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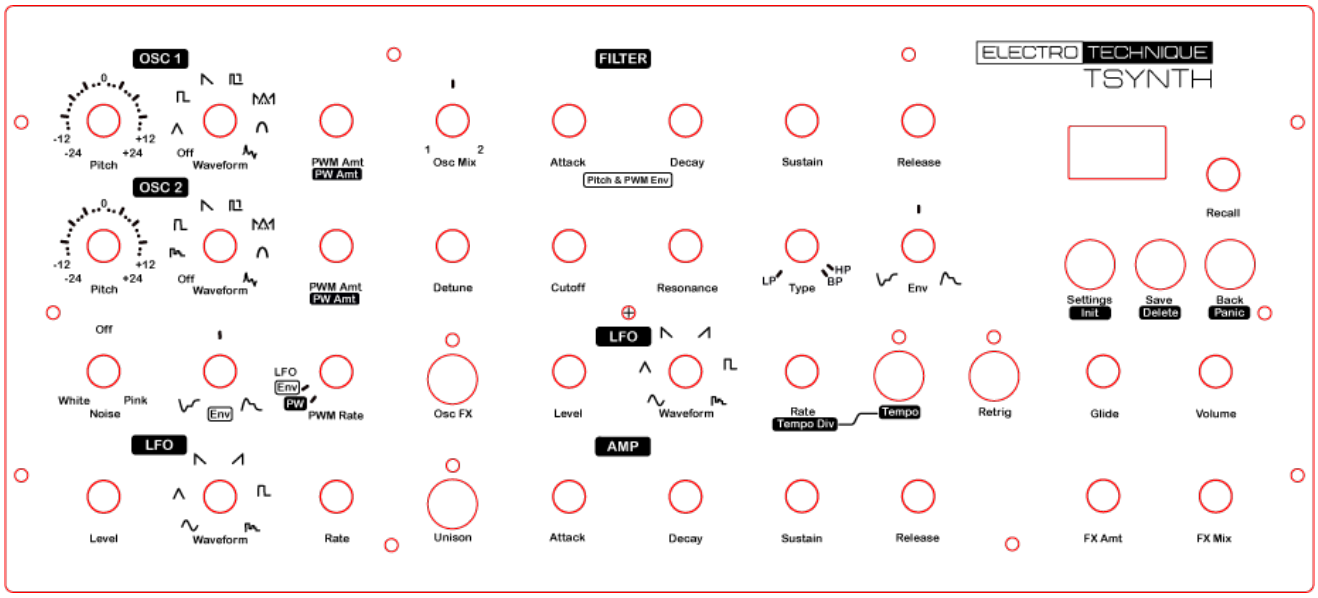
ELECTRO TECHNIQUE
TSYNTH

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.) **Pitch** 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 (this differs 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 moduulates 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). An icon [CLK] shows on the display when Tsynth receives a MIDI Clock signal. It will flash in time with the Tempo Division when this is active.

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.

SD Card

TSynth needs a FAT formatted SD card in the Teensy SD card slot. Do not use the SD card slot on the Audio Board, as there are pins used by the controls that are shared with the Audio Board. Basic, low capacity cards can be used (1GB is more than enough.) Use the SD Card Formatter application from the SD Association to format the card first. www.sdcard.org/downloads/formatter

Problems with SD cards will prevent reading and saving operations.

Operation

TSynth works like an analogue poly synth from the late 70s and 80s. Patch sounds can be stored and recalled, but when recalled, the front panel controls will probably be completely different. If you recall a patch with a long attack time and turn the control when its set to a short attack time, the attack will jump to the current lower setting. This is unavoidable, as the potentiometer controls cannot turn themselves to the current setting. A way of getting around this is called *pick-up,* where the control is turned and no changes are made until it matches the current patch setting. TSynth doesn't implement this as it wasn't considered to be a better way, however it could be implemented as an option that can be turned on or off from **Settings**. The SCI Prophet 5 for example, had a button that can swap between current patch and current panel settings. TSynth allows this be pressing and holding the **Init** button or pressing and holding the **Recall** button.

Initialisation

Pressing and holding the **Init** button for a second**,** will initialise TSynth to the current panel control settings, so that the sound it makes will be the sound the controls are set to. This means that adjusting a control will not cause the sound to suddenly change as the control snds its current value.

Go back to current patch

Press and hold the **Recall** button for a second to go back to the current patch settings, ignoring any changes made by the controls.

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**

Deleting Patches

Back button will cancel and move back to previous screen.

Deleting any patch

Hold **Delete** for one second ⇨ Turn the **Recall** encoder to select the patch to delete ⇨ **Recall**

There will be a delay as TSynth deletes the patch and then re-numbers all the patches to maintain consecutive patch numbers on the SD card.

Settings

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

MIDI Ch - the MIDI channel TSynth will accept incoming MIDI data on including All (Omni on)
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 acts globally, but patches can save this and TSynth will honour it when recalled.
Pitch Bend - this sets the pitch bend range in semitones.
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.
Encoder - often you find that some encoders will have their *A* and *B* pins swapped, so that turning clockwise will decrement instead of increment. This setting will change this so that turning clockwise will always increment.

The Settings menu allows scope for expansion; for example, velocity sensitivity could be set for the loudness of the amplifier or the cutoff frequency of the filter.

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 not sound if set to maximum (too 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 and may be due to the non-standard 44.117kHz sampling frequency used by Teensy 3.6. 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.

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 to see what configuration works. TSynth can be powered from a USB powerbank and played by a 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 FAT 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.