myFocuserPro2
Let's make a DRV8825-HW203 Full myFocuserPro2 Controller

v1.13 (Jan 2019)

This document describes how to build a myFocuserPro2 DRV8825 HW203 Full Focus Controller

Note: there may be slight differences in layout, parts and schematics show here compared to the main PDF. This is due to different revisions as the myFocuserPro has been developed over 4 years as well as different available options. It is unreasonable to expect the author to keep every single document up to date when a change is made. It is also unreasonable to assume that when looking at a specific schematic or PCB that it covers all available options. There are different schematics and PCB's for each option so please do not assume that one schematic or PCB will show all of these.

The documents reflect what was in use at the time of creation.

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Contents

RESTRICTIONS

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In other words, the author accepts no responsibility to damage caused to any equipment or goods or self by using the ideas, schematics and code associated with this project, or loss of income or all other losses that may be incurred.

PRECAUTIONS

- **Never disconnect or connect the stepper motor when the Arduino or External Power is ON. This can result in damage to the driver board**
- **The correct method is to ensure everything is connected then connect the external power 12VDC**
- **Disconnect the external power 12VDC prior to disconnecting the USB cable**

IMPORTANT LINKS

MAIN PDF WHICH YOU SHOULD READ FIRST!

Part1a Working Out Your Hardware Requirements
https://youtu.be/J6vh_iS2JsE

Part1b Assembling your focuser
https://youtu.be/aB0vM2evxEM

Part1c Testing your focuser
https://youtu.be/Kye_BaU67Aw

Part1d Adjusting the stepper motor current of the myFocuserPro2 controller
https://youtu.be/u2Z0dFaiiyM

Part2a Get The Software
https://youtu.be/KwAxsUjqi_o

Part2b Load ASCOM and Arduino IDE and Libraries
https://youtu.be/m1BJGCBR-nU

Part2c Programming the Firmware
https://youtu.be/2f4X6omc2NI

Part3a Initial setup of Focuser settings
https://youtu.be/mZmWG_vQ1uM

Part3b Overview of Focuser settings
https://youtu.be/yuXUDxkdAgU

Part3c Overview of Windows App Menu Options
https://youtu.be/jsq7kXDv3_Y

Part3d Overview of ASCOM Driver Settings
https://youtu.be/Gh4dpqDFouQ

Part3e Upgrading the Controller Firmware
https://youtu.be/cSvOVw8Djsw

Part3f Controlling more than one myFocuserPro2 controller
https://youtu.be/sEvvWYNMCFs

Part4 myFocuserPro2 Home Position Switch
https://youtu.be/ADi2W0nsypI

Part5a myFocuserPro2 Temperature Compensation
https://youtu.be/YXRqP-V1fcM

Part5b Understanding temperature compensation in myFocuserPro2
https://youtu.be/uIEgBXL9Cks

PARTS LIST

DRV8825HW203 CORE COMPONENTS (M VERSION)	Quantity	Supplier	Cost
Arduino Header Pins 40, Breakable 2.54mm 1pc of 40 pins	1	Robothome	3.07
Toggle switch mini ON-OFF SPDT 3pin	1	ymvon	0.32
Mini toggle ON OFF switch (power on reset circuit)	1	aushop	0.56
470uf 16V Electrolytic Capactitor (power on reset circuit)	1	runber2012	1.25
100uf 50V Electrolytic Capacitor (for DRV8825)	1	tayda2009	0.10
DRV8825 Driver Board	1	friendly-arm	2.09
Nano v3 ATMega328P 1KB EEPROM 2KB SRAM	1	gowin_electronic	3.80
Plastic Enclosure Hobby Box	1		
Power Socket Female Panel Mount 12V 2.5mm x 5mm	1	dailyappliance2010	0.99
Power Plug Male 2.5mm x 5.5mm x 14mm	1	dailyappliance2010	0.99
Ceramic Capacitor 0.33uf	1		
Ceramic Capacitor 0.1uf	1		
LM7808 Voltage Regulator TO-220 package	1	shieldsfans	1.15
LED Blue 3mm Blue 5V Pre-wired 20cm lead	1	colorfulplace	0.60
LED Green 3mm Blue 5V Pre-wired 20cm lead	1	colorfulplace	0.60
LED Bezel Holder 3mm	3	tayda2009	0.40
LED Red 3mm 12V Pre-wired 20cmm lead	1	bestshop2008hk	0.43
1N5408 3A diode	1	satisfyelectronics	0.15
PTC resettable fuse 3A	1		
RS232 DB9 male connector	1	chipworld	0.30
RS232 DB9 female panel mount connector	1	chipworld	0.30
PCB Ordered on line from Fritzing	1		
Buzzer Continuous 5V	1	moncss8	0.20
TDK 5mm Clip On EMI RFI Filter Snap Around Ferrite	1	janeh2100	0.40
NEMA17-PG27 Stepper Motor	1	omc-onlinestepper	48.00
Flexible Shaft Coupler 6-6mm	1	forever-esoft	2.30
TEMPERATURE PROBE COMPONENTS (MT)	**Quantity**	**Supplier**	**Cost**
4.7KΩ Resistor 1/4 watt	1		0.10
Thermometer probe DS18B20	1	alice1101983	1.84
Stereo Female Jack 3.5mm Chassis Mount	1	Mouser Electronics	0.93
Stereo Plug Male 3.5mm	1	louisliu2009	0.99
FULL COMPONENTS (F)	**Quantity**	**Supplier**	**Cost**
Green 12mm Mini Round Waterproof Lockless Momentary Push Button Switch (for PB switches)	1	chip_partner	1.68
Red 12mm Mini Round Waterproof Lockless Momentary Push Button Switch (for PB switches)	1	chip_partner	1.60
1.2KΩ resistor (for push buttons)	3		0.30
1MΩ resistor (for push buttons)	1		0.10
LCD 1602 I2C Module	1	hkseller2014	2.98
LCD 1602 Module	1	seemmy	1.95
or replace LCD1602 with OLED I2C Display	1	huasharenmin2013	3.48

