RND STEP

Thank you for choosing the RND STEP - a creative collaboration module from Steady State Fate and DivKid

Featuring three channels, comprised of:

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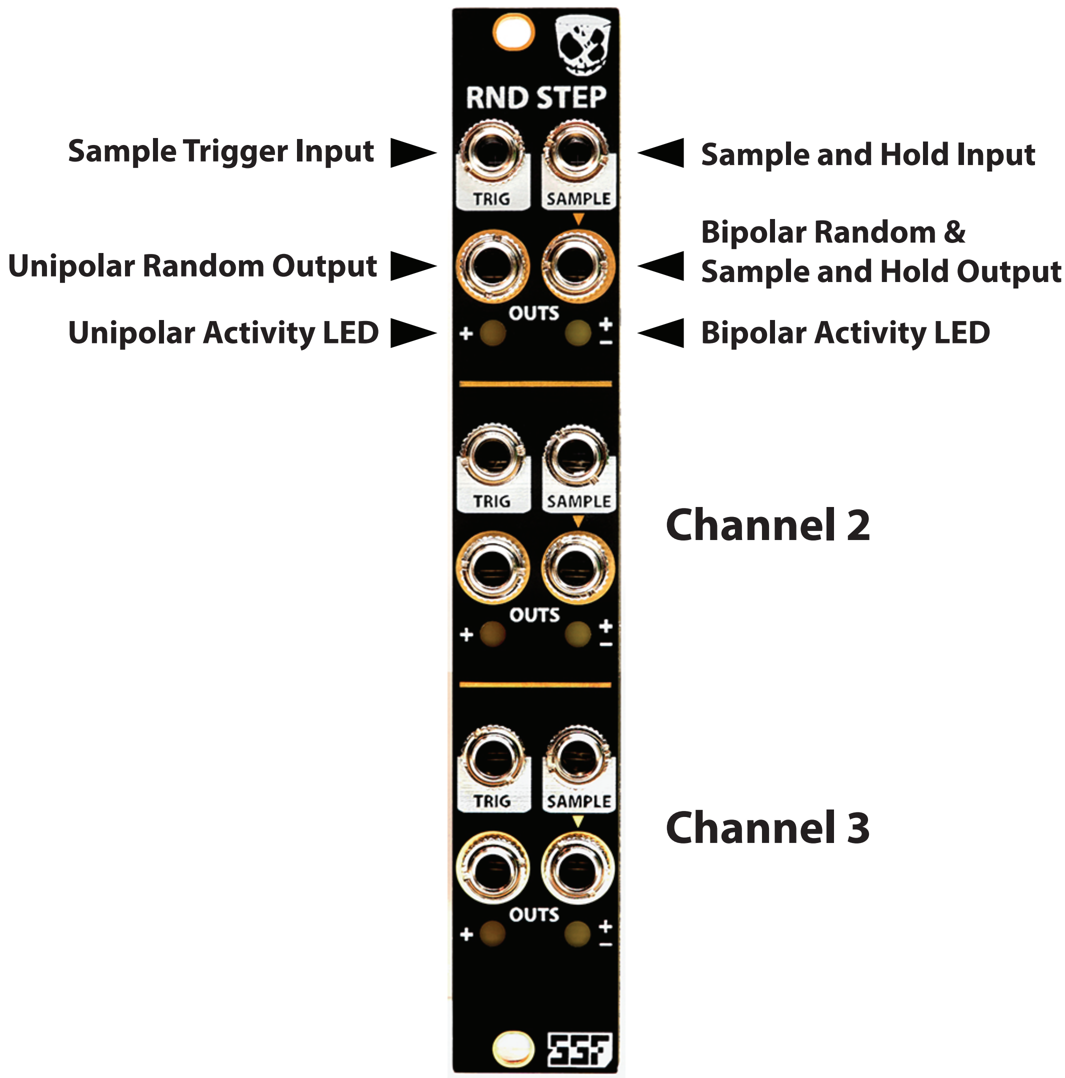
· A sample trigger input to control the sampling interval*
· Sample and hold input to sample external voltages
·Separate Unipolar [+] and Bipolar [+/-] default stepped random outputs
· Two sample activity LED indicators

**Channel 1's trigger input is normalized to channel 2 and 3's trigger inputs below*
Patching into trigger 2 and/or 3 will break the normalization



Sample Trigger Input [TRIG]

The trigger input is provided to control the two unique S&H circuits in each of the three channels. Patch a fast rising edge waveform into this input to tell the two S&H circuits to take a sample from the internal analog noise generators or signal patched into the SAMPLE input.

