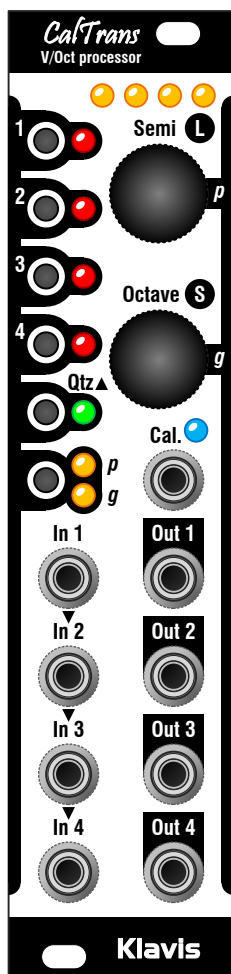


CalTrans V/Oct processor

Quad programmable Volt/Octave CV calibrator and transposer

Introduction

The CalTrans solves issues encountered when playing tonal music with a modular system: tracking problems, curves unrelated to Volt per octave ratio, limited octave range, cumbersome transpose, ... The Caltrans corrects and expands the range of troublesome VCOs and brings V/Oct tracking to anything that oscillates. Besides calibration, the CalTrans offers live play features. Each channel can be quantized and any combination of them transposed jointly. VCOs whose tracking doesn't go high enough to follow the leader will see their pitch repositioned in their highest possible octave so that the global harmony is unaffected. You can add a pinch of portamento and glissando to each channel and save the whole in user presets.



Features at a glance

- Four V/Oct processing channels, each with individual :
 - Curve correction and range expansion for any VCO, VCF or other oscillating circuit with a CV acting on pitch
 - 1-for-1 V/Oct mode for use without target calibration
 - Switchable semitone quantizer
 - Adjustable portamento time
 - Adjustable glissando time
- Dedicated semitone and octave transpose encoders
- Inputs cascading with zero added load for stable pitch control
- Four user presets storing transpose, portamento and glissando
- Storage of the calibration profile for each channel
- Maximum voltage range covering 10 octaves
- Presets, calibration and current state retained over power cycle
- Volt/Oct inputs factory-calibrated in flash memory
- User adjustable input scaling to correct voltage inaccuracies in your sources
- Easy firmware update via a simple audio file
- High-quality push-encoders with metal shaft
- Skiff-friendly & compact module

New features described in this manual require firmware update 1.17

Installation and security

Purpose

This module is meant for installation in a Eurorack-compliant chassis. It adheres to Eurorack Doepfer mechanical and electrical specifications.

Do not attempt using this module in other mechanical or electrical contexts.

Installation

Before the installation, disconnect the mains power supply from your modular system. Some power supplies are not safely isolated; there is a risk of injury!

See in the specifications if this module requires 5V from the supply rails. If 5V is needed and your rack is not providing 5V, do not attempt connection!

Check that the current consumption requirements of this module, when added to your installed set of modules do not exceed the available current from your supply. This is done by adding up the current draw of all modules (mA) separately for each of 5V, 12V and -12V rails. If any of these 3 sums exceeds the available current of your supply for that voltage, do not connect the module to your system; you need a stronger power supply.

The provided supply flat cable can only be inserted in the appropriate orientation at the back of the module, so there is no risk of error on that end. However, you should pay attention to the orientation of the cable in the socket of the supply PCB inside your chassis. Cheap sockets without shrouding may allow you to plug in the connector the wrong way!

The red stripe on the cable should match a stripe printed on the supply board. The stripe also indicates the -12V side. In case there is no stripe, a -12V marking is a safe indication of the orientation.

Double check that the connectors are fully inserted and correctly oriented before switching on the power supply. In case of an anomaly, switch off the power supply immediately and check everything again.

Firmware update

Once acquiring your CalTrans, go the Klavis web site, download and install the latest firmware.

The product can be updated by playing an audio file such as “CalTrans_1.xx.wav”.

