Focuser Basics

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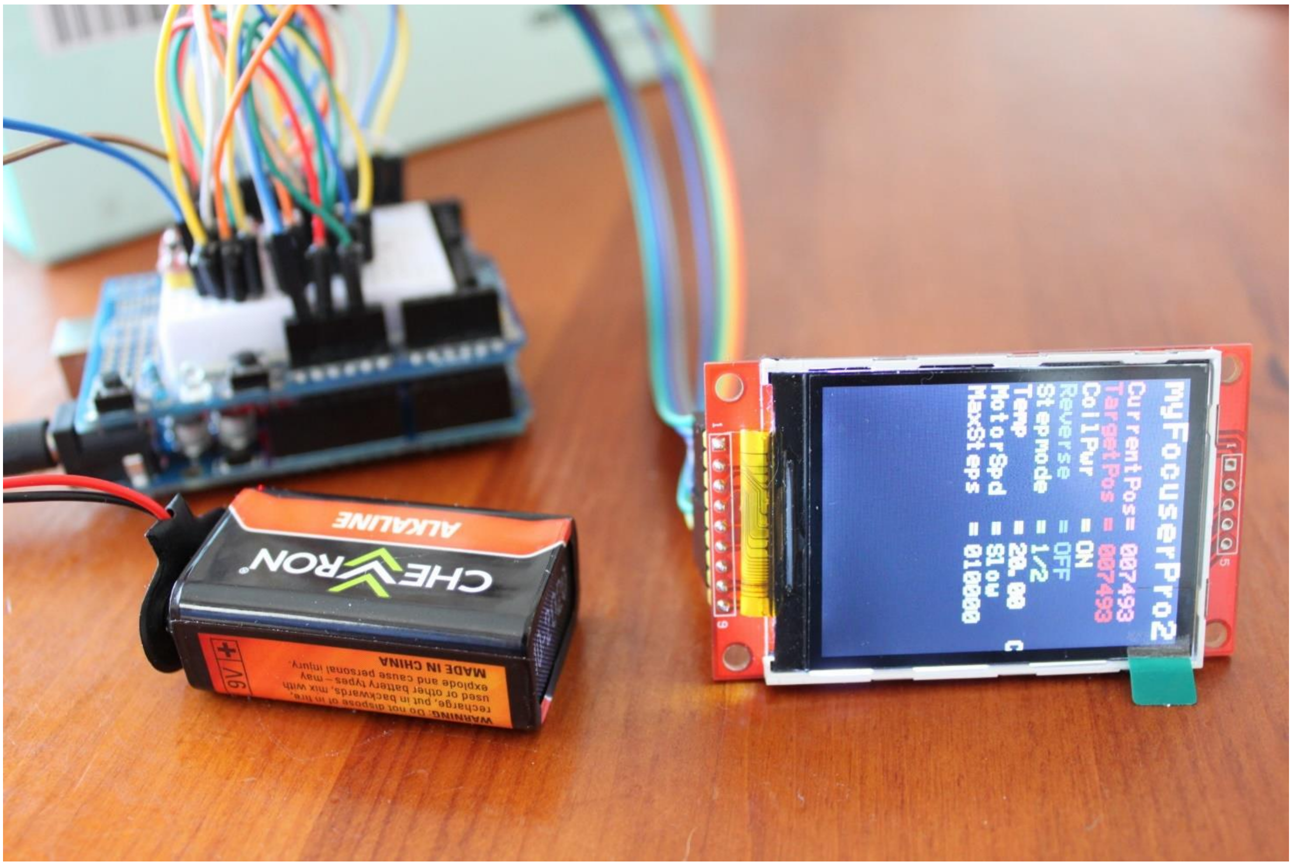
FOCUSER BASICS



SOME FOCUSER BASICS TO START WITH

This is important. Please ensure you read this section first as the size of your telescopes CFZ (critical focus zone) will determine which option is best for you.

