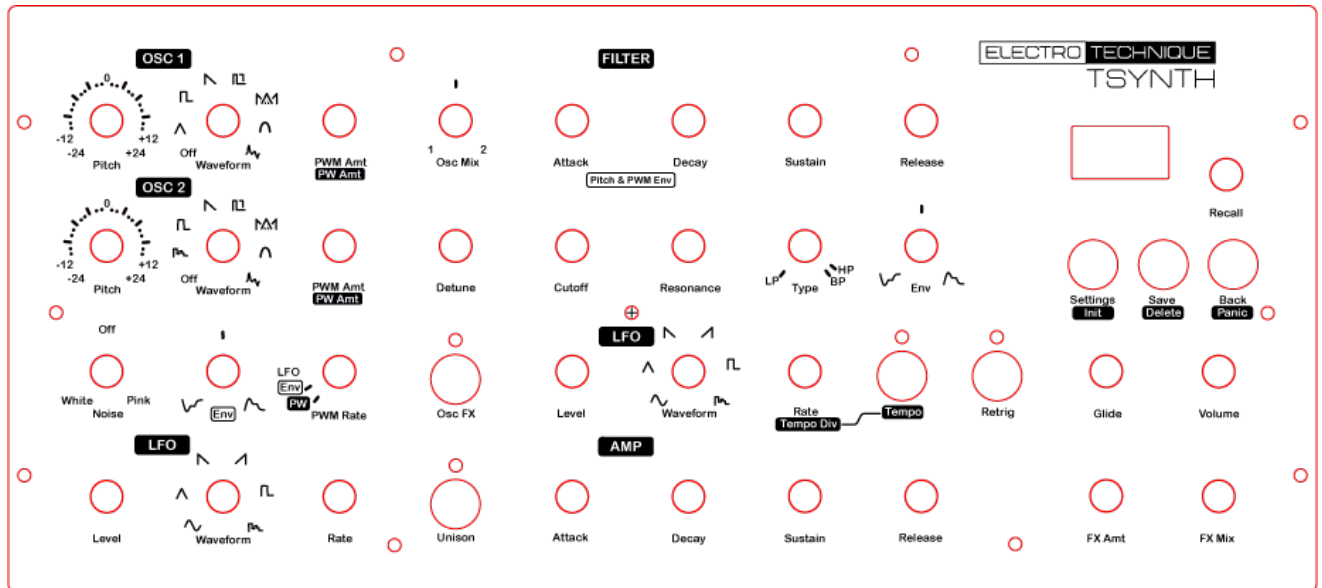# ELECTRO TECHNIQUE
TSYNTH

USER MANUAL

TSynth is a programmable polyphonic synthesizer based on the Teensy microcontroller board. The front panel is divided into distinct regions that should be familiar to anyone who has used an analogue or analogue-like synthesizer.

Oscillators

Both oscillators are identical except for the first and last waveforms. Oscillator 1 has triangle and oscillator 2 has sample & hold (which is an audible random value pulse wave.) Octave sets the pitch of the oscillator relative to the other. It ranges from -24 semitone to +24 semitones with values of -24 and -12 to +12 in semitone intervals, then +24. The waveforms available are the usual triangle, square, sawtooth, the already mentioned sample & hold, plus variable pulse, variable triangle (sawtooth to triangle to ramp waveforms), rectified sine (parabola) and harmonic (these differ on both oscillators for variety).
Pulse width may be set to a fixed value or modulated using the filter envelope or a dedicated LFO - **PWM Rate** (see section on PWM Controls.)

The volumes of each oscillator may be adjusted using **Osc Mix**, which mixes between both oscillators on full (middle) or decreasing one down to zero while the other is full. To turn an oscillator off, the waveform can be set to **Off**.

Detune detunes oscillator 2 relative to oscillator 1 and is useful for giving a thicker, chorus-like effect. This also works with **Unison**, which will detune all the voices relative to the others, up to the maximum set by **Detune**.

Noise will allow **White** or **Pink** noise to be introduced. The centre setting is **Off** and adjusting each side will increase the volume of either **White** or **Pink**.

Env is a pitch modulation applied by the filter envelope. Centre setting is none and this may be adjusted to increase a negative or postive envelope. Negative (anticlockwise) goes down then up. Positive (clockwise) goes up then down.

The oscillators have their own dedicated **LFO**. This has a **Level** control for the amount. A **Waveform** choice and a **Rate** (speed) setting. The Waveforms are sine, triangle, sawtooth, ramp (or reverse sawtooth), square and sample & hold.

