

# SERGE

## New Timbral Oscillator

### (NTO) for Eurorack

The Serge NTO is an iconic Serge design and one of the rarest, most sought-after oscillators. To quote the original 1983 Serge catalog:



*The Serge New Timbral Oscillator (NTO) is the state-of-the-art VCO, featuring exceptional range, superb temperature stability, and accurate tracking. Dynamic depth frequency modulation and voltage control of waveform allow unprecedented control over a wide range of sound qualities.*

#### EXPONENTIAL 1 VOLT/OCTAVE RESPONSE

*Exponential response parallels the response of human hearing perception as well as musical pitch structure. With multiple oscillators, each must respond exponentially to control voltages to allow transposition from key to key and to produce alternative equal-tempered tunings such as quarter and third tones. In addition, the one-volt-per-octave response assures that the New Timbral Oscillator is compatible with most keyboard and computer controllers.*

#### ACCURATE TRACKING

*When two or more oscillators are tuned, it is expected that they will remain in tune throughout their entire range (in other words, that they track). Even two oscillators which track within a fraction of a semitone will be out of tune at the extremities of their range. Therefore, the New Timbral Oscillators have been designed so that any two will track within one cycle/second throughout their entire musical range.*

#### TEMPERATURE STABILITY

*Instability of pitch with changes in temperature is the criticism of most synthesizer VCO's. Performers are aware of the disastrous effects of temperature when they must desperately retune oscillators that have drifted during a live performance. The temperature sensitive components are kept at a static temperature by a solid-state "oven".*

## WIDE FREQUENCY RANGE

The frequency range covers from below 16 to 16Khz. With control voltages, the range can be further extended from less than 0.1 Hz (10 sec/cycle) to greater than 100,000 Hz.

## VARIETY OF WAVEFORM OUTPUTS

In addition to three standard waveforms (sine, triangle and sawtooth) of exceptional purity, the New Timbral Oscillator offers a variable waveform output providing an amazingly varied range of sounds, unavailable on any other synthesizer. This waveform is voltage controllable, allowing dynamic control of sound quality.

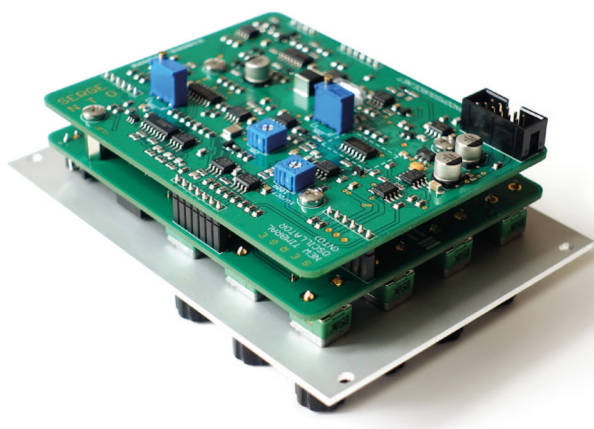
## DYNAMIC DEPTH LINEAR FREQUENCY MODULATION

Dynamic depth frequency modulation is now available to the analog synthesist. Frequency modulation (FM), the modulation of one oscillator by another, generates both harmonic overtones (found in most acoustic instrument sounds) and non-harmonic overtones (bells, percussive, and electronic timbres). By varying the amplitude of the modulating oscillator, the richness or complexity of the sound can be varied. However, with conventional FM, an annoying pitch shift occurs. With the New Timbral Oscillator, Linear FM avoids this pitch shift, making it possible to maintain accurate pitch control while changing the quality of sound. A built-in VCA assures accuracy and provides dynamic voltage control of Linear FM Depth. Of course, conventional exponential FM is also available on the New Timbral Oscillator.

The New Timbral Oscillator offers two voltage control inputs calibrated to one volt per octave and one variable voltage control input. One of the calibrated inputs incorporates a variable Portamento. This allows gliding from pitch to pitch at a voltage-controllable rate, set at each oscillator rather than from the controller (such as a keyboard), and therefore independently variable at each New Timbral Oscillator. All of the output levels are "hot", greater than +4 db to ensure maximum signal-to-noise ratio.

