# The Educational DIY Synth Thing
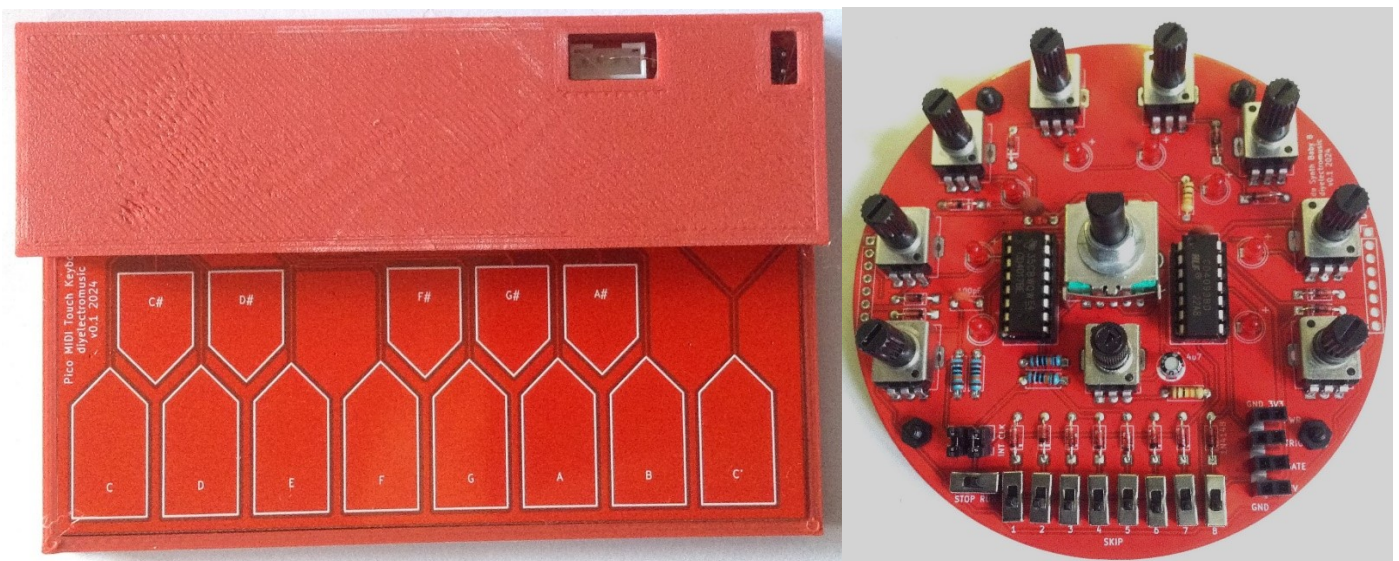
## Optional Add-on Device Projects

### Introduction

This carries on from the previous chapters and assumes that one has a working Synth Thing and has worked through all of the starter projects.

There are three sections in this chapter covering the following:

- The optional add-on touch Keyboard.
- The optional add-on "baby 8" style step sequencer.
- MIDI

In each case once again amplification and power are required as described previously.

### The Add-on Devices



The Touch Keyboard (left) and Baby-8 Sequencer (right).
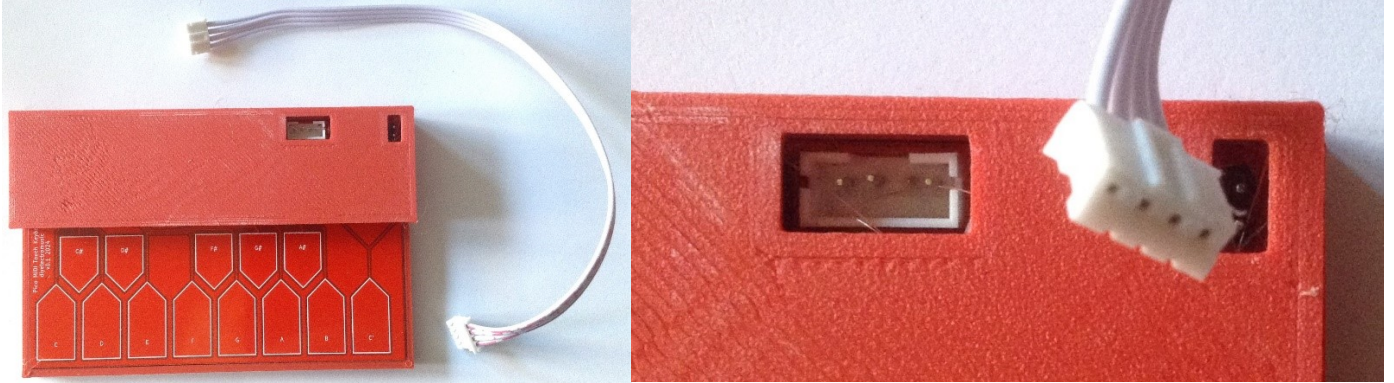
Reference Details:

- https://diyelectromusic.com/2024/07/14/educational-diy-synth-thing-part-7/
- https://diyelectromusic.com/2024/09/01/baby8-cv-step-sequencer-part-4-in-use/

# Touch Keyboard

## Basic connections and setup

Equipment required:

- Synth Thing with power and audio output.
- Touch Keyboard.
- 4-way ribbon cable with JST PH to JST PH connectors (see photo).



The cable connectors are "keyed" and can only be inserted in a particular orientation as shown above.

With the Synth Thing powered off, the keyboard can be connected as shown below.