Osc FX applies a Korg MS20 style, XOR type 'ring modulation' effect to the oscillators. This introduces harmonics to the sound and may not work with certain combinations of waveforms such as two pulse types. This could be expanded in future to allow other types of effect.

Unison sounds all the oscillators together when a note is played and sets the synth monophonic. As mentioned, **Detune** will set all the oscillators slightly detuned from each other up to the maximum set by the **Detune** control.

PWM Controls
Both oscillators feature variable pulse and variable triangle waveforms that can be manually adjusted or modulated by the filter envelope or a dedicated LFO.

Fixed Pulse Width / Triangle shape
Set the **PWM Rate** control to zero where it's marked **PW**. The two controls above - **PW Amt** will set the pulse width / triangle shape. The central middle setting corresponds to a square wave (50% duty cycle) or a triangle waveform depending on the oscillator waveform.

Pulse Width / Triangle shape modulation by filter envelope
Set the **PWM Rate** control to where it's marked **Env**. The two controls above - **PWM Amt** will set the amount of modulation pulse width / triangle shape receive from the filter envelope.

Pulse Width / Triangle shape modulation by LFO
Set the **PWM Rate** control to **LFO** and above. The two controls above - **PWM Amt** will set the amount of modulation the pulse width / triangle shape receive from the a dedicated LFO. **PWM Rate** will adjust the rate (speed) of this LFO. The LFO waveform is a sine wave.

Filter
The Filter section features an ADSR envelope with **Attack**, **Decay** and **Release** times from 1ms up to almost 12s, which is also used by the oscillators pitch envelope and by the PWM control, as outlined in the Oscillators section. The envelope modulates the cutoff frequency of the filter and the amount of the effect is by the **Env** control, which allows a positive (clockwise) or negative (anticlockwise) modulation of the cutoff.

The cutoff frequency is controlled by the **Cutoff** control, with resonance level set by the **Resonance** control. The **Type** control will vary the filter type between low pass (LP) through to high pass (HP) acting as a notch filter, to band pass (BP). This is known as a state variable filter and has a 12dB per octave cutoff response. Resonance may produce distortion when set to full with the cutoff at the resonant frequencies of particular waveforms.

There is a dedicated LFO for the filter with a **Level** control, a selection of **Waveform**s and a **Rate** (speed) control. Setting the **Tempo** switch to on, makes the LFO sync with incoming MIDI clock signals from a sequencer (like Ableton Live, Logic Pro etc) This also allows the **Rate** control to set the tempo divisions for a particular tempo. The **Tempo Div** control will allow the LFO to sync to a

frequency that is a division of a bar 1/16, 3/32, 1/8, 3/16, 1/4 .... for a particular tempo, in beats per minute (bpm).

Retrig will retrigger the LFO to start from the same point in the waveform every time a new note is pressed regardless of whether other notes are still held. This can be useful if you want to play a series of notes and have the filter modulate each note in the same way.

Amplifier
This is a standard ADSR envelope with **Attack**, **Decay** and **Release** times from 1ms up to almost 12s.

Saving and Naming Patches
Back button will cancel and move back to previous screen. If you make a mistake naming patches, press back button.

Save a new patch

Save ⇨ **Recall** ⇨ Turn the **Recall** encoder to select letters and numbers. Press **Recall** to select each character and move to the next one to select. Press to select final character. ⇨ **Save**

Overwriting an existing patch

Save ⇨ Turn the **Recall** encoder to select the patch to overwrite. ⇨ **Save**

Renaming an existing patch

Save ⇨ Turn the **Recall** encoder to select the patch to rename and press **Recall**. ⇨ Turn the **Recall** encoder to select letters and numbers. Press **Recall** to select each character and move to the next one to select. Press to select final character. ⇨ **Save**

Settings
Pressing **Settings** allows access to a number of patch and global level settings for TSynth. These are:

MIDI Ch. - The MIDI channel TSynth will accept incoming MIDI data on, including All (Omni on). This is global.
Key Tracking - This modulates the filter cutoff frequency as you go up the keyboard to higher notes. The idea is that the cutoff increases to allow higher frequencies to sound clearer. It can be set to None (cutoff doesn't change) Half (some effect) and Full (full effect). This is saved with the patch.
Velocity Sens - This sets the velocity sensitivity of the amplifier and has four curves:
        1 - Linear, velocity value corresponds directly to the loudness.
        2 - Curve to maximum loudness.
        3 - Curve to maximum loudness at 70 and then flatten.