To build the correct focuser that matches your system we need to know

- The critical focus zone
- How much your focuser moves in one full rotation (in mm)
- These two measurements will determine what stepper motor resolution is needed (steps per degree or stepsize in microns)

CRITICAL FOCUS ZONE

The critical focus zone (CFZ) is related to the focal ratio of a telescope, and defines the distance over which the image is in focus (measured in microns). It is ideal to get at least a few steps within the CFZ (5 minimum), and this is done by altering the gearing ratio or using half stepping to increase the number of steps per revolution of the stepper motor. As the focal ratio gets smaller (i.e. a faster telescope optic) the CFZ reduces and thus a higher resolution stepper motor (more steps per revolution) is required.

The basic formula I have used is

CFZ in microns = focal_ratio * focal_ratio * 2.2;

For accurate focusing, it is necessary to get at least 10 steps within the CFZ. This is done by altering the gearing ratio (such as using gears or a pulley belt system) or using micro stepping to increase the number of steps per revolution of the stepper motor.

MEASURING FOCUSER DISTANCE PER ONE REVOLUTION OF FOCUS KNOB

We need to know how much your focuser tube moves per one full revolution of the focuser knob (measured in millimetres). For a refractor and Newtonian telescope this should be relatively easy to determine.

For determining this value for Schmidt-Cassegrain (SCT) telescopes, look here.

MEASURING STEP SIZE

Step size is the distance (in microns) the focuser tube moves for one stepper motor step. First **measure** how much your focuser tubes moves for one full revolution of the focuser knob (distance in milli-meters). Then divide this number by the number of steps per 1 revolution of your stepper motor. The answer is the distance that the focuser moves per step (called **Step Size**).

Step Size in microns = (distance one full focuser rotation in mm * 1000) / stepper motor steps per revolution

This value is used to determine how many stepper motor steps there will be within the CFZ of the telescope (ideal is about 10). Simply divide the CFZ by the step size to get the step-size value.

Step Size is supported by myFocuserPro2 controllers. Some applications may require a valid setting for Step-Size in order to work correctly. If enabled, then the Step-Size value stored by the controller will be returned. If Step-Size is not enabled, the ASCOM driver will throw a “Not implemented” exception which the client application should handle. You can specify the Step-Size and enable/disable this setting when connecting to the controller. Setting values are remembered.

Calculating CFZ, Step Size and Stepper Motor Resolutions

Telescope	Stepper Motor
Orion ED80T-CF	**28BYJ-48**
With a focal ratio of f6 the CFZ is about 79microns. One full revolution of the focus knob moves the focuser 18.5mm	28BYJ-48 has 2048 steps per revolution The stepper motor is connected direct to the focuser shaft so one revolution of the stepper is one revolution of the focuser knob Hence, 2048 stepper motor steps move the focuser 18.5mm, so 1 step moves the focuser (18.5*1000)/2048 = 0.009mm which is the stepsize The focuser moves about 9 microns per full step, this there are about 9 full steps of the stepper motor within the CFZ (79/9=8.77)
	NEMA17-PG5
	NEMA17-PG5 has 1036 steps per revolution (at full steps) The stepper motor is connected direct to the focuser shaft so one revolution of the stepper is one revolution of the focuser knob The focuser moves about 17.85 microns per full step of the stepper motor (18.5*1000/1036) There are about 4 full steps of the stepper motor within the CFZ (79 / 17.85=4.4) Full stepping does not give enough steps within the CFZ, so try half-stepping Using half-steps the focuser moves about 8.93 (17.85/2) microns per half step There are about 8-9 half-steps within the CFZ (79 / 8.93 = 8.85) The NEMA17PG5 should be operated in HALF_STEP mode! We need a driver board that supports half stepping for a NEMA17-PG5
	NEMA17-PG27
	NEMA17-PG27 has 5370 steps per revolution (at full steps) The stepper motor is connected direct to the focuser shaft so one revolution of the stepper is one revolution of the focuser knob The focuser moves about 3.44 microns per full step of the stepper motor (18.5*1000/5370) There are about 23 full steps of the stepper motor within the CFZ (79 / 3.44=22.9) Full stepping gives enough steps within the CFZ
	NEMA14-0.9°
	NEMA17-PG5 has 400 full steps per (1600 steps at quarter stepping) The stepper motor is connected direct to the focuser shaft so one revolution of the stepper is one revolution of the focuser knob The focuser moves about 11.56 microns per 1/4 step of the stepper motor (18.5*1000/1600) There are about 4 full steps of the stepper motor within the CFZ (79 / 11.56=6.4) Full and stepping will not give enough steps within the CFZ, so try 1/4-stepping We need a driver board that supports 1/4 stepping for a NEMA17-PG5

