Rotary Table Controller Hardware Construction

This document explains how to put together the hardware to create a division controller.
It covers machining the case, wiring the various sockets and modifications to the stepper driver to enable it to fit.

It's relevant to how I make them with a few exceptions (I CNC the front panel for example).
It doesn't cover the construction of the controller module, keypad or opto-isolator, these are covered in other documents.

If the second port isn't required the opto-isolator can be left off. If you don't need to bring out the sense, ack & limit lines then the 9 pin GX16 can also be left off.

See also "HardwareManual" which covers the general use of this hardware and "Manual V3.04" which covers the operation of the current version of the firmware.

Parts Required:

Case: Hammond 1550G 222mm x 146mm x 55mm

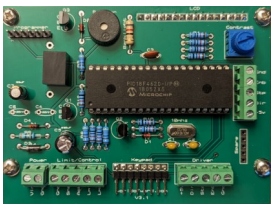
Motor connector: 4 Pin XLR chassis mount socket (and matching plug).

GX16 9 pin chassis mount socket (and matching plug)

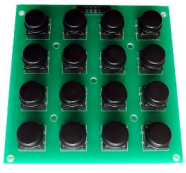
Chassis mount power connector 5.5mm x 2.5.

DM556/DM542 Stepper driver

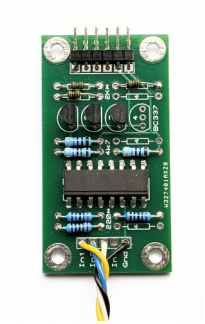
Divider Module



Keypad



Opto isolator board



Overlay

Mounting hardware. (Nuts and Bolts are all M3 Stainless).

Module to case (these come with module).
4 x 16mm csnk screws.
8 x nuts.
8 x shakeproof washers.
4 x 12mm threaded standoffs (brass?)
4 x 6mm pan head screws.

Keyboard to case.
4 x 18mm cnsk screws
12 x nuts.
8 x shakeproof washers.

Opto to case.
4 x 12mm cnsk screws.
4 x M3 nuts.
4 x shakeproof washers.
4 x insulated standoffs – 5mm length. M3 clearance.

Motor connector to case.
2 x 10mm cnsk M3 screws.
2 x M3 nuts.
2 x shakeproof washers.

Stepper driver to case.
4 x 12mm cnsk.
2 x 6mm cnsk.
6 x nuts.
M3 insulated washers (I use 2 ‘paper’ washers per screw).

Misc
Rubber (or metal) cover for the GX16 socket to protect it when not in use.

Preparing the case.

Front.

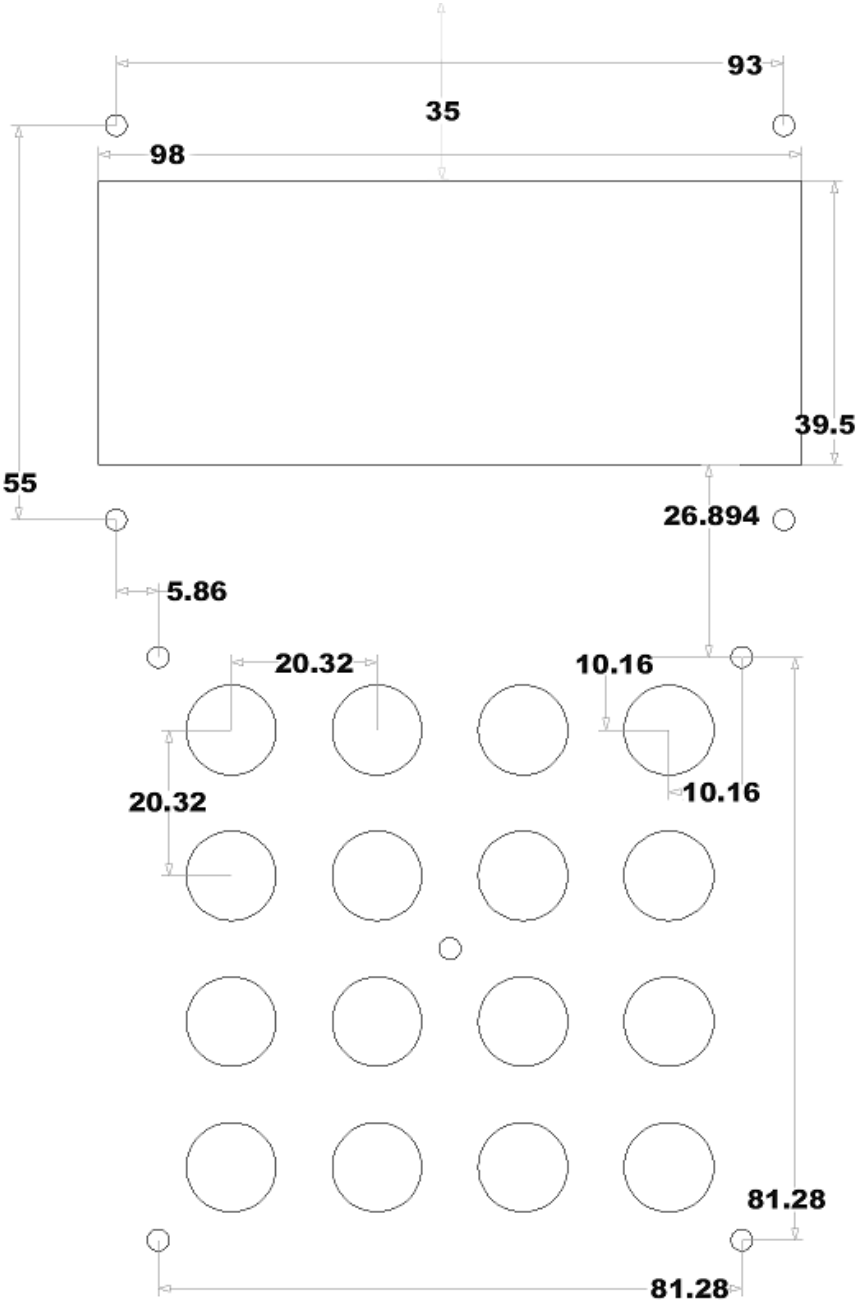
Whilst not critical (the overlay hides most of this), care should be taken to centralise the overlay left to right for cosmetic reasons.

