Oscilloscope Use

Introduction

An oscilloscope is really useful for seeing signals and waveforms, and for audio frequencies even a cheap (sub £30) digital oscilloscope is really useful.

This assumes the use of a DSO152 oscilloscope as shown below. These are available quite cheaply online. But any other oscilloscope should be fine too.

In each case once general amplification and power are required as used previously.

DSO 152 Oscilloscope – available online for around £30.

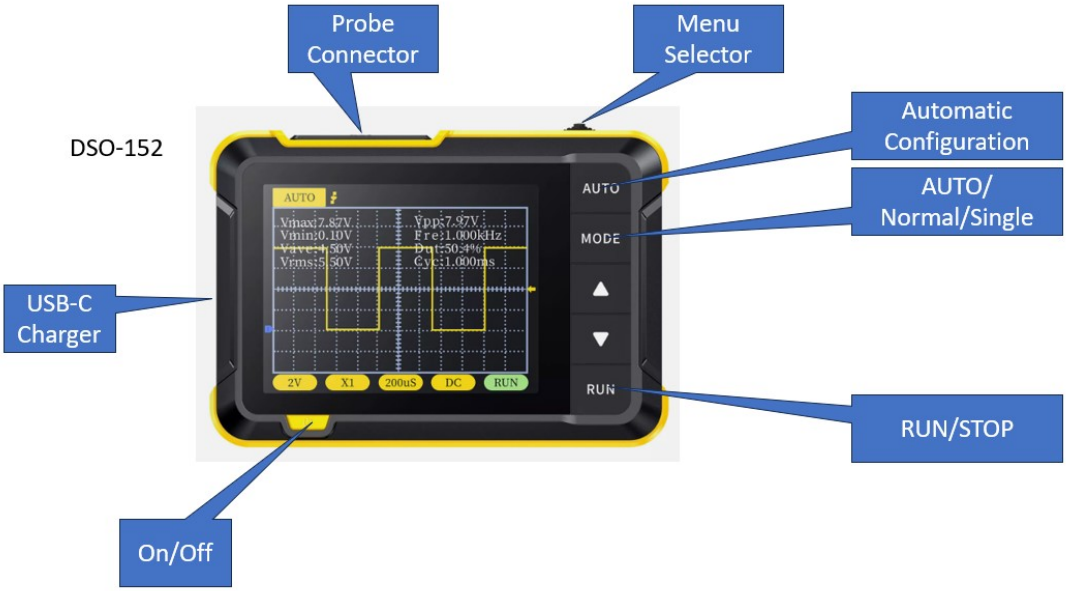
Core Components Required

The following basic additional components are required to perform all the experiments in this chapter:

- Solderless breadboard – ideally a “half+” type.
- Oscilloscope, adaptors and probes.
- Jumper and patch wires.
- Amplification, power and audio leads.

Oscilloscope Controls

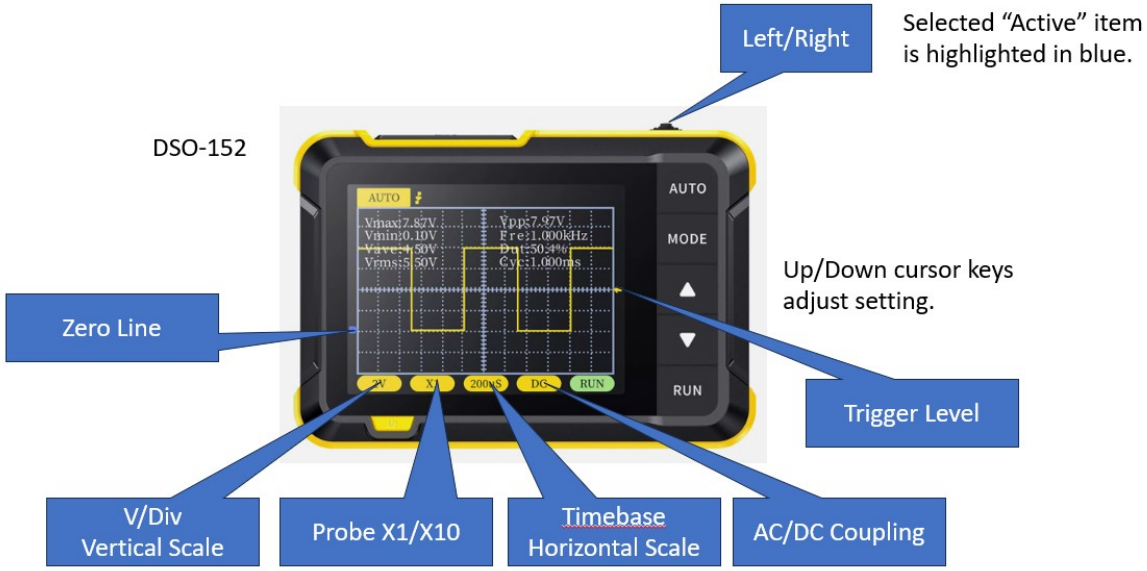
The basic operation of the oscilloscope is shown below. Note On/Off has to be held for a short while to turn it on. A short press will power it off. There is a USB-C port for charging the internal battery.