4 - Curve up to maximum loudness.

Choose an appropriate curve for the keyboard response. This is saved with the patch.

Pitch Bend - this sets the pitch bend range in semitones. This is global.

MW Depth - this sets the modulation wheel maximum depth. This is like the level control in the oscillator LFO section but allows lower levels of modulation (vibrato in this case) to be applied. This is global.

MIDI Out Ch. - The channel MIDI out will transmit on. Can be switched off. Only works over USB host and client and is useful for recording parameter changes while recording a sequence. This is global.

Encoder - Choose Type 1 or Type 2 depending on how your encoder produces pulses when turning. If your encoder decrements when turning clockwise, change the type here. This is global.

Pick-up - An experimental feature that only allows a panel control and the corresponding MIDI CC control, to start changing the parameter value when it matches the current patch value. This is to prevent jumps when the control suddenly changes the parameter value. Turn the control slowly and smoothly, and the control will pick-up the current value when it gets to it and change it. An icon of a knob appears on the display when changing parameters, when this is on. This is global.

Bass Enh. - This enhances the bass frequencies using the SGTL5000 codec chip on the audio board and doesn't involve the Teensy. This will only affect audio from the headphone socket. This is global.

Oscilloscope - An experimental feature that shows what the waveforms look like. This is taken just before the stereo chorus effect. This is global.

VU Meter - This is a linear meter that shows the amplitude of the audio signal - not really VU standard. This is global.

The **Settings** menu allows scope for expansion; for example, velocity sensitivity could be set for the modulation of the filter cutoff frequency. You could set different types of filter, user waveforms, effects...

Initialisation

Pressing and holding the **Settings** button for one second invokes **Init,** which will re-read all the panel controls and set TSynth to the current panel settings.

Other Specifications

Power - 5V 180mA from USB

Digital Audio - 16 bit, 44.117Hz (for Teensy 3.6) - headphone jack and audio interface recommended for recording.

Known Issues

Occasional digital noises from audio over USB, possibly attributable to the 44117Hz sample rate T3.6 uses. T4 uses 44100Hz and will probably be better. Audio from Audio Board is fine and is recommended for recording purposes.

Plugging in a MIDI controller may alter current patch settings. Arturia Minilab for example, sends its current panel control settings when plugged in, causing MIDI CC messages to be received by TSynth, altering settings.

Low cost (sub $10) USB to MIDI converters can have problems handling clock signals and SysEx, which get mixed up with note on/off and CC messages. Use quality converters made by a known brand name.

There is a significant latency (delay) between TSynth receiving a MIDI note and hearing it on a computer via USB audio - about 100ms. For recording, use the headphone output and send through a quality audio interface featuring low latency ASIO drivers.

Troubleshooting

No sound
- Check Waveforms are not set to off and volume is mid way.
- Check filter cutoff and filter type will allow sound through.
- Pulse Width of Pulse waveforms will be quiet if set to maximum (very narrow!)
- If using digital audio via USB, check your computer. Windows sometimes doesn't pass the audio through - Go into the Control Panel, Manage Audio Devices and the Recording tab. Double-click the digital audio device and go into the Listen tab and set the Listen to this device to on - you may find it's already on and you have to toggle it off and on so it works again.

Pressing **Init** to set TSynth to the panel control current settings and with the controls set to make sound, will show if there is a problem.

Digital noises
This may happen occasionally when using the USB digital audio. The analogue audio is fine.
Not all the waveforms are anti-aliased / band limited and noise will be noticeable with higher frequencies and particularly with the variable pulse waveform. This is another area for improvement within the Audio Library. The chorus / ensemble effect may also introduce some noise.

Humming Noises
This could be attributable to ground or mains noise through the USB port if connected to a pc or an external amplifier and needs action by you see what configuration works. TSynth can be powered from a USB powerbank and played by a small MIDI controller without an attachment to the mains or a pc, this would show if noise is from the mains or possibly your computer.

SD Card problems
Use a low value (1GB is more than enough!) SD card. It doesn't need to be particularly fast and cheaper, older cards are fine. Ensure that the card is formatted as FAT16 before using it and the SDFormatter application from the SD Association is recommended:
www.sdcard.org/downloads/formatter/

Other problems
If there are intermittant problems, check the hardware. Are there dry solder joints, is the Teensy properly seated in the header socket if you used one, are the potentiometers smooth. TSynth is a DIY project and it is up to the individual to build it properly.