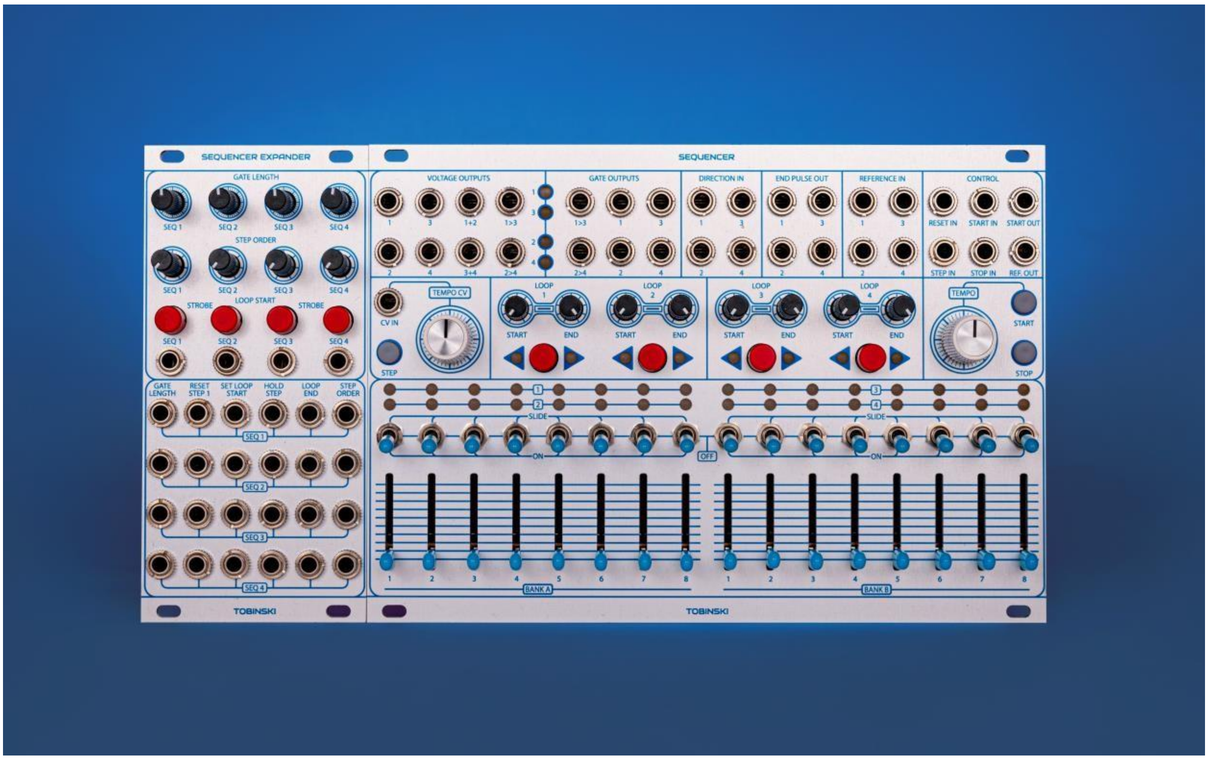
Tobinski

SEQUENCER
AND
SEQUENCER
EXPANDER

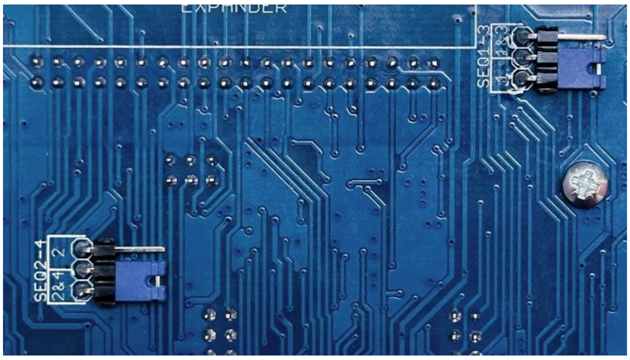
USER MANUAL



The Tobinski Sequencer is designed to be experimental, immediate, playable and fun!

The sequencer features two banks (A and B) of 8 voltage sliders which are referenced by two 8 step sequencers or “play heads” each. These play heads can be set to different loop lengths and combined to produce longer sequences or polymetric patterns.

The sequencers are also chained together via internal switching to produce up to 18 step sequences. The behaviour of the switching can be set via jumpers on the back PCB so that switching occurs either at the loop end pulse of the bank A sequencers or at the loop end pulse of the currently selected sequence. In the image below the jumpers are set so that Seq 1 to 3 (top right) will switch via seq 1 end pulse and seq 2 to 4 (bottom left) will switch via seq 2 AND 4 end pulses.



It should be noted that when the jumpers are set to 1&3 or 2&4 and the end pulse for the bank A and bank B sequencers occur at the same time, then the switch receives 2 pulses. As the pulses have very slight differences in timing then one will occur just before the other and that will be the sequencer that stays selected, so it will appear as if the switch isn’t working. In order to avoid this the loop length of one of the sequencers should be changed.

Each sequencer features Loop Start and Loop End controls, plus Direction switches.

8 CV outputs and 6 Gate outputs provide the main connections to the outside world.

Each sequencer can also be clocked individually using the Ref. Inputs or there is an onboard analogue oscillator that drives all sequencers together.

The Reference (clock) signal is +-5V falling sawtooth. The sharp transition from -5V to +5V is used to progress the sequencer steps and the falling ramp from +5V to -5V is used to control both the SLIDE time and derive the GATE length.

The Start, Stop and Step controls plus CV inputs and outputs for the internal clock allow the sequencer to connect to other sequencers and act as either master or slave.

The sequencers can also function as complex envelope generators, complex LFOs, counters, dividers or programmable pulse generators.

The Sequencer Expander module extends the functionality of the sequencer to give access to all the possible features, including individual channel control of reset pulses, CV over Loop Start and End points, Step Hold (ratcheting), Gate Length control, Step Order addressing, and Strobe.

The Strobe and Loop Start CV input on the Expander module can be used to select the sequence step via CV. When connecting an oscillator to the Loop Start CV input and depressing the Strobe button, the sequencer can used as a programmable wave shape oscillator, or it can be used to quantize the Loop Start CV input to 8 discreet voltages.

One point to note is that the sequencer uses 2 different technologies for the Loop Start selection. On sequencers 1 and 3 the selection is done via analogue circuitry and on sequencers 2 and 4 it's done using a microcontroller. These 2 options give more interesting results when using the Strobe function to make a graphic waveshape oscillator as the analogue circuits can go up to very high frequency without any issues, whereas the digital ones start producing aliasing which adds quite a nice glitchy quality to the sound at higher frequencies.

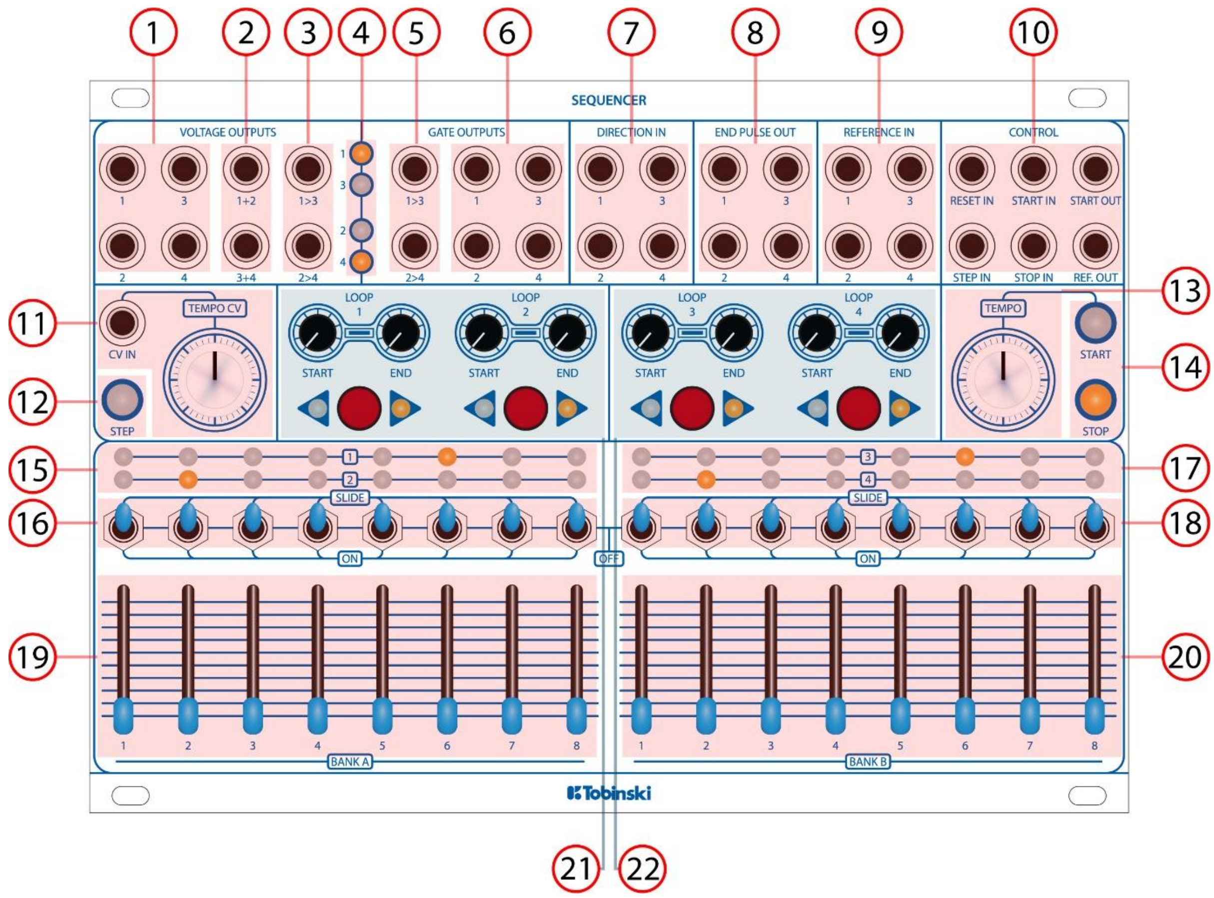
IMPORTANT POINTS TO NOTE

Due to the fact that these are analogue circuits, some features are not 100% perfect. The points to note are:

- The sequencer circuits take a while to warm up and the voltages from the CV outs drop slightly during this time.
- The voltages out from each sequencer might not be quite the same, so if CV Out 1 is compared to CV Out 2 by connecting each in turn to an oscillator v/oct input then one might be slightly sharp or flat compared to the other.
- The HOLD voltage of a step that is set to OFF might not be exactly the same as previous ON step voltage, so it might sound slightly sharp or flat. This effect can be reduced by ensuring the slider of the OFF step is set to the same level as the ON step but there might still be a slight difference.

These small errors are due to the tolerances of components and can't be avoided without adding a ton of extra trimmers making the design completely unviable but they are very minor issues and part of the magic and charm of analogue circuits is in embracing these idiosyncrasies. In operation it's not really an issue but for the sake of clarity it's worth mentioning.

Another important point to note is that due to the analogue nature of the circuits, it takes a while to warm up and the voltages from the CV outs drop slightly during this time. You might also find that the voltages out from each sequencer are not quite the same, so if CV Out 1 and CV Out 2 are compared by connecting to an oscillator v/oct input then one might be slightly sharp or flat compared to the other. This is due to the tolerances of components and can't be avoided without adding a ton of extra trimmers making the design completely unviable. These small errors are part of the magic and charm of analogue circuits. In operation it's not really an issue but for the sake of clarity it's worth mentioning.



1. CV outputs (0V to 5V), for sequencers 1, 2, 3 and 4.
2. CV outputs (0V to 10V), for Bank A sequencers 1 and 2 added together and Bank B sequencers 3 and 4 added together.
3. CV outputs (0V to 5V), for sequence 1 to 3 switching back and forth and for sequence 2 to 4 switching back and forth. There are jumper connections on the back PCB to

select whether switching occurs at the Loop End of bank A sequencers or whether switching occurs when the currently selected sequence Loop End point is triggered.