Points to note:

- The Keyboard gets its power from the Synth Thing, so no further connections are required.
- As the Keyboard works by capacitive touch, it will work better if the person using it also touches the exposed connector at the rear.
- One option is to hold the keyboard with one hand touching the read connector and play it with the other.
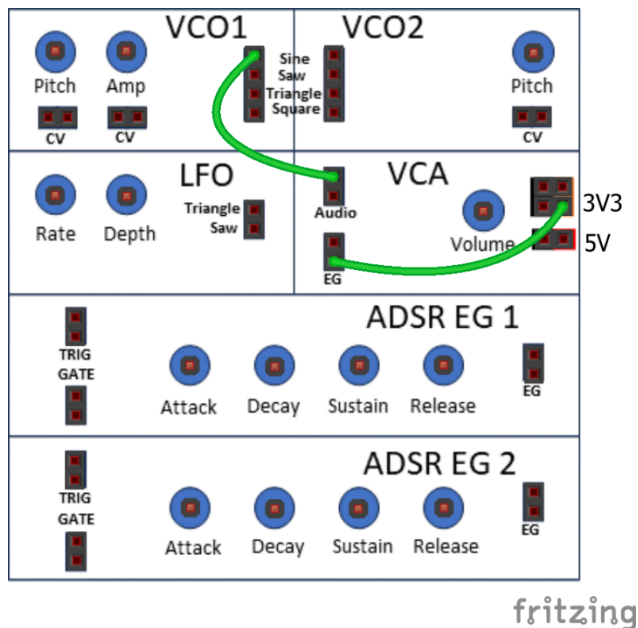
The following projects in this section assume keyboard is connected.
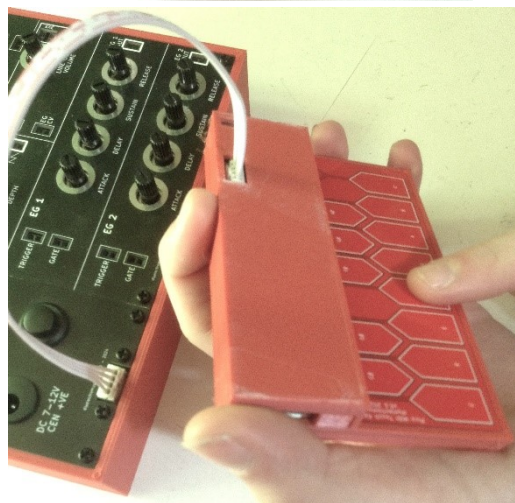
## 1. Basic Oscillator (VCO) Output

This project revisits the sounds of the individual oscillators.



Connect the wires as shown.

Recall that this provides a fixed HIGH level signal (3V3) to the VCA which means it will always be sounding – there will be no beginning or end to the sound.

Once again the output of VCO1 is fed into the audio input of the VCA so what is heard is the sound of the VCO directly.

Turn up the VCA volume and the VCO1 amplitude. Turn down the VCO1 pitch control.

Play some notes using the keyboard.

Experiment changing the VCO1 pitch control whilst playing notes from the keyboard.

Experiment with different VCO waveforms.

## 2. Dual Oscillator Output

Repeat the first experiment with the second oscillator then try sounding them both at the same time.
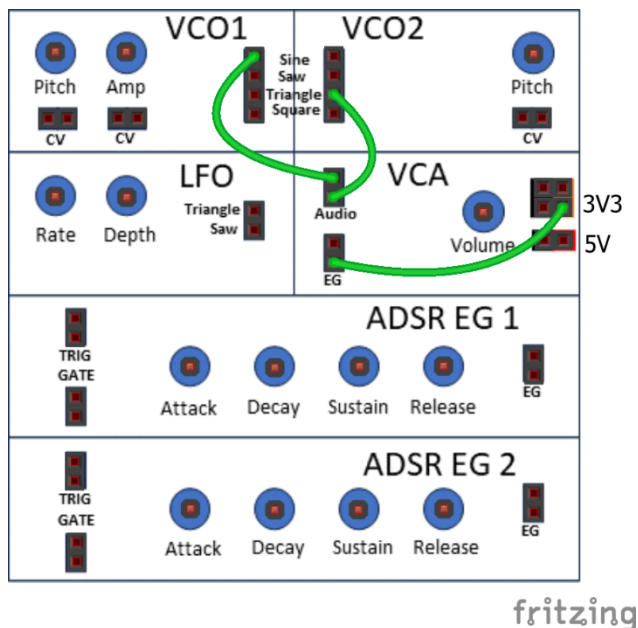


Once again connect the wires as shown, again with a constant HIGH signal into the VCA.

This now feeds the outputs of both oscillators into the VCA audio input which performs some rudimentary mixing of the two signals.

Start with both pitch controls turned right down and play some notes on the keyboard.

Experiment with changing the pitches. Experiment with mixing different waveforms.

Use the amplitude setting for VCO1 to fade that signal in and out.

Experiment with the following whilst playing:

- Detuning one of the VCOs.
- Try to get one VCO exactly one octave above the other.
- Try other intervals: a fifth, a third, something else.
- Using different waveforms for the two VCOs.

