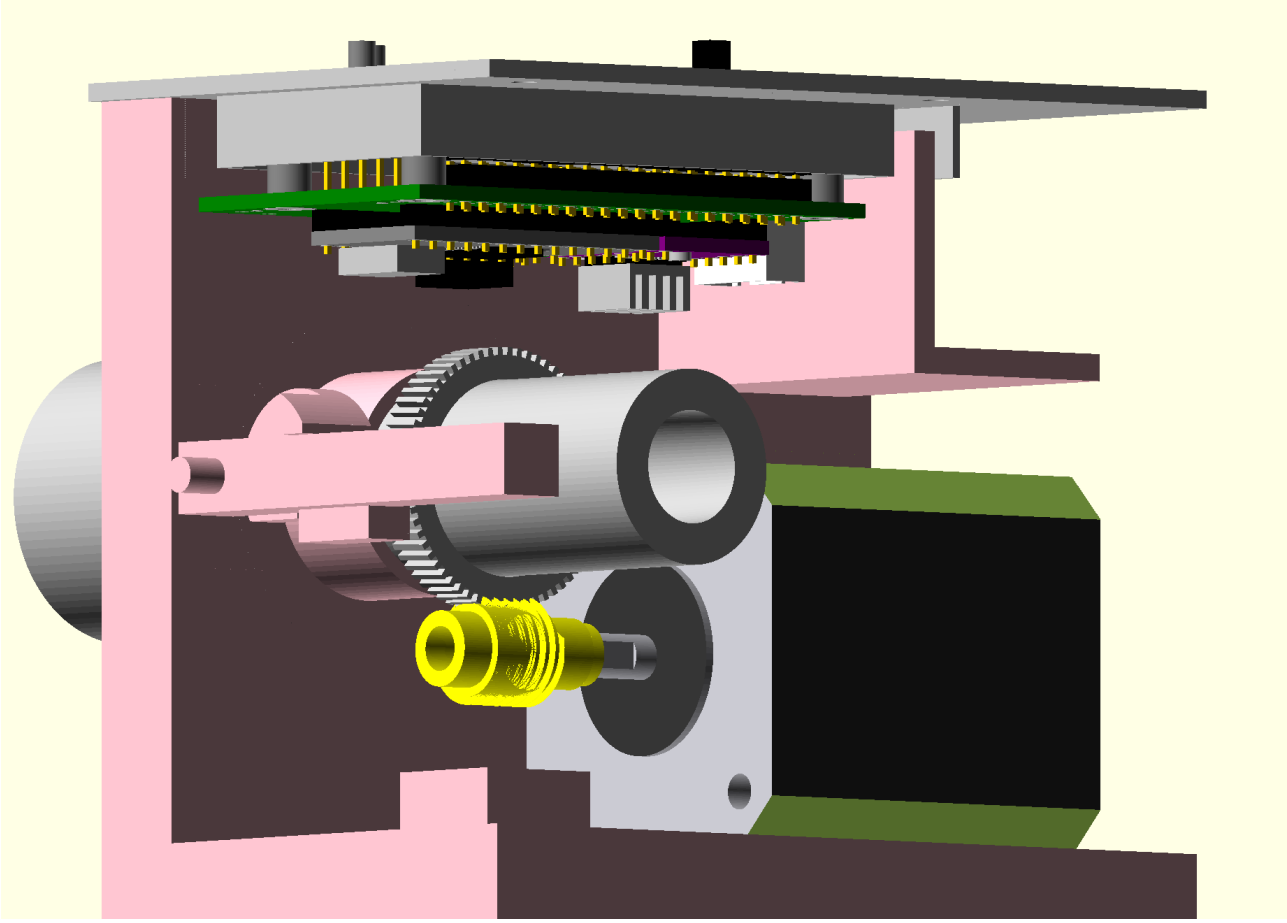
The Rawson Divider Electronics Construction



Introduction

This document covers the basics required to put together the electronic components for the Divider.

The mechanical construction is covered in a separate document.

Description

This document covers the construction of the Adafruit ItsyBitsy version of the Divider. This is based on an ATSAMD51 microcomputer. There is a separate document covering the earlier Raspberry PiZero version.

The main component parts required to build this version are as follows:

Stepper motor
Stepper motor cable
12v socket
Microswitch
Adafruit itsybitsy M4
Adafruit OLED bonnet
Stepper Driver
Voltage regulator
Top plate mount
Button extensions
Bracket & Wedge
Perspex window
Holding screws
Circuit board
470 ohm resister
2.7K ohm resistor x 2
Buzzer
100uF 25v capacitor
12volt 2A supply

The items shown with a grey background are assumed to be 3D printed plastic items for the purposes of this document. The bracket and wedge are described in the '**Divider Construction**' document