Many types of signals can be used to trigger the S&H. These could be standard trigger and gate sources, square waves from VCO/LFO's or Envelopes with fast attacks.

Read more about triggers in the technical section if you are unsure about proper trigger sources for RND STEP.

While each bank has a trigger input, the upper trigger input will control the lower two triggers via jack normalization. Patching into trigger 2 and/or 3 will break the normalization from trigger 1.

Unipolar Random Output [+]

The unipolar jack outputs positive random values in the range of 0 to +5V and is special because it will output 0V roughly 50% of the time. This is useful in situations where the user wishes to include a base or bottom level modulation setting in a particular patch. For instance, when scanning wave tables, controlling the level of a delay effect, etc.

The Unipolar random output is always sampling from the internal pink noise sources. Therefore, upon receiving a trigger this will always output a unique random voltage.

Sample and Hold Input [SAMPLE]

Use this input to sample external voltages in the range of -10V to +10V.

Here you have access to one of the two high-performance analog S&H circuits in each bank. Patch any CV or audio rate source into this input and use the trigger input to take a sample from it, then hold that sample for a period of time until the next trigger strikes the trigger input.

Sampled voltages will output via the bipolar [+/-] output jack, hence overriding the default, bipolar random output, described below.

Learn more about the high performance sample and hold in the technical section...

Bipolar Random / External Sample & Hold Output [+/-]

By default, the bipolar jack outputs positive *and* negative random values in the range of -5 to +5V.

Random values are sampled from a unique analog pink noise generator for each output.

If a signal is patched into the SAMPLE input, the internal noise generator is bypassed in favor of sampling the external signal.

Sample Activity LED Indicators [+][+/-]

The [+] and [+/-] LEDs indicate when a sample is taken and held by the S&H circuits.

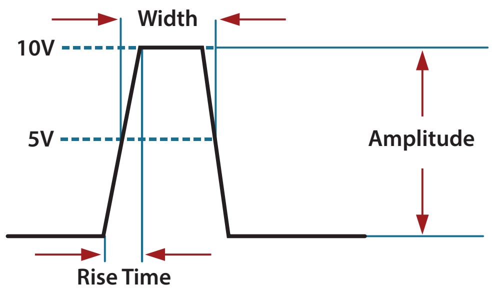
LED brightness is indicative of the voltage level that was just sampled and therefore will be dim if the sampled voltage is low and bright when the sampled voltage is high.

The [+/-] bipolar LED changes in both brightness and color; RED = positive and GREEN = negative.

Technical Information

Trigger Requirements:

In general, minimum trigger amplitude should be at least 5V and 50µs (microseconds) in length to allow enough time to acquire an accurate sample. While the majority of gates and trigger sources easily meet this requirement, other voltage sources may also be used as a trigger, as long as the above specifications are met and they have a rise time (attack speed) of 1.5ms (milliseconds) or less. Please see the graphic below for reference.



Sample and Hold:

A basic analog S&H is comprised of a trigger-activated switch and a sampling capacitor. When the trigger is active, the switch is turned on, allowing the sample source voltage to charge the sampling capacitor connected to the output of the switch. The sampled voltage is then held by the capacitor until the next time that the switch is activated and a new sample is acquired.

Accuracy

In order to achieve accurate sampling, the switch must be held open long enough for the capacitor to charge to the level of the sampled source. RND STEP's S&H circuits were engineered to achieve very accurate acquisition of the sampling source.

However, there can be a few factors affecting accuracy from time to time that cannot be avoided. This is known as sample error and can/will involve external contributions from system noise and op amp offsets - both typically only in the 1-15mV (millivolt) range. But also an intrinsic uncertainty period (jitter) during the acquisition time while the switch is opened and closed to take a sample.