## 3. ADSR Envelope Generator

The keyboard will automatically trigger both envelope generators, so to use them, we just need to patch one of them into the VCA.
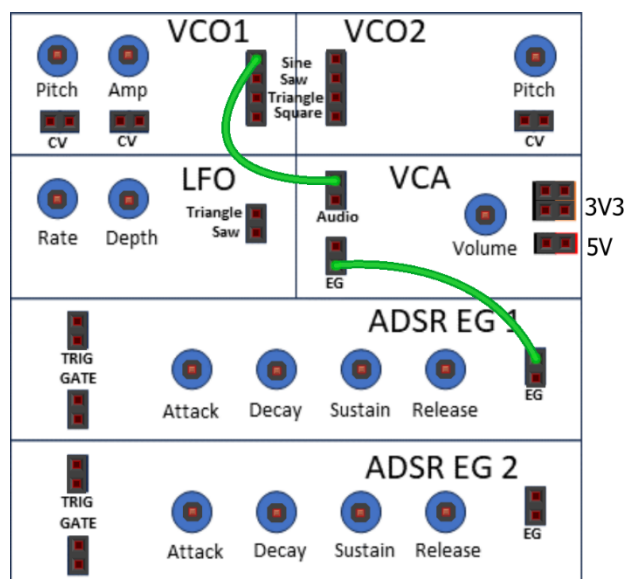


Notice that the VCA EG signal is no longer connected to 3V3 – it is now connected to the output of the first envelope generator EG1.

Also notice that unlike the projects in the first set of experiments, we don't need a wire to trigger the EG. It is done automatically from the keyboard.
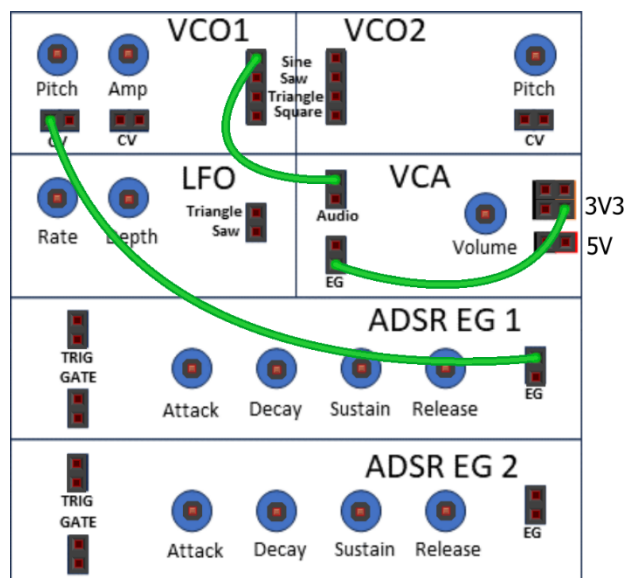
Set the ADSR knobs roughly as follows:

   A – almost fully anti-clockwise.
   D – almost fully anti-clockwise.
   S – fully clockwise.
   R – in the middle.

Ensure the VCO1 and VCA volume are turned up and play some notes on the keyboard.

Experiment with the ADSR settings.

## 4. ADSR Envelope Generator for Pitch

Repatching the VCA to the 3V3 line, we can now patch EG 1 to control the pitch of VCO1.



It is recommended that the Pitch control is turned right down and that the Sustain level is set fairly low.
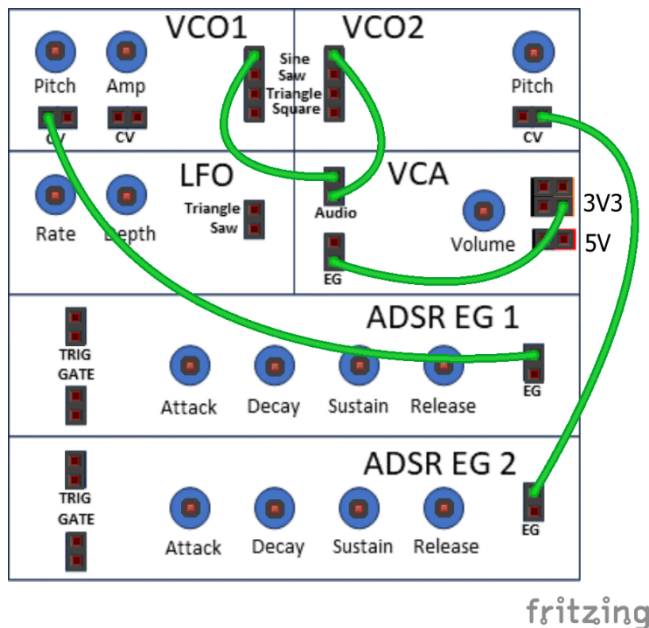
Play some notes on the keyboard.

Experiment with different ADSR settings.

See what happens when the Pitch control is used as well.

## 5. ADSR Envelope Generator – Dual Pitch Control

This repeats the previous experiment but now both VCOs are patched in and each EG is wired to control a VCO each.



Start with both Pitch controls turned right down and a fairly low sustain level on each EG.

Play some notes on the keyboard.
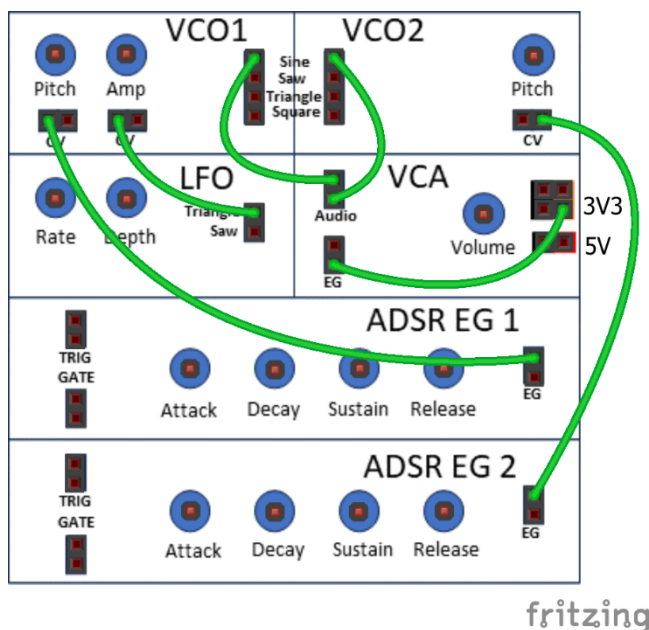
Experiment with different ADSR settings.