Component Detail

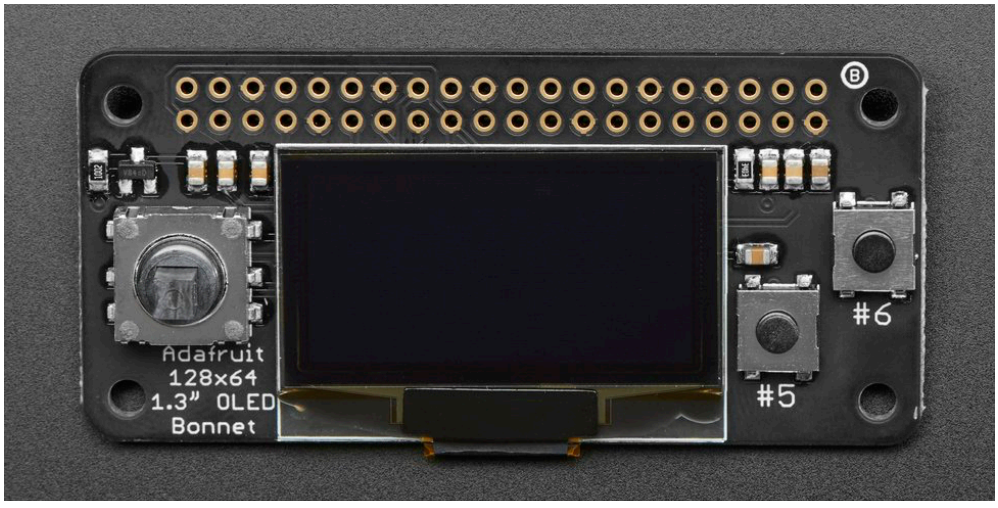
Stepper Motor

There are many stepper motors available but for this construction there is a minimum requirement.

> **Steps/revolution:** For the accuracy required this must be a minimum of 200 which gives a step angle of 1.8 deg. The prototype has a Nema 17HS19-1684S.
>
> **Size:** to fit the mechanical design it must be nominally 42mm wide x 42mm high x 47mm deep.
>
> **Current:** It must have a current/per coil rating of 1.5 - 2 Amps. The prototype's is 1.68 Amps, 2.8 Volts,1.65 Ohms. The maximum current that the driver board can handle is 2 Amps.
>
> > **NB**. Since the prototype was built, 400 step Nema 17 motors have become available. If one of these is used, the worm gear could have its teeth reduced by half to 30 for the same accuracy. Software Version 0106 and above will accommodate this.

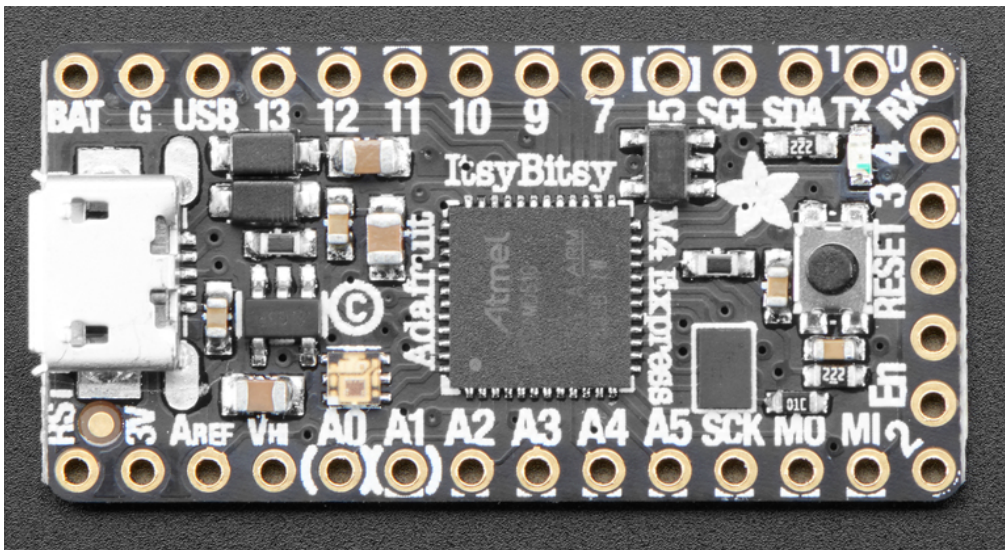
Screen and Controls

This design is built around an Adafruit OLED bonnet built to fit a Raspberry PiZero. The monochrome OLED screen, although small, is very clear and comes with a joystick control and 2 buttons. The software is built around this device and a special circuitboard is available to enable the screen to be married with the ATSAMD51 microcomputer and the other components.