WHAT YOU WILL NEED

- Solder Iron
- Solder
- Cutting Hobby Knife/Scalpel
- Magnifying Glass
- Print outs of the schematic and layout

WHY USE A FULL FOCUSER?

- control of the focuser is using a computer or via push buttons
- there is a requirement for temperature readings or temperature compensation
- manual focus or auto-focus
- need access to display or other options such as rotary encoder or blue-tooth
- if you use the full design board layout/pcb, you can leave off some components and add them later if you decide you need those extra features
- the full board all supports the MT and M options

RECOMMENDED STEPPER MOTORS

NEMA17-PG5 or NMEA17-PG27. The Nema17-PG27 provides the highest torque and the most number of steps per revolution and is suitable for very heavy imaging trains.

CONCERNED ABOUT STEPPER MOTOR SIZE AND WEIGHT

An alternative is the NMEA14 which is much lighter, but uses 0.9 degree step movement with 400 steps per revolution. Using microstepping, this gives 800 steps at half-stepping. This stepper is best used with the DRV8825 driver board.

This stepper motor is ideal for the majority of focusing solutions.

STRIPBOARD OR PCB?

- for DIY projects a stripboard is a good choice if you know how to solder, read circuits and have some trouble-shooting skills
- a PCB can look professional; less mistakes should be made; but costs more than a stripboard. Fritzing PCB's can be ordered online by creating an account and clicking on the links in the PCB-ORDER file or listed in the firmware file. This PCB version is updated as new features are introduced, the stripboard is not.
- The REV4 PCB is a DIY board which you can make yourself.

The stripboard is the easier to make. However, the PCB gives a nice clean layout and minimizes mistakes.

AISLER PCB

There are a number of PCB designs (double sided, plated through holes, silk screened, professionally made) that can be ordered (with or without a part pack – not all parts are in the pack and some may need to be purchased from an alternative supplier such as eBay) online. The PCB version is updated as new features are introduced, the stripboard is not.

The board also support Full, MT (Minimal+Temp) and M (Minimal) options if the associated components are not mounted on the PCB. In other words, you can use the same Fritzing PCB build to support different build options

- Minimal
- Minimal plus temperature probe
- Full including display, push buttons

simply by adding or omitting certain components and changing the firmware version file.

The ASCOM driver and Windows software supports ALL options. The correct Arduino code version must be used with the correct driver board build option.