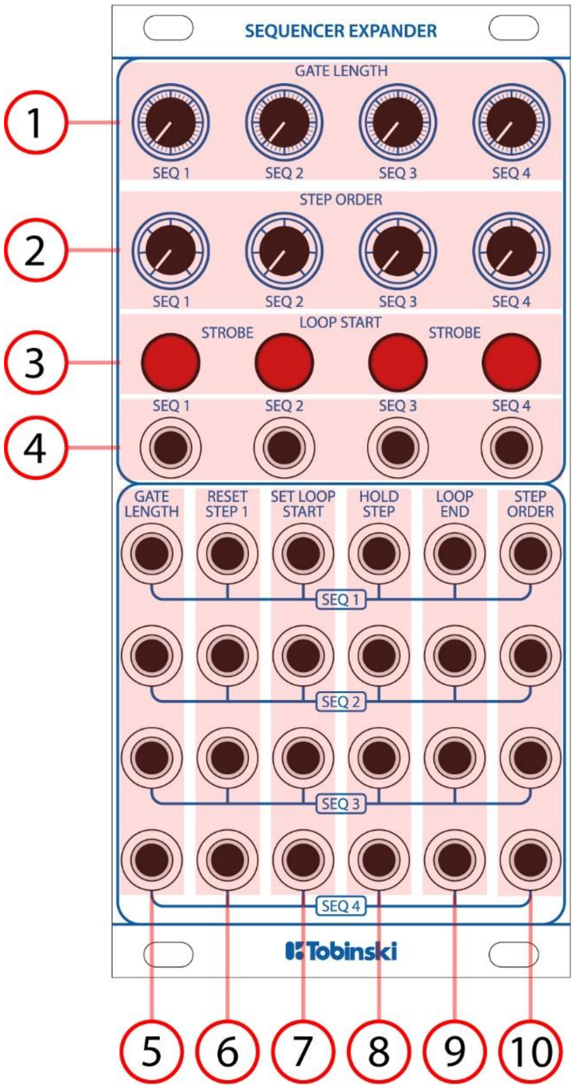
4. LED indicators for the 1>3 and 2>4 sequence selection.
5. Gate outputs (0V to 5V), for the 1>3 and 2>4 sequence selection.
6. Gate outputs (0V to 5V), for sequencers 1, 2, 3 and 4.
7. CV input to switch the direction of the sequence. Works with a 0V to 5V pulse to trigger switching.
8. End Pulse output (0V to 5V), pulse occurs when the loop resets to the Loop Start position.
9. Reference clock inputs for sequencers 1, 2, 3 and 4. The preferred reference signal is a +-5V falling sawtooth (in order to ensure the Gate length and Slide work as intended), but a regular 0V to 5V clock source can also used.
10. Control section featuring:
    - Reset input (0V to 5V pulse), to set all sequencers to Step 1.
    - Step input (0V to 5V pulse), to trigger one cycle of the internal reference clock when in stop mode. Used to sync internal reference clock to external clock sources. The Tempo control can be used to match the falling ramp of the internal clock to the external sync pulse.
    - Start input (0V to 5V pulse). Resets the sequencers to their Loop Start positions and starts the internal reference clock. If the reference clock is already running then a 0V to 5V pulse will reset the sequencers to their Loop Start positions.
    - Stop / continue input (0V to 5V pulse). Stops or starts the reference clock whenever it receives an input pulse.
    - Start out (5V). Sends out 5V when the reference clock is running. Can be used to sync other sequencers or if using the Tobinski LFOs module as a clock source it can be used to CV the LFO amplitude level (so it stops clocking the sequencers when the stop button is pressed).
    - Reference output (+-5V falling sawtooth). Output of the internal clock source, can be used to sync other sequencers or can be connected to the Ref. In of the Tobinski Harmonic Timing Generator module to use the multiplier section to provide multiples of the reference clock from 1 to 8 times the internal clock speed.
11. Tempo CV input and Bipolar attenuverter. Exponential FM input for the internal reference clock.
12. Step button. When the reference clock is stopped, the step button will produce one cycle of the reference clock which advances the sequencers (providing there is nothing plugged into the Reference input for the sequencer).
13. Tempo control. Frequency for the internal reference clock.
14. Start and Stop buttons for the internal reference clock. When the start is pressed the sequencers rest to their Loop Start points. If the Start button held the Sequencers are

held on their Loop Start steps while the clock keeps running much like a manual ratcheting effect.

15. Bank A sequencers 1 and 2 step LED indicators.
16. Bank A Sequencers, Step (ON-OFF-SLIDE), switches. When the switch is on the step produces a gate pulse and CV level set by the associated step slider.
    - ON – Produces a Gate pulse and CV level set by the associated step slider.
    - OFF – No Gate pulse and holds the CV level of the last step that was played.
    - SLIDE – Produces a longer Gate pulse plus a CV level that linearly slides from the last played step CV level to the current CV level with a period of 1 reference clock cycle. Also known as a constant time slide.
17. Bank B sequencers 3 and 4 step LED indicators.
18. Bank B Sequencers, Step (ON-OFF-SLIDE), switches.
19. Bank A Sliders. Slider voltages (0V to 5V) referenced by sequencers 1 and 2.
20. Bank B Sliders. Slider voltages (0V to 5V) referenced by sequencers 3 and 4.
21. Loop Start control, Loop End control and Direction switches for Bank A, Sequencers 1 and 2.
22. Loop Start control, Loop End control and Direction switches for Bank B, Sequencers 3 and 4.

All inputs are tolerant of full modular +-12V signals.

Sequencer
Width 36HP
Depth (internal from panel) = 27.5mm
-12V @ 267mA
+12V @ 300mA
+5V @ 46mA



1. GATE LENGTH Control. At 50% the gate is approximately 1/3 of the step time for ON gate pulses and approximately 85% for SLIDE gate pulses. As the control is reduced to 0 the SLIDE gate pulses are reduced more than the ON gate pulses so at 0 they are about the same at approximately 5% of the step time. When the control is increased to 100% the ON gate pulses are increased more than the SLIDE gate pulses so at full both gate pulses are approximately 99% of the step time.
2. STEP ORDER control. Re-arranges the step order of the sequence to 1 of 6 different patterns.
3. STROBE pushbutton. When activated the sequencer step can be set via the LOOP START control on the sequencer or via the LOOP START CV input.
4. LOOP START. CV input added to the LOOP START control on the sequencer. When in STROBE mode connecting an oscillator to the LOOP START CV input allows the sequencer to be used as a programable wave shape oscillator.
5. GATE LENGTH. CV input (0V to 5V) to control the gate length.
6. RESET STEP 1. Resets the sequence to step 1 on the rising edge of a received pulse (0V to 5V).

7. SET LOOP START. Resets to the sequence LOOP START position on the rising edge of a received pulse (0V to 5V).
8. HOLD STEP. Holds the step for ratcheting type effects with CV input is above approximately ~3V.
9. LOOP END. CV input (0V to 5V) to control the LOOP END point of the sequencer.

All inputs are tolerant of full modular +-12V signals.

Sequencer Expander

Width 12HP

Depth (internal from panel) = 27mm

-12V @ 30mA

+12V @ 63mA

+5V @ 8mA

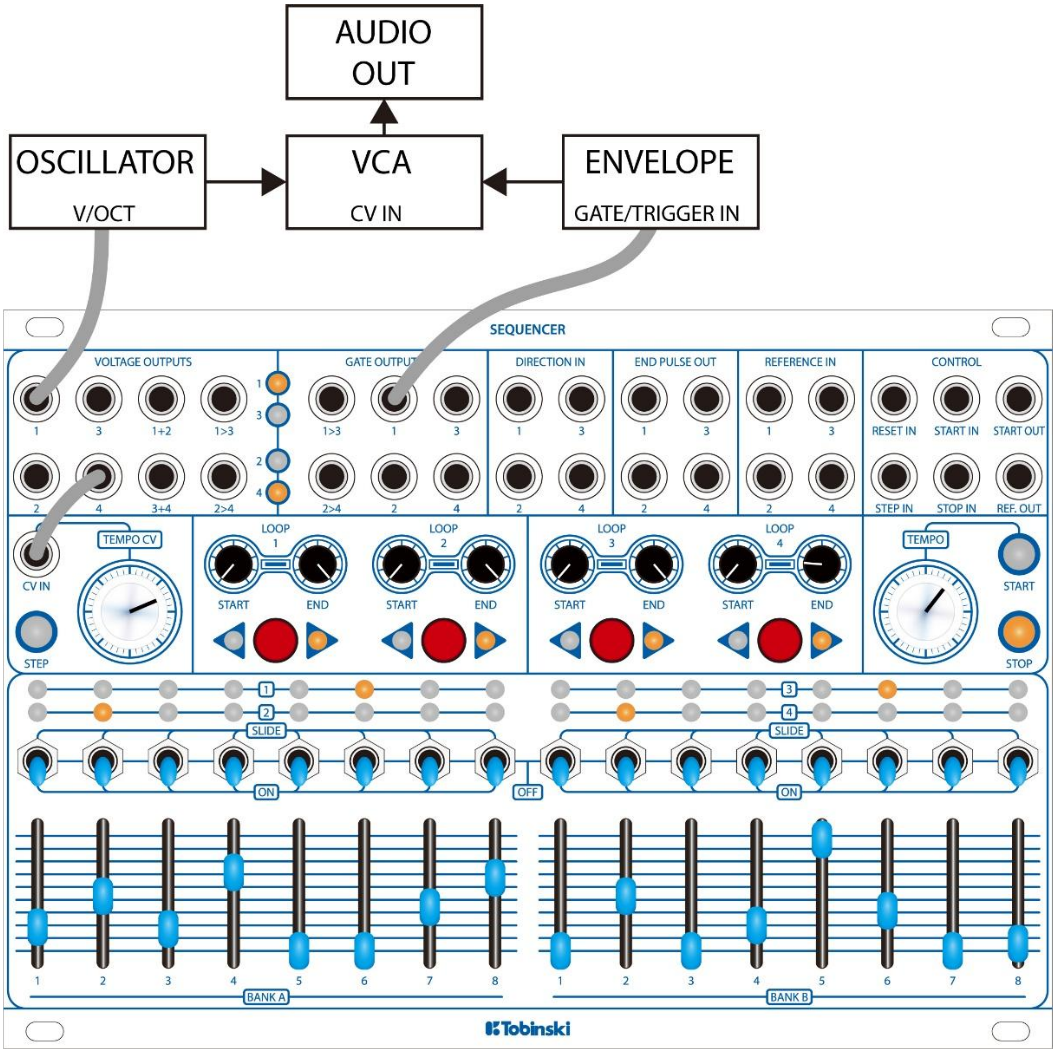
40 Pin ribbon cable connection from expander to sequencer.

SEQUENCER EXAMPLE PATCHES AND TIPS

3 WAYS TO START THE SEQUENCER

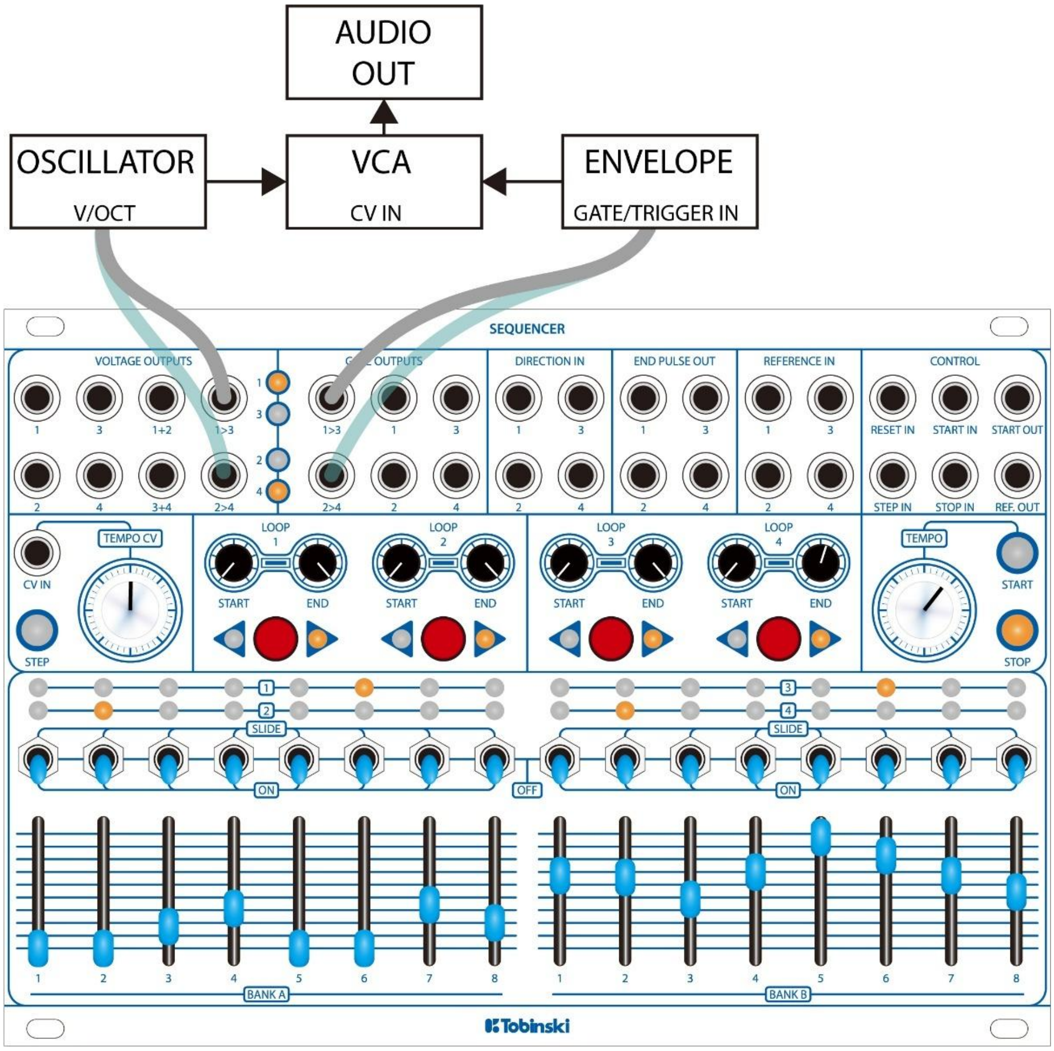
1. Press PLAY – The sequencer will start from the LOOP START point. If the START button is held the LOOP START step will be held or if the START button is pressed while the sequencer is running then the sequence will jump back to the LOOP START point. If the START input is used then a low to high pulse will reset to the LOOP START point but the hold function only applies to the START button.
2. Press STOP – The sequencer will start from the next step without being set to the LOOP START point.
3. Patch the START OUT to the RESET input and press STOP – The sequencer will start from step 1 and then loop from the LOOP START to LOOP END points. Useful if the LOOP START is set to something other than step 1.