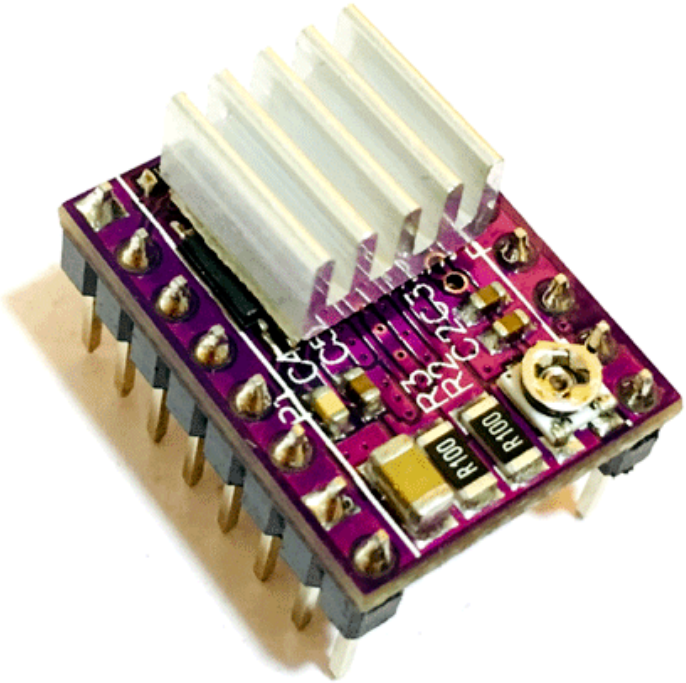
Microcomputer

Software version 0106 and above runs on an Adafruit ItsyBitsy M4 Express. This is a tiny board containing an ATSAMD51 microcomputer, 2Mb of memory and other ancillary components.



Stepper Driver

This component acts as a control interface between the low voltage microcomputer and the 12 Volts that the motor requires. The Divider design is built around the DRV8825 device.

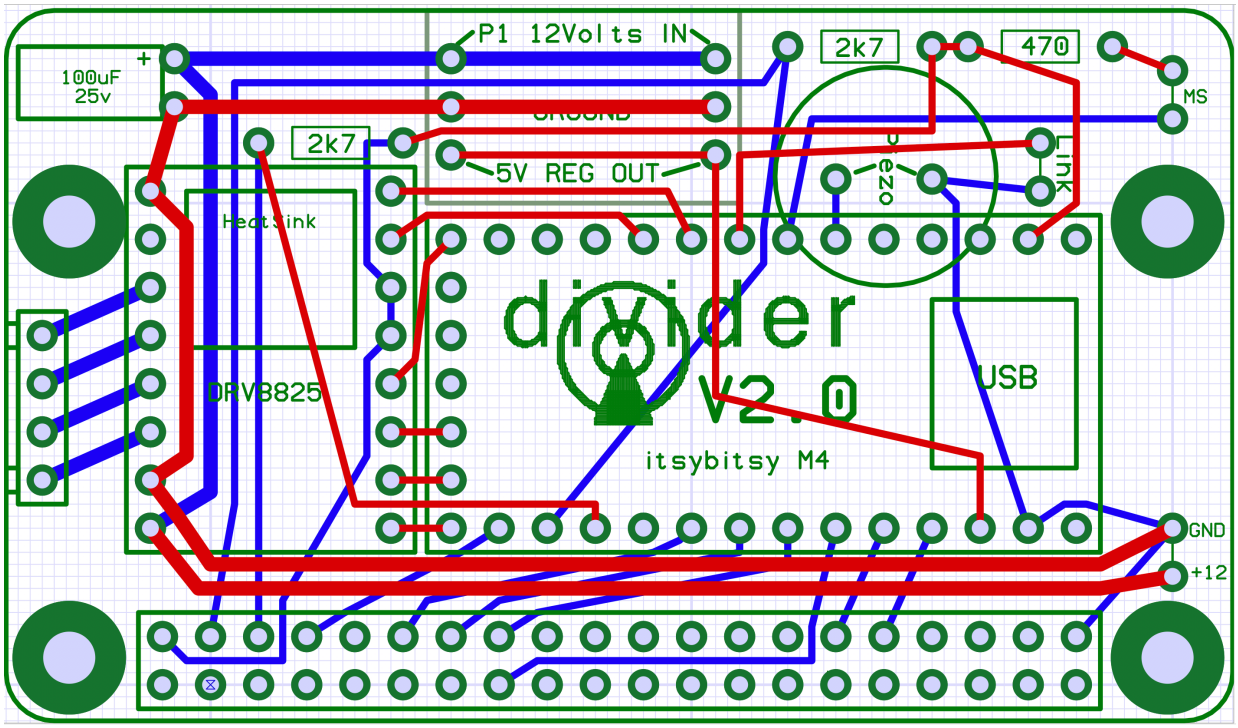


Voltage Regulator

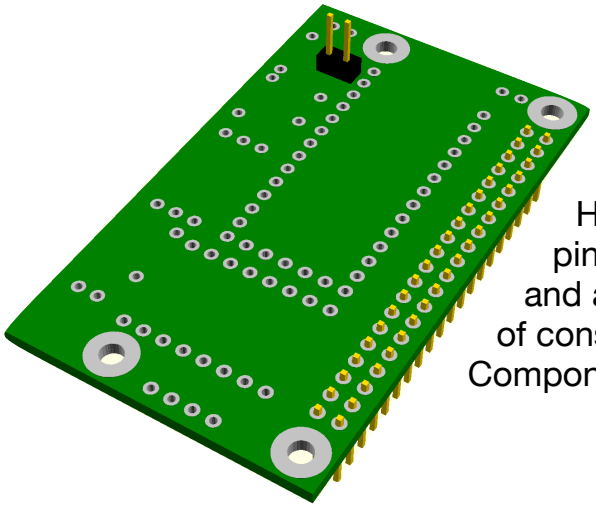
Because the Divider runs off a 12 Volt supply it is necessary to drop that down to 5 Volts for the microcomputer. For this a OKI-78SR, 5v 1.5A voltage regulator is used.