There is a left/right/push control at the top which selects various items on the display which can then be adjusted using the up/down buttons.

The other buttons switch between various modes of operation as shown above.

The adjustable parameters from the menu selector are shown below.



Although in many cases it will be sufficient to press "AUTO" and let the oscilloscope work it out for itself.

Here is a copy of the basic control “cheat sheet”

KEY FUNCTION

BUTTON	OPERATION	FUNCTION
	Short press	Control parameters function selection
	Short press	Exit auto calibration (Auto calibration page)
	Long press	Enter the automatic calibration page
	Short press	Control parameters function selection
AUTO	Short press	Automatic adjustment (frequency below 45Hz cannot be calibrated correctly)
MODE	Short press	AUTO/Single/Normal switching
	Long press	Rising edge/falling edge switching

BUTTON	OPERATION	FUNCTION
▲	Short press	Parameter addition adjustment
▼	Short press	Parameter subtraction adjustment
RUN	Short press	Run/pause waveforms (other pages) Enter auto calibration (Auto calibration page)
	Long press	Show/close detailed parameters
⏻	Short press	On
	Long press	OFF

Probes and Connections

The oscilloscope comes with a basic crocodile clip lead and USB-C to USB-A power cable. For a little extra cost at time of purchase, a probe set can also be included.

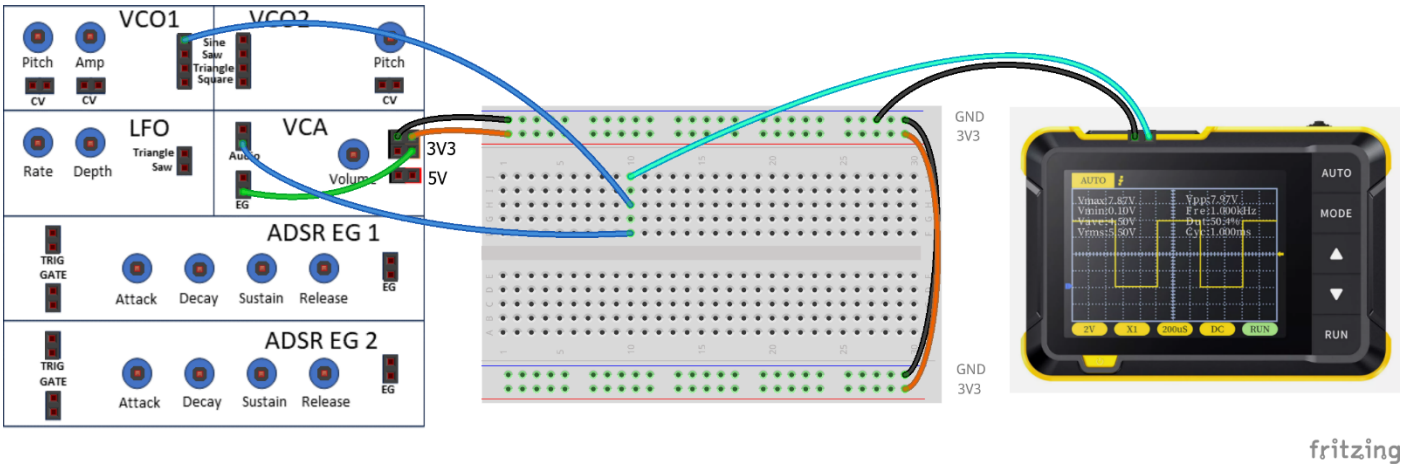
Other items that will be really useful include: RCA (phono) to BNC adaptor; RCA (phono) to 3.5mm stereo TRS jack adaptor; twin RCA (phono) to 3.5mm stereo TRS jack lead.