VARIABLE TEMPO AND SWING



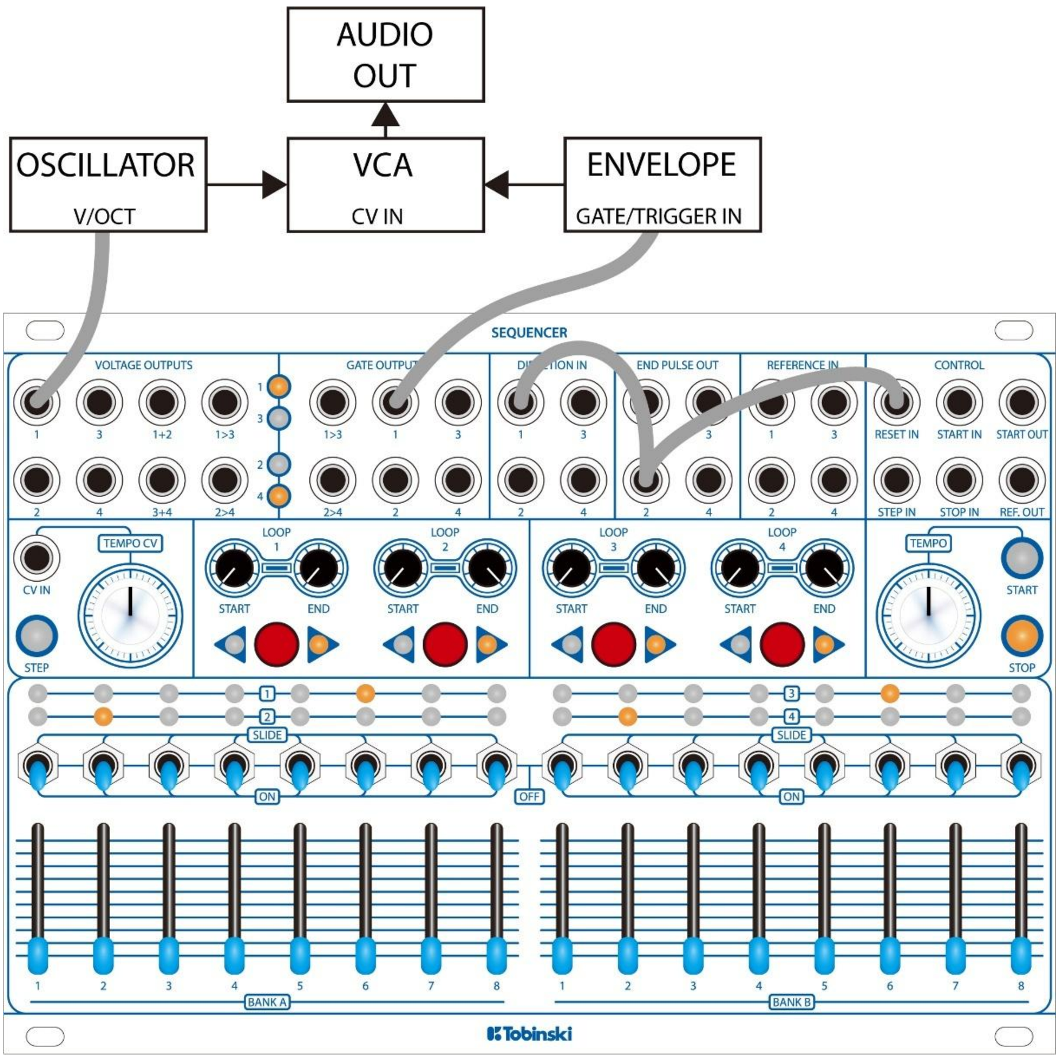
This patch uses VOLTAGE OUTPUT 4 to control the tempo. If sequence 4 is set to a 2 step loop and the second step slider is higher than the first then you can get swing timing. Adjusting the slider level and TEMPO CV control will increase or decrease the swing amount. If sequence 4 loop is set longer then you can get much more variable timing. This can be interesting if the VOLTAGE OUTPUT to the oscillator is also used as the TEMPO CV voltage. Then the TEMPO will increase on high notes and decrease on low notes or vica versa if the TEMPO CV is between 0 and 50%.

SEQUENCER SWITCHING USING 1>3 AND 2>4 OUTPUTS



This patch uses the 1>3 or 2>4 VOLTAGE and GATE OUTPUTS that switch from the BANK A (sequencers 1 and 2) to the BANK B (sequencers 3 and 4) to produce up to 18 step sequences. The control of the switching is determined by the jumper settings on the back PCB as discussed earlier in the manual. As set from the factory, the 1>3 jumper is set to 1 so that BANK A sequencer 1 controls the switching and the 2>4 jumper is set to 2+4 so that both BANK A sequencer 2 and BANK B sequencer 4 control the switching. In this way 1>3 can produce up to 18 steps if both LOOP START and LOOP END are set to step 1 for sequencer 1. 2>4 will only switch over providing the END PULSE OUT for both sequencers 2 and 4 do not go high at the same time. If they do then switching will occur twice very rapidly and will appear as though it's not switching at all.
Another addition to the above example is to patch from the END PULSE OUT of the BANK A sequencer used to the RESET IN or START IN so that the BANK B sequencers start at the same point when switching over.

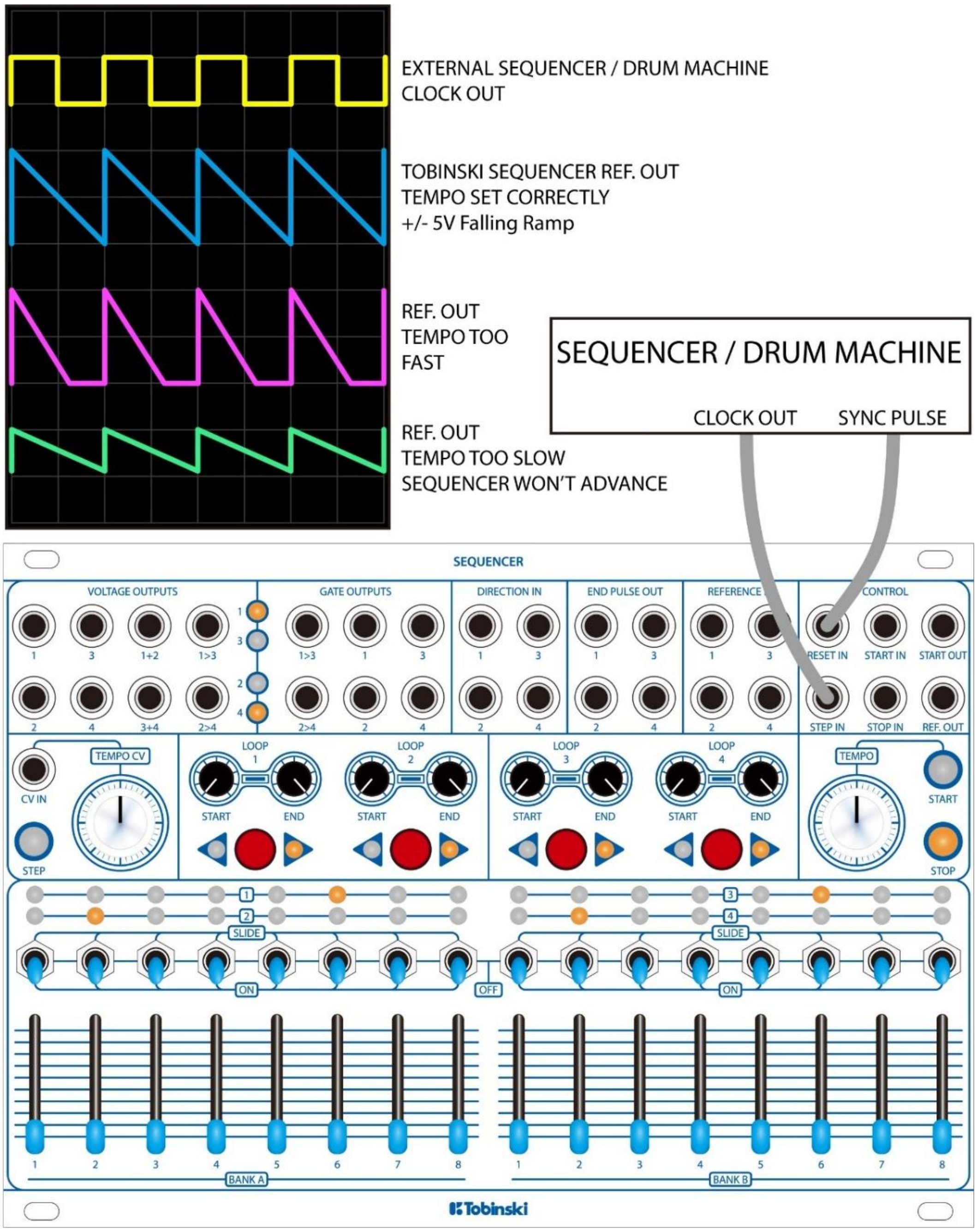
8 STEP PING PONG (PENDULUM)



This patch can do a ping pong or pendulum type sequence of 8 steps where the sequencer counts up then back down again. In the above example sequencer 1 is the VOLTAGE OUT source and sequencer 2 controls the DIRECTION IN switching.

1. Set sequencer 1 LOOP START and LOOP END both to step 1.
2. Set sequencer 2 LOOP START to step 1 and LOOP END to step 8.
3. Patch END PULSE OUT 2 to both DIRECTION IN 1 and RESET using a stackable or mult etc.
4. Run the sequencer.

SYNCHRONISING TO EXTERNAL SEQUENCER OR DRUM MACHINE



This patch shows the connections for synchronising to an external sequencer or drum machine using the RESET and STEP inputs of the sequencer. The VOLTAGE and GATE connections have been left out of the above diagram for the sake of clarity.

The CLOCK OUT of the external source is connected to the STEP input of the sequencer so it fires one pulse of the sequencer clock every time the leading edge of the external clock goes high.

The SYNC PULSE of the external source is connected to the RESET input of the sequencer so that it resets to step 1 every time the sync pulse goes high.

The falling ramp generated by the sequencer internal clock uses the leading edge (sharp low to high transition) to advance the sequencer steps and the falling ramp to control the SLIDE and GATE time.

In order to generate the correct SLIDE and GATE times, the TEMPO control on the sequencer should be set so that it matches the clock of the external source.