Experiment with detuning one of the VCOs.

Experiment with setting the VCOs to an octave.

Experiment with different waveforms.

## 6. Include the LFO

Now we add in the LFO.



Recall that to use the LFO to control the amplitude of VCO1 the Amp setting must be turned right down.

Start with the ADSR S setting pretty low once again or possibly optionally start with the EGs disconnected from the VCOs..

Experiment with all of the controls:

- LFO Rate and Depth.
- LFO waveforms.
- ADSR for both EGs.
- VCO pitch controls.
- VCO waveforms.

## 7. Final Keyboard Patch

This final patch suggests a base from which new patches might be created.
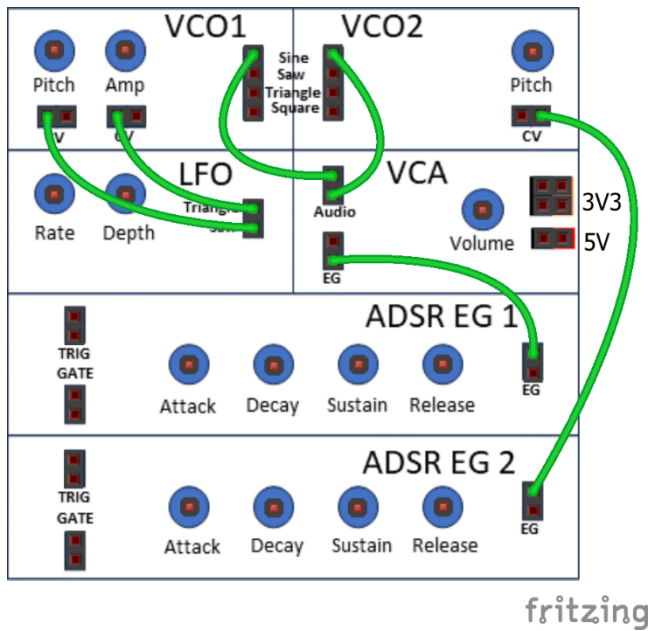


The initially suggested patch does the following:

- EG1 controls the VCA to shape the overall volume of each note.
- The LFO controls both patch and amplitude for VCO1.
- EG2 controls the pitch of VCO2.

Play some notes on the keyboard and experiment with all the settings:

- Rate and Depth for the LFO.
- Swap or remove the links between the LFO and VCO1.
- Try different waveforms for the VCOs.
- Experiment with EG1 ADSR settings to change the overall shape of the sound.
- Experiment with EG2 ADSR settings to change how VCO2 is added to the sound.
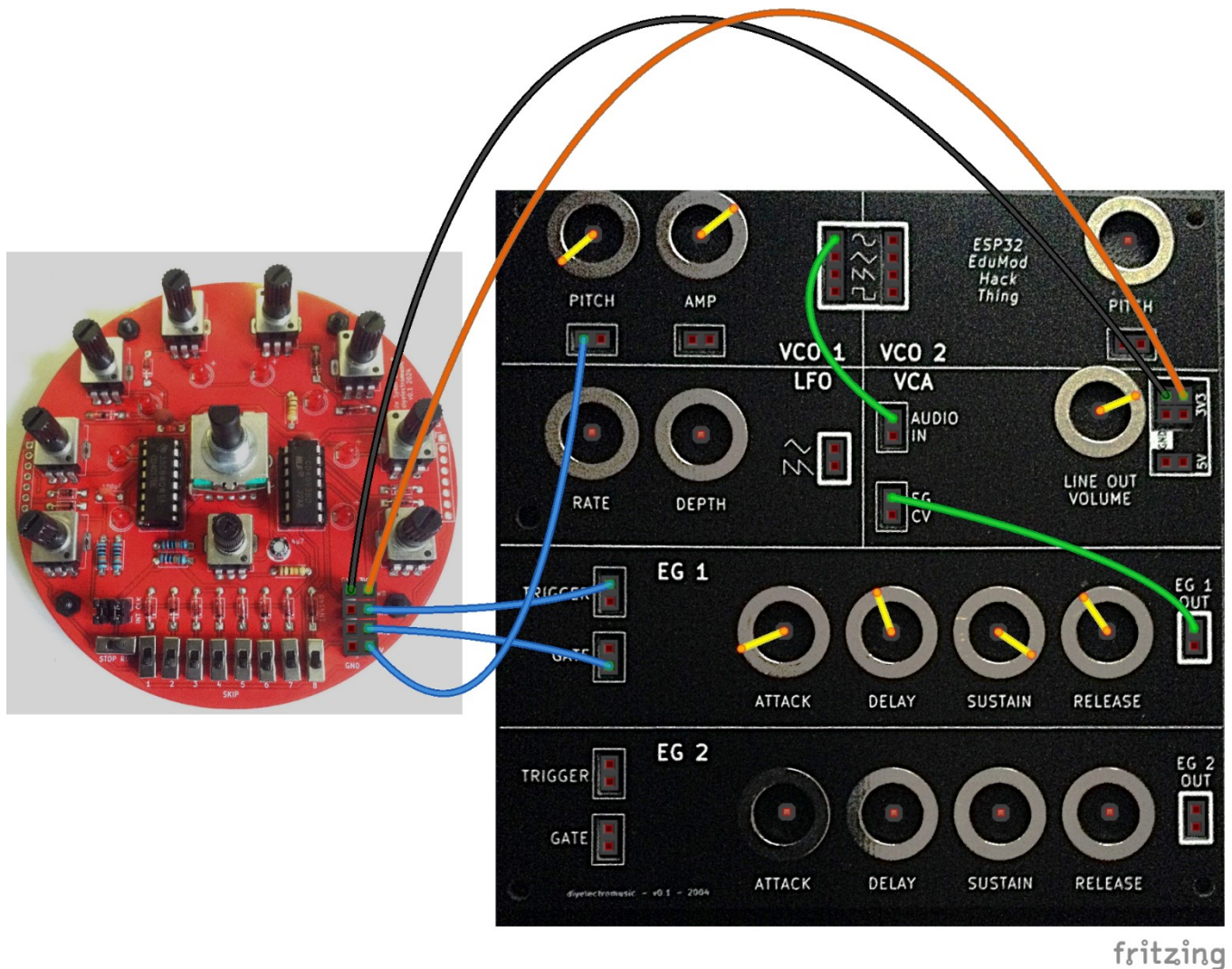
# Baby-8 Sequencer