The top of the ‘slot’ for the LCD should be approximately 35mm from the top of the case so that the overlay is correctly positioned vertically.

If available the template provided with the overlay can be temp glued to the front and used to drill the front and cut out the LCD slot.

Once drilled the holes should be de-burred and the mounting holes for the LCD and keypad countersunk such that the screws sit flush or slightly below.

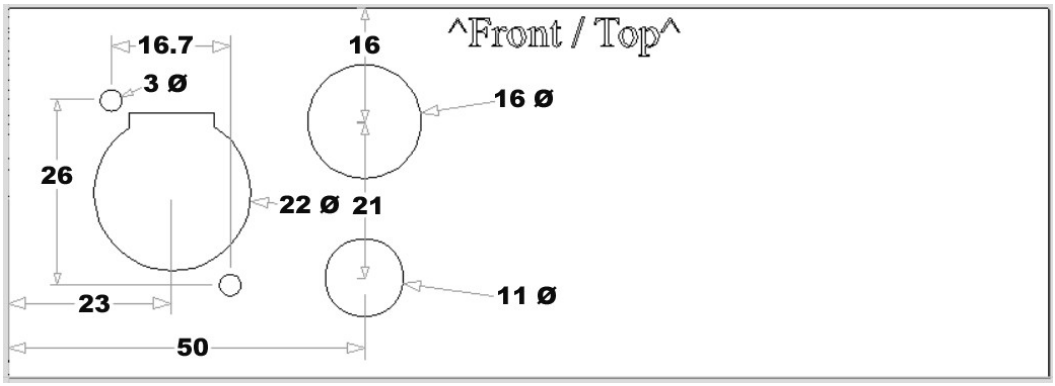
Mounting holes (only the 4 outside are used) are drilled 3mm. Keypad holes 13mm.



Bottom:
Next the holes for the sockets can be drilled.

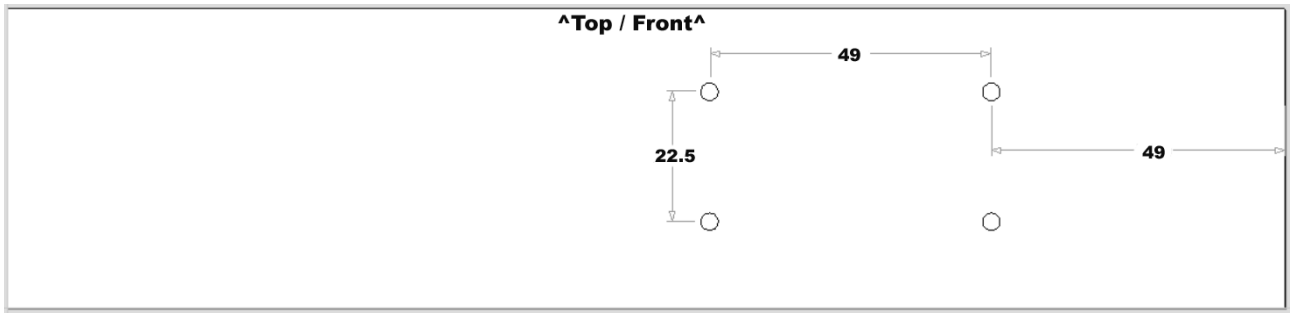
The power socket is around 50mm from the edge. Don't move it further in since it'll foul the stepper driver.
Make sure you're fitting these to the correct side.

The notch for the motor connector can be easily filed to fit the connector.



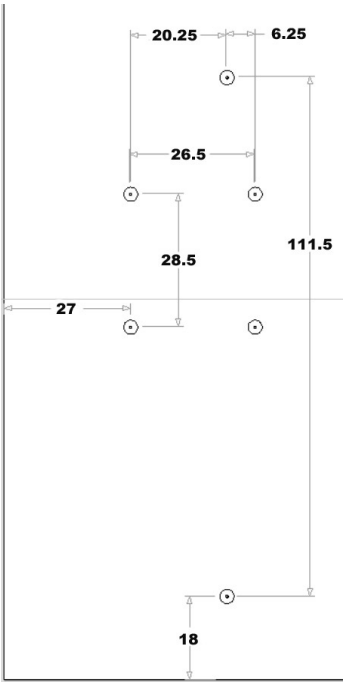
Left side (same side as connectors):
This is drilled M3 clearance and countersunk to take the opto isolator board.

Positioning isn't critical and the holes should be roughly in the centre vertically for cosmetic reasons.



Base/Bottom:

Finally the holes for the stepper driver are drilled. Looking at the controller from above the driver is sat on the opposite side to the connectors, so with the back facing you (as if the controller had been flipped over) the screw holes sit in the bottom left corner as shown. Again drill M3 clearance and countersink.



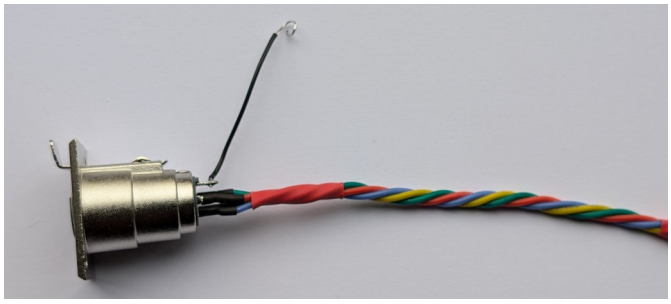
Preparing the cables.

Colours I mention here are what I use and are arbitrary.

Silicone cables are used for hookup to the driver for flexibility and are 20swg.

All other wires are 7 strand (0.2mm, 1.2mm overall) interconnects. These are very low current so any suitable wire will do.

Stepper motor connector.



Requirements:

4 x190mm lengths of 20swg silicone wire. 1 each: Red (A+), Blue (A-), Yellow (B+), Green (B-).
A short length of black interconnect cable.
Suitable heat-shrink.