Circuit Board

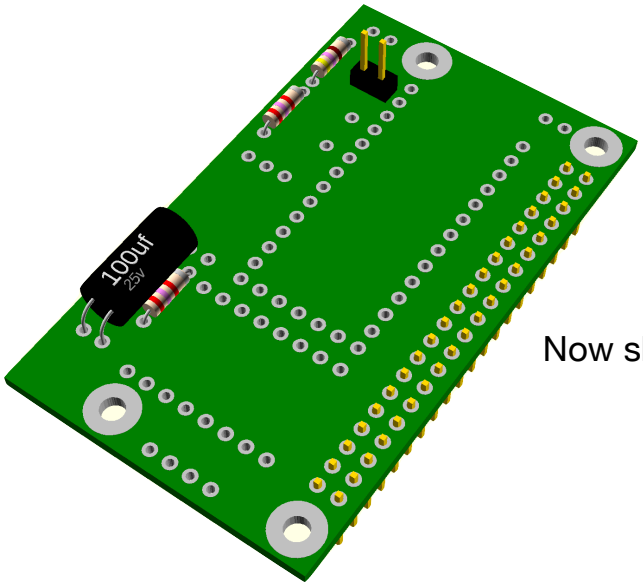
To achieve simple interconnect between the various components a bespoke circuit board is available.



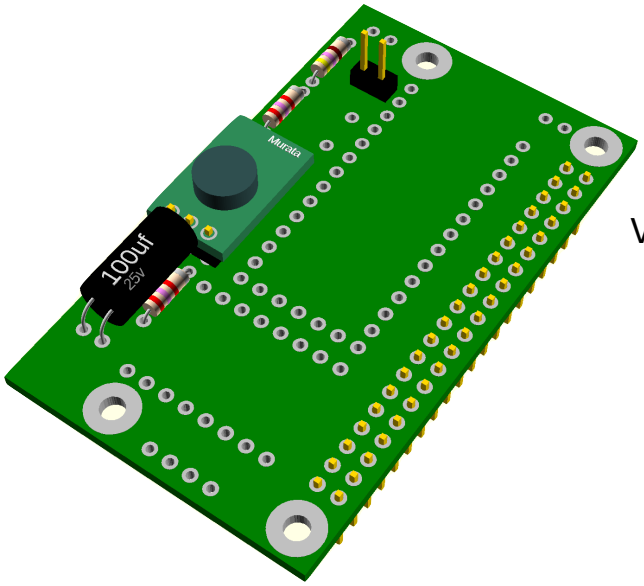
Building the board



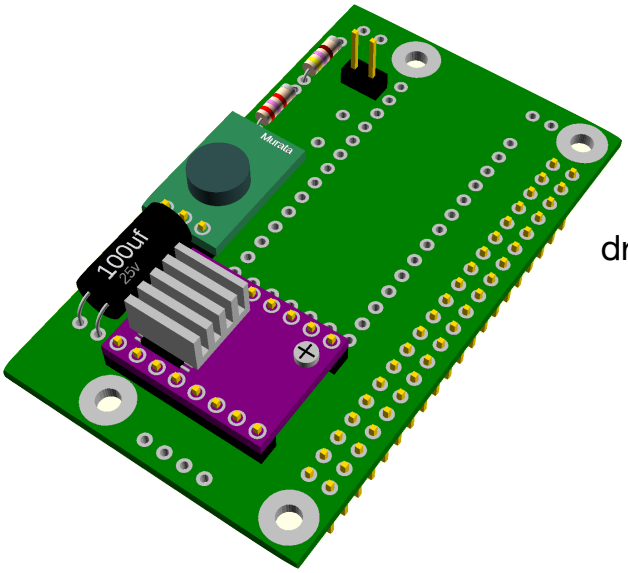
Here's a representation of the circuitboard with pins added for connection to the OLED display and a 2 pin jumper. You should not infer any order of construction from the following graphics. Components may be added in any order.



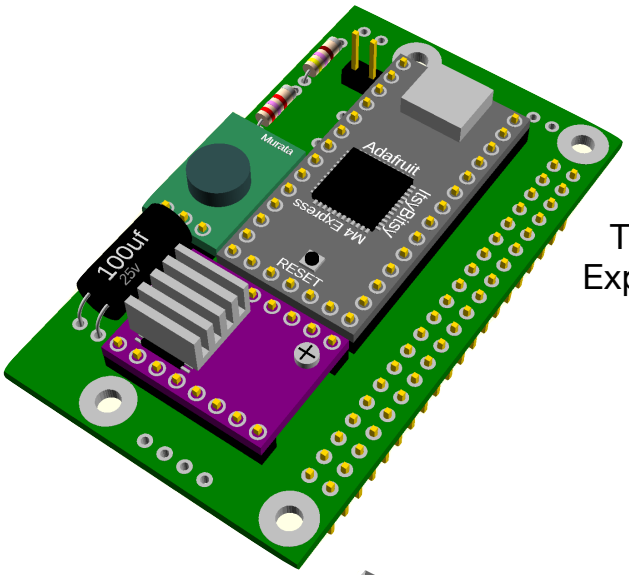
Now shown with the resistors and capacitor fitted.