Procedure

- Connect a mono cable between your audio playing device headphone output and the CalTrans calibration input.
- Prepare to play the audio file
- Set the play level at two thirds
- While pressing the channel 1 and Qtz buttons, switch on your modular case supply
- The six yellow LEDs will flash
- Start playing the audio file

If everything goes fine

- After a while, the first yellow LED will go on
- As the update is progressing, the following yellow LEDs will also go on
- When the green LED is flashing, the firmware is updated successfully
- Press the top encoder to restart the module

If the sound level is too low

- Two red LEDs will blink alternately
- Stop audio playback
- Slightly increase the audio playback level
- Press the bottom encoder button
- Start audio playback from the beginning

If there is an error during the playback

This is indicated by the 4 red LEDs

It is possible that the sound setting was too loud to begin with.

Diminish the sound level drastically and restart the procedure.

Playback error can also be due to various parasitic sound causes:

- Touching the cable
- Using sound-generating features of your phone or computer
- Some power saving feature affecting the audio playback
- Surrounding noisy modules, bad electrical grounding or modular supply noise
- Having some sound enhancing processing (3D, compression, etc) being active

Overview

What is the CalTrans?

Each of the following functions can be used independently or jointly

V/Oct curve corrector and expander

Sending proper 1 V per octave signal to the CalTrans handling a corrected VCO will play proper octaves (and semitones in between).

In other words, the CalTrans is a relative tuner: the pitch difference between semitones (and thus octaves) will be equal.

Transposer

With or without incoming V/Oct signal, the connected VCOs can be transposed up and down by semitones and octaves.

Portamento processor

The signal can be slewed, slowly moving from the current voltage (note) to the next one in an adjustable time. This is done by emulating the typical exponential decay curve of analog circuitry

Glissando processor

The signal can be stepped, progressively moving from the current voltage (note) the new one by going through all semitones in between.

Quantizer

Sticking the incoming voltage to the closest semitone voltage step (note)

Input voltage corrector

Storable corrections to inaccurate input voltages drastically increase the accuracy and usability of MIDI/CV controllers and other voltage sources