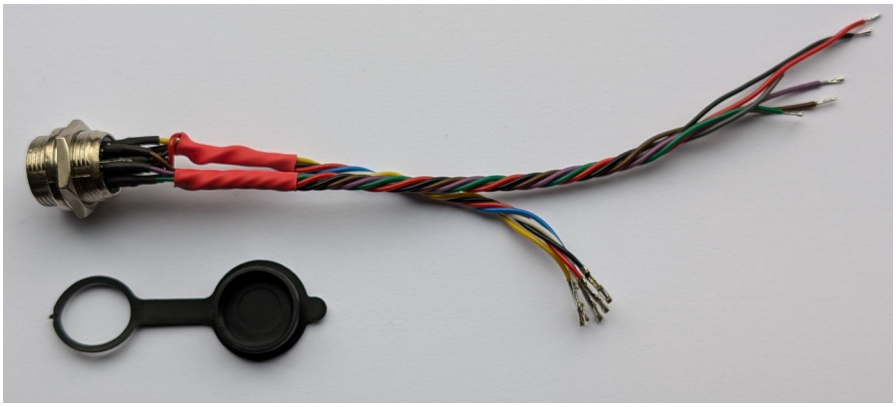
The 4 lengths of wire are soldered as follows: Red – Pin1, Blue – Pin2, Yellow – Pin3, Green – Pin4.

The short black lead is soldered to the earth connector as shown. This will be ‘trapped’ under one of the screws to provide connection to the case.

The individual wires have heat-shrink slid down to cover the terminals, then the wires are twisted together and held in place by two pieces of heat-shrink to stop them unwinding.

The end can then be stripped and tinned ready to hook up to the driver.

GX16 Expansion connector.



Requirements:

4 x 120mm interconnect. Yellow, Blue, White, Black.

5 x 190mm interconnect. Grey, Green, Purple, Brown, Black.

1 x 310mm interconnect. Red.

You'll also need a 6 pin crimp header and terminals. (Similar to what the keypad uses).
This is how the short cables connect to the opto-isolator.
Do not fit the header until the socket is mounted – it won't fit through the hole!

Also the rubber cover (if required) and heat-shrink.

First strip the long and short black cables, twist them together and tin them. They are now soldered to Pin 9 and a piece of heat-shrink used.

Then the 3 remaining short cables are connected. Yellow - Pin 1, Blue - Pin 2, White - Pin 3.
Again add heat-shrink.

Now the 4 remaining long cables are connected. Grey - Pin4, Green - Pin5, Purple - Pin 6, Brown - Pin 7.
Again add heat-shrink.

Now bundle up the short wires separately from the long wires, add the red cable and twist them together.
Do the same for the long wires with the other end of the red cable included (it just loops through at the socket).
Twist those together too and then add heat-shrink to stop them unwinding – as per image.

Cut the short wires to all the same length and crimp (or solder) on the crimp terminals as per image.

Image also shows a typical rubber cover.

Power connector cable.

Requirements.

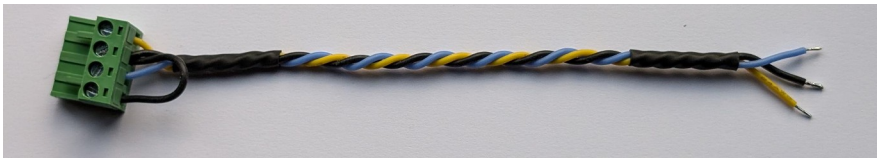
2 x Silicone 220mm, Red, Black. (The cable I use here comes as a pair)
2 x interconnects 200mm, Red, Black.
Heat-shrink.

Strip the ends of the 4 wires and twist together the red wires (may need to add the heat-shrink now before soldering).
Solder the pair of wires to the centre terminal and heat-shrink.

Do the same for the black but to the outside terminal.

Twist up the cables into two pairs and add heat-shrink as shown.

Driver connection.



Requirements.

3 x Silicone 200mm, Blue, Yellow, Black.
1 x short loop of interconnect, Black.
4 (or 6) pin connector removed from stepper driver.
Heat-shrink.

Twist the 3 cables together and apply the heatshrink to prevent them unwrapping.

Trim the ends to the same length, strip and tin.

Prepare the loop as per photo by stripping and tinning.

Fit into socket. Yellow – Pul+, Blue – Dir +, Black and one end of the loop to Pul – and the other end of the loop to Dir -.

If the connector was a 6 pin just leave the ENA connections unwired.

Assembly

Fit the 4 mounting screws for the LCD into the case with a single lock washer and nut.
Tighten these up fairly tightly – you really don't want them to come loose…

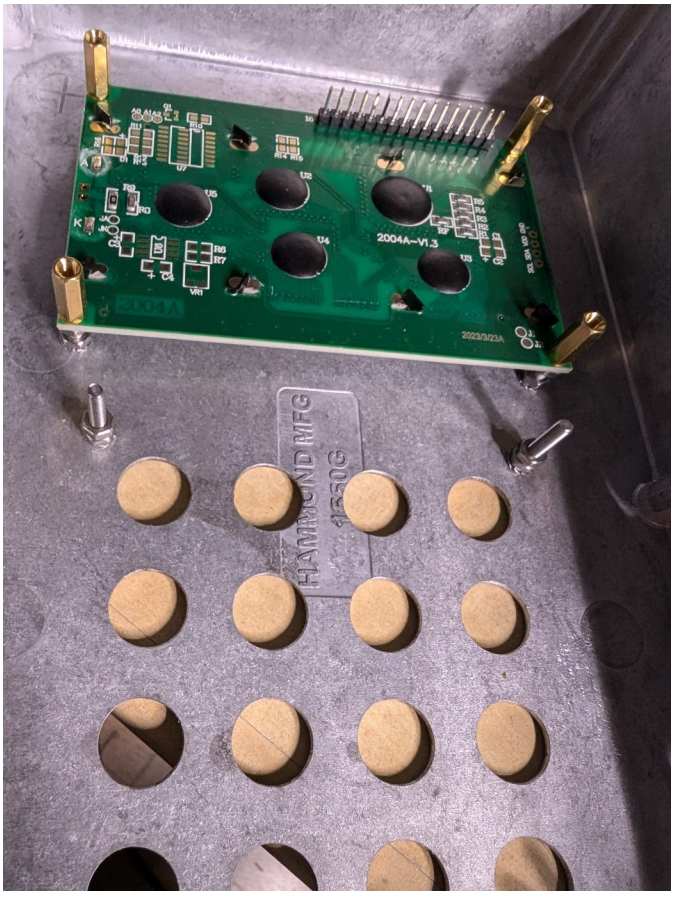
It can help to initially have the PCB roughly in place over the screws to ensure they're fairly straight. If they don't line up once tightened a bit of judicious "manipulation" can straighten them.