## New Timbral Oscillator Reloaded

It took 2 years of development, the kind help and support of a number of people - in particular of Serge himself! - and a crazy technical effort (including a multilayer pcbs, numerous precision parts and references, fancy op-amps) to bring the NTO to SMT - the R\*S version stays very close to the original NTO design, but avoids obsolete parts and features a few additions and technical improvements:

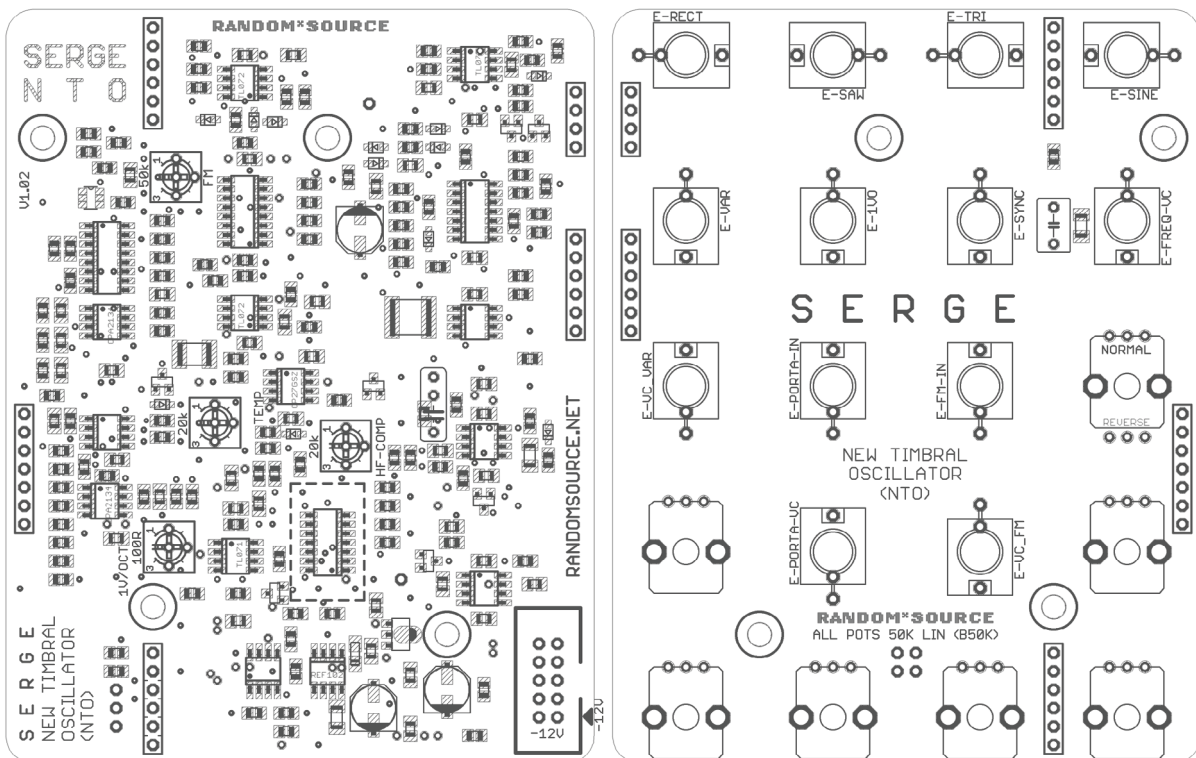


- New **PULSE output** (square wave) allows to directly trigger DSGs, drive Pulse Dividers etc.
- Oven temperature can be adjusted.
- Precision parts (like 0.1% resistors) and precision voltage references to eliminate the effect of fluctuations in temperature or power supply.
- Direction of Portamento knob can be set to taste.
- No wiring needed.

The NTO by Random\*Source is the only version licensed and authorized by Serge.