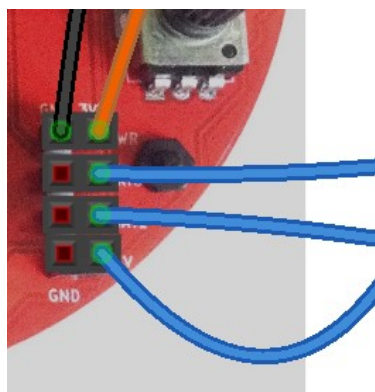## Basic connections and setup

Equipment required:

- Synth Thing with power and audio output.
- Baby-8 Sequencer.
- Jumper wires.

The basic connection is shown below. Note that the Baby 8 is powered from the 3V3 connection of the Synth Thing.



There are three outputs from the Baby 8 as shown in the detail below:



From top to bottom, the connections are:

- GND and (3V3) Power INPUT
- TRIGGER OUTPUT
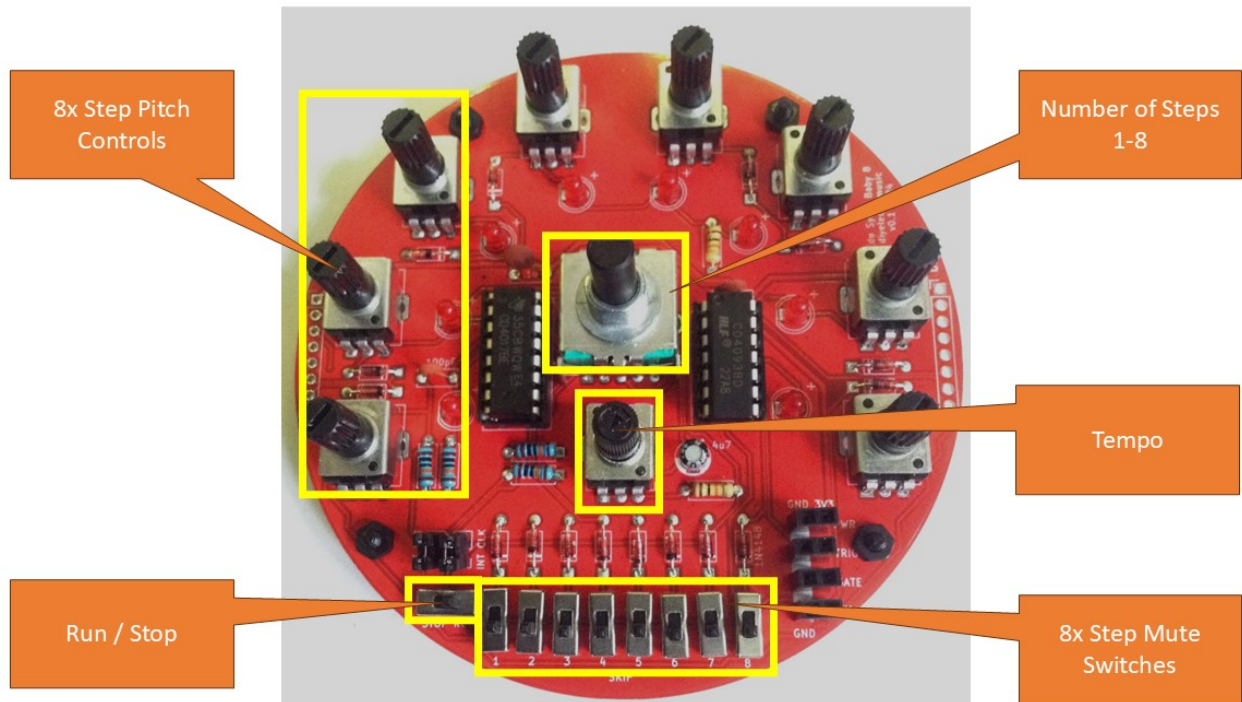- GATE OUTPUT
- CV (Control Voltage) OUTPUT

## Baby 8 Basic Use

With the connections as shown overleaf, this will explore the basic operation of the Baby 8.

Key principle of operation:

- The Baby 8 will provide pitch CV and GATE/TRIGGER signals to the Synth Thing.
- The Synth Thing will provide power to the Baby 8.

The following highlights the main controls for the Baby 8.



### Number of Steps

- This determines how many steps will be played in the sequence. Up to 8 steps can be included, which corresponds to the knob be turned fully clock-wise.