Do the same for the keypad – again actually putting the keypad in place on the back for the initial tightening can help keep the screws straight.

Once you're happy add another nut to all 8 screws and spin them down – these are what we'll use to set the height of the LCD and keypad.

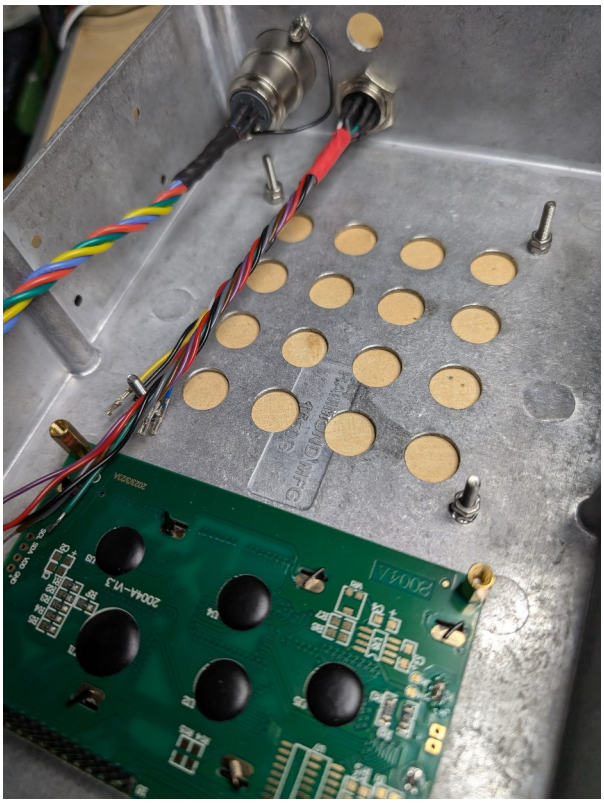
To fit the LCD, put the case face down on a flat surface and drop the LCD onto the screws – the surface will ensure the LCD is flush with the front, now reach under and run the 4 nuts up until they're against the LCD.
If we lift it up and check then the LCD should now be flush with the front (I usually wind the nut up 'one flat' since it's better for the LCD to be slightly recessed.

Now use the 4 brass stand-offs to hold the LCD in place and tighten. Recheck.

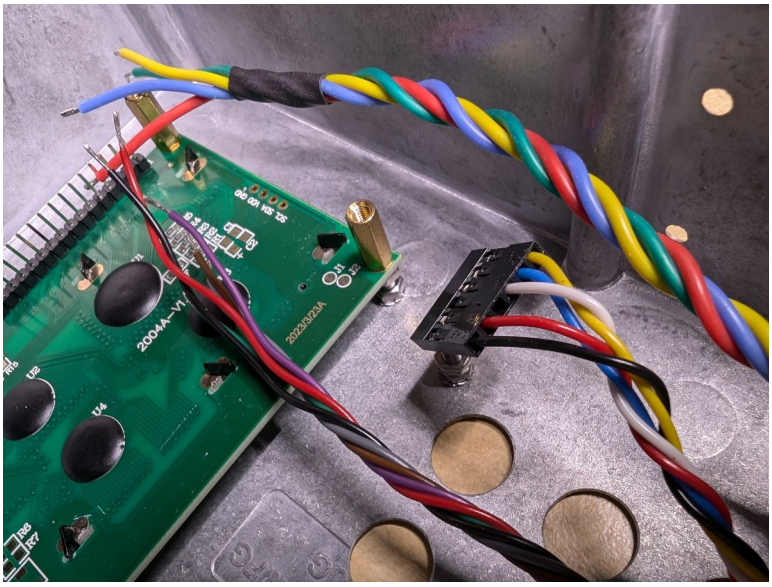


Next fit the stepper motor socket and GX16.
Probably easier to fit the GX16 first since you can more easily get at the nut.

Note the short black wire providing an earth connection to the case from the motor connector.
(If you have the rubber cover remember to fit it to the GX16 at this point).

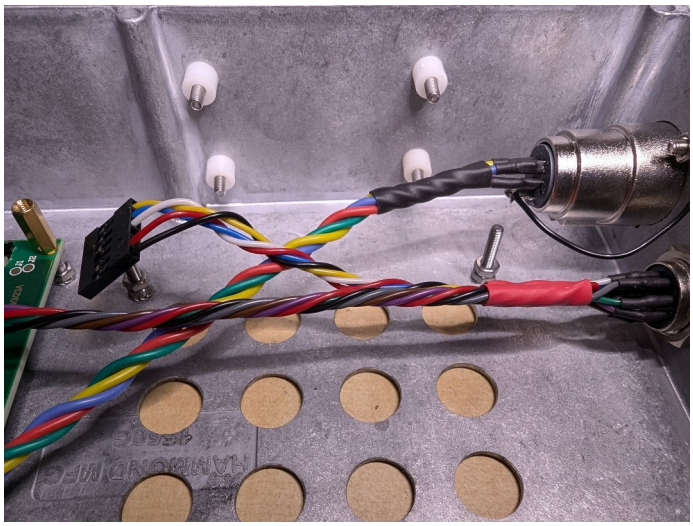


Next, fit the cover onto the crimp terminals. Note the order.
If you're not using these colours then simply make sure the equivalents connect.