AISLER PCB DRV8825HW203 M-MT-F-BT

This PCB can be used in either F, MT or M configurations only. The PCB can be ordered online at https://aisler.net/p/DWEURMAC

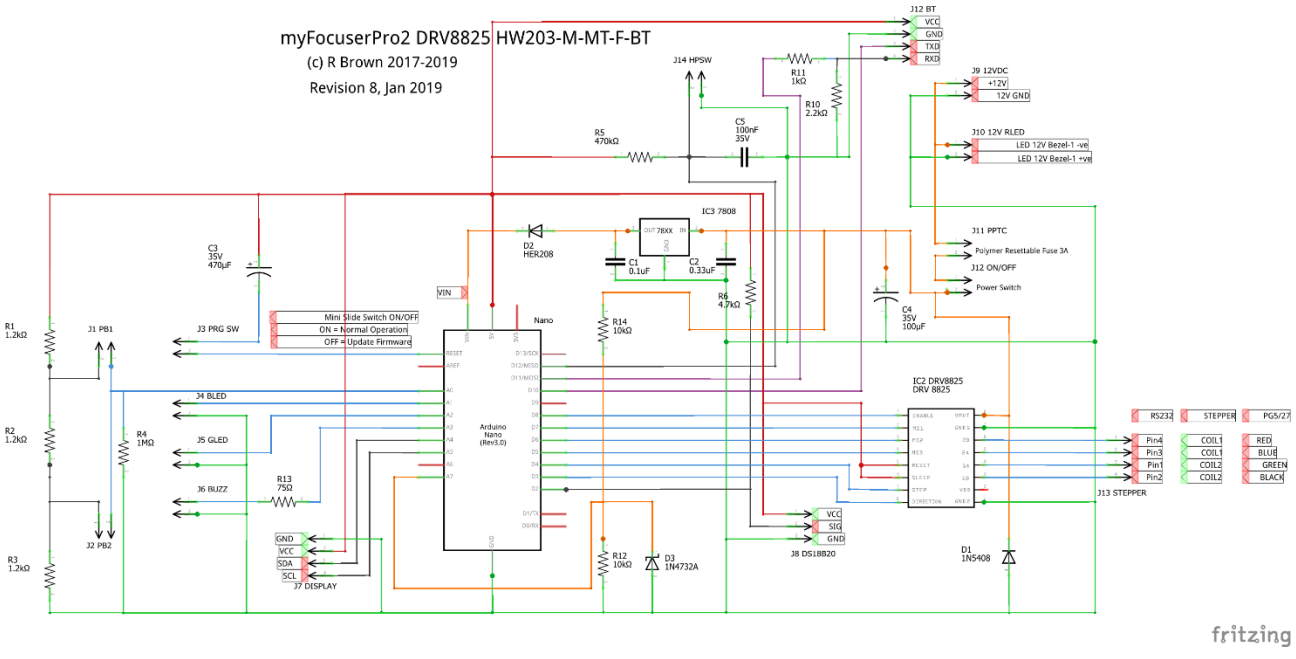
FIRMWARE FILE

_DRV8825_HW203

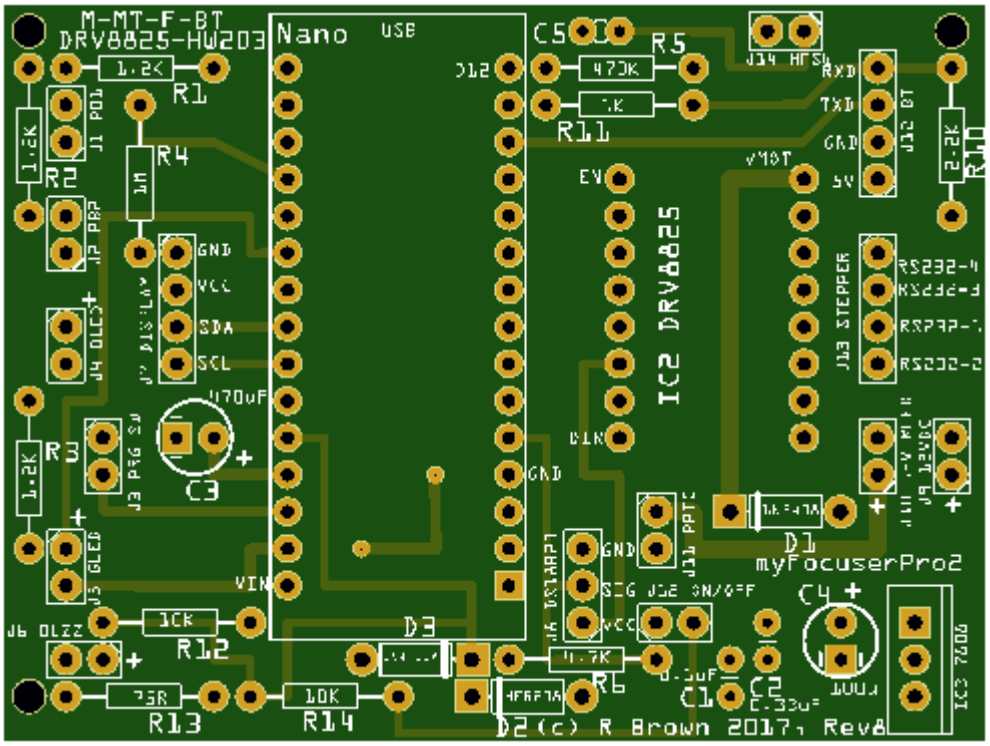
The PCB is high quality and all component placements are clearly marked. A PCB can be built and working in a couple of hours. It is a simple matter of soldering the components to the PCB.