### Tempo

- The speed of the sequence is set using the tempo potentiometer. Turning clockwise increases the tempo.

### Mute Switches

- Each step can be individually muted (or skipped). Note, this only prevents the GATE/TRIGGER output triggering - the CV will still be set to the pitch according to the position of the corresponding knob.

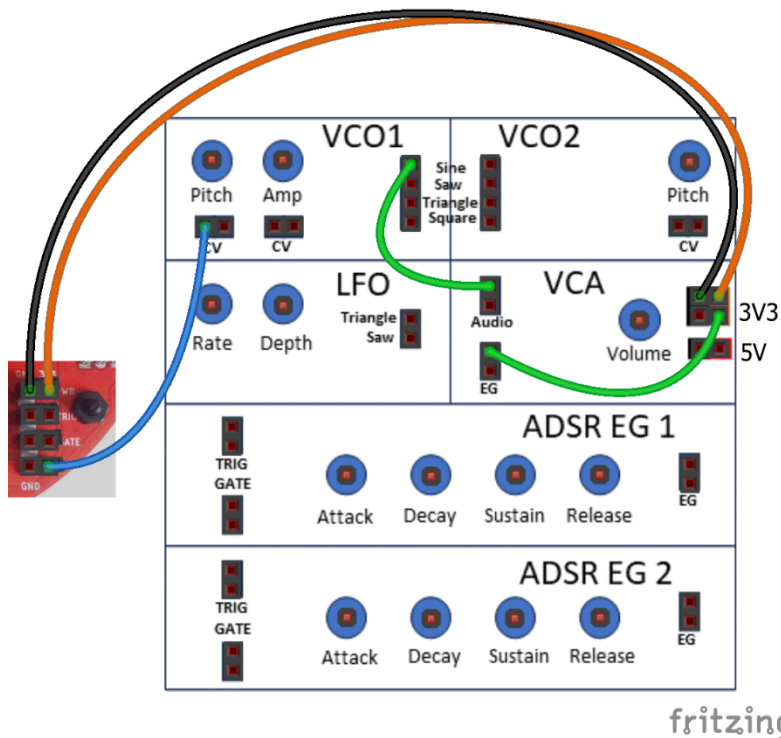### Run/Stop

- This can be used to pause the sequence.

### Step Pitch Controls

- There are 8 potentiometers around the edge of the Baby 8. These are used to set the pitch of the corresponding step. Turning clockwise increases the pitch. Each step has a corresponding LED.

## 1. Simple Pitch Sequence

This explores the most basic use of the Baby 8 – controlling the pitch of a VCO.



As with all these projects, the Baby 8 is powered from 3V3 and GND from the Synth Thing.

Only the connection points of the Baby 8 are shown.

The VCA has a constant HIGH level, so is always on and the VCO1 Sine OUTPUT is connected to the VCA's audio input.

Set up the Synth Thing as follows:

- VCO1 Pitch control turned right down (anti-clockwise).
- VCO1 Amp control turned right up (clockwise).
- VCA Volume control turned right up (clockwise).

On the Baby 8 turn the Steps Switch fully clockwise to run through all 8 steps.

Ensure the Run/Stop switch of the Baby 8 is in the RUN position (to the right).

Experiment changing the Tempo switch and the 8 pitch controls for the different steps.

Change the number of steps using the rotary switch.

Note that the mute switches do not function when the TRIGGER/GATE outputs are not in use.

## 2. Dual Pitch Sequence

This repeats the first experiment but adds in the second VCO.
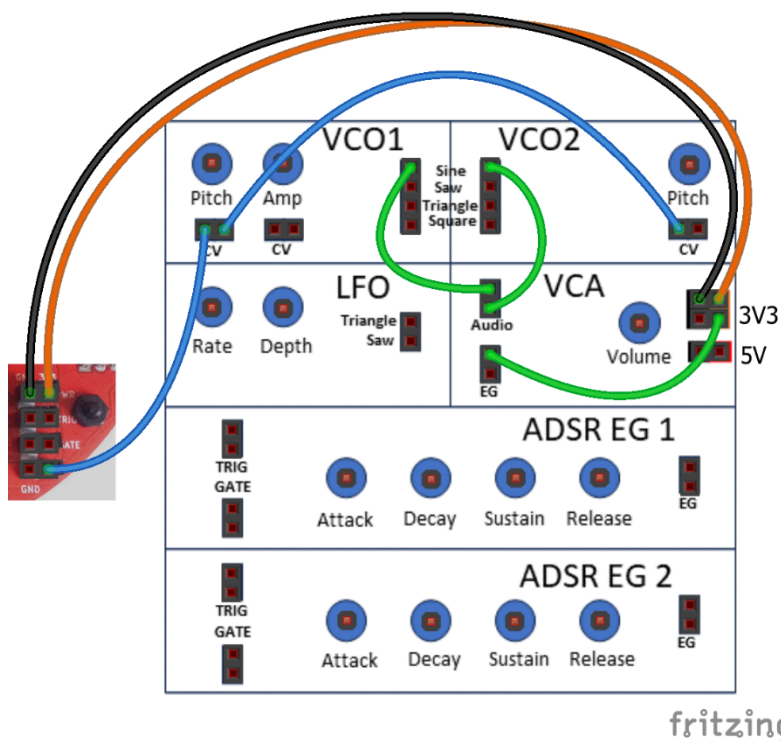


Two additional connections are required:

- Passing the Baby 8 CV onto VCO2.
- Sending VCO2 to the VCA.

