SERGE
New Timbral Oscillator (NTO)

The Serge NTO is an iconic Serge design. Quoting 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 temerature 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.

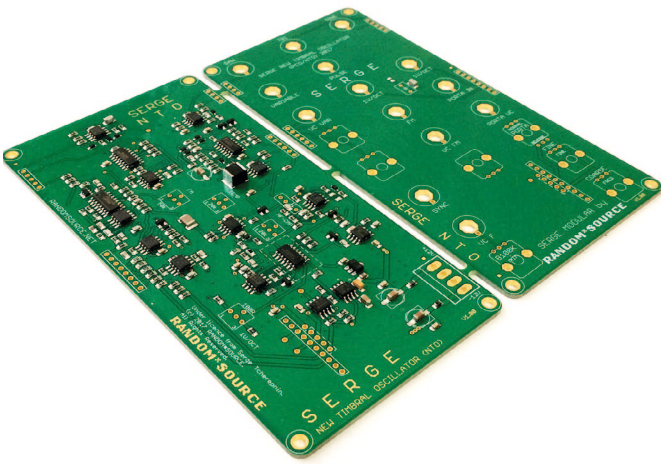
DYNAMIC DEPTH LINEAR FREQUENCY MODULATION

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:

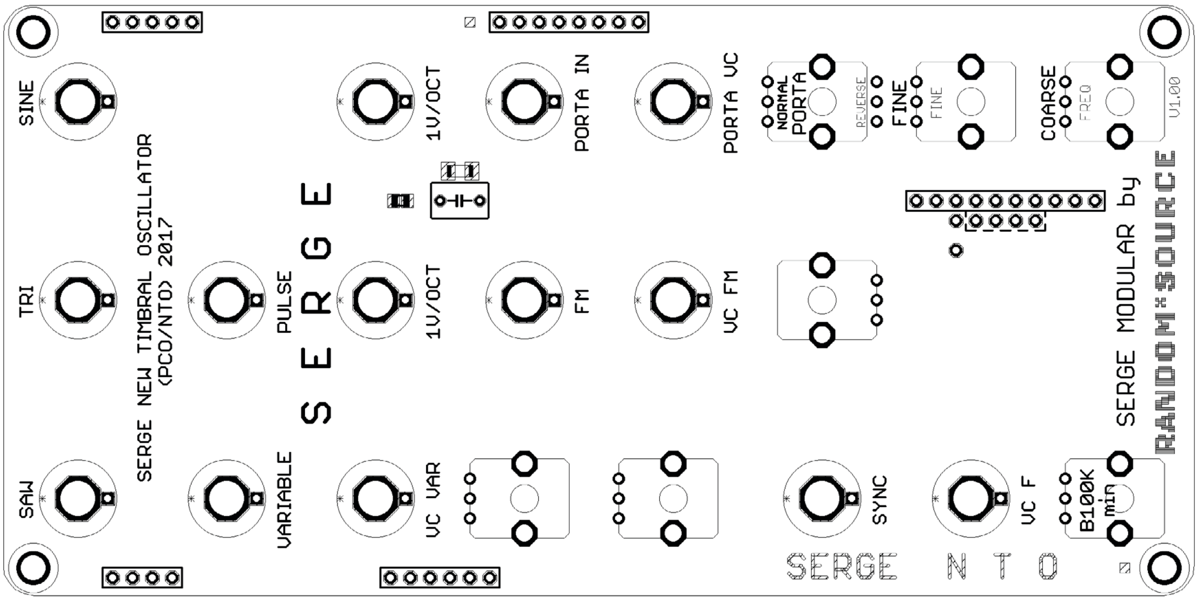


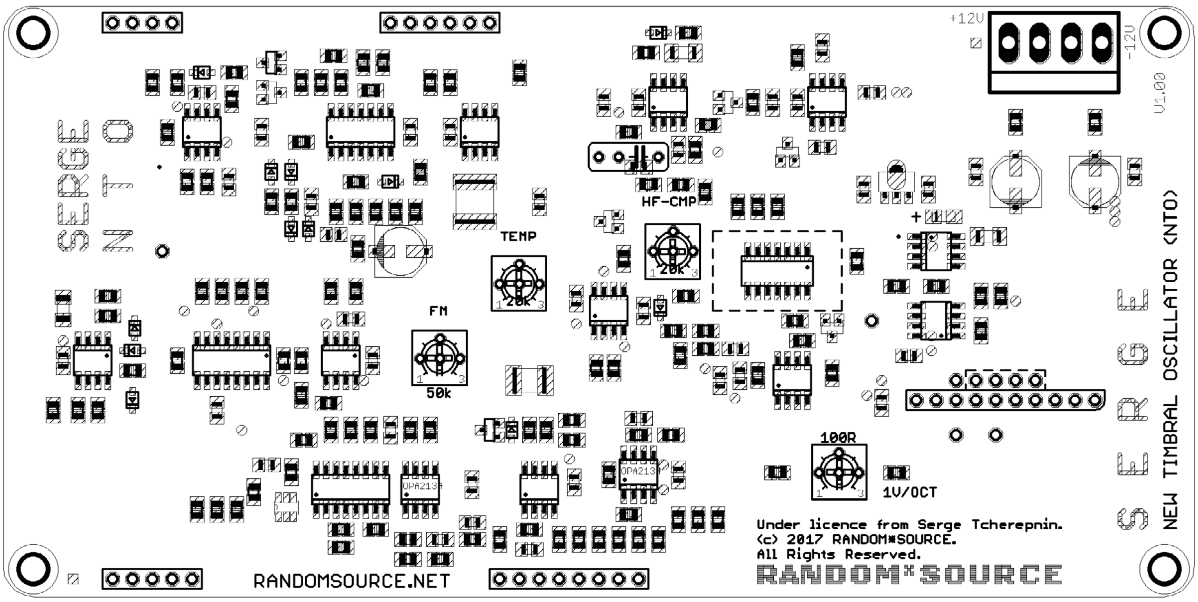
- New **PULSE output** (square wave) allows to directly trigger DSGs, drive Pulse Dividers etc.
- Oven temperature can be adjusted.
- Precision parts (like 0.1% resistors) and precision voltage references to eliminate the effect of fluctuations in temperature or power supply.
- Direction of Portamento 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 pcbs - 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, MTA-156 power header.
- Parallel to the 10-pin connector on the lower side of the pcbs is an optional 5-/ 6-pin connector. You can use this one in addition to the 10-pin connector so that power is connected via 2 pins, however, this is not mandatory.
- 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 the pot can be installed in 2 different ways. Recommended to try this out before soldering the pot.





Bill of Materials

Trimmers

2	20k	TEMP, HF-COMP	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	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	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	MTA-156		MTA-156 power connector
1	SIL header 4 pol		connectors to link main pcb to panel pcb
1	SIL header 5 pol		
1 (2)	SIL header 6 pol		
1	SIL header 8pol		
1	SIL header 10pol		
4	10mm standoffs +	spacers - hight should match	Not absolutely necessary
8	matching screws	the SIL headers / connectors	
1	Banana Jack	PULSE OUT (red)	Emerson-Johnson Mouser: 530-108-0902-1 (red) or Thonk
1	Banana Jack	SYNC (violet)	Emerson-Johnson Mouser: 530-108-0912-1 (violet) or Thonk
3	Banana Jacks	SINE, VARIABLE, LIN FM IN (black)	Emerson-Johnson Thonk / Mouser: 530-108-0903-1 (black)
9	Banana Jacks	CV / unipolar (blue or white)	Emerson-Johnson Thonk / Mouser: 530-108-0910-1 (blue), 530-108-0901-1 (white)
1	Potentionmeter 100k or more	linear (B100K, B250K or B500K) for VC F (Exponential FM)	Alpha 9mm vertical pcb mount - value determines knob sensitivity in the center