Please watch this video on youtube to see how easy this is.
https://www.youtube.com/watch?v=aB0vM2evxEM

PCB SCHEMATIC



PCB

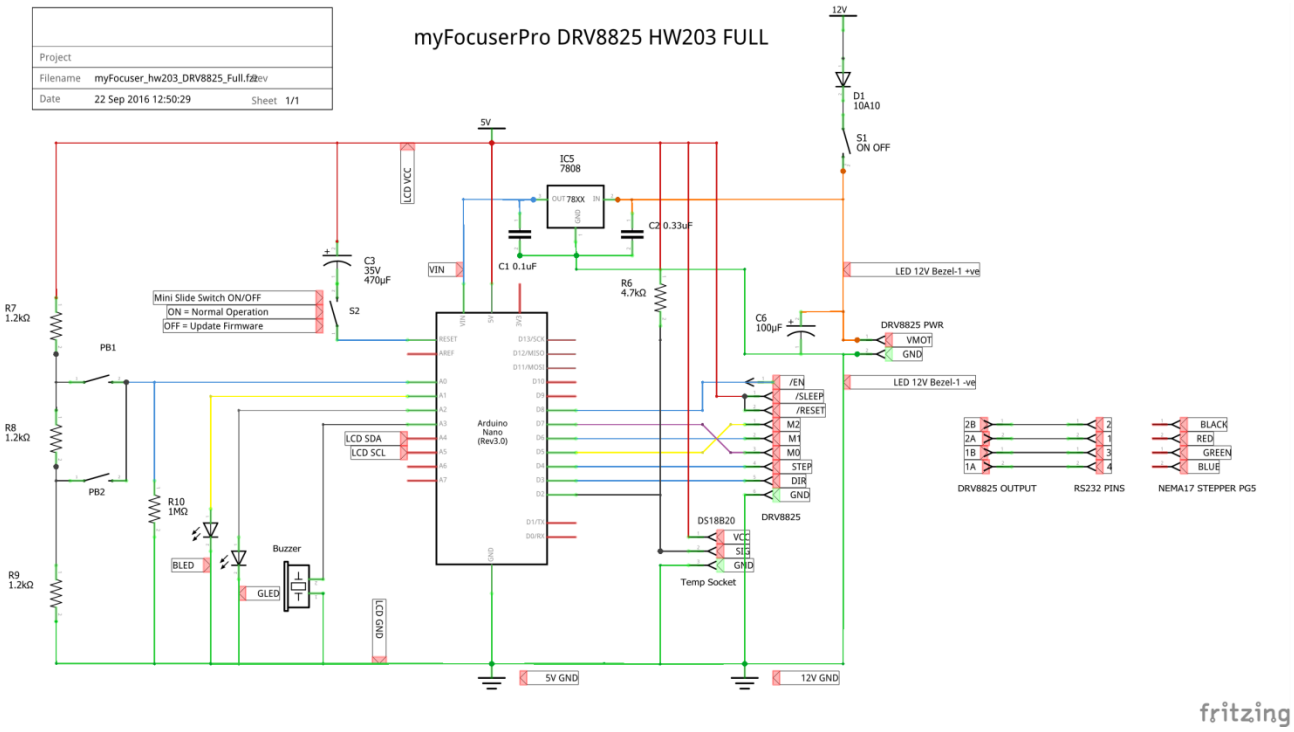


This PCB can be used in either F, MT or M configurations only. The PCB can be ordered online at
https://aisler.net/p/DWEURMAC
https://aisler.net/brown_rb/my-project-repository/myfocuser-drv8825-hw203-mmtfbt