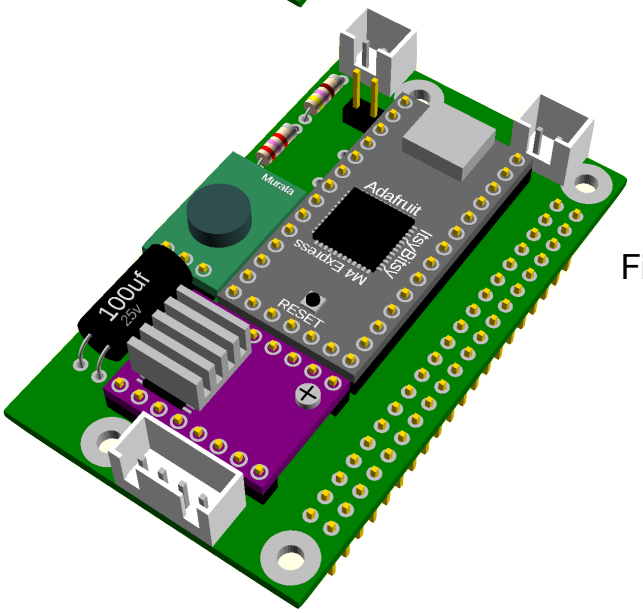
Here, to the back, is a representation of the Voltage regulator.



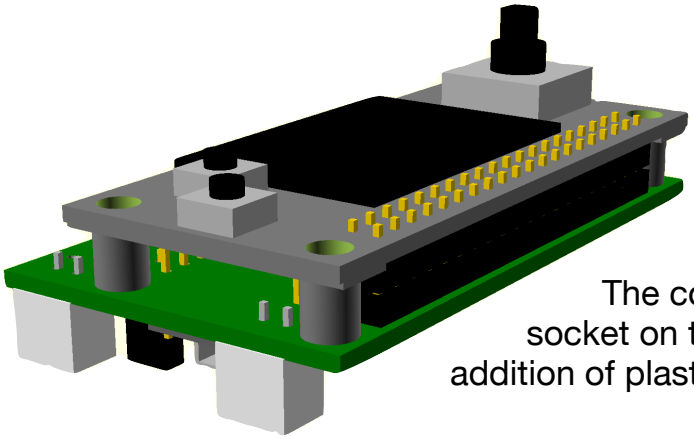
And now the addition of the stepper motor driver



The heart of the system, the ItsyBitsy M4 Express shown added here.



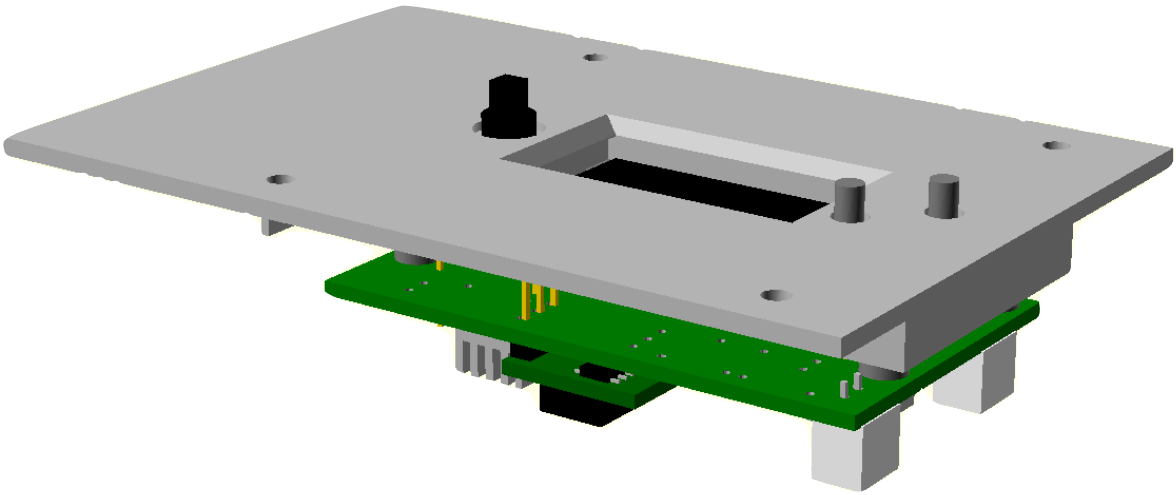
Finally the sockets for external connections.



The completed circuitboard plugs into the socket on the OLED bonnet, shown here with the addition of plastic spacers.

The circuit assembly is mounted with 4 screws to a plastic face plate which in turn fixes to the steel mechanical assembly. The buttons have been extended with a plastic component.