## Technical Aspects:

- Use antistatic precaution when handling the NTO pcsb - don't touch the small SMD parts and ICs with your hands.
- Only these parts have to be soldered in: 4 trimpots on the main pcb, an (optional) 470nF or 1uF film capacitor on the panel pcb, 5 pin stripes to connect the main pcb to the panel pcb, Euro power header.
- Traditionally the Portamento knob was wired so that fully clockwise there was no(!) portamento effect while CCW meant maximum. You may find this counter-intuitive, so you can set the pot behavior using 2 jumpers: vertically means classic Serge-style, horizontally means modern (turning the knob up means more effect). **You have to set the jumpers one way or the other to be able to use the knob(!)**



## Bill of Materials

### Trimmers

2	20k (25k also works for TEMP)	TEMP, HF-COMP Single-turn recommended	Trimpot (Bourns 3362P, Vishay T73YP203KT20 or anything that matches the footprint) to adjust the oven temperature and the high-frequency compensation.
1	100R	1V/Oct Single- or Multiturn	Trimpot (Bourns 3362P, Vishay T73YP101KT20 or anything that matches the footprint) to adjust the tracking of the 1V/Oct inputs. I find single turn sufficient.
1	50k	FM Single- or Multiturn	Trimpot (Bourns 3362P or Vishay T73YP503KT20 or anything that matches the footprint) (see FM Calibration).

### Misc

1	470nF Film cap	on panel pcb	(or 1uF Film), 5mm lead spacing, e.g. WIMA MK2-5
1	Euro Power connector		MTA-100 power connector, Reichelt: WSL 10G
1	SIL header 4 pol		connectors to link main pcb to panel pcb
3	SIL header 6 pol		
1	SIL header 7pol		
4	10mm standoffs +	spacers - hight should match	Not absolutely necessary
8	matching screws	the SIL headers / connectors	
13	Thonkiconn Jacks		3.5mm Jack Sockets (PJ301M-12) from Thonk
1	Potionmeter 100k or more (50k works, too)	linear (B100K, B250K or B500K) for <b>VC F</b> (Exponential FM)	Alpha 9mm vertical pcb mount - value determines knob sensitivity in the center (range is always the same)
6	Potionmeter 50k or 100k	linear (B50K or B100K)	Alpha 9mm vertical pcb mount available from Thonk, Tayda

## Building

This is simply a suggestion - you might find a different workflow more practical:

1. Solder the trimmers and the power connector onto the main pcb.
2. Solder the 470nF film cap onto the panel pcb. This capacitor is to remove any DC offsets from the signal going into the (black) Linear FM input. It is in parallel to a 100n COG cap already installed (increasing a 470nF cap effectively to 570nF), so even if you do not install the additional film cap, the LIN FM should still work. The size of this cap (combination) affects the behavior of (very) low frequency signals going in, however, there is another capacitor later in the audio path, so the effect is limited. Also, for normal audio rates, it should not make much or any difference, only if you use frequencies like 20Hz. So no need to worry about the size of this cap much. 470nF should work fine.
3. Solder pins and install 2 jumpers in the middle of the panel pcb setting the direction of the Portamento knob. Make sure you install the pins on the right side (not where the pots and jacks sit) so that you can change them without having to unmount the panel pcb.
4. Add spacers / standoffs (10mm) to the panel pcb. Spacers are not really necessary as the connectors firmly hold the main pcb anyway, but if you choose to add them, this is a good time.
5. Main pcb and panel pcb are to be connected through precision SIP socket and pins. It is recommended to use the pins on the main pcb (facing down, soldered from above) and the pin sockets on the panel pcb (standing up, soldered from the front panel side). Break or cut off the pieces you need and stick them together so that main pcb and component pcb form a nice sandwich (don't solder yet). Check that you didn't leave out any pins / holes and that the sockets are all on the same side (panel pcb). Also make sure the pcbs have the right orientation (so that the pots will sit outside!). Solder all the pins in while keeping the sandwich together - this avoids any misalignments.
6. Carefully separate the sandwich - if you used precision sockets, this may not be too easy - they stick together nicely (giving a good connection).
7. Mount the Thonkiconn jacks and the potentiometer onto the panel pcb. Pots should sit on the printed side - this side faces the front panel. **Don't solder them in yet.**
8. Carefully mount the pcb (with the pots and jacks inserted) onto the front panel. You may then have to wiggle each pot a bit to get the pots through. Make sure the threads of the pots go through completely and the pots sit right at the front panel. Screw the jacks and pots onto the panel.
9. Once everything is nicely in place, solder the pots and jacks onto the pcb (while the front panel is attached).
10. Mount the main pcb onto the panel pcb and fasten it using screws / spacers if desired.
11. Connect a power cord supplying +12V, GND, GND, -12V to the power-header on the main board and double check the direction of the power header before you turn power on. You should be ready to go :-)