6	Potentionmeter 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. Mount the Banana jacks onto the front panel.

2. 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.

3. 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.

4. Carefully separate the sandwich - if you used precision sockets, this may not to too easy - they stick together nicely (giving a good connection).

5. Solder the FM cap onto the panel pcb. Ignore the empty resistor footprint (SMT).

6. Solder the 4 trimmers and power connector to the main pcb.

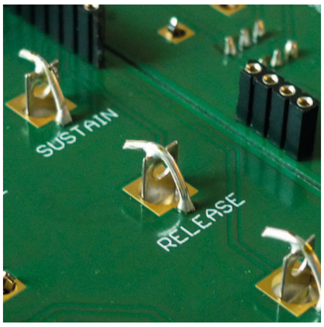
7. Mount the pots onto the component pcb. Pots should sit on the printed side - this side faces the front panel. Don‘t solder them in yet.

8. If you want to test the direction of the portamento pot, you should be able to carefully power up the pcbs (being connected and sticking together) without a front panel so you can test the direction. Same for the value of the VC F pot. If you‘re happy, separate the pcbs again.

9. Carefully mount panel pcb onto the front panel. You may 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 pots to the panel.

10. Once everything is nicely in place, solder the pots onto the panel pcb (while the front panel is attached).

11. Solder the banana jacks in. You can either solder them directly to the surrounding vias (ring round) or - which makes removing easier should you ever need to do that - by inserting a stiff (bare) wire into the little hole (via) and solder that wire to the top of the banana jack:



12. Mount the main pcb onto the component pcb and fasten it using screws / spacers if desired.

13. Connect a power cord supplying +12V, GND, GND, -12V to the MTA-header on the main board and 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 fequency 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 be 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 about 10Hz, 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. 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 LInear 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 105mA to 125mA.

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

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