Contributing factors include sample feed-through (track and hold during the sampling period), and overshoot/ringing via the on/off switching and high speed charge/discharge cycles to the sampling capacitor. For the sake of simplicity, we can sum these factors into a single term called Sample Error. RND STEP has the ability to sample very accurately with a worst case Sample Error margin of *0-80mV* as long as the proper trigger requirements are met.

V/OCT Pitch Sampling

While the sample error described above is almost undetectable when sampling most modulation voltage sources, pitch tracking applications are extremely sensitive. To quantify this, a 1 volt range of control covers 12 semitones in an octave. This means that each semitone is 1/12 of a volt or 83.33mV. Every semitone is further divided into 100 cents, equating into 0.833mV per cent of control. This is a very small amount of voltage. Thankfully, most of us cannot detect a pitch offset less than 3-4 cents (2.49-3.33mV) without a trained ear. However with this level of accuracy and the possibility of sample error in mind, we can understand the factors involved when using the RND STEP for pitch tracking.

That being said, RND STEP can and will sample pitch very well in the context of what an analog S&H is physically capable of. It is important that the user understands the process of tuning separate VCOs, the differences in how they track V/OCT and the differences in VCO stability and pitch drift - which all tend to affect tracking to the same degree as sample errors.

Please take note that when two separate VCOs are tuned to the same pitch, the pitch difference between the two manifests as a secondary beat frequency that gets slower as the two VCOs become more in tune with each other. Even a slight difference in pitch will produce a faster beat frequency between the two VCOs as Pitch CV is increased.

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One final thought when sampling pitch in critical situations is to use a quantizer after RND STEP. This can be a good option but the consideration of proper tuning and VCO characteristics still plays an important role in achieving accurate results.

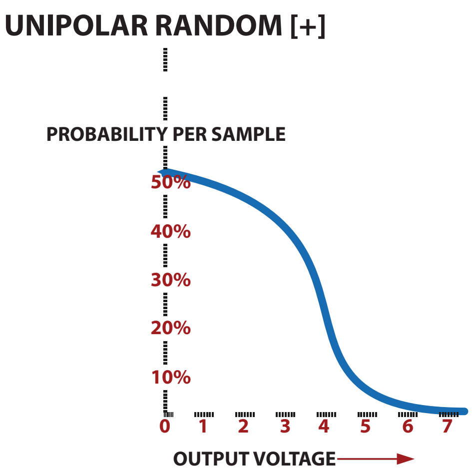
HOLD TIME (DROOP RATE)

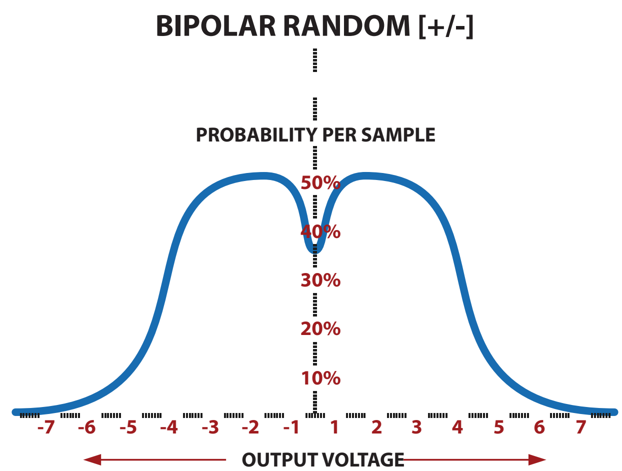
Another important characteristic of an analog S&H is the ability to hold the acquired sample constant for a period of time. While it is typically considered that the hold time for an analog S&H is generally very poor, RND STEP provides a substantial improvement over the average expected performance.

Since samples are held in a capacitor, there can be physical limitations that contribute to the sampled voltage eventually falling lower from the original value over time. This is called Droop Rate and is subject to current leakage and dielectric absorption within the circuitry, the measure of capacitance of the sampling capacitor and the input impedance of the output buffer.