What the CalTrans is not

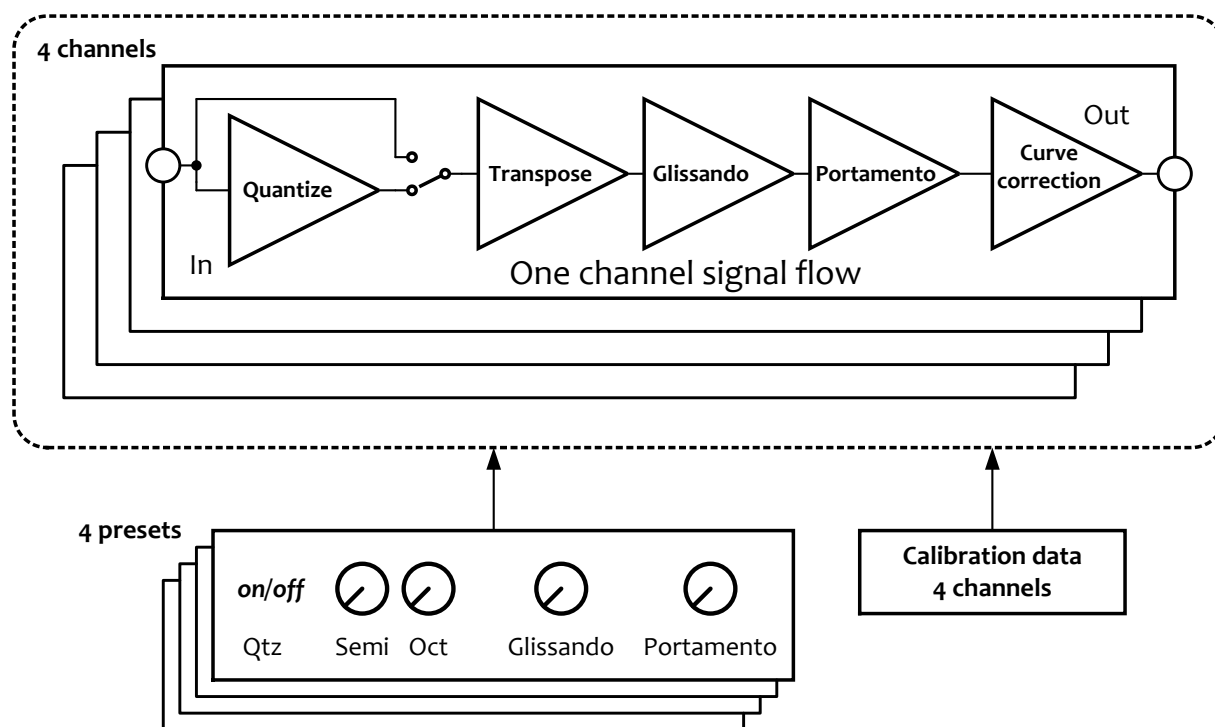
Absolute tuner

The CalTrans is not an absolute tuner; it is a relative tuner. The CalTrans is not about adjusting your VCOs to a specific pitch-related note all by itself.

Once curve-corrected, a VCO must be brought to the desired note, using the transposing encoders and then fine-tuned in relation to some reference (e.g. A = 440Hz) using the fine tuning knob on the VCO. This also implies that correcting multiple VCOs each on their channel may end up in different notes that each need be transposed and fine adjusted individually.

The reason for the manual transpose and fine tuning is because there is no standard in the world of modular synths about which voltage should give which note (or pitch or frequency). Every manufacturer does it its own way.

Signal and data flow



The CalTrans fulfills two independent roles:

1. It corrects and usually expands the usable Volt/Octave range for up to four VCOs at once
2. It applies various musically-related voltage treatments independently for each of the four channels:
 - Switchable semitone quantization
 - Transposition per semitone and octave
 - Portamento with adjustable duration
 - Glissando with adjustable duration

Note:

The terms VCO and oscillator apply to any module capable of oscillation with pitch CV input.

Calibration

There are two calibration modes:

1. V/Oct calibration for correcting VCOs whose tracking is not optimal.
2. Neutral calibration for VCOs that follow V/Oct nicely and need no curve correction. Neutral calibration is for benefitting of the transpose, quantize, portamento and glissando

Volt/Octave correction is done through a calibration procedure for each oscillator in turn. The calibration is per channel (and related VCO/oscillating gizmo), and done only once.

If you're not interested in the V/Oct calibration aspect and only want to use the other features, you can set one or more channels to Neutral calibration.

Note that for each channel, only one V/Oct calibration data set is stored.

- Once calibrated in V/Oct, the oscillators should not be swapped between channels.
- Channels set to Neutral calibration are interchangeable; their curve is neutral 1:1 between in and out. (except if you deliberately change the scaling of the different inputs)

Presets

There are four preset locations.

- Each preset stores the quantizer, transposition, portamento and glissando for all four channels.
- **Storage of presets is independent from calibration data.**
- Loading and storing presets does not affect the input and output calibration.

Input & outputs

In 1, 2, 3, 4

These inputs are meant for V/Oct control voltages. They accept voltages between zero and seven volts. By default they expect V/Oct signal.

The V/Oct input scaling can be adjusted; see [Calibrating the inputs scaling] on page 16.

Normalization

When an input (from 2 to 4) is left unconnected, it receives its signal from the previous numbered input.

Note that the input scaling applied to chained inputs is the one from the connected input!

Out 1, 2, 3, 4

These outputs correspond to the four inputs and drive the oscillator targets.

Calibration input

This input is only used during the V/Oct calibration procedure. It accepts typical levels generated by oscillators. This input is not used after calibration is done.

The Neutral calibration procedure (1:1 in/out) makes no use of the Calibration input.

LEDs

Red LED column

These four LEDs relate to the four processing channels. They tell on which channels changes are applied. Other uses of these LEDs are covered further down.

Yellow LED row

These four LEDs provide different visual clues depending on the context.

By default, they indicate the transpose setting for the lowest numbered channel currently selected. Transposition is indicated by lighting building up, away from the middle: to the left for lower and to the right for higher transpose values. When no LED is lit, there is no transposition.

Other uses of these LEDs are explained in the corresponding section.

