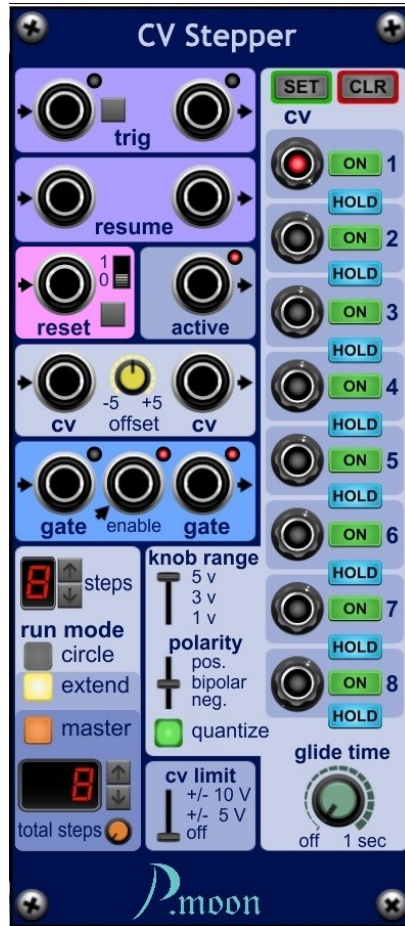# CV Stepper

Version i, build #5, 2023-04-25

CV Stepper is an improved variant of **Stepper**. With added CV knobs, it can deliver a different voltage at each step. Additionally it has got a glide function. It works even triggered with audio frequencies. So it can be used as stepped wave form oscillator too.

CV Stepper's internal control is equal to that of **Stepper**. So both **P.moon** modules may be cascaded in mixed order, even with less than 8 steps each.

Function

Basically **CV Stepper** works as *n*-step circle counter. That means, after step *#n* counter restarts with step #1. This is realized in *circle run mode*. Number *n* of steps can be set from 1 to 8.

In order to build up a sequencer with more than eight steps, *extended run mode* can be used. Now internal counter starts with step #1 too. But when step *#n+1*

is reached, *cv out #n* gets OFF, a *resume out* pulse is delivered and *trig out* repeats *trig in* signal to use at *trig in* of appended **CV Stepper**. For a better understanding, you can find links to some example presets at the end of this manual.

Appended **CV Stepper** starts operation now. It step count may be set to *m*. At step *m+1* it stops operation and sends a *resume out* pulse as well as *trig out* pulses to following **CV Stepper** in cascade.

Basically last **CV Stepper**'s *resume out* pulse may be sent back to *resume in* of first **CV tepper**. That works, when first **CV tepper** is not defined as **master**. But because of VST host timing, one trigger pulse will be lost, so that sequencer cascade cycle will insert a silent step before first **CV tepper** restarts operation.

In order to get a regular stepping behavior, first **CV tepper** should be set to *master*. When that toggle button is on, another digital counter display appears. Please set this counter to total sum of all cascaded **Stepper**'s *steps* counters. This counter value is used instead of *resume in* for master **Stepper #1** restart, when a new sequencer cycle begins.

In order to prevent **CV Stepper** from undefined state, *resume in* jack will not function, when **CV STepper** is defined as *master*.

So all cascaded **CV Stepper** modules form just one circle counter. And each **CV Stepper** can set to any step number from 1 to 8. Whole cascade will work with total sum of preset steps.

Normally this sequencer sends out a gate signal with almost one step length. Only at beginning of a step gate signal disappears for exactly one scan (1/48000 sec). So it can be used to trigger envelope generators. The two possible exceptions will be declared later.

Signal levels

This sequencer covers several purposes. So it can process any signal voltage. According to actual use, different knob ranges, polarity as well as a hard signal limiting are available.

An input signal voltage greater than 2.5 volts will be acknowledged as '*active*', '*on*' or '*true*'. Any lower voltage will be seen as '*inactive*', '*off*' or '*false*'. At *trig out*, *resume out, active out* and *gate out* '*on*' output signal voltage is 5 volts, while '*off*' is 0 volts.

Controls and jacks

Trig input jack receives external clock signal. Every OFF ON change forces one step forward. LED flashes at OFF ON change. The push button allows a manual trigger.

Trig out signal is used to trigger next appended **CV Stepper**. In **extended run mode** this output repeats **trig in** signal, after actual stepper exceeds preset step count.