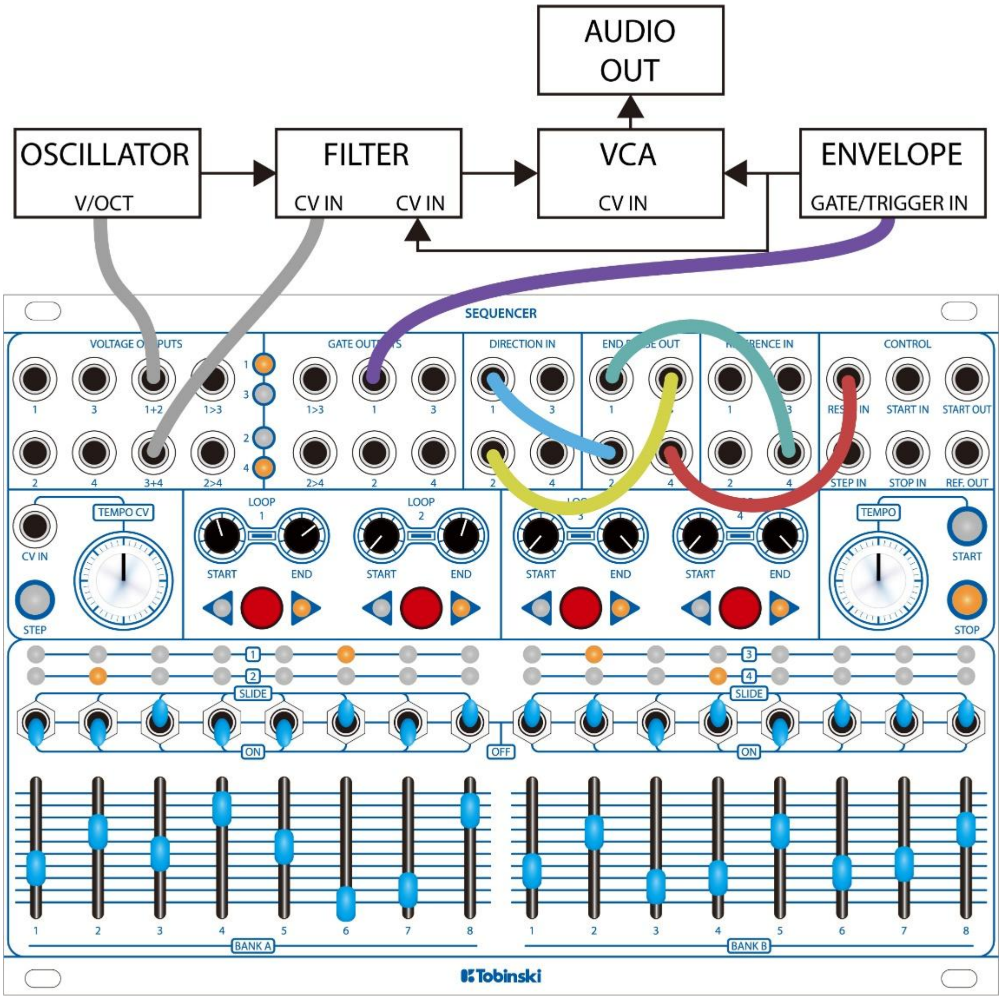
The Scope diagram in the top left shows the clock output of the external sequencer or drum machine in yellow (as shown it is a +5V square wave but it can be anything up to +-12V and the duty cycle can be long or short).

The blue trace shows the REF. OUT which is the internal sequencer clock. This is how the waveform looks when the TEMPO is matched to the external clock.

The pink trace shows the REF. OUT signal when the TEMPO is too high. This will make the SLIDE and GATE times shorted and can be as an effect in operation.

The green trace show the REF. OUT when the TEMPO is too low. As the TEMPO control is decreased the SLIDE and GATE times get longer but there is a point where the REF. OUT signal no longer passes 0V so the leading edge is not capable to advance the sequencer.

CREATING MORE COMPLEX SEQUENCE PATTERNS



This patch serves as an example of how to use the END PULSE OUT as a clock source, reset trigger and direction control to create complex evolving patterns.

The GREY cables are patched into the V/OCT input of an oscillator and the CV input of a filter from the 1+2 and 3+4 VOLTAGE OUTPUTS. These outputs have larger 0v to 10v range so attenuation might be necessary to limit the range.

The PURPLE cable is patched to the gate input of an envelope that is in turn connected to a VCA and the second CV input of the filter.

The BLUE cable is patched from the END PULSE OUT 2 to the DIRECTION IN 1 input to flip the direction of sequence 1 whenever sequence 2 loop completes one cycle.

The YELLOW cable is patched from the END PULSE OUT 3 to the DIRECTION IN 2 input to flip the direction of sequence 2 whenever sequence 3 loop completes one cycle.

The GREEN cable is patched from the END PULSE OUT 1 to the REFERENCE IN 4 input to advance sequence 4 whenever sequence 1 loop completes one cycle.

The RED cable is patched from the END PULSE OUT 4 to the RESET IN input to reset all sequences to step 1 whenever sequence 4 loop completes one cycle.

LOOP START 1 is set to step 4.
LOOP END 1 is set to step 6.

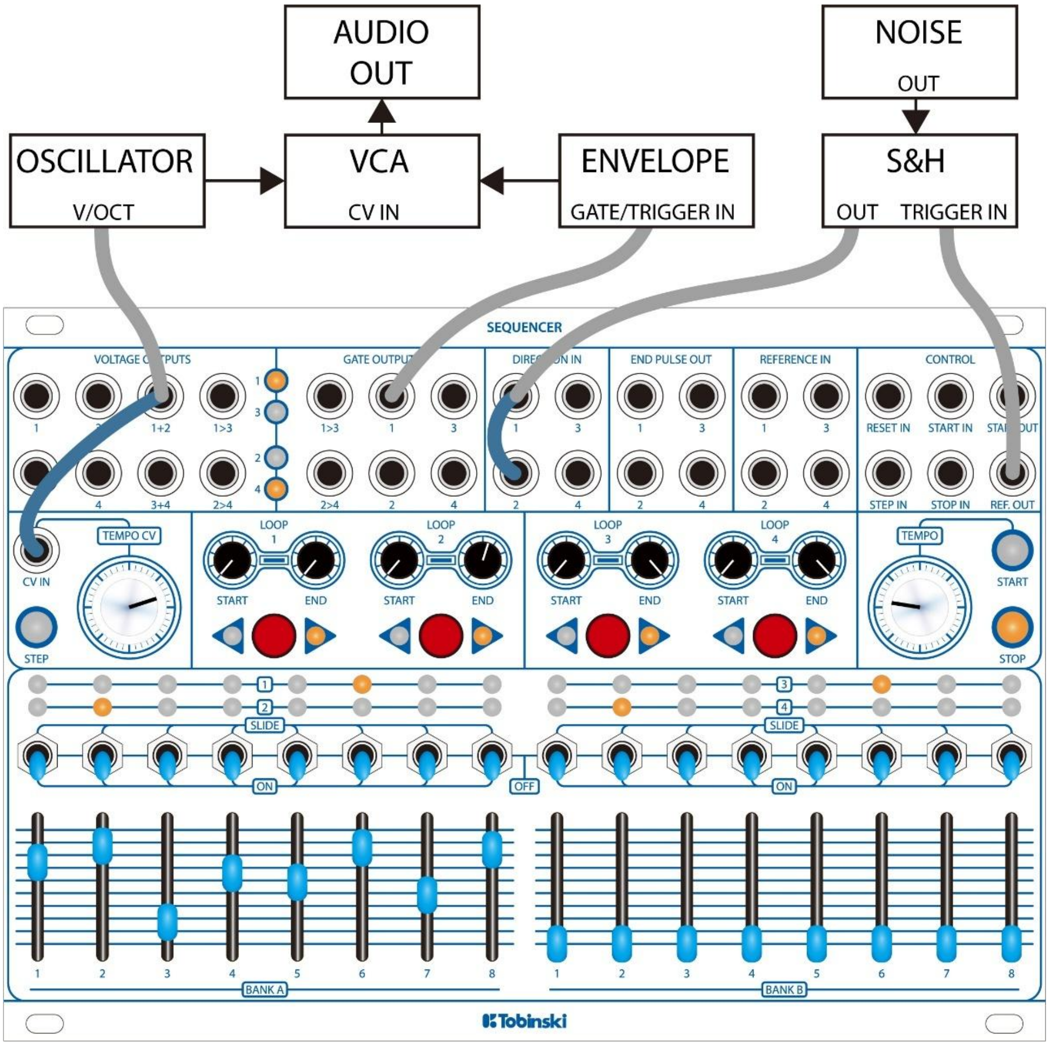
LOOP START 2 is set to step 1.
LOOP END 2 is set to step 5.

LOOP START 3 is set to step 1.
LOOP END 3 is set to step 8.

LOOP START 4 is set to step 1.
LOOP END 4 is set to step 8.

The LOOP START and LOOP END setting are important in order to make sure the sequencers can complete one cycle in order to trigger the END PULSE OUTs. Changing the loop lengths can also produce interesting results though!

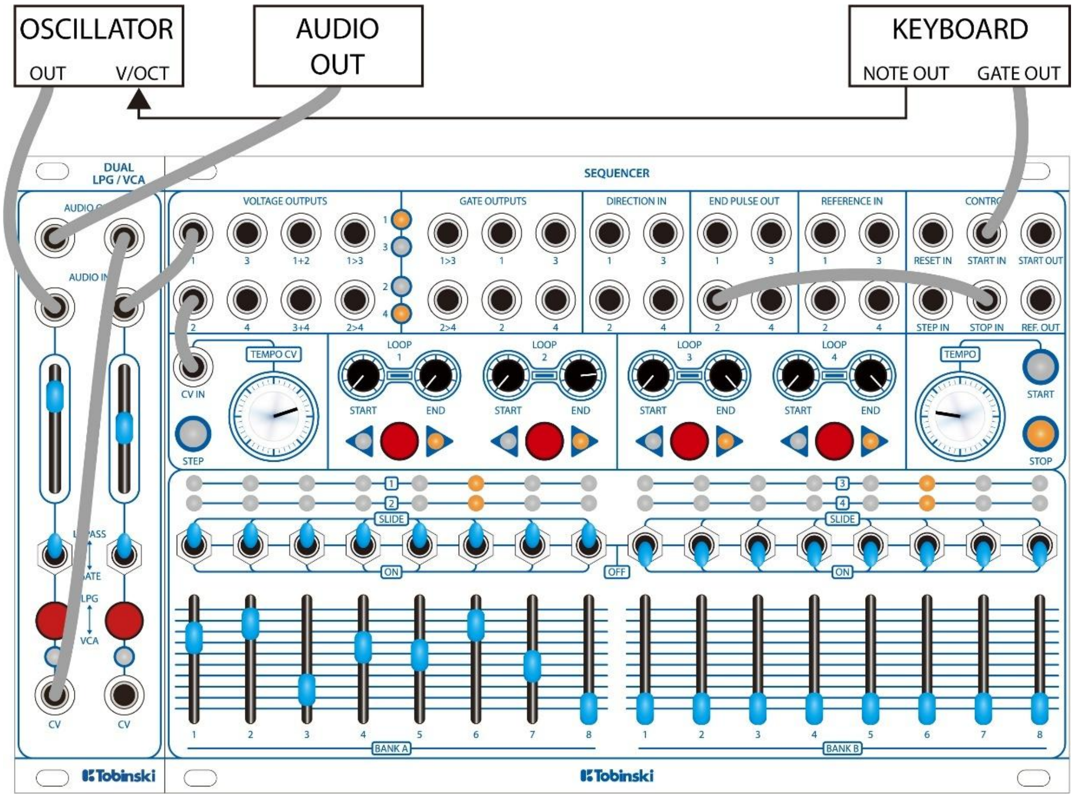
SAMPLE AND HOLD DIRECTION SWITCHING



Using a sample and hold and a noise source to generate random pulses clocked by the REF. OUT can produce some interesting effects. In this example the 1+2 VOLTAGE OUTPUT is used to drive both the TEMPO CV and the V/OCT input of an oscillator using a stackable cable. The envelope is triggered from GATE OUPUT 1 and then a sample and hold using a noise source source as it's sample source is triggered from the REF. OUT of the sequencer. The output of the S&H is then patched to both DIRECTION IN 1 and 2 using a stackable cable.

The settings of the sliders determine the pitch of the notes and the speed of the sequencer so that high notes step through more quickly than low notes. This also determines how often the S&H gets triggered. With the sliders set as in the above illustration, the steps will settle on the lowest note that is step 3 and then run again quickly through the other steps forming random but sometimes repeating patterns.

ENVELOPE AND LFO



The sequencer can also be used as a multistage envelope or LFO generator. However it should be noted that due to the nature of the analogue circuits some low pass filtering might be required to remove clicks from the VOLTAGE OUTPUTS.