Qtz = Quantize

This LED blinks when there is at least one channel with active quantize

p/g = Portamento & Glissando

One of these LEDs is on when editing portamento or glissando. It also tells if the yellow LED row currently relates to portamento or glissando.

Calibration

This LED indicates an ongoing calibration-related operation.

Controls

Channel buttons

These correspond to in/out 1~4 and are used to select one or more channels. They also serve to select one of the 4 presets.

Encoders

These are used to transpose the channels, adjust the portamento and glissando durations.

- When pressed separately, they activate the load and store operations.
- When pressed jointly, they reset the transpose

Quantizer button

This is used to edit the activation of the quantizer in each channel.

A long press on this button initiates the Neutral calibration procedure.

p/g button

This is used to enter the editing of portamento and glissando durations for each channel.

Holding it to then press a channel button enters the input jack calibration procedure.

Module operation

V/Oct Calibration

This is for VCOs that need their tracking be corrected.

1. Connect a wave output from the VCO to the CalTrans calibration input.
Use preferably sine or square; alternatively any simple wave will be fine.
2. **Disconnect or disable any modulation that may affect the pitch or phase** of the VCO.
The CalTrans channel inputs are not needed and are ignored during V/Oct calibration.
3. On the VCO, set the fine tune halfway and the coarse pitch setting around the lowest note you intend playing in tune. No need to be actually in tune at this point.
4. Connect one output channel of the CalTrans to the V/Oct or other pitch control input of your VCO (or oscillating module).
The pitch may jump unexpectedly; ignore it and do not retune your VCO.
5. Press the channel button corresponding to the output connected to the VCO.
6. Wait for the Calibration LED to end up full on. Calibration is done and saved automatically.
7. Remove the jack in the calibration input and start again with the next VCO using another CalTrans channel.
8. Note that CalTrans stores a single V/Octave Calibration setting for each of its four channels. That same channel setting will be applied to all four presets. The setting for any channel can be updated at any time using the procedure described here.
9. A “Neutral Calibration” setting (page 11) will supersede and replace any V/octave Calibration setting for that channel.
10. At this point your chosen oscillator should be calibrated: Check the result by turning the Octave encoder up and down.
You can now connect a voltage source to the CalTrans input.
HOWEVER, your oscillator will probably NOT be playing “in tune” with any other oscillator, or according to any specific pitch. If, for instance, you want 4 volts applied to the CalTrans input to produce middle C (C4) from the oscillator connected to the output of that channel, you need two more steps:
 - First, use the CalTrans Octave (lower) knob and Semi (upper) knob to get as close as possible to your target pitch.
 - Then, use the FINE tune knob (NOT the COARSE knob) of your target oscillator to do the final pitch adjustment.

Calibrating VCOs with voltage range starting negative

To benefit from the full extent of their octave covering, some VCOs also need being driven below zero volt. Therefore, when doing their V/Oct calibration, their base pitch should be set one to three octaves higher than the lowest note to be played.

The CalTrans will make the best of the available range. If for example the VCO has a range from minus 1V to +4V (covering 5 octaves), after calibration, it will be possible to play these 5 octaves only using positive voltages; a simple transpose will reposition the VCO’s pitch range in the voltage range you find practical on the controlling (generator) side.

VCO types and settings that won't work

Make sure that:

- there are no multiple zero-crossings in the wave (typical of wavetables and FM synthesis)
- the wave is not multiple (e.g. chord, stacking, unison, ring mod, atonal, noise, ...)
- there is no modulation that affects shape, phase or frequency
- there is no sound processing that affects phase or frequency
- the sound amplitude is stable and continuous without audible retriggering or loop e.g modules that require repeated triggering to hold their sound won't work

If any of these requirements is not met, V/Oct calibration will not work.

V/Oct Calibration troubleshooting feedback

Various problems can prevent or disrupt the calibration. A problem is indicated by the channel's red LED and the green calibration LED flashing alternatively. One of the yellow LEDs, from left to right indicates the cause of the trouble:

LED 1. Signal missing – error – calibration stops

The audio signal coming from the VCO is too low or absent

- Check the cable and level from your VCO output
- You may possibly need to amplify the signal before bringing it to the Cal input
- Try a different waveform

LED 2. Signal unstable – error – calibration stops

The signal is inconsistent in frequency, phase or level, hampering the frequency measurement.