A pulse at **resume** input jack allows actual module operation. It is used in **extended run mode** only when **master** toggle button is off.

Resume output gets active, when **trig in** pulse #(n+1) is received. (n = preset number of **CV Stepper**'s usable step stages) Normally it is used in **extended run mode** to enable appended **Stepper** operation.

In **circle run mode** as well as in **extended run mode** this signal can be used to trigger other events at each sequencer cycle restart, for example a parallel sequencer.

Different from most other sequencers, a CV OFF-ON change at this input jack resets internal step counter to 'zero' instead of 'one'. Only at first trig pulse step stage #1 will get active. A click on *reset* push button provides a manual reset. Sliding switch lets you select, whether **CV Stepper** jumps to state 0 or 1 after reset is done.

When a step stage of this stepper module is active, **active** output jack will deliver a 5 volt signal, and corresponding LED will be lit.

A voltage at **CV in**put jack will be added to that of sequencer's active **CV knob**. This input can be used to chain sequencers, for keyboard tracking or for modulation.

With this knob an **offset** is setable in the range from -5 to +5 volts. This offset will be added to **CV out**put voltage.

At this output jack you will get total sum of **CV in**put voltage, **CV offset** and **CV knob** voltage of actual active stepper stage.

Gate input jack is used to chain gate voltages from stepper to stepper. It's input voltage will be sent to **CV out**put only when this stepper module is <u>not</u> active.

Gate **enable** input is usable for special effects, like ratcheting. It's logical state and internal calculated gate state will build a boolean AND. When no cable is connected to this jack, it's state is read as '*true*'.

1. When the stepper is not active at the moment, this output jack repeats signal from **gate in**put jack.

2. When the stepper is active at the moment, **gate out** is

   a: active after one scan (1/48000 sec) for one step, when active step is switched on.

   b: active during whole step, when *HOLD* is on at previous step stage.

3. Cases 1 and 2 are only true, when additionally

   a: No cable is connected to **enable** input jack.

   b: A cable is connected to **enable** input jack and it delivers a '*true*' state voltage (> 2.5 volts).

This value determines number of step stages for the **CV Stepper** module. It can be increased or decreased with click on an arrow button.

While reducing number of steps it can happen, that active step is on a higher number. In this case that stage will be toggled off, disabled and last possible stage will become activated.
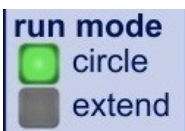
Two radio buttons allow selection of two different *run modes*. Visibility of several control elements depends on selected mode.

Common mode is *circle* run mode. It is used at a single operating **CV Stepper**.

If several **CV Steppers** are chained, **extend**ed *run mode* has to be selected.

A **master** toggle button appears.

Master button should be toggled on, when actual module is the first one in a **Stepper**/**CV Stepper** cascade.

Counter *total steps* becomes visible as well as arrow buttons and a knob.

Counter's value must be equal to total sum of defined step stages within whole **Stepper** cascade. It can be increased and decreased with arrow buttons. You might better use orange knob to preset higher numbers. Also a right click on the knob lets you chose "Edit Value". Then you can input a number with PC keyboard.

For special cases it makes sense to set *total steps* to a lower value. That will resolve in an earlier restart of master stepper, while cascade would continue until last step.

Up to 999 steps are possible within a stepper chain.

For each stepper stage there is one *CV knob*. Click and draw up or down to increase or decrease CV value. Or do a right click on it and chose '*edit value*' from context menu. Available value depends on later described '*knob range*' and '*polarity*' settings. Please note: The CV value will be processed even when respective stage is switched off.

ON toggle button allows creating a new gate pulse for this stage.

HOLD toggle button will prevent *gate out* signal from one-scan-break at next step beginning.

1. When a stage is switched off and it gets active,

   - a blue LED is lit in the knob center,

   - CV from this stage is added to *CV in*put and *offset* and then sent to *CV Out*,

   - *gate out* sends an 'OFF' signal during whole step.

2. When a stage is switched ON and it gets active,

   - a red LED is lit in the knob center,

   - CV from this stage is added to *CV in*put and *offset* and then sent to *CV Out*.

   a: When *HOLD* is off at previous stage, *gate out* sends an 'ON' signal starting next scan.

   b: When *HOLD* is on at previous stage, *gate out* keeps on sending an 'ON' signal.