Most analog S&H designs will droop at a rate of a few millivolts per second (mV/s) to tens of mV/s or even poorer performance values. Equating this into a pitch tracking scenario, this can be a number of cents to as much as a semitone or more over a few seconds. In comparison, RND STEP has an average droop rate of 60µV/s (microvolts per second) This is roughly 4mV/min, a 60-100x improvement in performance!

Random Sample Distribution





------------Normalized probability distribution when sampling the internal pink noise generators------------

Important Considerations and Technical Specifications

Due to the nature of the very high gain needed to amplify transistor noise, noise generators can pickup the signals emitted from other modules, power supplies and external radio frequencies. Having six unique noise generators equates to an antenna array and is something to consider when choosing placement of the RND STEP in your modular rack. This may or may not have any affect on performance but is still something to be aware of.

Power Requirement:

RND STEP exhibits a nominal current draw of +/-67mA. However, current spikes may exceed 120mA per rail if all Sample outputs are holding a high value and driving the LEDs into high brightness.

Width: 4hp **Depth:** 44mm (1.732”)

HUMANISE YOUR PATCHES

A favourite patch and one of the reasons the original idea came to life was to simply "humanise" a patch with lots of unique random voltages. When we pluck a string, or strike a drum it's never the same. Even when we try to be robotic and machine accurate it's not possible. So human performance leads to slight variations in all aspects of sound and we can simulate that in our patches with random voltages. Of course as with all modulation attenuation is important, even more so for very subtle "humanising" modulations.

One example would be a simple subtractive mono synth patch. Taking a pulse wave into a filter then into a VCA. If we add unique random values per step or note in a sequence to change pulse width, filter cut off, filter resonance and VCA level we'll instantly have interesting changes for every note played. If we extend that to have an LFO control the filter cut off as well as an envelope controlling the filter cut off and VCA level we could also add random voltages to LFO speed and envelope times … you can see we need lots of unique random voltages to really humanise all the patch points even in a basic mono synth style patch.

Another example of humanising would be to take a modal synthesiser or a more complex digital voice and add unique random voltages to the level and timbre of the exciter and to the decay, structure, position and brightness of say a resonator. We can compare that to a real world example of a stick hitting a drum where we can vary the position of the stick, the velocity the stick strikes the drum, the position we strike the drum head and how that affects brightness and decay of a real acoustic instrument.

ADD EXCITEMENT TO PERCUSSION

A simple and fun patch is to use noise to make hi hat sounds in a VCA and use sample and hold to modulate the decay time of the envelope controlling the VCA. It adds a lot of energy, excitement and movement to otherwise static percussion sounds. Add in a filter before or after the VCA and shape the noise tone with another random voltage moving the filter cut off and/or resonance.

AUTO CHORDAL COMPOSITION

I'm sure many of us like letting the machines compose for us. With RND STEP we can have 3 voices of pitch and level control for a three voice ever changing chordal drone. You'll need 3 oscillators into 3 VCAs and trigger the top input on RND STEP with a clock or rhythm pattern of choice. Take the unipolar outputs into a multi channel quantiser and use the quantised voltages to control the pitches of the 3 oscillators (note they'll need to be tuned tightly into unison first). Then offset the VCA levels to let the oscillators drone through and use the bipolar voltages to add more level or take more level away. If you pan the voices around the stereo field you'll have a stereo drone where each new trigger gives a 3 note chord where each voice will have a unique volume per step too … lovely with soft waveforms (sines or triangles) into a big reverb.

AUDIO RATE DESCTRUCTION - DOWNSAMPLING

RND STEP works right through audio rates which allows us to create an analogue downsampler. Patch a high frequency oscillator into the trigger input, take your audio (full patch, beat, bassline, samples etc) into the sample input and patch out of the bipolar output. Varying the rate of the oscillator at the trigger input will adjust the aliasing style overtones and pitch of the downsampling effect. To further the patch try modulating the pitch of the oscillator used to trigger RND STEP. Either with the same 1v/oct sequence as your audio into the sample input, which gives pitch tracking overtones, or with some random or fluctuating voltages to change the downsampled overtones over time.