Spreadsheet Calculations Showing Various Options

Example1: StellarVue Refractor f7.1 and NEMA17-PG5 half stepping

SV102T with NEMA17PG5 STEPPER MOTOR

usbFocus		SVFocuser
Degrees Per Step	mm per myFocuser Step	mm per 360 degrees
0.3475	0.0164	**17**

1036	steps per 360
16.41	microns full step
8.20	**microns 1/2 step**

Per step the myFocuser motor will move the focuser 16.41 microns Full Steps

CFZ for StellarVue SV102T in microns			Number of steps for Motor	
Focal Ratio		cfz	Full-Steps	**Half-Steps**
7.1	**Prime**	**111**	**7**	**14**
14.2	2x Barlow	444	27	54
21.3	3x Barlow	998	61	122
36	5x Barlow	2773	169	338
5.68	**0.8 Reducer**	**71**	**4**	**9**

Note: Motor is set to Reverse Direction and Half Steps for SV102T

SV102T Focus Position		**NEMA17 Steps (Half)**	
0cm	Min Travel		
1cm		0	START
2cm		1218	
3cm		2436	
3.2cm	OSSAO	2680	
3.5cm		3045	
4cm		3654	
4.4cm	**Focus**	**4141**	
4.5cm		4263	
5cm		4872	
5.65cm		5664	STOP
6cm		6090	
6.5cm	Max Travel		

609.4117647 Full steps per cm
1218.823529 Half Steps per cm

As you can see, this will give 14 half-steps within the CFZ at f7.1 and 9 steps at f5.68, which is adequate for repeatable accurate focusing using a direct connection with a flexible coupler.

Example2: Orion ED80T-CF f6 Refractor with 28BYJ-48 Stepper Motor and ULN2003 Driver

ED80T-CF with myFocuser 28BYJ-48 Stepper

myFocuser		OrionFocuser
Degrees Per Step	mm per myFocuser Step	mm per 360 degrees
0.1758	0.0090	**18.5**

2048 steps per 360

9.03	um per step
4.52	um per half-step

Per step the myFocuser 28BYJ-48 motor will move the focuser 9.03 microns

CFZ for Orion ED80T-CF in microns			Number of steps for Motor	
Focal Ratio		CFZ	Full-Steps	Half-Steps
6	Prime	79	9	**18**
12	2x Barlow	317	35	70
18	3x Barlow	713	79	158
30	5x Barlow	1980	219	438
4.8	0.8 Reducer	51	6	**11**

Note: Motor is set to Normal Direction and Full Steps for ED80T-CF
Note: ULN2003 driver does not support half-steps - if half-steps are needed, then use LD293D shield

As you can see, this will give 9 full-steps within the CFZ at f6 and 6 steps at f4.8. Using half-steps, this would just be adequate for repeatable accurate focusing using a direct connection with a flexible coupler.

Examples
My example focuser has four (4) full turns of the focuser knob from the minimum full IN position to the maximum full OUT position.

Example 28BYJ-48 Stepper
For the 28BYJ-48 stepper motor at 2048 steps per revolution, with the stepper attached to the single knob of the focuser, then this gives 2048*4 or 8192 maximum possible steps. We unclamp the flexible coupler and manually position the focuser to be ½ turn out from the minimum IN position, then re-clamp the flexible coupler.