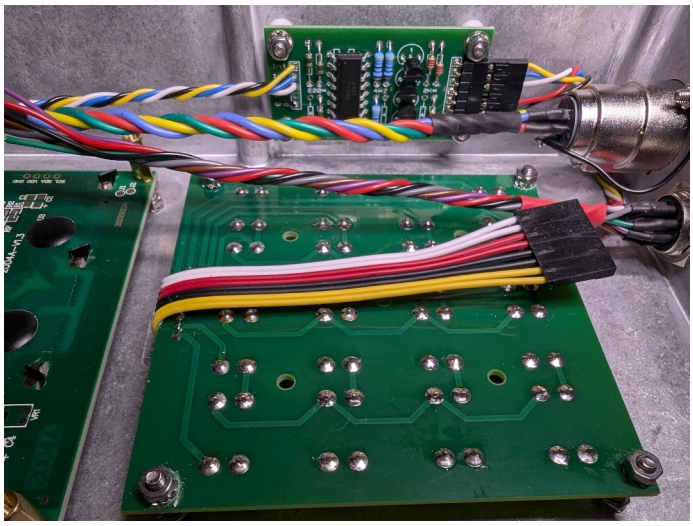


Now add the 4 screws for the opto-isolator and the insulated standoffs and fit the board using a lock washer and nut.

The connector can now be pushed on (black to bottom) and the cable moved out of the way.



The keypad can now be placed.



To adjust the height of the keypad it helps if it’s a bit tight on the screws (it usually is).

With it roughly in place (but high), use a nut spinner to adjust the nuts in turn whilst feeling the protrusion of the keys in the corner nearest the nut.

What is usually correct is when a key is pressed that it’s roughly flush with the front of the case (when released it sits slightly proud into the raised surface of the embossing on the overlay).
If you use an alternative overlay adjust to suit.

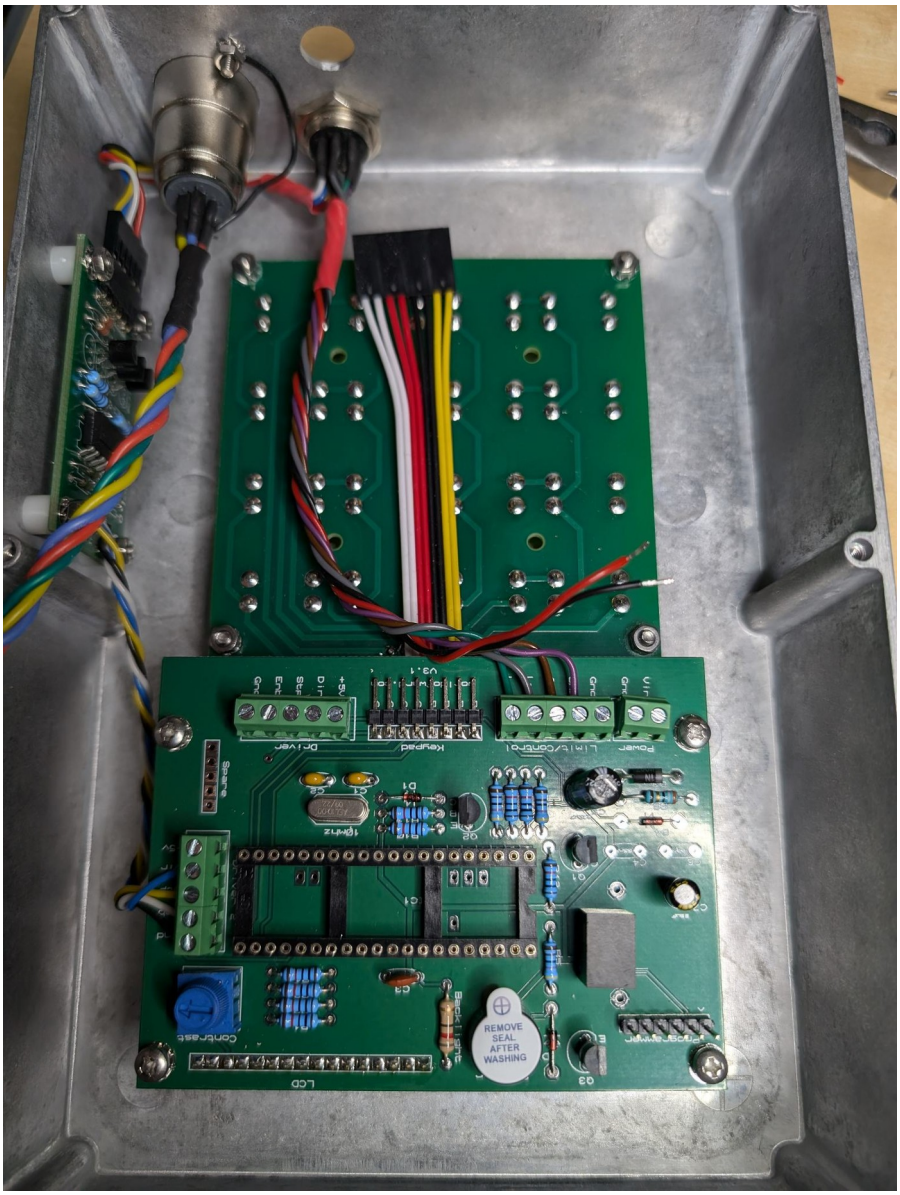
When all 4 corners are like that, reach round and spin the bottom nuts up as per the LCD.
Tighten each of the top nuts and double check.

Now fit the controller PCB back onto the LCD and secure in place.

The opto-isolator fly leads can be connected to the second port.
Black – Gnd, White – Enb, Yellow – Stp, Blue – Dir.

Next trim, strip and tin the long wires from the GX16 and hook them up.
Green – Lim 2, Grey – Lim 1, Brown – Ack, Purple – Sense.

Red and black can be left since they'll hook up with the power connector wires.