- Check both cables between the CalTrans and the VCO
- Ensure that there is no cabling or setting creating a modulation on your VCO
- When using asymmetrical waves, try inverting their polarity. (e.g. a sawtooth ramp up wave is not ideal because of the measure being done along a soft slope. Once the signal is inverted, the measure will be effected on a sharp rising edge, improving the precision)

LED 3. Base frequency too low – error – calibration stops

The CalTrans does not start calibration for notes under 20Hz

- Retune the coarse setting of your VCO above 20Hz

LED 4. Base frequency possibly too high – warning – calibration continues

Your base frequency is above 80Hz. This warning draws your attention on the fact that you may miss some usable range at the bottom of the frequency span.

You possibly forgot setting your VCO to a lower frequency before starting the calibration.

- Tune the coarse setting of your VCO to a lower frequency

After correcting an error, unplug and reinsert the calibration jack to restart the procedure.

Visual feedback of a successful calibration

During calibration, the yellow LEDs tell the currently covered range. Illumination from left to right represents contiguous frequency ranges from low to high. Each LED can have various illumination behaviors telling the extent of the coverage:

- Full on: the range is completely covered
- Almost permanently on (black blips): the range is almost covered
- Blinking: the range is covered halfway
- Flashes: the range is barely covered
- Off: the range is not covered at all

Ideally, the more LEDs are fully on, the best.

For example, all you have are two yellow LEDs on the right side; your coarse setting was likely set too high. Lowering the coarse setting of your VCO and redo calibration might extend the range to lower notes.

Play recommendations after V/Oct calibration

These recommendations do not apply for Neutral calibrated channels

- Do not touch the coarse setting or octave switch of your VCOs anymore!
When using the Klavis Twin Waves dual VCO, you can lock the tuning pots.
- All transpose must be done via the CalTrans encoders
- Only a subtle pitch retuning (smaller than a quartertone) is allowed on your VCOs; bigger changes must be done via the CalTrans transpose encoders.
Doing otherwise will break the calibration relationship!
However, after the calibration is done, any CV pitch modulation of any amplitude to your VCO is perfectly OK. (e.g. vibrato, pitch trill, envelope sweep, ...)
- Some oscillators change their pitch response when changing the wave shape. For these oscillators to play in tune, the sound settings should be adjusted before calibration and not modified thereafter.

VCO still out of tune?

If your VCO does not play in tune after V/Oct calibration (and fine tuning it); do the following test:

- Remove all jacks from the CalTrans inputs (because of cascading!)
- Hook up a tuner to your VCO, and do a fine adjust to reach the closest semitone
- Use the CalTrans octave encoder to check the accuracy over the VCO range

If this works fine, the cause of inaccuracy is on the source side.

See [Calibrating the inputs scaling] on page 16.

Neutral calibration

This is for VCOs that track well and don't need curve correction.

The Neutral calibration replaces the V/Oct calibration in a given channel

- For each channel that should be Neutral calibrated, connect a cable between its output and the corresponding input of the CalTrans.
- There should be no jacks in the other channel inputs
- Press and hold the Qtz (Quantize) button until the blue Cal LED starts flashing
- If successful:
 - the Cal blue LED goes steady on
 - the Qtz green LED flashes
 - the calibrated channel(s) red LED goes on
 - Neutral calibration is stored automaticallyCalibration (V/Oct or Neutral) on the other channels is unaffected.
- Remove all input jacks; the calibration procedure is over

Neutral calibration issues

When jacks in the inputs are not coming from their related channel output, the Qtz green LED will not go on. Those channels will have their red LED flashing.

However, channels whose calibration succeeded will have their LED steady on.

Notes about Neutral calibration

Neutral calibration does not identify (and store) the specifics of the VCO currently connected at the output. Therefore, some niceties of V/Oct calibration are missing:

- The end of range – up and down – is not handled
- All curve/tracking errors of the target VCO remain present as if directly connected without the CalTrans
- There is no “intelligent” transpose that keeps the VCO in harmony with others when going over/below its musical tracking limits.