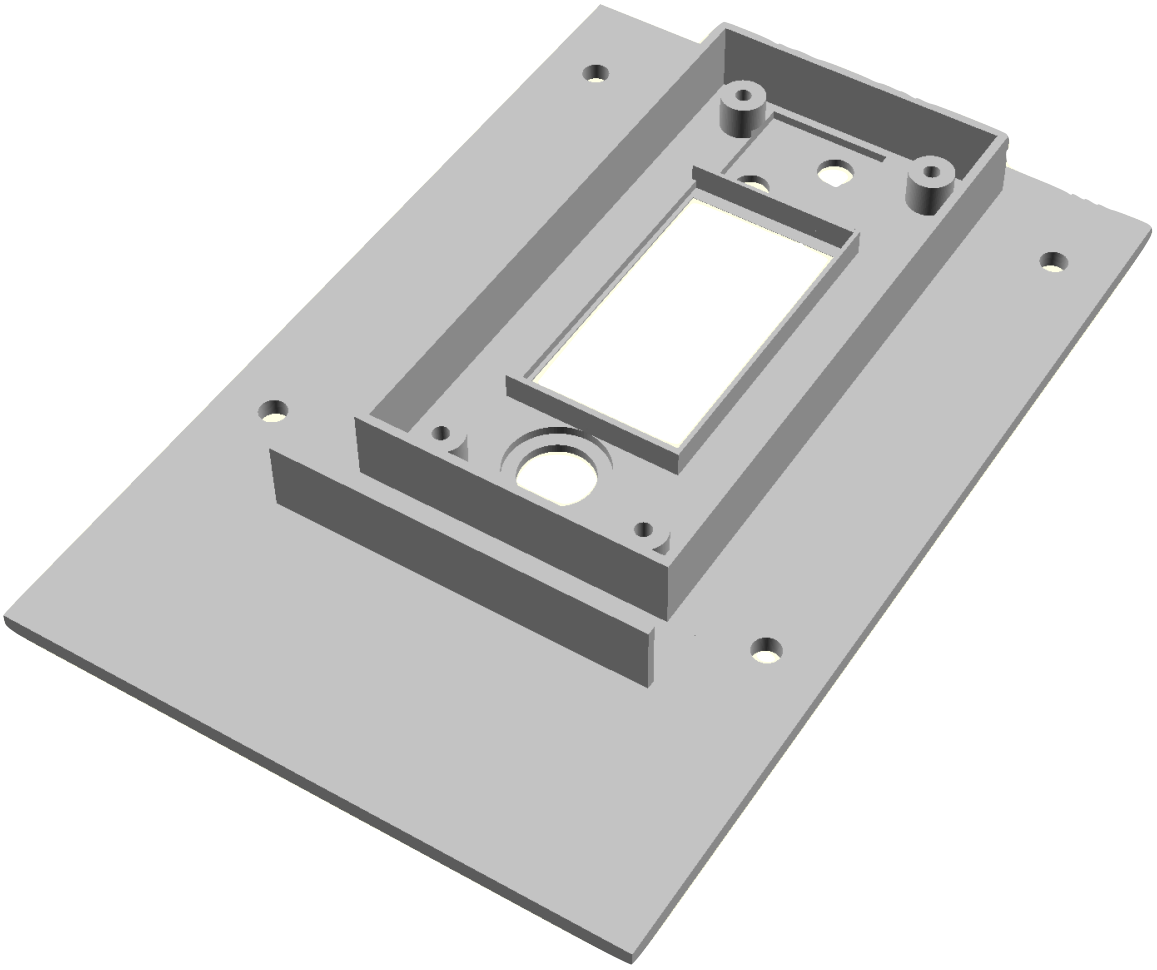
All plastic items are 3D printed.

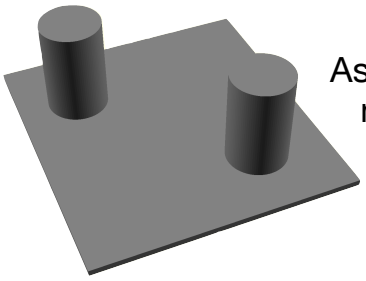


Plastic items

This is the top plate that is used as a mount for the electronics. It is shown here upside down. There is little room for manoeuvre in the placement of the electronics so this top plate's dimensions are important.

If you would prefer to make this from metal then there is a drawing available in the main construction document.