DIY STRIPBOARD DRV8825HW203 FULL

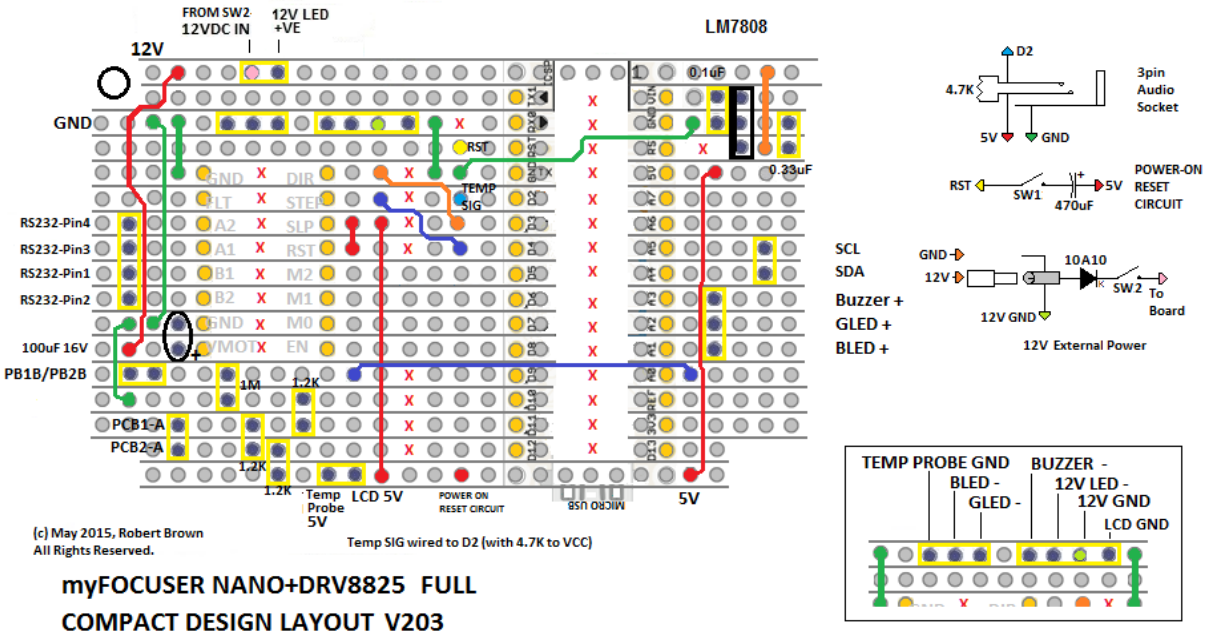
Stripboards do not get updated when new features are added. But they do provide a good low-cost solution for a budget DIY controller. Assembly time is considerably longer than a PCB solution, typically taking several days to complete.

STRIPBOARD SCHEMATIC



Stripboard Layout

The stripboard layout looking from the top component side is as follows. The red X indicates the copper track must be cut. We are looking **down** onto the board and looking through it to see the tracks underneath.



It is best to work in a designated order. A suggested order is

1. Cut the tracks on the underside of the board
2. Install and solder all the required links first (shown above as blue, orange, red, green
3. Install and solder all resistors and capacitors and diode
4. Install and solder the LM7808 voltage regulator
5. Install and solder the DRV8825 chip (check it is the right way round)
6. Install and solder all the Header Pins
7. Install and solder the 15P headers for the Nano
8. Wire up the ON/OFF switch and connect it to the stripboard
9. Wire up the Power on reset circuit and switch and connect it to the stripboard
10. Wire up the 3p Audio socket for the temperature probe and connect it to the stripboard
11. Insert the Nano carefully into the 15p headers (ensure it is the right way round)
12. Move onto testing

FIRMWARE FILE TO USE

_DRV8825_HW203

Note that additional options such as BlueTooth, Infrared or Rotary encoder are not listed here. The design covered in this document is the DRV8825_HW203 FULL option (push buttons, LCD, temperature probe, no IR, BT, Wifi or HomePosition Switch)

STEPPER MOTOR CONNECTIONS

For the recommended Stepper Motor, shown on the layout board

I have a RED/BLACK/GREEN/BLUE Wire Stepper. How do I connect it?
Now if the stepper you purchased was not the 17HS13-0404S-xxx then the wiring will be different.
There are 4 wires to the stepper motor. Normally the manufacturer posts a data sheet which describes the two coils and what color the leads are.

If this is missing then one uses a multi-meter set to resistance to measure the coil resistance.
With one lead on black, connect the other lead to red, then green, then blue. Only one combination will have a low resistance value, all others high.
If Black-Red have the low resistance then that also means green=blue is the the other pair.