The above example shows the setup for an 8-stage envelope generator triggered from a keyboard.

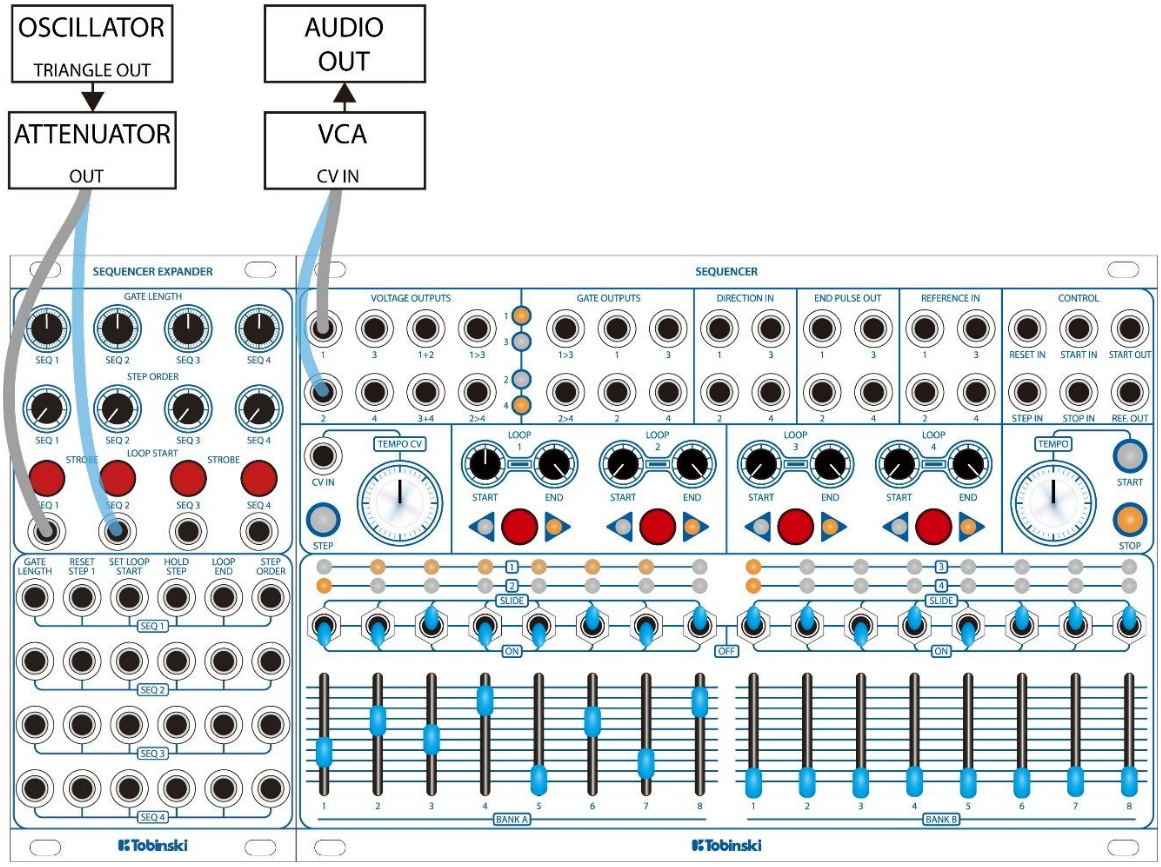
- The gate out of the keyboard is patched to the START IN to start the sequencer running whenever a note is played on the keyboard.
- END PULSE OUT 2 is patched to STOP IN to stop the sequencer running.
- Sequencer 2 LOOP START is set to step 1 and LOOP END to step 7 so that the END PULSE OUT occurs on step 8 of sequencer 1.
- Sequencer 1 LOOP START and LOOP END are both set to step 1 which is the maximum length of the sequence.
- VOLTAGE OUTPUT 1 is patched to a low pass filter that can also operate down to DC. The filter frequency is set so that it removes the clicks from the VOLTAGE OUT 1 envelope. In this example the right channel of the Dual LPG/VCA set to LPG - low pass mode is used with the slider around 50%.
- The output of the LPG is then patched to a VCA in this case the left channel of the LPG/VCA that is set to VCA mode.
- The oscillator is then patched into the VCA and the output is sent to the mixer or speaker etc.

It should be noted the clicks produced by the VOLTAGE OUTPUT are only apparent if a VCA is used and sine or triangle wave is coming from the oscillator. If using a LPG as the VCA or the saw or square outputs of the oscillator then the clicks are either removed by the slow response of the LPG or are not so apparent with the harmonic content from the saw or square wave oscillator.

To use the sequencer as an LFO simply remove the END PULSE OUT 2 to STOP IN patch cable for an LFO that resets to the LOOP START point every time a key is pressed on the keyboard or remove the GATE OUT from the keyboard to the START IN of the sequencer for a free running LFO.

EXPANDER EXAMPLE PATCHES AND TIPS

GRAPHIC VCO USING STROBE AND LOOP START INPUTS

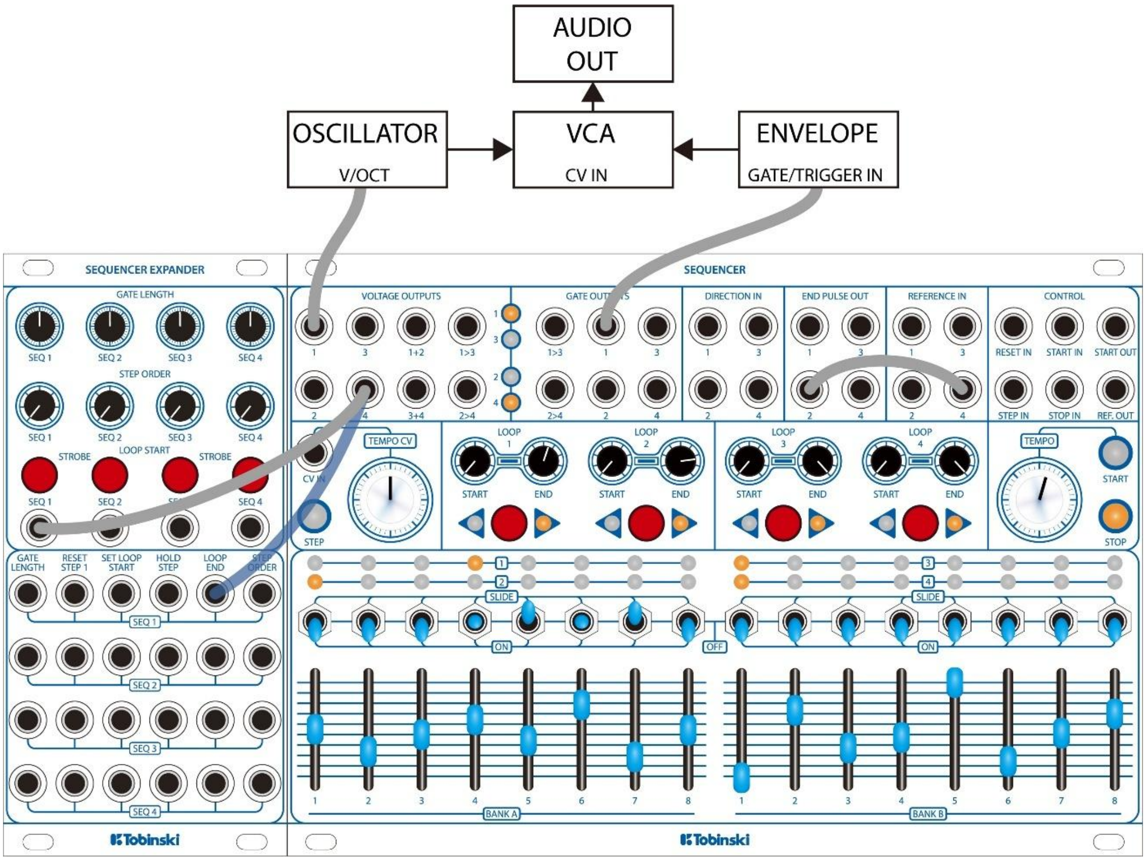


This first patch with the Expander shows how it can enable the Sequencer to be used as a graphic VCO.

- Patch an oscillator into an attenuator to limit the output to +/- 2.5V. Higher levels into the Expander can be used without issue but the range of the Expander CV inputs are all 5V. Using a triangle wave will enable the scan though the sequencer steps to be even going back and forth but any waveshape can be used to produce different scanning effects.
- Patch the attenuator output to the LOOP START, SEQ 1 input. SEQ 2 input can also be used as that uses a microcontroller based circuit to control the LOOP START which produces some interesting aliasing effects at higher frequencies.
- Make sure the STROBE button is pressed in and set the Sequencer 1 LOOP START control to 50%. The LOOP START control acts as an offset to the incoming VCO and can be used to change the timbre of the graphic VCO.
- Patch VOLTAGE OUTPUT 1 (or 2 if that channel is being used), to a VCA and then out to a mixer or speakers etc. The VCA and VCO can be controlled externally using a keyboard and envelope etc.
- Adjust the sliders, LOOP START, attenuator level to get different timbres.

- Start the sequencer running while strobing sequencer 1 and note the effect this has on steps that are switched to SLIDE, OFF or ON. Try adjusting the TEMPO to get different effects.

COMPLEX PATTERNS USING LOOP START AND LOOP END CV



The LOOP START inputs can also be used to change the loop start point dynamically while the sequencer is running.

- Ensure none of the STROBE buttons are engaged and the sequencer is running normally when START is pressed.
- Patch VOLTAGE OUTPUT 1 and GATE OUTPUT 1 as the control for the external voice.
- Patch END PULSE OUT 2 to REFERENCE IN 4 to clock sequence 4 at a much slower rate. This is required so the change of the LOOP START CV can be observed more clearly.
- Patch VOLTAGE OUTPUT 4 to Sequencer Expander LOOP START SEQ 1 input.
- Set the LOOP START and LOOP END controls as in the above diagram.
- Set the stage switches and sliders for BANK A as in the above diagram.

You should be able to see that the loop start position changes as sequencer 4 moves through each of it’s steps.

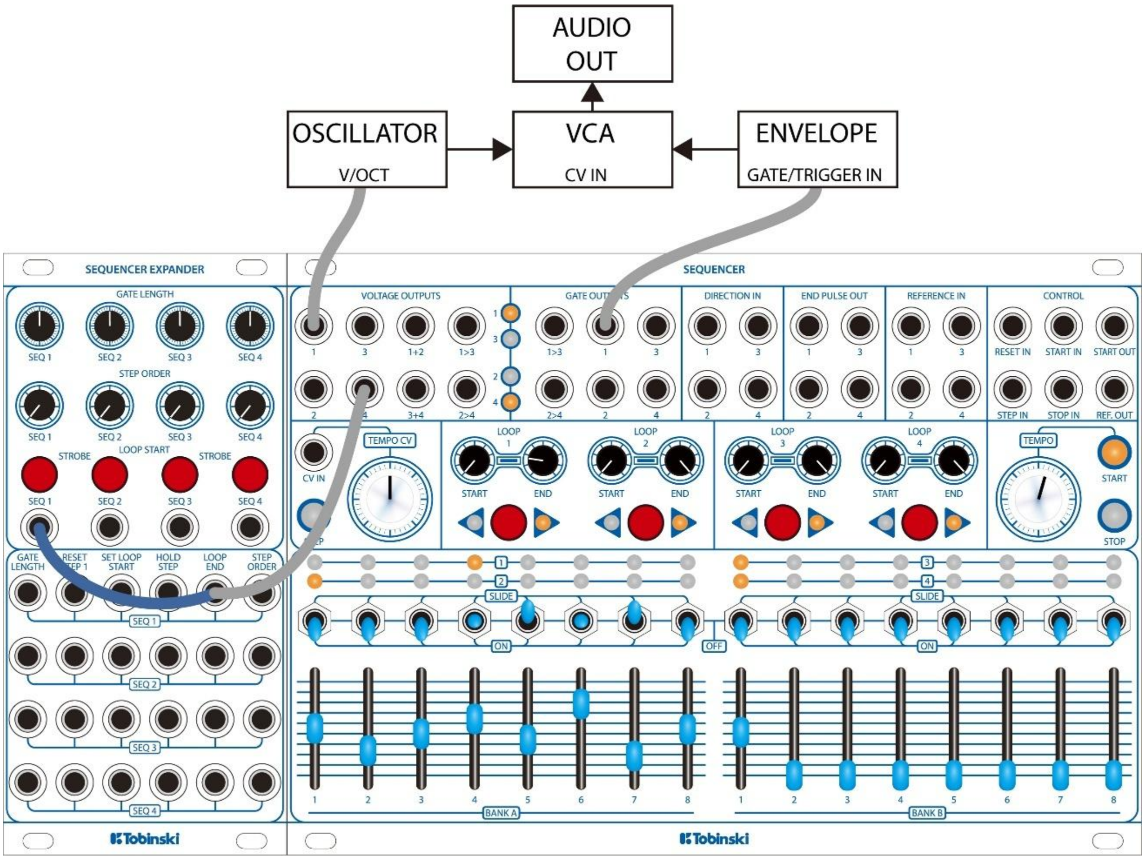
Also note that BANK A steps 4 and 6 are set to OFF and the proceeding steps 5 and 7 are set to slide. You should hear on steps on 5 and 7 the slide down in pitch which gives an accent to the steps. Try adjust the sliders for steps 4 and 6 and note how even though they are

themselves not being played they can still be used to set the starting voltage for the proceeding slide step.
Adjusting the LOOP START or LOOP END for sequencers 1, 2 and 4 will change the pattern.