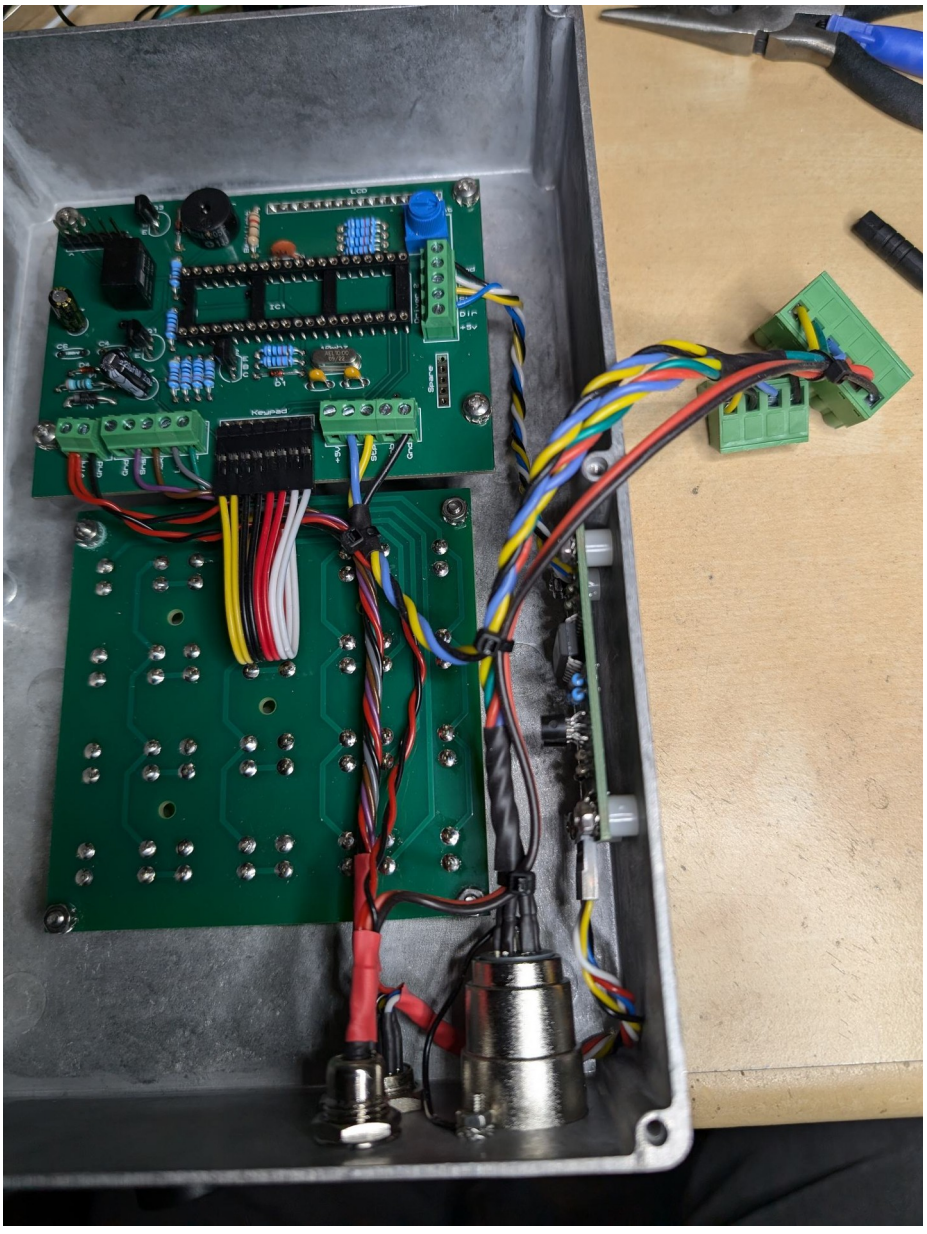
Next we can fit the power connector – make sure the negative connector is pointing down to prevent it fouling on the stepper driver.

Also fit the driver connection we prepared earlier. This connects to ‘Driver 1’, Black – gnd, Yellow – step, Blue – dir.

The thin power wires are routed to the power connector on the controller and paired up with the two wires we’d left from the GX16.
The keyboard cable can now be folded over and plugged in.

The silicone power wires can be run alongside the 4 from the stepper socket and trimmed and tinned.
Note the use of wire ties (4) and where they’re positioned, this is to minimise movement at the connections and the subsequent risk of breaks.

Then the remaining 6 pin connector can be removed from the driver and the power and stepper motor connected to it.



Preparing the stepper driver.

The stepper driver doesn't fit in the case without removing the heat-sink so must be stripped down and the PCB removed.

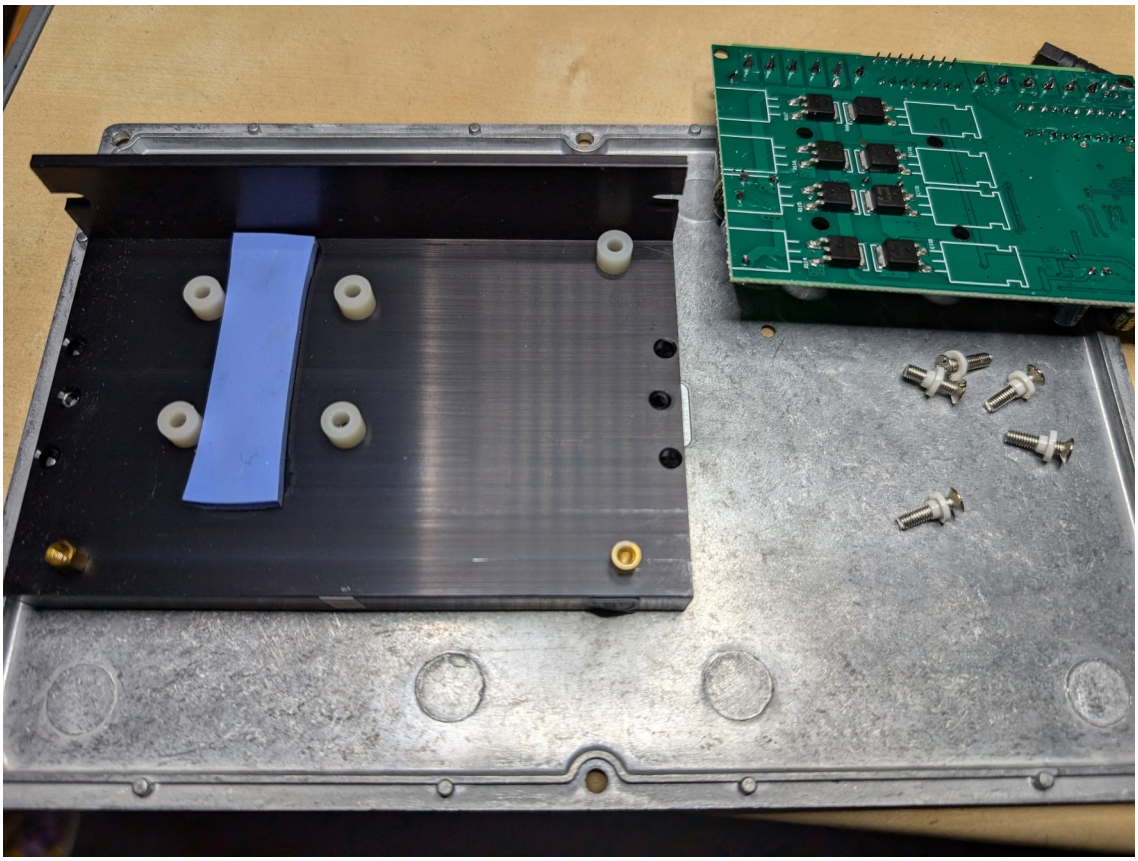
There are two types of stepper drivers.
One uses surface mount components and heat conductive foam, the other uses larger transistors and a thin rubber pad.