Now the next bit might be a bit harder.
Let us assume the outputs of the DRV are A1, A2, B1 and B1. A1 is for one pair and B1 is for the other pair.

The possible number of combinations to wire are

A1=Black, A2=Red, B1=Green, B2 = Blue

or A1=Black, A2=Red, B1=Blue, B2=Green

or A1=Red, A2=Black, B1=Green, B2=Blue

or A1=Red, A2=Black, B1=Blue, B2=Green

For me, the correct combination is when
Looking directly at motor shaft of the stepper
-VE (ie going IN or to lower position numbers) stepper moves CLOCKWISE
+vE (ie, going OUT or to higher position numbers) stepper moves ANTICLOCKWISE

You will need to try each of the four combinations in turn. The one that gives the smoothest motor movement and the correct direction is the one to use.

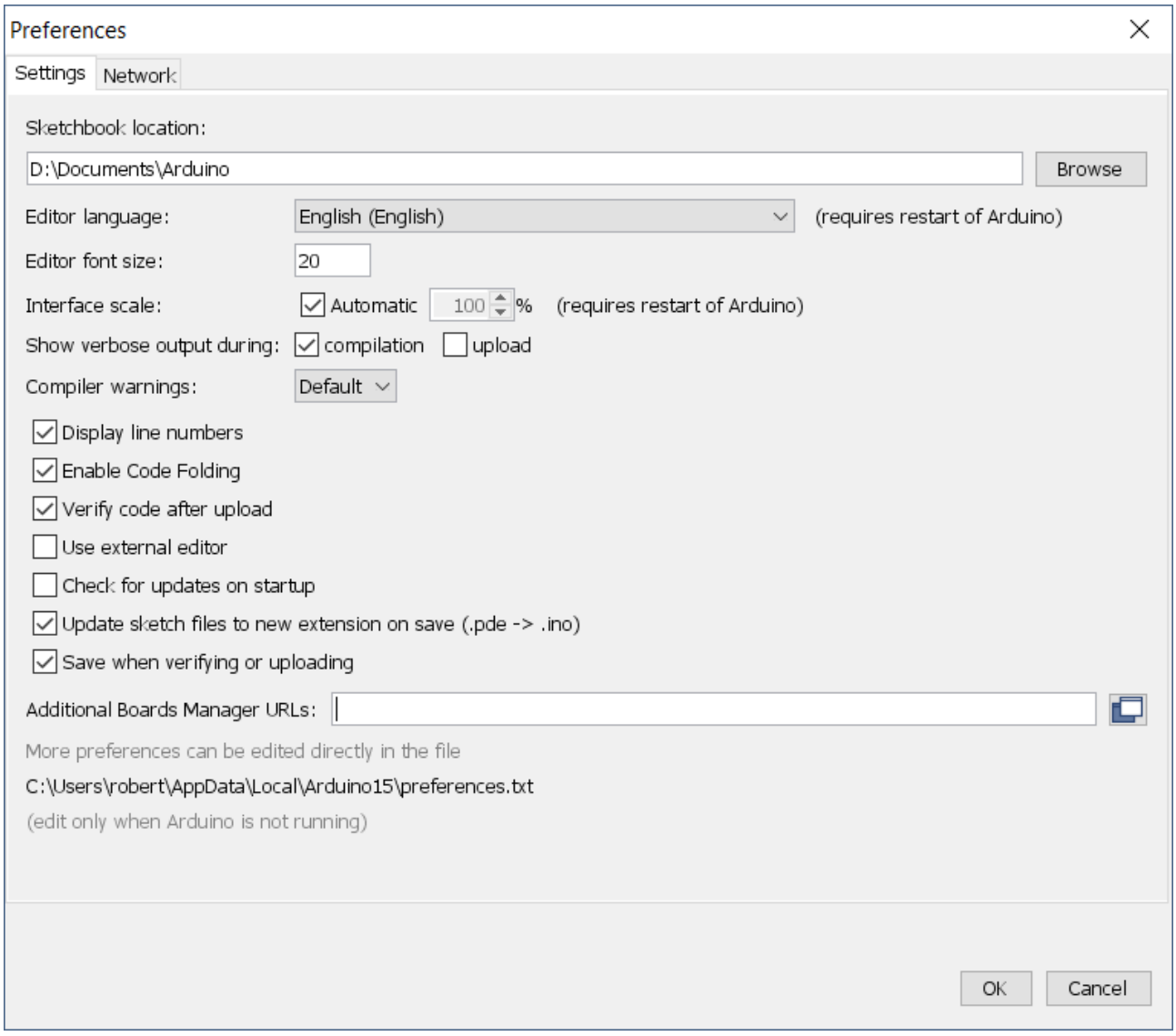
DOWNLOAD AND INSTALL THE ARDUINO IDE

I recommend v1.6.8 which is here

Run the installer and remember to install the drivers for the Arduino at installation of the IDE.