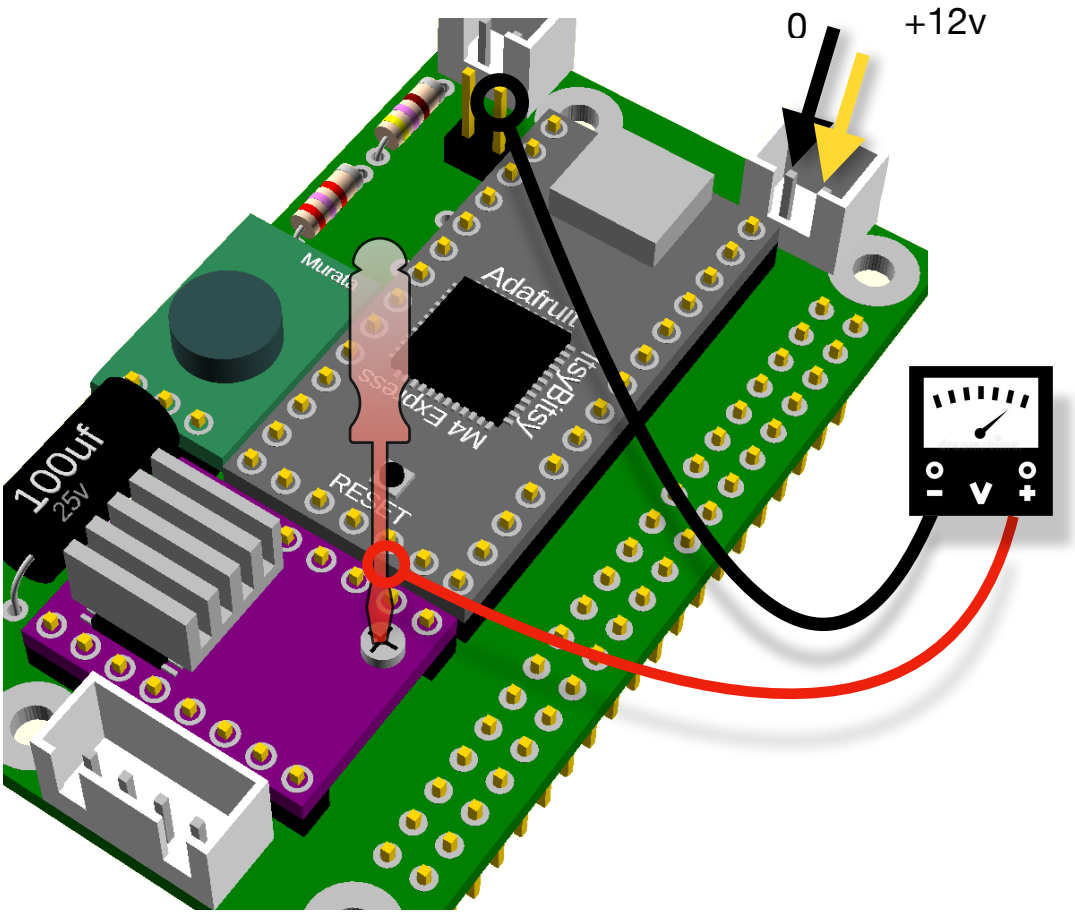




As the buttons on the OLED display are very short it is necessary to extend them. This plastic item does the trick. And as they are joined together, easy to handle. The base is made very thin so as to remain flexible. This ensures that the buttons don't interact with each other when pressed.

Setting Motor Current

The DRV8825 driver limits the current on the motor windings and this limit value must be set before the motor is connected.
To achieve this, connect a multimeter positive terminal to a small metal screwdriver and the negative terminal to the pin shown by the black arrow (this is a ground pin).
Power up the unit by attaching a 12 volt supply to the right hand socket. The YELLOW arrow indicates the positive terminal.



Set the multimeter to read DC volts and touch the screwdriver (connected to the positive terminal) to the adjustment screw indicated by the screwdriver on the graphic. Turn the screw whilst reading the meter until the voltage is equal to half the current rating of the motor windings.

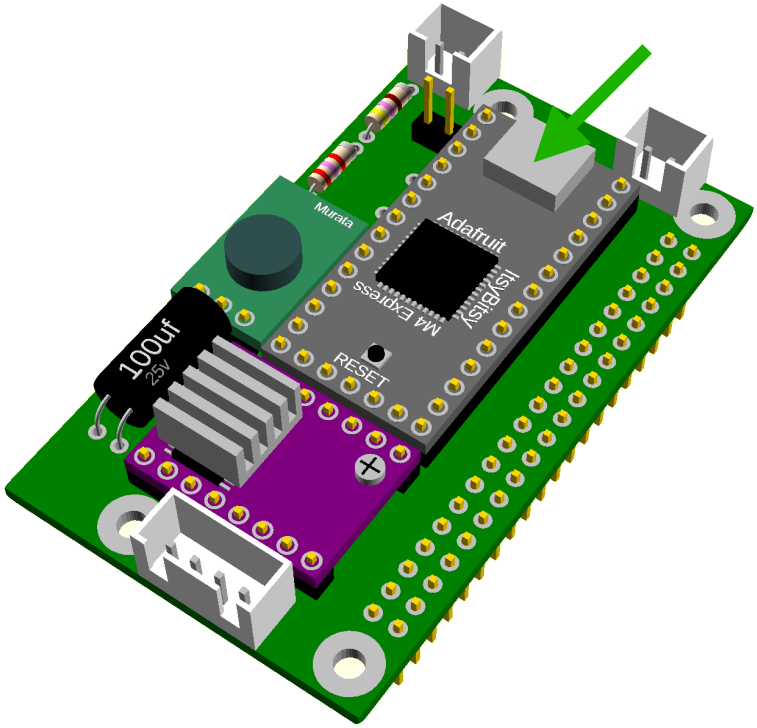
> eg. If motor windings require 1.68 Amps the voltage should be set to half of 1.68 which is 0.84 volts.

It is difficult to get this spot-on so set it as close as possible but on the low side.

From this point the motor can be connected but NEVER CONNECT OR DISCONNECT THE MOTOR WITH POWER ON THE BOARD.