You can use the same kind of patch to modulate the LOOP END point as shown with the blue cable in the above example.

It should be noted that CV control for the Sequencer and Expander, is in the range of 0V to 5V (inputs are protected so +-12V CV will not damage anything), and that the Sequencer LOOP START, Sequencer LOOP END, Expander GATE LENGTH, Expander STEP ORDER controls all produce 0V to 5V which are added to the associated CV inputs.
Therefore if, in the above example, the LOOP START control is set to step 8, then the CV from VOLTAGE OUTPUT 4 will have no effect as the control is already maxed out.
In this case you would have to invert VOLTAGE OUTPUT 4 before going into the LOOP START SEQ 1 input so that it subtracts from the LOOP START control.

LOOP SCRUBBING

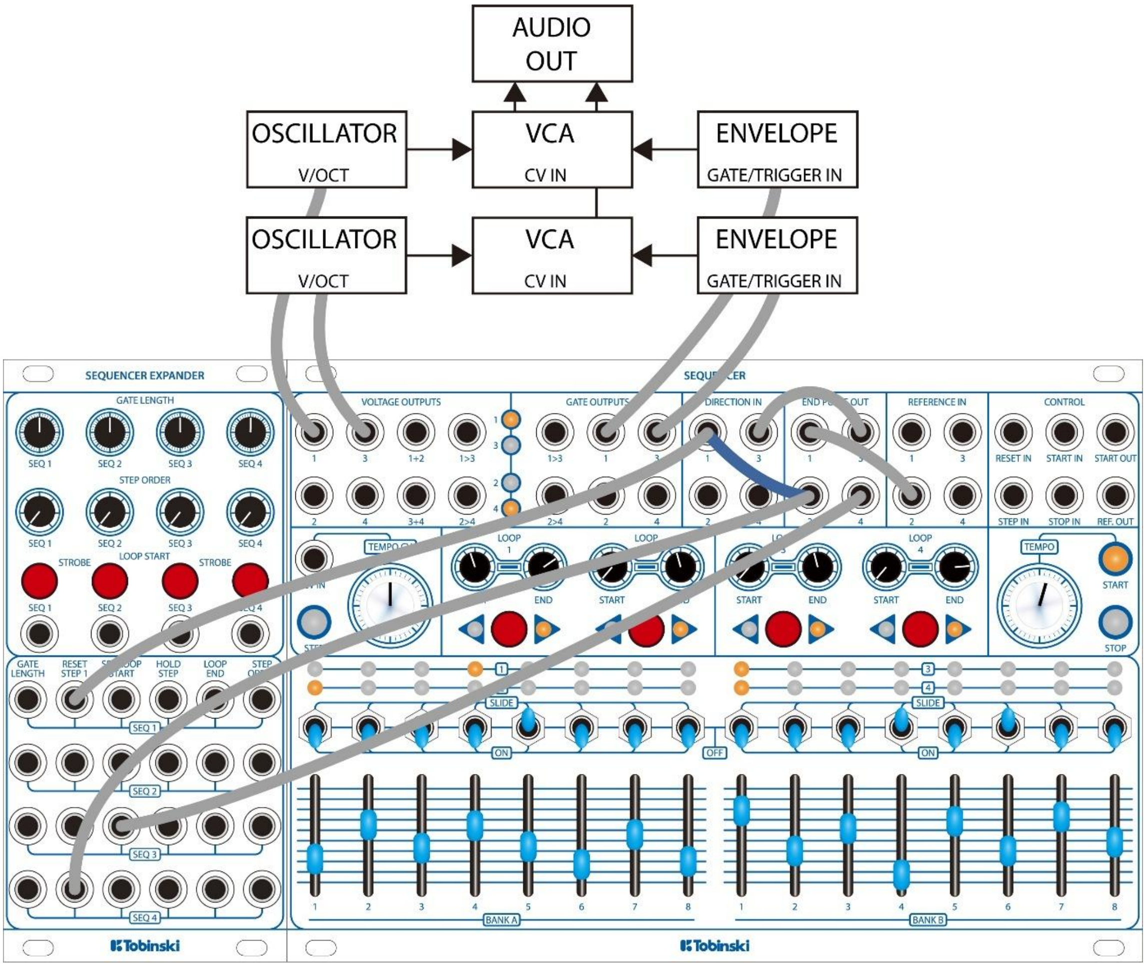


This patch is similar to the previous patch in that it uses the LOOP START and LOOP END CV inputs but in this example the CV control is just a slider used as a 0V to 5V source to scrub through a loop.

- Patch the VOLTAGE OUTPUT 1 and GATE OUTPUT 1 as the control for the external voice.
- Patch VOLTAGE OUTPUT 4 to both LOOP START SEQ 1 and LOOP END SEQ 1 inputs using a stackable or mult.
- Make sure STROBE 4 button is engaged so sequencer 4 does not run when the sequencer is running.
- Set sequencer 4 LOOP START control to step 1.
- Set sequencer 1 LOOP START control to step 1 and LOOP END control to step 2.
- Run the sequencer and adjust sequencer 4 step 1 slider to scrub through the loop.

You can try increasing the loop length of sequencer 1 or using an LFO etc as the LOOP START and LOOP END CV to automatically scrub through the loop.

EXTENDED PATTERN VARIATION USING RESET AND SET LOOP START



This is a fun patch for patterns that repeat over many bars but still retain the original melodic ideas, kind of like jamming around a theme. It uses the RESET STEP 1 and SET LOOP START Expander inputs which either set the sequence back to step 1 or back to the loop start point set by the Sequencer LOOP START controls. It should be noted that these inputs require a sharp positive going pulse to trigger the circuit, in this case the outputs from the END PULSE OUT are used.

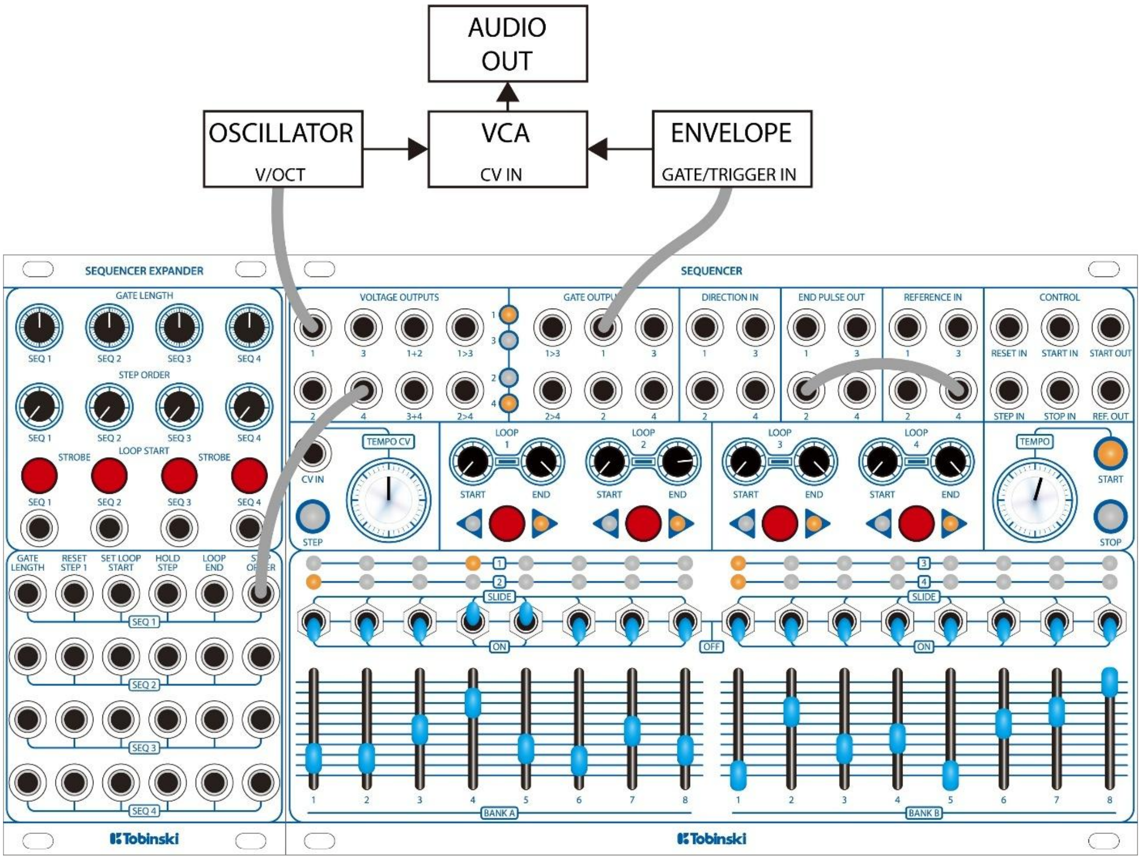
- VOLTAGE OUTPUTS 1 and 3 plus GATE OUTPUTS 1 and 3 are patched to two independent voices as illustrated.
- END PULSE OUT 2 is patched to Sequencer DIRECTION IN 1, Expander RESET STEP 1 SEQ 1 and Expander RESET STEP 1 SEQ 4.
- END PULSE OUT 1 is patched to REFERENCE IN 2.
- END PULSE OUT 3 is patched to DIRECTION IN 3.
- END PULSE OUT 4 is patched to Expander SET LOOP START SEQ 3.

The sequencer LOOP controls are set to:

- LOOP START 1 is set to step 4.
- LOOP END 1 is set to step 6.
- LOOP START 2 is set to step 1.
- LOOP END 2 is set to step 4.
- LOOP START 3 is set to step 1.
- LOOP END 3 is set to step 4.
- LOOP START 4 is set to step 1.
- LOOP END 4 is set to step 7.

Adjusting the loop lengths and manually switching direction can produces subtle variations in the patterns.

STEP ORDER PATTERN VARIATION



The STEP ORDER controls and STEP ORDER CV inputs can also be used to create pattern variation. The manual control is useful for occasional changes to give a bit of variation every now and then, whereas the CV control is great for something that is more repetitive or complex. The nice thing about this control is that the original melody or bassline etc., is retained.