CONFIGURE ARDUINO IDE

Start the Arduino IDE and choose **File** then **Preferences**



The important things are

- Display Line Numbers
- Save when verifying or uploading
- Show verbose output during Compilation

Set these settings as indicated then click OK. You will need to close and then restart the Arduino IDE application for these settings to take effect.

DOWNLOAD THE LATEST FIRMWARE FOR MYFOCUSER PRO

https://sourceforge.net/projects/arduinoascomfocuserpro2diy/files/CODE%20ARDUINO%20FIRMWARE/

INSTALL THE REQUIRED LIBRARY FILES

Follow the instructions in the firmware zip file.

HOW TO TEST THE BOARD

One step at a time!!

If you have successfully powered the board and there is no smoke, congratulations.

Connect the controller to the computer using a USB cable

If ambitious, you can navigate to the DRV8825_HW203 folder and double click on the DRV8825_HW203.ino file. This will start the Arduino IDE and load the focuser code into the IDE.

1. Select the Board type by selecting from the menu bar, **Tools** then **Board** then **Arduino Nano**
2. Select the correct COM Port by selecting from the menu bar, **Tools** then **Port** then the com port associated with the Nano board
3. To test compile the code, click on 
4. You will see a lot of messages in the bottom window of the IDE
5. If successful you will see a **Done compiling** message as well as

Sketch uses 21304 bytes (66%) of program storage space. Maximum is 32256 bytes.
Global variables use 895 bytes (43%) of dynamic memory, leaving 1153 bytes for local variables. Maximum is 2048 bytes.

This means there was no errors. If there are errors they will be displayed and please do not hesitate to ask for help in finding out what those errors are and their cause by posting a message on the site or emailing me direct.

6. If you have a successful compilation then you can attempt to program the controller by clicking on the  button. This will compile the code and send it to the Nano controller.
7. When the upload to the controller is complete, you will see the message **Done Uploading**
8. If you get this message **Problem Uploading to Board** then you have selected the wrong comport
9. If you get this message **Uploading** and is displayed for a long time (minutes) then you have selected the wrong board type. Uploading should take less than 60s. Eventually the upload will time out and you will get a **Problem Uploading to Board** message

If the upload is successful, the controller will reboot at the end of the upload.

1. For this, it is not necessary to have the stepper motor connected and not necessary to have 12V external power.
2. The first thing you should notice is that the backlight of the LCD should come on. If it does not, you need to check the wiring for the LCD as well as look here for LCD issues
3. Once the LCD is working, you should see the boot messages appear after the controller is rebooted.
4. Sometimes you will need to adjust the brightness pot on the back of the LCD to see the display better. First start with the pot about mid-way and then reset the controller (there is a reset button on the Nano itself – press and hold for 2s then release – this will restart the Nano)

5. You should now see the main LCD which cycles through two pages of screens every few seconds
6. If the temperature probe is already connected, proceed. **IF NOT** then you need to power off the controller and disconnect the USB cable. Now connect the temperature probe. After that, reconnect the USB cable.
7. Look at the Temp = display and it should be displaying the current temperature of the probe – if it is, check to see that it is working by holding the metal end of the temperature probe in your hand for a minute to warm it up – you should see the temperature rise.
8. If there is no value for Temp you will need to check the temperature probe wiring. Make sure you do not connect/disconnect the temperature probe when power is on. You will need to verify the connections (wires) for the probe.
9. If the value does not change then there is a wiring issue also. Recheck all the wires for the temperature probe.
10. Once the temperature probe is working you can start the Windows Application and connect to the controller.
11. Take time to get familiar with the various options and settings of the Windows application.

The last step involves the stepper motor. Please read the FAQ before continuing.