But for many experiments simply using the crocodile clips to connect to jumper/patch wires will be sufficient.

Oscilloscope Use with a Breadboard

1. Oscilloscope and breadboard

This project shows how using a solderless breadboard can make connecting the oscilloscope a bit easier.



Whenever there isn't a spare connector for the oscilloscope, signals can be brought off the Synth Thing to the solderless breadboard and joined together to allow a spare connector for the scope.

Notice that the oscilloscope is connected to the breadboard GND which saves using one of the few connections on the Synth Thing itself.

The oscilloscope GND can remain connected whilst the "active" wire can be used as a probe to move to different locations on the breadboard or Synth Thing to explore what is happening.

With a basic Sinewave signal, start with the controls as follows:

- VCO1 Amp and VCA Amp turned fully clockwise.
- VCO1 Pitch half-way.
- Press "AUTO" on the oscilloscope.

This should show the output sine waveform on the display.

Switch between the four different waveform outputs for VCO1 and observe each on the oscilloscope.

Then switch back to the Sine wave.

2. Oscilloscope Detailed Parameters

Continuing with the same circuit as the firs experiment, we can now look a the Oscilloscopes main controls.

If there is no writing already on the display, push and hold "RUN" until the writing appears.

- Change the VCO1 Pitch and watch how the frequency changes.
- Change the VCO1 Amp and watch how the Vmax and Vpp changes.

Vpp means the "peak to peak" voltage the difference between the lowest and highest voltages shown on the display. The internal audio signals of the Synth Thing will be 0 to 3.3V.

3. Oscilloscope Horizontal Scale

The menu selector at the top of the scope can be used to highlight the middle yellow oval at the bottom on the display. This is the oscilloscopes time-base measure and will set the horizontal scale.

There will often be a number in "mS" units, corresponding to the number of milli-seconds (1000th of a second) each box in the grid on the display represents.

By way of example, for a 440Hz "concert A" sine wave, there will be 440 repeats of the basic wave each second. That means the time between each peak is 1/440 seconds each or just over 2mS each.

Perform the following:

- Try to set the pitch to close to 440Hz.
- Use the left/right and up/down buttons to select 2mS as the timebase.
- Observe how each wave pattern is close to being a single box wide.
- Experiment with different timebase settings and see how the display changes.

4. Oscilloscope Vertical Scale

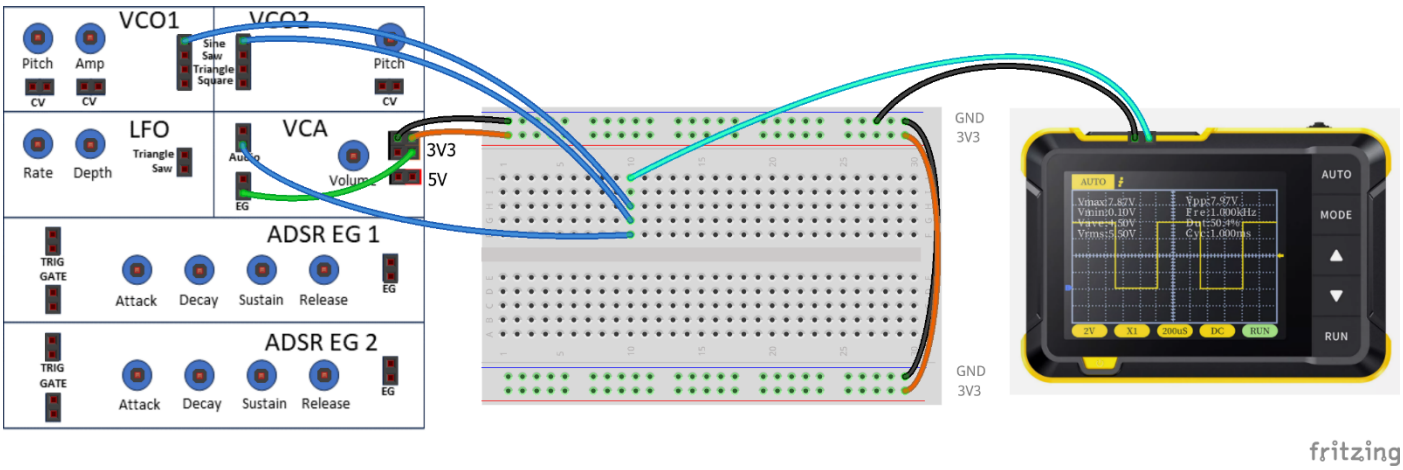
Now use the menu to select the left-most yellow oval at the bottom of the display. This is the oscilloscopes "voltage per division" measure and will set the vertical scale. It may often be stated in either "V" or "mV" for volts or milli-volts and indicates the voltage level represented by each box in the grid on the display.