You can HOLD button toggle on, when both previous and actual stage are switched ON. Otherwise HOLD buttons will be set off and disabled (dark gray colored).

A click on **CLR** push button will set off all **ON** and **HOLD** toggle buttons. That results in disabling all **HOLD** toggles.

A click on **SET** push button will set all **ON** toggle buttons to ON. Because *HOLD* function is possible only between ON toggled stages, all **HOLD** toggle buttons will be enabled now (light gray colored).

Knob range slider lets you chose maximum positive or negative knob value. When you set slider to a higher value, CV knobs will keep their actual set values. Same is with lower range, if possible. Otherwise CV knob position will be set to new minimum or maximum value.
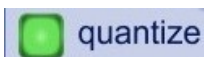
With polarity slider output CV can be adapted to various purposes. These variations are:

|					
pos.:	0	<=	value	<=	+range
bipolar:	-range	<=	value	<=	+range
neg.:	-range	<=	value	<=	0

A change of *polarity* slider will affect knob *ranges*. As described above, this may result in lost CV settings.

Quantize function of this sequencer differs a little from common known quantize function. Instead of rounding CV to half tone level, the on toggled quantize button will activate 'snap positions' for CV knobs. This allows off tuning.

How that?

First set your tones easy with activated quantize function. Then toggle off quantize function and do any fine tuning with *CV knobs*. When you reactivate quantization, these fine tunings will be kept! Besides *CV in*put and *CV offset* will be processed without quantizing too.
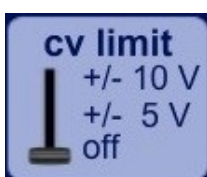
Voltage Modular® modules normally operate with voltages from -5 to +5 volts. So it might be necessary to hold any signal within these limits. Sometimes users connect their PC to hardware modular synthesizers, which mostly use 10 volt signals. If needed, you can clip CV Stepper's input and

output voltages by setting CV limit slider to appropriate position. When slider is set to 'off', signal clipping will be happen at +/- 1000 volts, what should not affect any purpose.

A glide time can be set from 0 to 1 second in steps of 1 millisecond. This glide does only affect CV voltage, when actual module is active.

Example Presets

Example 1

This is a typical preset with two cascaded **CV Stepper** modules, which work as 16 step sequencer. **Stepper** is used to change sequencer's basic tone.

For chaining **CV Steppers** or **Steppers** these signals have to be linked: *trig*, *resume*, *cv*, *gate*. A feedback from last to first ('master') module is not necessary.

Preset: PM CV Stepper Example 1.voltagepreset
Sound: CV Stepper 1, glide.mp3

Example 2

This preset demonstates creation of 'ratcheting' effect.

STEPPER 1 and STEPPER 2 work as 16-step sequencer. STEPPER 4 changes sequencer's pitch. It is triggered from same source as STEPPER 1, so is Sample&Hold too.

So for every sequencer step there is a chance, that S/H output is high enough for boolean logic to match a 'true' state. With this circuit, ratcheting could happen for each sequencer step. There are musical reasons to prevent that. STEPPER 3 is inserted to solve that problem. It's outputs '1' and '5' are fed to another AND circuit. This allows ratcheting only for distinct steps. On sequencer long notes ('HOLD') start just at these steps '1' and '5'.

Preset: PM CV Stepper Example 2.voltagepreset
Sound: CV Stepper 2, ratcheting.mp3

Example 3

In this preset there is also a 16-step sequencer. But this time it is triggered by a high audio frequency. Now sequencer's CV output voltage is not used to modulate an oscillator, it IS an oscillator output signal.

Left oscilloscope shows the stepped wave form. On right side you can see filtered signal.

This preset contains a second variation, where sequencer CV knobs are adjusted to other values. Oscilloscope shows resulting wave form.

On a 3.6 GHz driven PC this preset works with triggering tones up to 'D5' tone.

Preset: PM CV Stepper Example 3.voltagepreset

Example 4

In this preset common sequencer consists of two **CV Stepper**s too. But here *enable* inputs are used at **CV Stepper** modules. This way *gate* output pulses length can be controlled by input *enable* pulse length. A **P.moon Pulser** provides this changeable pulse length.

Preset: PM CV Stepper Example 4.voltagepreset
Sound: CV Stepper 4, gate length.mp3

You can find more example presets and PDF manuals at:
https://p-moon-modules.de