1. Make sure the Power ON Reset Circuit is disabled
2. Connect the stepper motor as per instructions
3. Connect the external 12V power supply but leave the switch off
4. Turn the switch ON
5. The Nano should now be powered from the external 12V supply (via the LM7808) and you should see the LCD light up and the boot messages displayed
6. If the Nano does not power up there is an issue and you will need to check all the 12V external wiring, ON/OFF switch and LM7808 circuit before continuing. I can provide further instructions on how to do this but will involve the use of a multi-meter
7. If the Nano is powered, then connect the Nano to the computer using the USB cable
8. Now start the Windows Application and Connect to the correct COM PORT at 9600bps.
9. When connecting, you should see the Nano reboot. If it does not, disable the Power ON Reset Circuit before continuing
10. Once connected the Windows application should display the current settings and Ready message in the Status bar
11. Now attempt a move by clicking on +100 or -100
12. If the motor moves – Success
13. You will still need to adjust the DRV8825 pot for the motor – there are instructions in the FAQ
14. To adjust the pot manually I would
    a. Set the motor speed to slow
    b. set the focuser position to maxSteps value (enter the value into the focuser position box and then click set position)
    c. click HOME
15. Whilst the stepper is moving I would adjust the pot as discussed in the FAQ

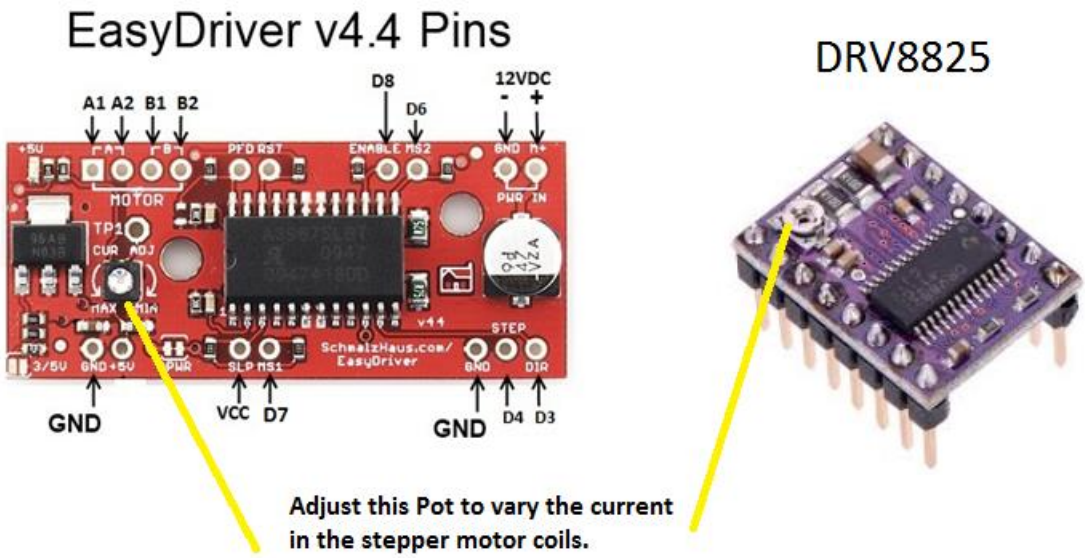
And that is about it. Now you can think about

1. Reconnect the Power On rest circuit
2. Put everything in a case
3. Mount the stepper motor on your focuser

Now go back to the main PDF and read all about CFZ and READ the section on the initial setup of your focuser.

ADJUSTING THE POT ON THE DRIVER BOARD FOR CURRENT MAXIMUM

You will need to adjust the POT on the DRV8825 or EASYDRIVER board to get optimal stepping of the stepper motor. This pot adjusts the current that flows in the coils of the stepper motor.



Adjusting the Stepper Motor manually

It is best to use a ceramic or plastic screwdriver when adjusting the pot. I would suggest a plastic knitting needle which has the end filed down to look like a screwdriver.

1. With the controller connected via USB, and 12V power to the driver board, set the focuser position to 0 and the Motor Speed to SLOW
2. Enter a focuser position of 5000 and click the Goto button
3. Wind the pot all the way anticlockwise until the motor stops moving
4. Now very slowly turn the pot clockwise until you see the motor start to turn. If the maxSteps is reached, just reset the focuser position to 0 and then type in 5000 for the position and click Goto again
5. Slowly turning the pot, when you see the stepper start to move ok without jerking, then slowly turn no more than 1/8th clockwise from that point
6. It should now be close enough
7. If you go too far then there will be too much current and the motor will run hot. You should use no more than 12V external power

On some driver boards clockwise might be anticlockwise. Once set, then switch to 1/4 stepping and repeat the 0 then 5000 Goto. The motor should run smoothly without missing steps (a missed step will be a sudden jerk which you will be able to feel or hear). If there is any of this, you might need to ever so slightly turn it a little more. Be careful as a little turn can make significant changes in current.