It can make sense using V/Oct calibration instead of Neutral calibration even for VCOs that track well. This will offer all the musical related niceties otherwise lost.

Channel selection for transpose & p/g editing

- Press the button of the channel you intend transposing or editing
To select more than one channel, hold one of them while adding the other(s)
- Release all buttons; the channel selection is valid until being changed again

Transposing

Transposition works independently of the quantizer being active or not.

- Turn the top encoder for semitones
- Turn the bottom encoder for octaves
- Press both encoders simultaneously to reset the transpose

Applying a quantizer

- Press the Qtz button; the channel LEDs tell which quantizer is active
- Press a channel button to toggle its quantizer on/off
- Press the Qtz button to exit quantizer editing

The Qtz LED and the channels with quantize active have their LED blinking or reverse blinking when selected. This way you can see on which channels a quantizer is active, whether these channels are selected or not.

Changing the portamento and glissando time

- Press the p/g button; the p LED will flash
- Turning the top encoder changes the portamento duration (zero to 20 sec) for the selected channels. The yellow LEDs give an indication of the duration applied.
- Turning the bottom encoder works the same but for glissando.
- The p and g LEDs follow whichever from portamento or glissando was tweaked last. This is useful to know what the duration indication relates to.
- Pressing an encoder brings the LED focus to that setting without changing its value.
- When done, press the p/g button to exit p/g editing.

Note that manual transpose goes through P & G processing

The glissando effect is making use of the quantizer. When activating the glissando, there might be a small jump in the fine tune that you need to readjust on your VCO. You can keep active the quantizer for that channel to avoid a pitch change when the glissando is switched on and off.

Loading a preset

- Press briefly the top encoder; the current preset yellow LED and all red LEDs flash.
- Press one of the channel buttons (1~4) to load the corresponding preset (1~4).
The corresponding yellow LED briefly flashes to indicate the preset loaded.

Storing a preset

- Press briefly the bottom encoder; the current preset yellow LED and all red LEDs flash

- Press one of the channel buttons (1~4) to store into the corresponding preset (1~4). The corresponding yellow LED briefly flashes to indicate the destination preset

Clearing a preset

There is no single operation to clear a preset. What you should do is writing default settings in a preset.

Here are the steps to follow:

- Select all 4 channels (red LEDs)
- Press both encoders at once (this will reset all transposes)
- Press the p/g button then turn each encoder counter-clockwise until all yellow LEDs are fully off; press p/g to exit
- Press the Qtz button and switch off all red LEDs
Press Qtz to exit
- Store those settings in one or more preset you want to clear.

Using the CalTrans with a sequencer, arpeggiator, etc

All equipment and modules that generate voltages according to V/Oct to create melodies are here called “generators”. This includes sequencers, arpeggiators, keyboards, MIDI to CV converters, and generally any CV equipment dealing with tonal music control and generation.

Note and pitch matching issues

According to the Volt per Octave metric, each semitone is $1/12^{\text{th}}$ of a Volt apart. All it guarantees is that in a perfect setup, after twelve such voltage steps you end up one octave away from where you started.

Unfortunately there is no specification for what voltage a given note should be and no reference to a given tuning key. Therefore it is up to the user to tune each VCO so that it will match the expected note shown on the sequencer or corresponding to the keyboard key.

Every piece of equipment can generate those V/Oct steps in the way it sees fit.

This lack of standard explains why the CalTrans only handles the spacing (voltage) between notes (semitones and octaves) and not absolute notes.

Double quantization issues

When patching the CalTrans between a quantized generator and a VCO, the Quantizer of the CalTrans might need being disabled. Otherwise, there’s a risk that a voltage falling on the edge of detection of the CalTrans semitone’s determination leads to notes being played above or below where they should be. This is in fact how you identify that very issue.

Low and negative range issues

It may happen that your V/Oct generator goes into the negative range, with the CalTrans missing that part of the range, or that the first note (theoretically at zero volt) does not play right.