# Calibration

Calibration should be pretty easy if you follow these steps - please beware that tracking is dependent of the oven temperature, i.e. changing the oven temperature requires (re-)calibration of the 1V/Oct trimmer!

## Oven Temperature and Tracking

Connect the SAW output to speakers so you can listen to any changes. **Turn the TEMP trimmer all the way down** (i.e. set the temperature as low as possible) - the pitch of the oscillator goes down as you lower the temperature. This base temperature saves energy and should work well in normal (climatic) conditions. The module will probably draw around 105mA now (depending on environment). Now feed a 1V/Octave signal into one of the inputs and calibrate the 1V/OCT trimmer. Do not touch the TEMP trimmer again (or you'll have to calibrate the 1V/Oct again!).

Beware that changing the 1V/OCT trimmer by nature always affects the pitch: start out with A1, for example, by playing that note on the keyboard and setting the pitch of the NTO to A1 (using COARSE and FINE knobs). Then play A2 on the keyboard to see how far off the pitch is (most likely you get a frequency too high or too low, i.e. the tracking is too steep or not steep enough). If you now change the 1V/OCT trimmer, you will move A1 away from the pitch you set before at the same time - however, you will increase or decrease the frequency range that a 1 octave jump in the keyboard (i.e. 1V into the 1V/Oct input) will cause. This is completely normal, so the goal is to set the trimmer so that the distance is one octave regardless of the pitch. So one approach is to keep jumping up and down 1 or 2 octaves and adjust the trimmer so that the range gets very close to the desired 1 or 2 octaves (without worrying about pitch being in tune) - any once that is fairly close to use FINE and COARSE to set the pitch precisely and then fine-adjust the trimmer for the desired precision.

If you're obsessed about getting the maximum tracking possible, make sure you have a precision voltage source (most keyboards are only roughly 1V/Oct - 1 cent corresponds to 1/1200th of a Volt) and that you also have a very precise frequency counter / tuner - many tuners are not very exact in higher frequencies. However, if you want to NTO to track over a normal, musically useable range, you should be able to get good results by ear or with a tuner very quickly.

## HF Compensation

The HF trimmer has a very subtle effect on higher frequencies - it will bring up those by a few Hz, which might be barely audible, so you may not notice its effect unless you have a fairly precise frequency counter. I personally do not care too much about HF adjustment and noticed that software tuners (e.g. in logic) do not seem to be able to handle the high frequencies affected by compensation, anyway. So HF trimming is rather optional.

## FM

**Exponential FM** is the input in the bottom left corner (with an attenuverter marked “**VC F**”). This is basically an (internal) CV processor going into a (hidden) 1V/Oct inout. **There is nothing to calibrate here.**

**Linear FM:** Unlike the PCO, the NTO offers voltage control over the Llinear FM (this is a unique NTO feature). The Linear FM section comprises the 2 jacks above the LIN FM knob. Input is the top (black) jack underneath the 1V/Oct in the center, VC input is the jack below. The FM trimmer on the pcb eliminates bleeding of a CV signal for the LIN FM section. To calibrate, feed a signal at audio range into the **white VC input (middle jack) for LIN FM** without any audio (FM input) signal going into the black input above and listen to the SAW output (pitch of the VCO). Adjust the trimmer so that the effect of the CV signal is as little as possible.

## Power Consumption

Depending on the oven setting (and environmental temperature), the NTO draws about 95mA to 115mA.

Please note that a good power supply is essential for VCO performance.

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