Essentially what we'll do is remove the heat-sink and replace it with the rear of the case so whichever method it uses we'll simply shift everything over.

Note some driver have more than 4 screws including some in the corners – ignore those. We'll only use the 4 mounting screws we drilled.

Also some recent drivers only use 3 screws! I don't like only using 3 so in this case quickly mount the driver on the rear of the case using 2 screws and then run a 3mm drill through the 'blank'. Clean up and we've now got 4 holes… (Don't worry there's nothing critical behind the missing screw).

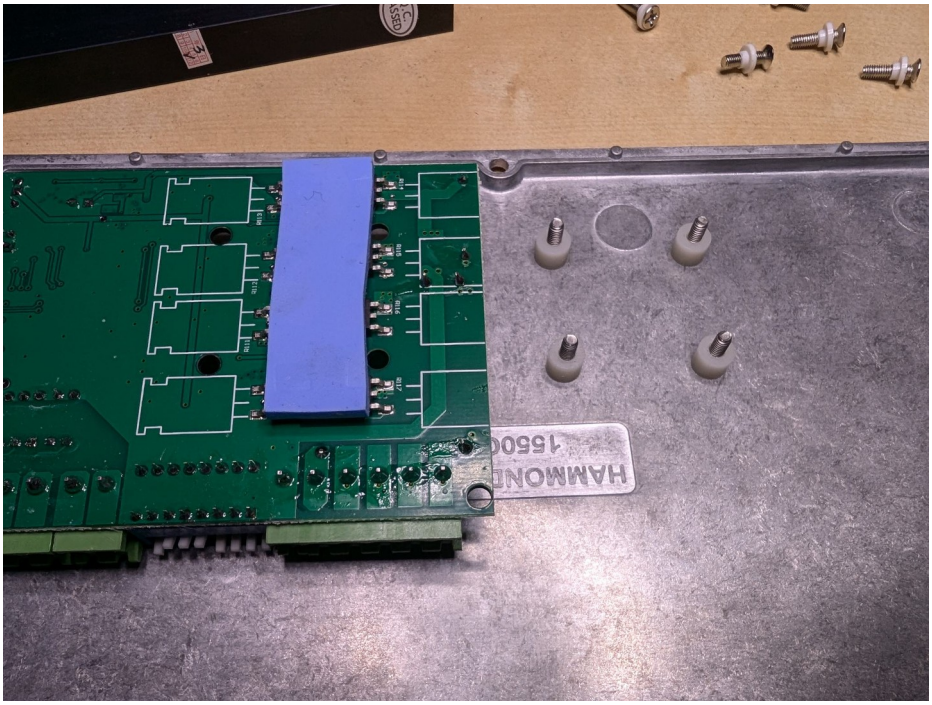
Image of a typical driver stripped.
This is a surface mount version, so note the thermal pad and spacers which we'll reuse.
The alternate version has no spacers and a thin rubber thermal pad instead.



In the case of the thermal pad version we'll put the pad over the surface mount transistors making sure it covers them.

We now put the 4 screws through the base ready to mount the board.

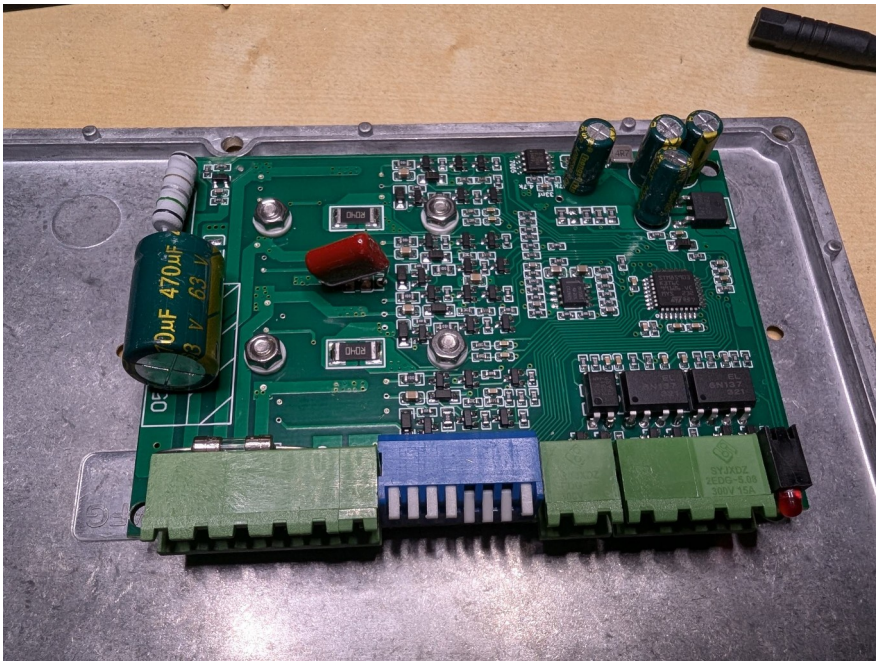
If we have the non-thermal pad version we wouldn't fit the spacers, instead we'd fit the rubber thermal pad over the screws instead.