Start with the Pitch controls turned right down on both VCOs (fully anti-clockwise).
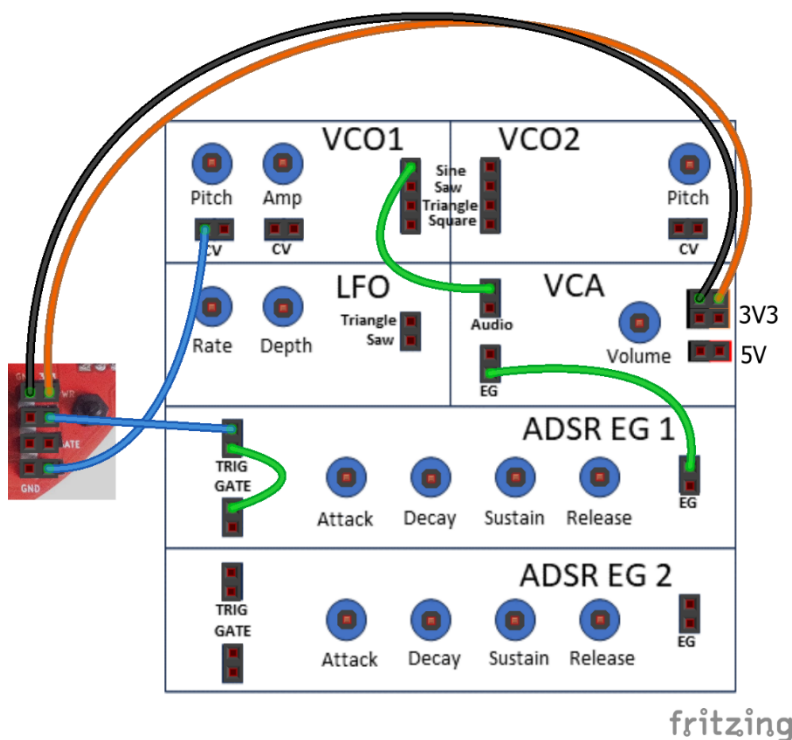
Create a sequence on the Baby 8.

Slowly detune VCO2.

Experiment with different settings for the VCO Pitch controls.

Try the different waveforms.

### 3. Baby 8 Trigger

To initially explore how the Baby 8 can TRIGGER the Synth Thing, first wire up the TRIGGER OUTPUT as shown below.



The Baby 8 GATE OUTPUT is a continuous signal whenever a step is playing, but the TRIGGER OUTPUT is a shorter pulse.

To see how the Baby 8 can both start and stop notes with the Synth Thing, we're using the TRIGGER OUPUT connected to both the GATE and TRIGGER INPUT. This means that the Envelope Generator will have time to both start and stop the envelope for each individual step.

Set the ADSR for a short A, short D, high S and reasonably short R.

Turn VCO1 Pitch right down and VCO1 Amp right up.

Create an 8-step sequence on the Baby 8 and turn the tempo down for a slow sequence.

Experiment with the effect of the ADSR settings on the playing sequence.

Notice how a quicker tempo will make it more difficult to complete the complete ADSR envelope if the settings are too long. In particular a long A or R stage will start to eventually overlap with the next step in the sequence.

Try muting some of the steps and see how that affects the playing sequence.

### 4. Baby 8 Trigger and Gate

Finally connect both TRIGGER and GATE to the Synth Thing.
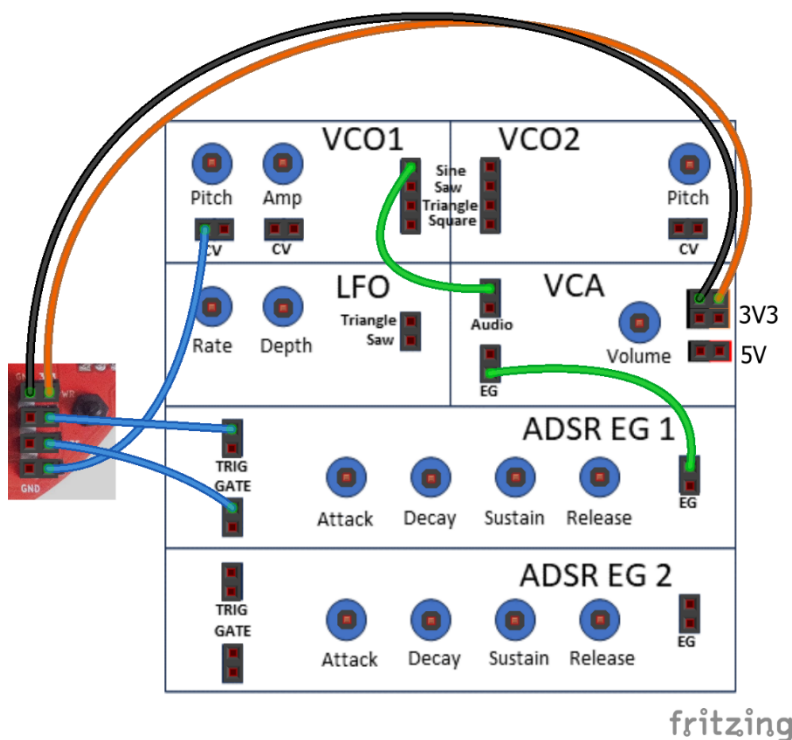


The basic operation will be quite similar to the previous experiment, but without the GATE ever releasing between the steps of the Baby 8, the Envelope Generator will never start its Release phase.

This makes the interaction somewhat complex.

Once again start with a short A, D and R and a slow tempo.

Experiment with muting some of the steps, starting with muting steps 2, 4, 6 and 8, effectively making the Baby 8 a 4-step sequencer with gaps.