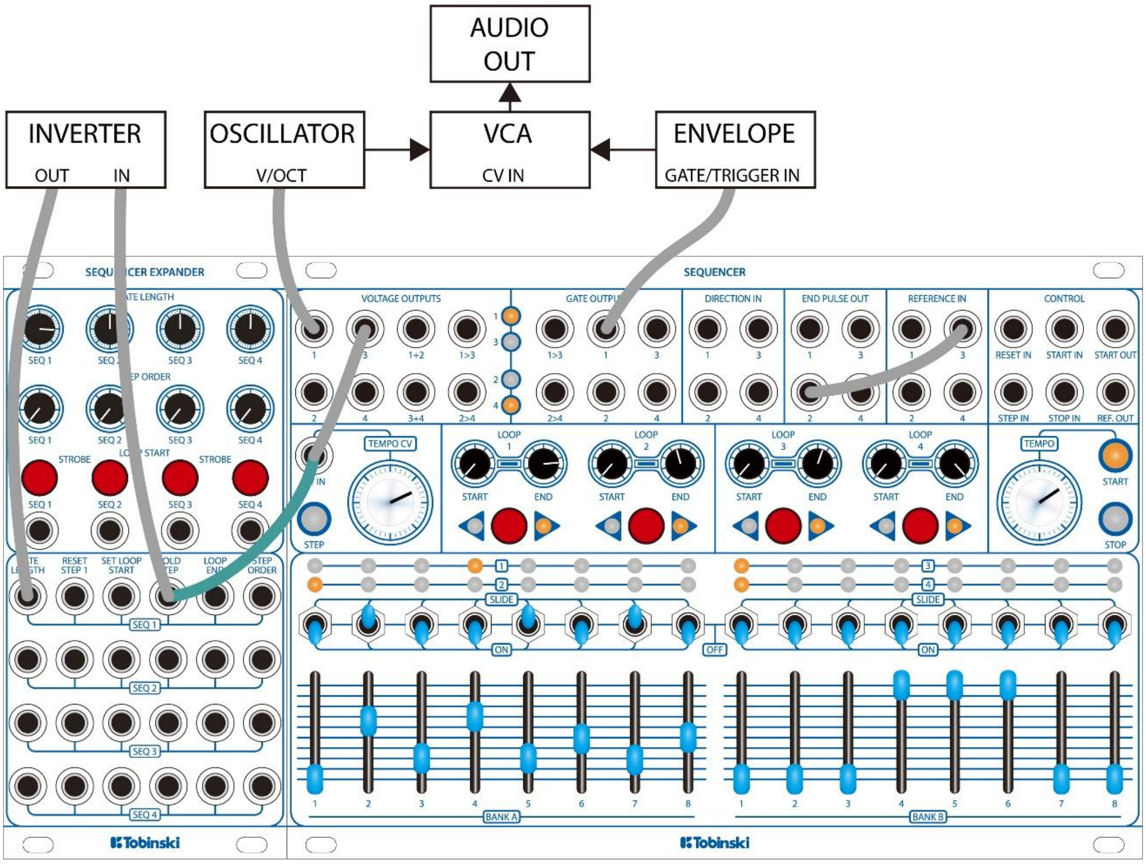
It should be noted that when the STEP ORDER control is adjusted and the step order changes, it’s not necessarily synced to the steps so some care needs to be applied when making the changes to ensure you don’t get some off beat step changes in the performance. Using a spare sequencer to make the changes and setting the stage switches to ON for that sequencer, ensures that the CV will be applied in time with the clock.

The basic settings for this patch are:

- VOLTAGE OUTPUT 1 and GATE OUTPUT 1 are patched to the synth voice.
- END PULSE OUT 2 is patched to REFERENCE IN 4 to clock sequencer 4 every time sequencer 2 completes a cycle.
- VOLTAGE OUT 4 is patched to Expander STEP ORDER SEQ 1 input.
- All LOOP START controls are set to step 1 and LOOP END to step s8 apart from sequencer 2 where the LOOP END is set to step 7 in the above example. These can all be changed and experimented with though.

This patch can be expanded further by using END PULSE OUT 1 to clock sequencer 3 and then patching VOLTAGE OUTPUT 3 to Expander STEP ORDER 4 input.

RATCHETING USING HOLD AND GATE LENGTH



This last patch uses the Expander HOLD and GATE LENGTH CV inputs as well as the Sequencer TEMPO CV input to create rhythmic ratcheting effects.

The GATE LENGTH control is slightly different to the other Expander controls in that the gate length is normal when the control is at 50%. In this example the GATE LENGTH CV is being subtracted from the GATE LENGTH control using an inverter so the gates are shorter when the HOLD STEP CV is active.

- VOLTAGE OUTPUT 1 and GATE OUTPUT 1 are patched to the synth voice.
- END PULSE OUT 2 is patched to REFERENCE IN 3 to clock sequencer 3 every time sequencer 2 completes a cycle.
- VOLTAGE OUTPUT 3 is patched to TEMPO CV IN, HOLD STEP SEQ 1 and an inverter.
- Inverter output is patched to GATE LENGTH SEQ 1.
- The BANK A and BANK B sliders should be set as shown. The BANK A sliders are just the melody so they can be adjusted to taste. The BANK B sliders control when the HOLD STEP is activated and the GATE LENGTH. Setting them to their maximum and minimum levels makes setting the tempo controls a bit easier.
- The TEMPO CV and TEMPO controls should be adjusted so that the rhythm is fairly constant.

The sequencer LOOP controls are set to:

- LOOP START 1 is set to step 1.
- LOOP END 1 is set to step 7.
- LOOP START 2 is set to step 1.
- LOOP END 2 is set to step 4.
- LOOP START 3 is set to step 1.
- LOOP END 3 is set to step 5.

Adjusting sequencers 1, 2 and 3 loop lengths produce different accent notes for the ratcheting. The settings above should allow the effect to accent different notes as the loop repeats.

SEQUENCER CALIBRATION AND TEST PROCEDURE

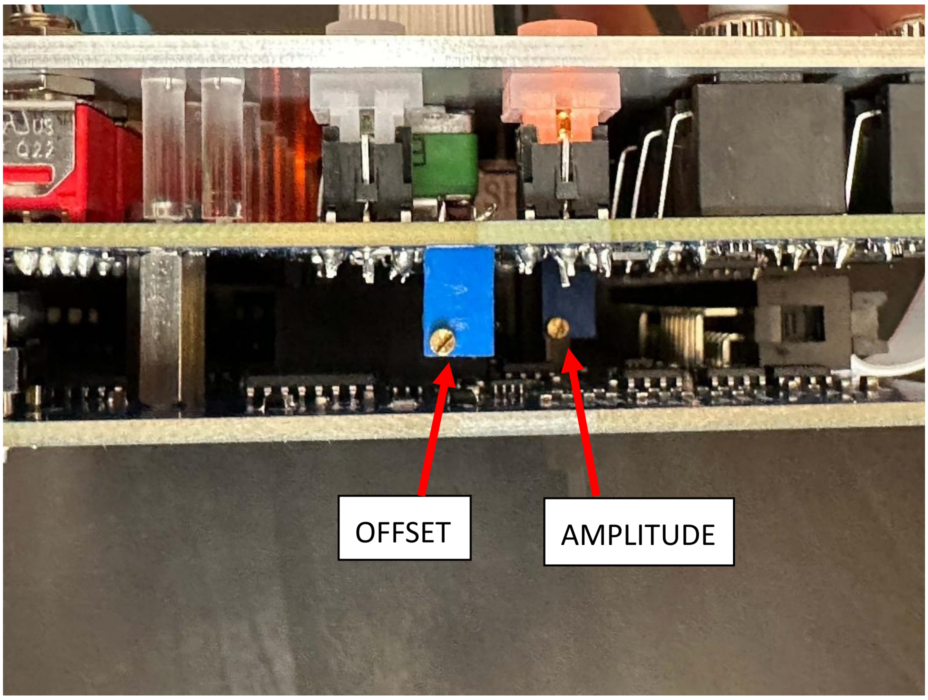
To calibrate and test the Sequencer you will need an oscilloscope, an oscillator and a trim pot adjuster.

Due to the analogue nature of the circuits it is advisable to let the sequencer warm up for at least 30 minutes before starting the calibration procedure.

It should also be noted that due to the nature of the analogue components, some calibration will not be 100% accurate. This is because the tolerances of the components for each of the 4 sequencers are all slightly different and compensating for these effects would require a lot of extra trim pots making the design not feasible.

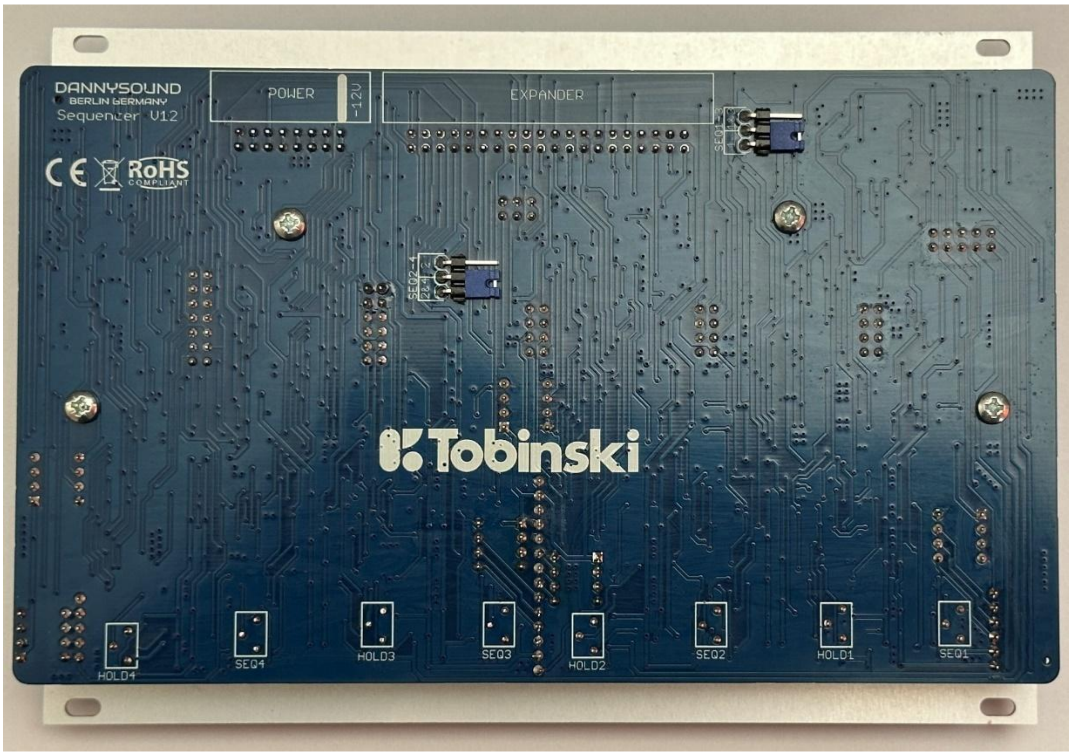
These issues are usually not so apparent in use but following the calibration procedure might help to get the best performance in the environment of the users particular set up.

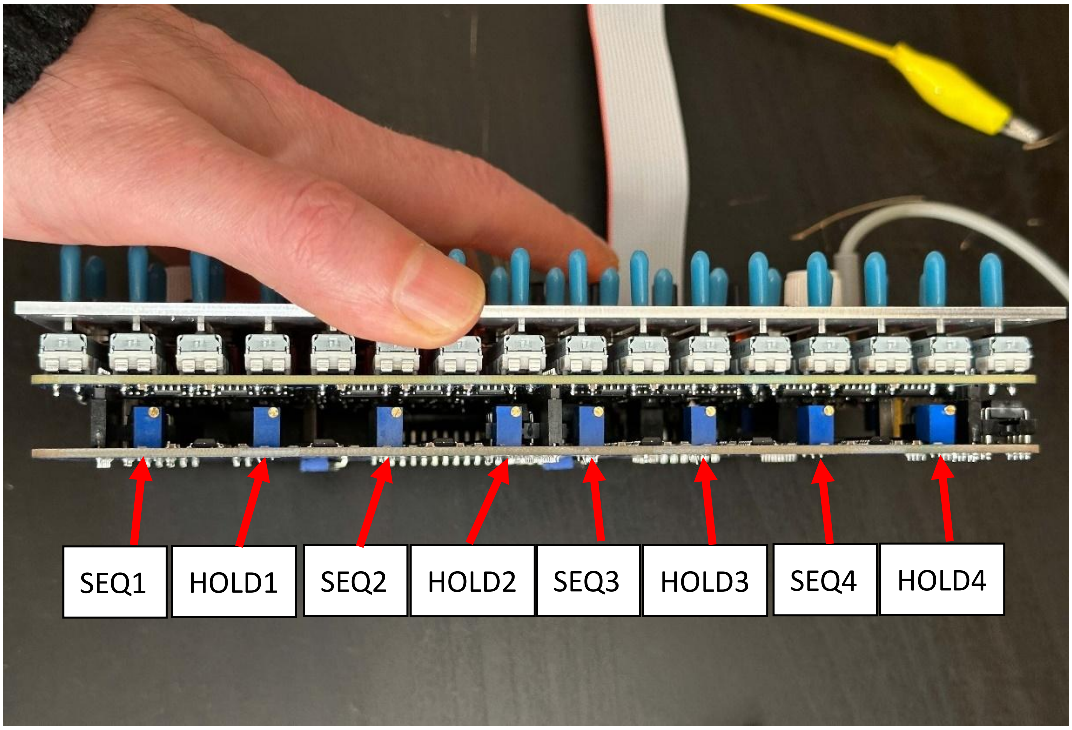
Calibrate the Reference Clock



1. Connect the REF. OUT to an oscilloscope.
2. Start the clock by pressing the START button.
3. Adjust the OFFSET trim pot so the falling ramp is centred around 0V.
4. Adjust the AMPLITUDE trim pot so the falling ramp is going from +5V down to -5V.