RICH STEREO FILTERING

With a highly flexible stereo dual peak filter (two filters per side) like the Stereo Dipole we can create a rich and exciting stereo sound from simple waveforms. Patch a saw or square wave into the inputs on both sides of your stereo filter. Then set the main cut off on each side and the additional filter peaks to taste. Add 4 unique random voltages from RND STEP so that the overall filter cut off changes per side and the additional filter peaks move around too. You can use the final two RND STEP outputs to control the resonance amount per side. As always attenuate and modulate to taste. With this example sequencing your oscillator with your main clock (say 16th notes) but using a divided clock (say divide by 16) to trigger input 1 on RND STEP - you will get a new stereo filtered space and set of resonant peaks per musical bar. Experiment with different clocks and trigger patterns to the RND STEP trigger inputs.

MAKE SEQUENCES FROM MODULATION

You can create interesting and new musical patterns by sampling modulation sources. Try using a cycling envelope or LFO into the sample input and steady clock into the trigger input. Now take the bipolar output into a quantiser (maybe through an attenuator first to restrict pitch range) and use that to control your oscillators. Playing with the rate and shape of the cycling envelope or LFO, scale on the quantizer and the trigger rate of the RND STEP will lead to new sequences. A simple example would be a rising ramp LFO with a fast clock to the trigger input. This will give stepped pitches that rise much like an upward moving arpeggiator. If you sample a triangle like envelope or LFO you will get the up down style response commonly found on arpeggiators. But if the rate of the triggering and the rate of the modulation you're sampling doesn't line up in some sort of phase together you'll get continually developing and moving patterns as opposed to repetitive arpeggiator style patterns.

AUTO HARMONY GENERATOR

This is a fun patch that came about from the high performance sampling accuracy of the RND STEP. We can often sample 1v/oct pitch without the need to re-quantise after the sampling (of course use a quantiser if you experience any out of tune notes).

Start with a sequence or arpeggio pattern, I'll use the example of an arpeggio. For simplicity let's say I have a 3 note arpeggio playing the notes C Eb and G (a simple minor triad). This arpeggio will have a clock to move through the 3 notes and the 1v/oct pattern of those notes first goes into a buffered multiple. Take one copy of the pitch signal to an oscillator and add that to your mixer, this is voice 1 in the patch.

Take a second split of the 1v/oct information into the sample input on the RND STEP and take the original clock to a clock divider. If we divide the clock by 3 and use that to trigger RND STEP we're now sampling every third note in the pattern. As the pattern is 3 notes C Eb G (repeating) this will always sample the same note. Take the bipolar output from RND STEP into the 1v/oct input on a second oscillator and patch that to your mixer as voice 2.

If you have your two oscillators very tightly tuned in unison it's very likely the accuracy of the RND STEP will be giving you two voices playing musically in tune together (see above in the manual regarding pitch and how that accuracy can be affected in a modular system, use a quantiser on the RND STEP output if you need to).

But we can have more fun creating more moving lines from this simple arpeggio … If I divide the main clock by 4 I now have a 3 note arpeggio and a /4 counter part for voice 2. In this example you'll have a pattern as follows

Voice 1
C Eb G C Eb G C Eb G C Eb G
Voice 2
C - - - Eb - - - G - - -

Have fun playing around with taking a pitch sequence into the RND STEP sample in and dividing down your main clocks (generating the initial sequence) into the trigger input and using the bipolar output to grab pitches from patterns and use those to play new patterns and harmonies that create counter parts against the original sequence.

DIGITAL STYLE CLOCKED NOISE

The internal noise generators on the RND STEP are pink noise. If we trigger the RND STEP at high audio rates (from a high pitch oscillator) we'll get pink noise from the outputs. This is useful for making percussion or for modulation of various modular parameters. If you bring down the rate of the oscillator going into the trigger input the noise tone we're monitoring from the RND STEP outputs will go through various digital style crushed clock noise, similar to explosions and sound FX in retro video games.

We can make retro game explosions or interesting percussion by using an envelope to control the rate of an oscillator, the oscillator to trigger the RND STEP and taking the RND STEP output into a VCA with another envelope. This will give us a burst of pink noise that modulates down into crushed noise tones as the sound decays in the VCA.