In such case there are two possible solutions:

1. Use a transpose function on the voltage generator to lift up its voltage range
2. Use a precision adder module between the generator and the Caltrans and feed it with a fixed voltage high enough to reposition the range within the positive domain.

Check in the specifications that the generator's output voltage fits the input voltage range of the CalTrans.

Background on portamento and glissando

Portamento

Portamento is a well-known voltage processing where a pitch voltage changes to another one in a smooth way. When done with an analog circuit, called an integrator, it follows a curvature called exponential decay. This curve jumps rapidly towards the target voltage to slow down progressively the more it approaches it. In the modular world, this function is also called slew.

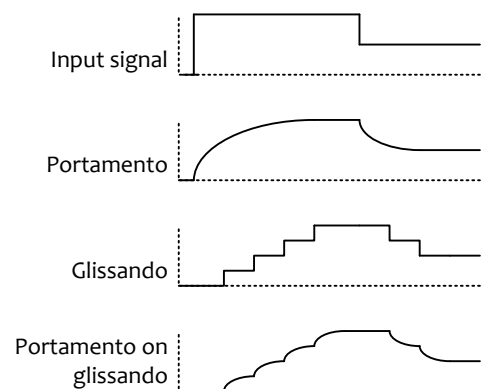
Glissando

Glissando is the change from one pitch to another by consecutive steps. This effect is approximately emulated by sliding the back of your hand on a keyboard, moving from note to note. With glissando, all steps are semitones. The step change is linear; it means that the steps duration is equal.

Portamento on top of glissando

When combining both portamento and glissando, the portamento will typically be set faster than the glissando for the glissando steps to be noticeable. When the portamento is then set a bit longer, the end result is close to linear portamento, which sounds strikingly different from the usual portamento effect.

When both settings are short, it ends up in some highly unusual "grainy" portamento.



Calibrating the inputs scaling

Proceed only if necessary

Perform the test [VCO still out of tune?] described on page 11 to be sure that you need changing the scaling. There's no point messing with the input scaling if the test was not done!

This procedure enables the CalTrans to compensate for certain inaccuracies that may be intrinsic to your voltage source (sequencer, MIDI to CV converter, keyboard, etc.), so that those inaccuracies don't degrade the pitch tracking of your oscillator.

Which issue are you facing?

1. If the pitch is consistently off by the same amount over several octaves, you should adjust it as described in steps 8 to 10 under V/Oct Calibration (page 9). This has nothing to do with scaling!
2. If the pitch drifts further away the more you transpose on your source, there is a scaling problem that can be solved by the procedure described hereafter.

A note about storage

Input scaling is stored once per channel regardless of the presets.

About input scaling

The scaling is the setting that makes the CalTrans "know" how far the voltage steps are from each other. If the setting is compressed, the incoming voltages will end up being expanded, leading to notes that are further away from each other than they should be. If the setting is stretched, it is the opposite; the output voltages will be compacted, leading to notes that are too close.

Why would you change that setting?

When using the CalTrans with voltage sources (e.g. sequencer, arpeggiator, keyboard, MIDI to CV converter) that do not produce perfect V/Oct signals, the CalTrans will follow and replicate their inaccuracy, leading to out of tune notes.

The best practice is to adjust such piece of equipment to generate precise V/Oct signals. When such adjustment is not feasible or desirable, you can instead adjust the CalTrans inputs. The procedure can also be used if for whatever reason the setting in the CalTrans does not suit you.

Procedure with a tuner

1. Equipment needed:
 - a. Tuner with chromatic mode
 - b. CalTrans
 - c. Stable VCO with low drift – but not necessarily with a good V/Oct tracking. It must however cover 5 octaves or more (after calibration)
 - d. V/Oct device/module that can generate notes (voltages) a few octaves apart
The modules should be in the same case to prevent supply and grounding issues.
2. Let your equipment warm up for enough time to reach its usual warm state

