- Set the **Coarse** knob of **I-ō47** to around 9:00
- Fine tune **I-ō47** with the **Fine** knob.
- Use the **Gain** fader and the **Q** knob of **I-ō47** to interpolate between the fold and PWM waveforms of Tš-L.
- Set **Q** to desired position

Control Path:

- Connect the 1V/Oct output of a sequencer to the **1V/Oct** input of **I-ō47**.
- Connect the gate output of the sequencer to the gate/trig input of cèis.
- Connect the CV output of cèis to the CV input of **vincâ** and set the corresponding CV attenuator to a desired position.
- Connect a sawtooth waveform LFO to the **FM Input** of **I-ō47** and set the **FM Attenuator** to around 9:00.
- Connect the attack gate output of cèis to the reset input of the LFO.
- Tune the second VCO of Cš-L to unison or a intervallic 3rd or 5th above the fundamental frequency of Tš-L.
- Set the square waveform of the second VCO of Cš-L to sub mode (sub button lit amber) and connect the square output to the **Strike Input** of **I-ō47**.
- Use **FM Attenuverter,** LFO parameters, **Gain** fader and **Q** knob to morph and change the voice to desired effect.

Manual Author: Collin Russell
Manual Design: Dominic D'Sylva

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