Calibrate the CV Outputs





Calibrate SEQ1 to SEQ4 trim pots.

1. Connect VOLTAGE OUT 1 to the v/oct input of an oscillator and make sure the oscillator can be heard.
2. Start the sequencer running and set all the sequencers LOOP START to 1 and LOOP END to 2 so they cycle only through steps 1 and 2.
3. Set sliders for steps 1 and 2 to 0 and set the switches for steps 1 and 2 to ON.
4. Disconnect the cable from VOLTAGE OUT 1 of the sequencer and listen for a change in pitch. Adjust the SEQ1 trim pot until the there is no change in pitch. Tip – The cable doesn't need to plug all the way into the VOLTAGE OUT socket, as long as the cable tip makes connection then it can be disconnected and reconnected easier while adjusting the SEQ trim pots.
5. Repeat step 4 for VOLTAGE OUTs 2 to 4 adjusting SEQ2 to SEQ4 trim pots.

Calibrate HOLD1 to HOLD4 trim pots.

1. Repeat steps 1 and 2 above.
2. Set the sliders to 50% and set step 1 switch to ON and step 2 to OFF.
3. Adjust the HOLD1 trim pot so the pitch of the oscillator stays constant.
4. Repeat step 3 for VOLTAGE OUTs 2 to 4, adjusting HOLD2 to HOLD4 trim pots.

It should be noted that setting the sliders to 50% might result in the hold voltage having a slight offset if the sliders are closer to 0% or 100%. Another point to note is that if the subsequent OFF sliders are not set to the same value as the last ON step, then a very slight drop or rise in pitch might be observed along with a slight click. This is normal behaviour and due to the tolerances of the components, in practice these effects are not really noticeable at all but for the sake of clarity it's worth mentioning.

TESTING

Sequence Steps

1. Set both the LOOP START and LOOP END to step 1 for all the sequencers.
2. Press START.
3. Note that the steps should go through all stages and repeat on step 1.
4. Increase the LOOP END to step 2 and note the sequence should loop from step 1 to step 2.
5. Repeat for steps 3 to 8 noting the loop length increases accordingly.
6. Repeat the process but adjust the LOOP START and note the loop length changes accordingly.
7. Press the DIRECTION button and note the sequence steps though in reverse order counting back from step 1 to step 8.

END PULSE OUT and DIRECTION IN.

The DIRECTION IN CV inputs are triggered using the leading edge of a pulse or square wave rather than a voltage that is above a particular level.

1. Connect the END PULSE OUT of sequence 1 to the DIR IN sequence 1.
2. Note the sequence reverses direction when the loop completes. It should be noted, if the sequence is set to loop from say step 1 to step 8 then in reverse direction it will only go 2 steps, from step 1 back to step 8, NOT from step 8 back to step 1 as in ping pong mode on other sequencers. Also note that if both LOOP START and LOOP END are set to the same step then the sequence will run through all steps back and forth but repeat on the LOOP START producing and 18 step sequence.
3. Repeat for sequences 2 to 4.

REFERENCE IN

1. Connect the END PULSE OUT 1 to REFERENCE IN 2.
2. Note sequence 2 only advances when sequence 1 completes a loop.
3. Repeat for REFERENCE IN 3 and 4 and finally REFERENCE IN 1 using the END PULSE OUT of one of the other sequencers.

CONTROL

Note – The RESET, START and STOP inputs are triggered using the leading edge of a pulse or square wave rather than a voltage level.

1. Set LOOP START of sequencers 2, 3, and 4 to step 3 and LOOP END to step 5.
2. Set sequencer 1 LOOP START to step 3 and LOOP END to step 8.
3. Press and hold START button.
4. Note how the sequences reset to their LOOP START points and repeat the steps while the START button is held.
5. Release the START button and press again.
6. Note how the sequencers run but get reset to the LOOP START points when the START button is pressed.
7. Press the STOP button once, then press it again.
8. Note how the sequencers start running again but do not get reset to the LOOP START points.
9. Increase the TEMPO control to maximum and note how the sequencers might stop running once the TEMPO is very high. This is normal as there is some filtering on the REFERENCE IN inputs to stop false triggering of steps if the clock source is noisy.
10. While the sequencer is stopped, press the STEP button.
11. Note how the sequencers advance 1 step every time the STEP button is pressed.
12. Connect END PULSE OUT 1 to RESET IN.
13. Run the sequencers and note how sequence 1 resets all sequencers to step 1 when the loop completes.

14. Connect END PULSE OUT 1 to START IN instead of RESET IN.
15. Note how sequence 1 resets all sequencers to their LOOP START point when the loop completes.
16. Connect END PULSE OUT 1 to STOP IN instead of START IN.
17. Note how the sequencer stops running when sequence 1 completes a loop.
18. Connect START OUT to the oscilloscope and note how it goes high to approximately +5V when the sequencer is running.
19. To test the STEP IN, make sure the sequencer is not running.
20. Connect the REF. OUT to the oscilloscope.
21. Connect a pulse or square wave out at an LFO rate from either an oscillator, sequencer or drum machine that is running to the STEP IN.
22. Note the wave form on the scope shows a falling sawtooth going sharply from -5V to +5V and decaying linearly down to -5V again. Increase or decrease the TEMPO control so the falling ramp is synced with the external pulse. Note – The sharp transition of the falling saw tooth is what advances the sequencer and the falling ramp part is determines the SLIDE time and the GATE length. If the TEMPO control is set too high the SLIDE time and GATE length will be very short. However if the TEMPO is set too low then the sequencer will stop advancing completely as the falling ramp gets retriggered before it reaches 0V.

VOLTAGE OUTPUTS

1. Connect VOLTAGE OUT 1 to the v/oct input of an oscillator.
2. Set LOOP START to step 1 and LOOP END to step 8.
3. Set all switches to ON.
4. Set all sliders to 0.
5. Press START and ensure each step does not change the pitch.
6. Set all sliders to 100% and ensure each step produces a high pitch, some variation might be heard but as long as they're all roughly the same it's fine.
7. Set some switches to OFF and note how the pitch of the last ON step is held. Note some variation in pitch is normal but again as long they're roughly the same it's fine.
8. Set all switches to SLIDE and adjust the sliders so that they're alternating from 0 to 100%. Note the pitch slides from step to step.
9. Repeat steps 6 to 8 for VOLTAGE OUTs 2 to 4.
10. Connect VOLTAGE OUT 1+2 to v/oct input of an oscillator.
11. Note the pitch range is increased as this output adds both sequencer 1 and 2 voltages together.
12. Repeat step 11 for VOLTAGE OUT 3+4.
13. Connect VOLTAGE OUT 1>3 to v/oct input of an oscillator.
14. Set sequencer 1 LOOP START to step 1 and LOOP END to step 8.
15. Set sequencer 3 LOOP START to step 1 and LOOP END to step 7.
16. Set sequencer 1 sliders to 0 and sequencer 3 to 100%.

17. Note the change in pitch corresponds to the LED indicator for the currently playing sequence.
18. Repeat steps 13 to 17 for VOLTAGE OUT 2>4.

GATE OUTPUTS

1. Connect GATE OUT 1 to an oscilloscope.
2. Set LOOP START to step 1 and LOOP END to step 8 and press START.
3. Set all switches to ON and note the gate pulses on the scope.
4. Set all switches to SLIDE and note gate pulses have an extended duration.
5. Set all switches to OFF and note that no gate signal is produced.
6. Repeat steps 1 to 5 for GATE OUT 2 to 4.
7. Connect GATE OUT 1>3 to the scope.
8. Set the switches for sequence 1 to ON and sequence 3 to SLIDE.
9. Note the change in gate length corresponds to the LED indicator for the currently selected sequence.
10. Repeat steps 7 to 9 for GATE OUT 2>4.

TEMPO CV

1. Connect VOLTAGE OUT 1 to the CV IN of the TEMPO CV.
2. Set LOOP START to step 1 and LOOP END to step 8.
3. Set all switches to ON and set sliders 1 to 4 to 0 and 5 to 8 to 100%.
4. Press start and set the TEMPO CV up to 100%.
5. Note how the sequencer runs faster through steps 5 to 8 and slower through steps 1 to 4.
6. Decrease the TEMPO CV to 50% and note how the sequencer runs as normal.
7. Decrease the TEMPO CV to 0 and note how the sequencer runs faster on steps 1 to 4 now and slower on steps 5 to 8.

END OF SEQUENCER TEST AND CALIBRATION!

SEQUENCER EXPANDER TEST PROCEDURE

There is no calibration for the expander but the test procedure is quite long as there are a lot of inputs to test! As well as an oscillator and oscilloscope, an adjustable DC source is required for testing. This can be achieved using the VOLTAGE OUTPUT of one of the sequencers that is not being tested and pressing the STROBE button. The slider for the step that is selected can then be used to adjust between 0V to approximately +5V.

GATE LENGTH

1. Connect sequencer GATE OUT 1 to an oscilloscope.
2. Set LOOP START to step 1 and LOOP END to step 8 and press START.
3. Set some of the switches to ON and some to SLIDE.
4. Set the GATE LENGTH control on the Expander to 50%.
5. Note the ON gate pulses are about 1/3 duty cycle and the SLIDE gate pulses are about 95% duty cycle.
6. Increase the GATE LENGTH control and note the ON gate pulse duty increases to about 95% at maximum while the SLIDE gate pulses stay at about 95%.
7. Decrease the GATE LENGTH control to 0 and note how both the ON and SLIDE gate pulses decrease in duty cycle with the SLIDE decreasing more so that at 0 there is just a short pulse from both.
8. Connect the Sequencer VOLTAGE OUTPUT of sequence 3 to the Expander GATE 1 CV input.
9. Press STROBE 3 button and use sequence 3 selected step slider to control the gate length.
10. Note the voltage at the GATE 1 CV input is added to the GATE LENGTH control setting, so if the control is at 100% then no effect will be observed. If the control voltage is negative though then the CV will be subtracted from the GATE LENGTH control.
11. Repeat steps 1 to 10 for GATE LENGTH 2 to 4 using whichever sequencer is not being used as the DC source for steps 8 to 10.

STEP ORDER

1. Set sequence 1 LOOP START to step 1 and LOOP END to step 8.
2. Press START.
3. Adjust the STEP ORDER controls from 0 to 100% and note the change in the step order as the control is increased.
4. Set up a DC source as in steps 8 and 9 of the GATE LENGTH test.
5. Connect the DC source to the STEP ORDER 1 input.
6. Adjust the DC source slider up and down and note the step order for sequence 1 changes accordingly. Note the STEP ORDER input is also added to STEP ORDER control as with the GATE LENGTH controls.

7. Repeat steps 1 to 6 for STEP ORDER 2 to STEP ORDER 4.

LOOP START and STROBE

1. Set up a DC source as in steps 8 and 9 of the GATE LENGTH test.
2. Connect the DC source to the Expander LOOP START SEQ 1 input.
3. Press the STROBE button for sequence 1.
4. Adjust the DC source slider up and down and note the steps for sequence 1 are selected accordingly.
5. Repeat steps 1 to 4 for SEQ 2 to SEQ 4.

LOOP END and HOLD STEP

1. Set up a DC source as in steps 8 and 9 of the GATE LENGTH test.
2. Connect the DC source to the Expander LOOP END 1 input.
3. Set sequencer 1 LOOP END to step 1 and note how the loop end point changes when the DC source is adjusted up and down.
4. Repeat steps 1 to 3 for LOOP END 2 to 4 using whichever sequencer is not being used as the DC source.
5. Repeat steps 1 to 4 for the HOLD STEP inputs but this time note how the sequence stops advancing when the DC source goes over approximately 50%.

RESET and SET LOOP START

The RESET and SET LOOP START inputs use the leading edge of a pulse or square wave to set each individual sequencer to step 1 or to the LOOP START step.

1. Set sequence 1 LOOP START to step 6 and LOOP END to step 8.
2. Set sequence 2 LOOP START to step 1 and LOOP END to step 8.
3. Connect Sequencer END PULSE OUT 2 to the Expander RESET 1 input.
4. Press sequencer START and note that sequencer 1 resets to step 1 when sequence 2 completes a loop.
5. Connect Sequencer END PULSE OUT 2 to the Expander SET LOOP START and note sequencer 1 is set to step 6 when sequencer 2 completes a loop.
6. Repeat steps 1 to 6 using the END PULSE OUT of one of the other sequencers to trigger the RESET and SET LOOP START of sequencers 2 to 4.