We turn on the focuser and run the myFocuserPro2 Windows application, select the correct COM port and connect to the controller. The focuser is currently at position 5000 (the controller has defaulted to position 5000). We enter 0000 as the focuser position and click the SET POSITION button, which tells the controller that the current focuser position is reset to position 0. This ensures that the stepper cannot drive the focuser fully home (it will stop one half turn away).

To determine **maxStep**, we also assume that we will drive the focuser OUT but stop one half turn before the maximum stop of the focuser. For our example, this is three full turns of the focuser knob. In stepper motor steps this is 2048*3 = 6144, so we need to set maxStep to 6144 in the setup dialog box.

In the myFocuserPro2 Windows Application we enter 6144 as the Maximum Position and click the SET button to send this value to controller.

For the initial focuser position, we determine the half-way point (0-6144) and so the initial focuser position will be 3072.

Next, we move the focuser from position 0 to the mid-point by entering 3072 in the focuser position text box and then click the GOTO POSITION button to move the focuser. Once the focuser has stopped moving, we can then close the application and power off the focuser. *If you notice that the focuser does not move when the GOTO POSITION command is sent to the controller, it is likely that the direction is incorrect. Try enabling Reverse Direction and then clicking the GOTO POSITION button again.*

To check that everything is set, we turn on the focuser and restart the myFocuserPro2 Windows application. You will see that the focuser position will be set to the midway point (in our example 3072) and that the maximum position is set to 6144.

As long as the focuser is not manually moved, or the coupler disconnected, the focuser is now setup with the correct values. Each time we connect to the focuser, the correct settings will be sent to the controller and will be saved so they can be recalled next time we run the software or access the ASCOM driver.

Example NEMA17-PG5 Stepper
For the NEMA17-PG5 stepper motor using half-steps, there are 2072 steps per revolution, with the stepper attached to the single knob, then this gives 2072*4 or 8288 maximum possible steps. We unclamp the flexible coupler and manually position the focuser to be ½ turn out from the minimum IN position, then re-clamp the flexible coupler.

We turn on the focuser and run the myFocuserPro2 Windows application, select the correct COM port and connect to the controller. The focuser is currently at position 5000 (the controller has defaulted to position 5000). We enter 0000 as the focuser position and click the SET POSITION button, which tells the controller that the current focuser position is reset to position 0. This ensures that the stepper cannot drive the focuser fully home (it will stop one half turn away).

To determine **maxStep**, we also assume that we will drive the focuser OUT but stop one half turn before the maximum stop of the focuser. This is three full turns of the focuser knob. In stepper motor steps this is 2072*3 = 6216, so we set maxStep to 6216 in the setup dialog box.

In the myFocuserPro2 Windows Application we enter 6216 as the Maximum Position and click the SET button to send this value to controller.

For the initial focuser position, we determine the half-way point (0-6216) and so the initial focuser position will be 3108.

Next, we move the focuser from position 0 to the mid-point by entering 3108 as the focuser position and then click the GOTO POSITION button to move the focuser. Once the focuser has stopped moving, we can then close the application and power off the focuser. *If you notice that the focuser does not move when the GOTO POSITION command is sent to the controller, it is likely that the direction is incorrect. Try enabling Reverse Direction and then clicking the GOTO POSITION button again.*

To check that everything is set, we turn on the focuser and restart the myFocuserPro2 Windows application. You will see that the focuser position will be set to the midway point (in our example 3108) and that the maximum position is set to 6216.

As long as the focuser is not manually moved, or the coupler disconnected, the focuser is now setup with the correct values. Each time we connect to the focuser, the correct settings will be sent to the controller and will be saved so they can be recalled next time we run the software or access the ASCOM driver.

In order for the focuser to work correctly. Incorrect values for Maximum Position or setting the zero position incorrectly may cause damage to either the focuser or stepper motor.

Please note that the values will be different for your focuser and these will need to be determined by you in order for the focuser to work correctly. Incorrect values for Maximum Position or setting the zero position incorrectly may cause damage to either the focuser or stepper motor.