See how the ADSR reacts to the GATE signal coming and going as steps are muted.

Whilst a TRIGGER and GATE are provided by the Baby 8, when being used with the Synth Thing, really using the GATE signal is probably not as useful as only using the TRIGGER, except for some quite specialised cases. For further experimentation it is recommended that only the TRIGGER is used.

# MIDI

The Synth Thing supports a TRS ("Type A") MIDI INPUT jack.  In fact the Touch Keyboard described earlier is actually a MIDI keyboard and is using MIDI to control the Synth Thing.

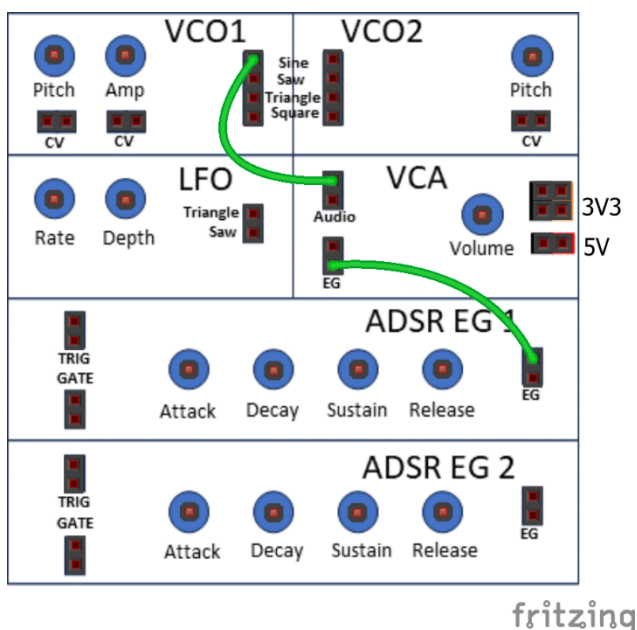To use with a traditional 5-pin MIDI device will require a MIDI DIN to TRS Type A converter cable.

The basic connectivity for MIDI is as follows:
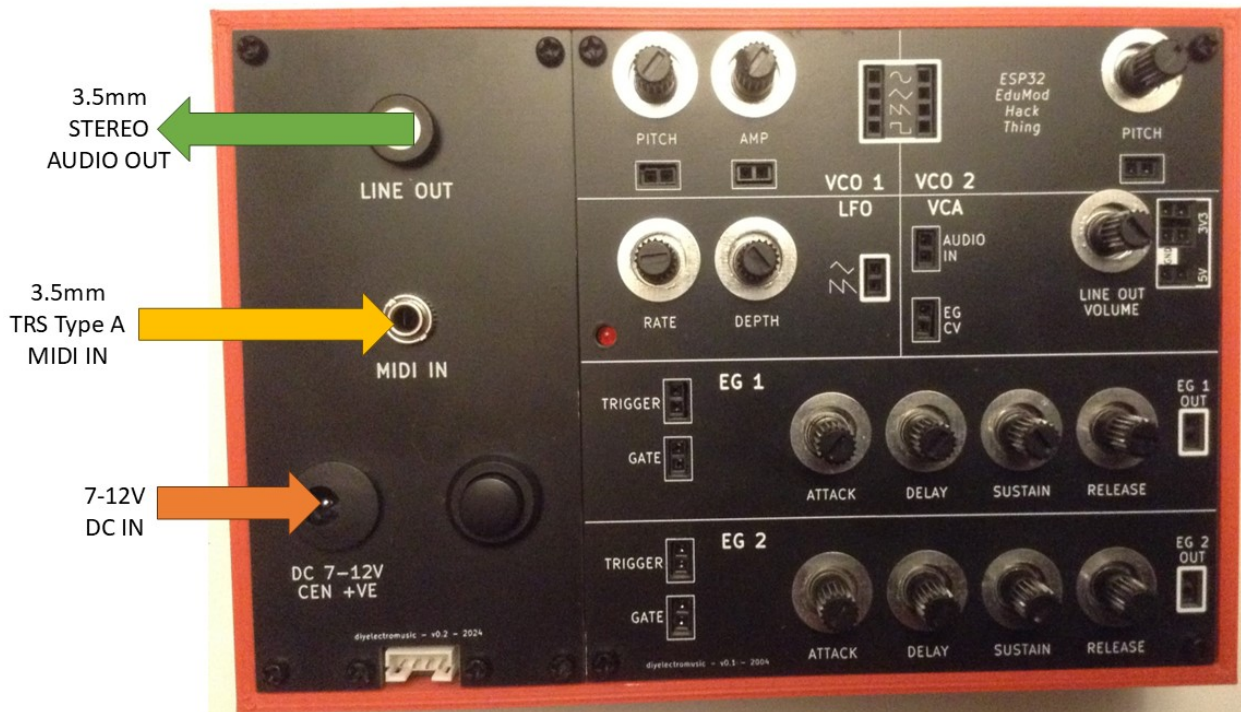


The Synth Thing will respond to MIDI Channel 1.  This cannot be changed without reprograming the device.

## A Basic MIDI Patch

The following basic patch can be used to demonstrate basic MIDI operation.



As with the keyboard examples, MIDI will automatically generate internal Pitch CVs for both VCOs, and GATE and TRIGGER signals for both EGs.

A key feature of the MIDI INPUT is that the full pitch range of MIDI notes becomes possible for the Synth Thing.  Far more than is available via the Pitch CV input.

All of the keyboard projects can now be repeated with MIDI.

In particular, experiment with:

- Using both VCOs.
- Using both EGs.
- Adding in the LFO.