Adjust the VCO1 Amp to full volume (fully clockwise). The top of the waveform should be close to 3.3V and the bottom close to 0V.

- Use the left/right and up/down buttons to select 1V as the V/Div scale.
- Observe how the waveform should now span just over three boxes on the display.
- Adjust the V/Div to 500mV – it is now possible the top of the wave is off the top of the display!
- Use the left/right and up/down buttons to select the small "L" cursor on the far left of the display and move it downwards. This will move the whole display down so that the whole waveform can now be seen.
- Experiment with the VCO1 Amp control to change the level.

5. Dual Oscillator Oscilloscope and Breadboard

Now connect in the waveform output from VCO2 as well, as shown below.



This patch uses both VCOs with a constant envelope and can be used to explore the waveform from two oscillators running together.

Set the controls on the Synth Thing as follows.

- VCA Volume are fully clockwise.
- VCO1 Amp fully anti-clockwise (off).
- VCO1 and VCO2 Pitch controls to around half-way.
- Use the Sine outputs from both VCOs.
- Watch the oscilloscope as the VCO1 Amp is gradually increased (turn slowly clockwise).
- Now attempt to tune both VCOs to the same pitch.

Press “AUTO” on the oscilloscope and adjust the timebase or V/Div to get a clear display of the waveform. If the detailed information is present, then press and hold “RUN” until it goes away.

Observe the waveform and how it changes as the oscillators are tuned to be closer together.

6. Dual Oscillator Oscilloscope – Complex Waveforms

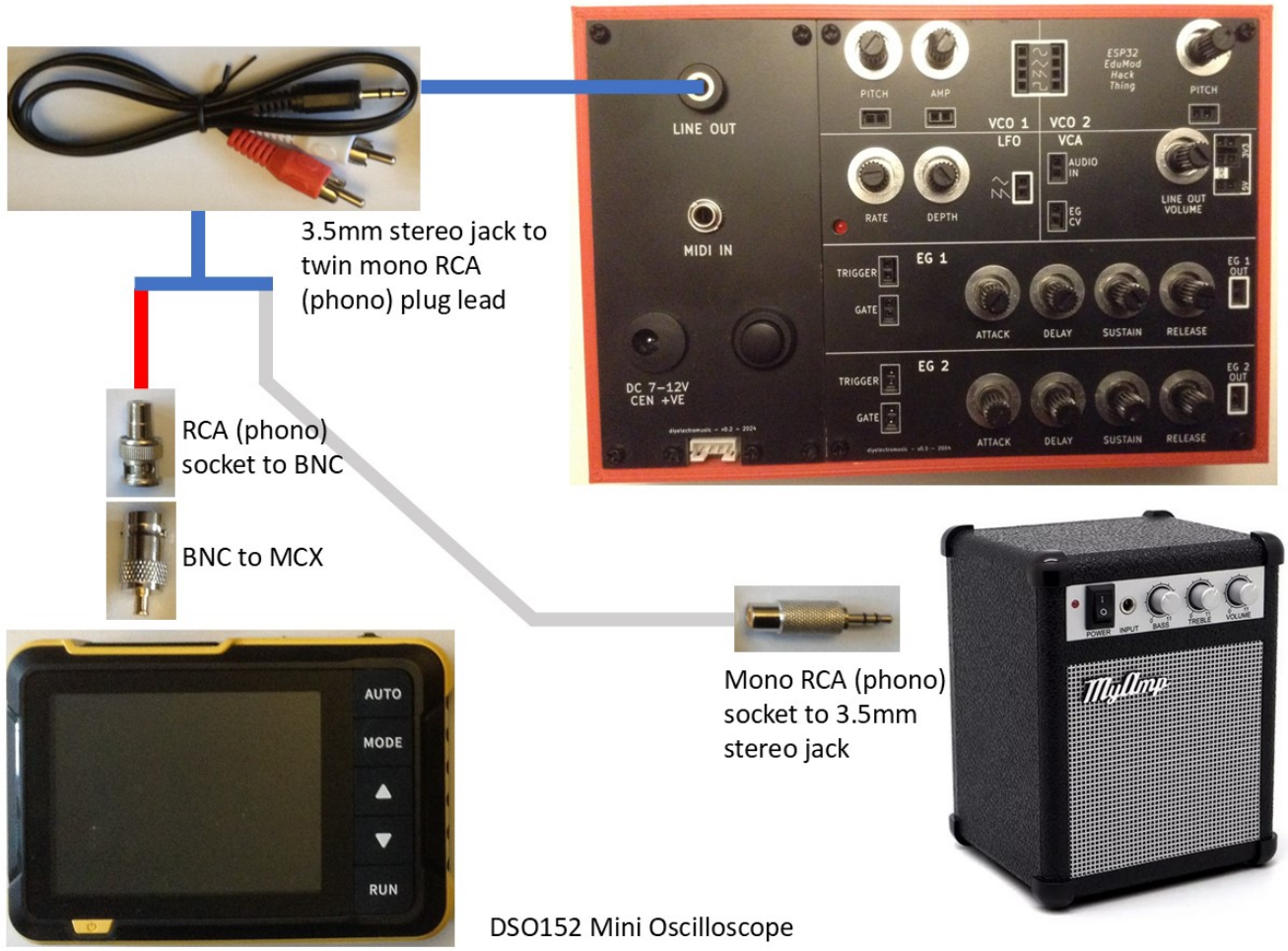
Continuing with the same circuit as the previous experiment, now see what happens to the waveform while doing the following:

- Adjust VCO2 to be just below, almost the same as, and just above VCO1.
- Tune VCO1 and VCO2 to be one octave apart.
- Experiment with different intervals.
- Experiment with different waveforms.

In particular note how two different waveforms, at two different frequencies, are combined in the waveform. See if you can spot the different frequencies “appearing” in the combined waveform.

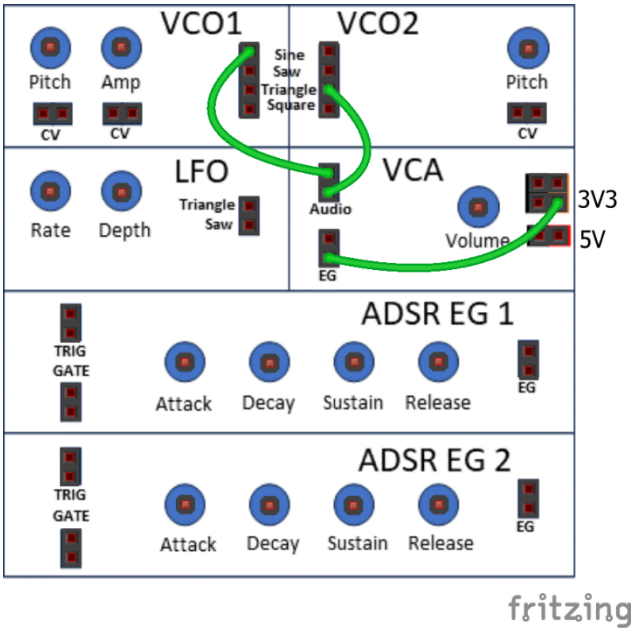
7. Oscilloscope and Audio Output

This project shows what is required to connect the oscilloscope to the audio line output.



A professional oscilloscope will usually come with probes to be connected by “BNC” connectors. A cheap hobby oscilloscope such as the DSO152 would typically come with “MCX” connectors, but hobby scopes often come with an adaptor to allow the connection of traditional “BNC” scope probes.

One way to capture the audio output of the Synth Thing is shown above. This uses a 3.5mm stereo to twin mono RCA/phone plug lead with one output going to an amplifier and the other to the oscilloscope (both via more adaptors as necessary).



This patch again uses both VCOs with a constant envelope and can be used to explore the waveform once again.

The difference this time being that we are now seeing the output from the VCA not just the oscillators.

This means that this can be used to show the results of adding in envelopes or additional circuitry, which will be useful in later experiments.