Software

If you have obtained the software separately it needs loading onto the ItsyBitsy device. This is achieved by plugging a USB cable from the ItsyBitsy to a PC or MAC where the software was previously downloaded. The USB connector on the ItsyBitsy is type ‘micro B’, popular with Android phone devices and must be a data cable not just a charging cable. The connection point is indicated by a Green arrow on the graphic. Power for the ItsyBitsy is provided by the USB connection whist loading software so the 12volt supply should not be connected.



What you do next depends on the initial state of the ItsyBitsy device, but basically it must have CircuitPython version 5.x installed before the Divider software can run. Instructions for getting to this point can be found via the following URL

https://learn.adafruit.com/welcome-to-circuitpython/installing-circuitpython

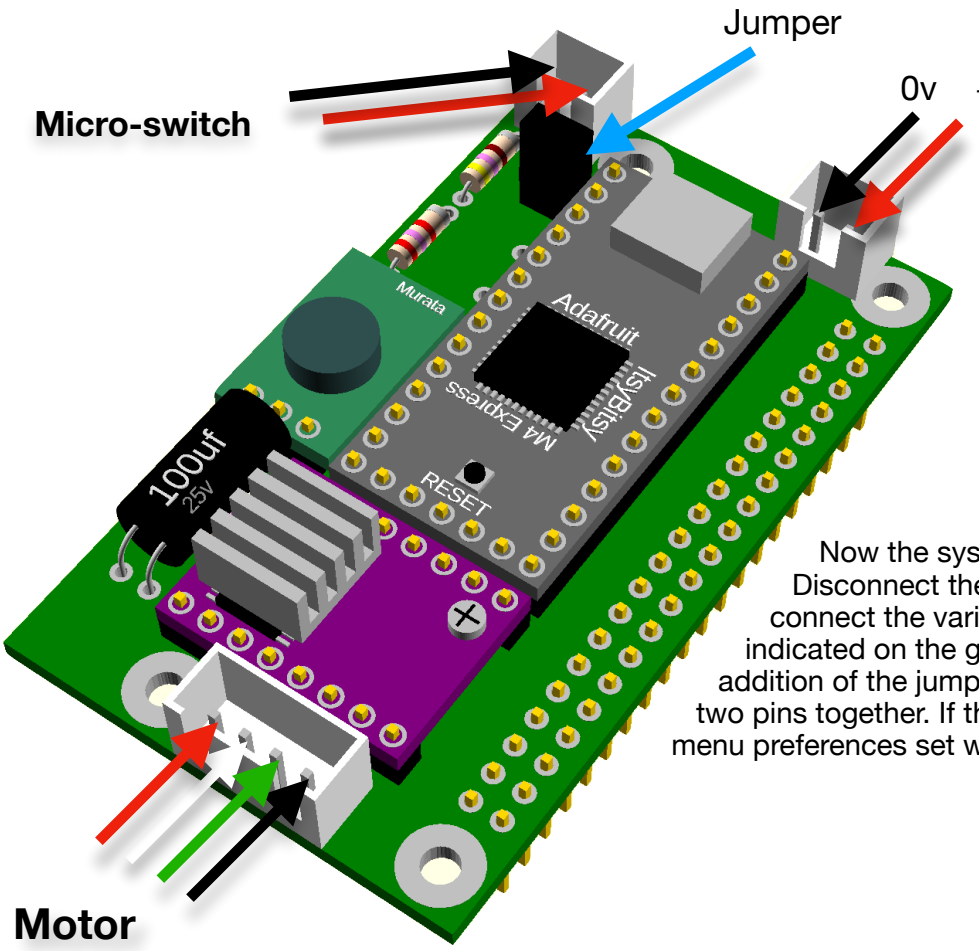
Once CircuitPython is established you can move the files to the CIRCUITPY drive.

When the ItsyBitsy is connected via USB it appears as an external drive called CIRCUITPY.

boot_out.txt	31 Dec 1999 at 23:01	107 bytes	Plain Text
boot.py	31 Mar 2020 at 20:02	286 bytes	Python Source
Check.txt	31 Dec 1999 at 23:15	Zero bytes	Plain Text
cherry-13-r.bdf	29 Feb 2020 at 13:29	27 KB	FontFo...cument
code.py	Today at 11:44	27 KB	Python Source
divider.dat	31 Mar 2020 at 22:35	2 bytes	DAT file
divider2.bmp	20 Mar 2020 at 16:48	9 KB	Windo...P image
lib	9 Apr 2020 at 10:44	--	Folder
lock.bmp	20 Mar 2020 at 17:14	2 KB	Windo...P image
LPD.txt	31 Dec 1999 at 23:01	210 bytes	Plain Text
owner.txt	22 Mar 2020 at 20:16	21 bytes	Plain Text

After copying, these files and library appear on the CIRCUITPY drive.

Connecting Up



Now the system can be tested. Disconnect the USB cable and connect the various components as indicated on the graphic. Note the addition of the jumper that connects the two pins together. If this is not connected menu preferences set will not be saved.

REMEMBER :-
DON'T CONNECT OR DISCONNECT THE MOTOR WHILE 12 VOLT SUPPLY IS CONNECTED.

After 15 seconds or so the start up screen should be visible on the display. Refer to the '**Divider User Guide**' for user instructions.