3. On the Caltrans, select the channel to process, and then press both encoders to reset any previous transpose setting.
4. Perform a V/Oct calibration of the VCO on the selected Cal Trans channel (page 9). However, do NOT touch any tuning knob on the VCO, including the FINE tuning knob! Make a note of the octave and (approximate) note that the oscillator is outputting at the end of the V/Oct calibration. (e.g., A2, C1, etc.)
5. Connect the V/Oct generator to the CalTrans input and ensure that the pitch is not changing (much). If needed, adjust the generator settings to obtain the smallest change possible.
6. Adjust your V/Oct generator to send a note about 4 octaves above the note produced at the end of the V/Oct calibration. (If that was A2, hit a note about A6.)
7. Put your tuner in chromatic mode and adjust the fine tune knob of your VCO to the closest semitone (up or down, whichever is the closest). Ensure that you made the smallest possible change to reach a semitone recognized by the tuner. Going too far away will reduce the precision of the operation.
8. Adjust your V/Oct generator to send a note that is exactly 3 octaves below the note you hit in Step 6. (If that was A6, now hit A3).
9. On the CalTrans, while holding the P/G button over two seconds, press the button of the selected channel.
 - a. The P/G, Calibration and channel LEDs are now flashing
 - b. The encoders adjust the scaling as follows:
 - Octave controls the coarse setting
 - Semitone controls the fine setting (1/20th of coarse)
 - c. The top row LEDs gives an indication of the setting, min (off) to max (full)
10. Turn the CalTrans encoders until your tuner shows that the oscillator's target note is perfectly in tune.
11. When done, press the selected channel button briefly to end the adjustment procedure and store the result. The green LED will flash briefly.

Procedure with a precision voltmeter

1. Equipment needed:
 - a. Voltmeter with 4.5 digit display or better and millivolt precision
 - b. CalTrans
 - c. Voltage source – the problematic module (sequencer, MIDI converter, etc.) that is creating the inconsistent tracking. This procedure will allow imprecise sources to be used, but they do need to be stable, with repeatable results.
 - d. A “multiple” module, splitter gizmo or Y cable with at least 3 connections
2. Let your equipment warm up for enough time to reach its usual warm state
3. Perform a Neutral Calibration (page 12) of the channel to be used with the problematic voltage source.
4. Simultaneously press both encoders on the CalTrans to reset any preexisting transposition.

5. Connect the voltage source to the multiple, then from there, to the CalTrans' input channel and the voltmeter.
6. Set your voltage source between 4V and 4.1V.
7. Connect the voltmeter to the CalTrans' selected channel output and note the voltage measured.
8. After holding the P/G button for at least 2 seconds, press the button of the selected channel. The P/G, Calibration and channel LEDs should be flashing.
 - a. The encoders adjust the scaling:
 - Octave is the coarse setting (not actual octaves !)
 - Semitone is the fine setting ($1/20^{\text{th}}$ of coarse)
 - b. The top row LEDs gives an indication of the setting, min (off) to max (full)
9. Adjust your voltage source 3 octaves lower.
10. Turn the encoders to have the voltmeter showing precisely 3 volt less that the voltage noted at step 8.
11. When the value is correct, press the selected channel button to end the adjustment procedure. The green LED flashes briefly and the result is stored.

When done with input scaling

Whatever the input scaling method you applied, both the V/Oct and Neutral calibration of the outputs can be used freely.

Specifications

Mechanical

Dimensions	mm	inches	Eurorack compliance
Height	128.40	5.06	3HE
Width	30.00	1.18	6HP
Depth behind panel (with supply cable inserted)	36.00	1.41	

Supply

The supply socket is protected against reverse insertion.

Supply rail	Current draw
+12V	44 mA
-12V	8 mA
+5V	0 mA

Input/output

All inputs and outputs can withstand signals between -12V and +12V without harm.

Jack	Effective voltage range received or generated
V/Oct input	0 to 7V
V/Oct output	-3 to +7V
Calibration input	1V p/p minimum, rising edge detection

Signals

Parameter	Values
V/Oct Calibration Frequency range	20 Hz to 10 KHz
Neutral calibration voltage range	1:1 in/out +/- transpose

Packing list

The box contains:

- CalTrans module
- 2x M3 black mounting screws + washers
- Eurorack-compliant supply cable
- Quick setup notice

Klavis products, including PCB and metalwork, are designed and manufactured in Europe.