The board is carefully placed over the screws and in the case of the thermal pad version we can reuse the little plastic insulating washers.

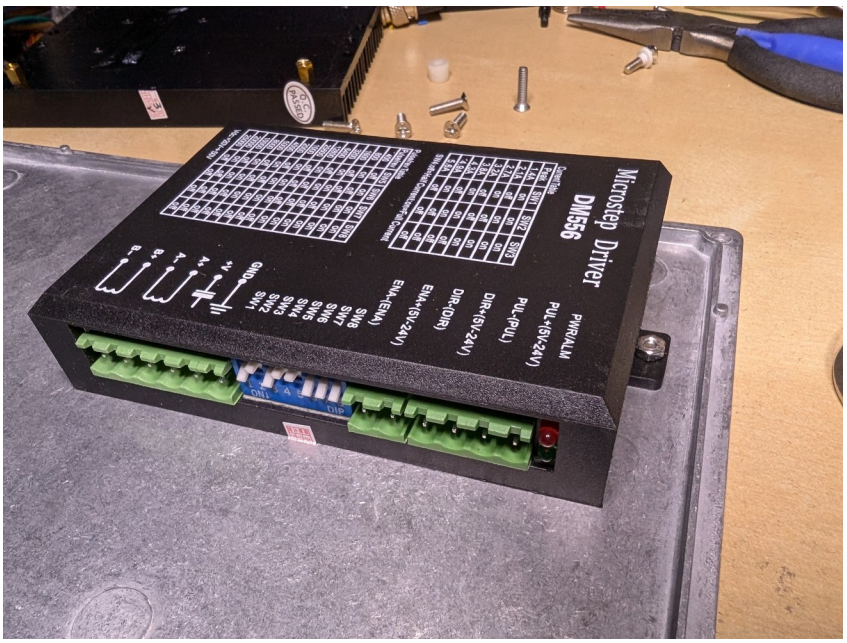
For the non-thermal pad version we should add suitable insulating washers between the nut and the PCB. (I use two ‘paper’ washers per screw).

Note whilst I reuse the various fittings I use my own screws rather than those that come with the driver.



Finally the case can be refitted and held in place with the two small countersunk screws and a nut (no room for a lock washer).

Note the DIP switches in the default setting “On, Off, On, Off, Off, On, On, On” (400 steps, 2.7A)



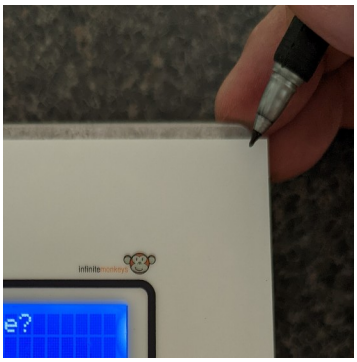
Plug in the cables, test and close up the box.

Attaching Overlay to Case.

Thoroughly clean the case with isopropyl alcohol.

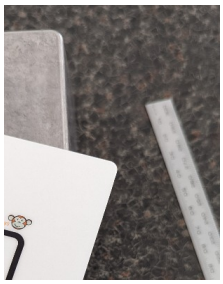
I'd recommend using a fine wire wool with the alcohol before final cleaning with the cloth.

Next, apply power to the controller to make it easier to position the window over the LCD.
(The keypad is fairly tolerant of positioning, whereas the LCD just looks wrong, so concentrate on the LCD).



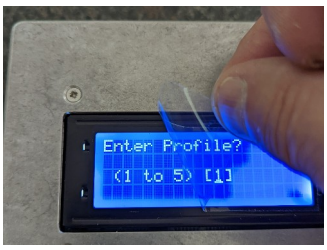
Once you're happy with the position, mark the final size of the overlay for trimming (ideally the same off both sides).
Typically 8mm comes off each side and you *may* need to trim the top or bottom by a couple of millimetres to even it up.

I recommend a straight edge and craft knife, taking several light cuts rather than one cut (which can pull the overlay over resulting in the cut drifting).



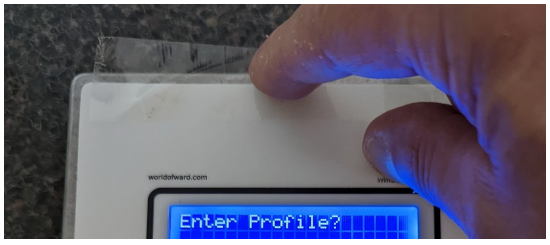
Next I recommend slightly rounding the corners to help prevent them 'catching' and lifting with use plus it looks nicer.
(I use a punch for these but a bit of work with a craft knife works especially if you have some kind of template).

If you still have the protective covering over the LCD now is the time to remove it.



Apply a strip of transparent tape along the top edge to use as a hinge.

Reposition the overlay and when you're happy stick the tape down so the overlay can't move.



Hinge the overlay back and peel off the backing.

Note that the glue is very grabby so don't let it touch the case until you're ready and try to handle it by the edges.

Now starting from the top centre run your finger down the front slowly curling the overlay onto the case.
(Sorry, couldn't take a picture with my finger running down the overlay!)

If you've made a mistake it's still possible to carefully peel the overlay back off the case, lift it from the edge with a craft knife blade.
(Possible but not easy so...)

Use a soft cloth and a moderate amount of pressure rub over the overlay to stick it down to the case. Start from the middle and work out to express any air.

You'll probably want to have unplugged it at this point otherwise the controller will literally 'go mad' processing all those button presses.

My final recommendation is using a hard plastic tool to round over the edge.
This will smooth off the edge making it less likely to catch.

Note that this requires a fair bit of pressure and a plastic tool will be less likely to mark the overlay if it slips than a metal one.

All Done.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Mode? P:1
1> Jog 2> Div
3> Deg 4> Cont
8> Prgrm 9> Setup
Division Controller
1 -0.01
2
3 +0.01
Speed
4 -0.1
5
6 +0.1
STOP
7 -1.0
8
9 +1.0
G Enter
< -10.0
0 Clear
> +10.0
C Back