It is important that the stepper motor stops and does not try to drive past the minimum and maximum points of your focusers travel.

STEP SIZE AND CRITICAL FOCUS ZONE

This section will examine the relationship of Step-Size (SS) to the CFZ.

Q: I Have an SCT telescope, focal ratio is f10. How do I calculate the step size?

A: This involves a number of inter-related maths. We know that CFZ in microns = focal_ratio * focal_ratio * 2.2, thus for an f10 telescope this is

CFZ = 10 * 10 * 2.2
CFZ = 220 microns

To get 10 steps within the CFZ the required Step-Size will be

SS = 220 / 10
SS = **22**

thus a Step-Size of around 22microns is required. Now for the sake of simplicity, we will make some assumptions.

1. The stepper motor is connected direct to the focuser shaft
2. We have selected a stepper motor whose current is around 400mA at 12V

What we do NOT know is how far your focuser moves in one full turn of the focuser knob. This is important and we cannot go much further without this information. That distance is something you will need to measure (in milli-meters) before continuing.

Q: How to measure how far the SCT focuser (primary mirror) moves in one focus knob revolution?

A: Using a Bahtinov mask to determine best focus, attach a diagonal and eyepiece (around 40mm is okay) which is inserted fully into the diagonal) and achieve good focus.

Next rotate the focus knob one full revolution. Then, without changing focus, slowly move the eyepiece outwards of the diagonal till focus is achieved. If focus gets worse as the eyepiece is slowly retracted, then you will need to start again, and after achieving best focus with the eyepiece fully inserted, this time rotate the focuser knob in the other direction.

Next measure the distance that the eyepiece has moved away from the top lip of the diagonal. Now we have the distance for one revolution of the focuser knob. Let us assume that you did measure it and your focuser moves 20mm in one full revolution.

Now we will proceed on that basic and in the following you can substitute the real value instead of the 20mm I am using.

Let us examine some different combinations of stepper motors.

CASE 1: NEMA14 0.9° at 400 steps per revolution at HALF STEPS USING 3:1 GEAR/PULLLEY/BELT

1 full stepper motor revolution is 400 steps, at half steps this is 800.
But using 4:1 gearing (in this case 3D printed gears, 120T on focus knob and 30T on stepper motor)
This gives 3200 steps per revolution, and 1 full focuser knob revolution moves 20mm, so per step = 20/3200 = 0.00625mm or 6.25microns. This is just good enough because we need a step size of 22microns and have 3 steps within the CFZ.

CASE 2: 28BYJ-48 ULN2003 2048 Steps per Revolution at FULL STEPS USING 3:1 GEAR/PULLLEY/BELT

1 full stepper motor revolution for the 28BYJ-48 is 2048 steps.
But using 4:1 gearing (in this case 3D printed gears, 120T on focus knob and 30T on stepper motor)
This gives 8192 steps per revolution, and 1 full focuser knob revolution moves 20mm, so per step = 20/8192 = 0.0024mm or 2.5microns. This is just good enough because we need a step size of 22microns and have approximately 9 steps within the CFZ.

So, what is the important need to know information - how far your focuser moves in one revolution.

For a refractor or Newtonian telescope, this is much easier and has already been covered.

Q: What can I do about backlash with the SCT focuser?

A: Backlash is a major problem with an SCT focuser. The only method is always try to focus in one direction without reversing. This means using an autofocusing program such as FocusMax.

An alternative is to affix a Crayford type focuser to the rear cell, and focus using the Crayford rather than the SCT focus knob. This eliminates the worst of the backlash/ Special focusers are available that can be used with a field flattener/reducer (they house the flattener/reducer within the focuser). But using a Crayford focuser attached to the SCT rear cell can be expensive.

STEPPER MOTORS

If using direct drive (stepper motor is connected to the focuser shaft using a flexible coupler) then the ideal requirements are

- Bipolar stepper motor
- 12VDC at less than 500mA
- Holding High torque (> 75oz.in)
- Small step angle (0.9°) or geared planetary reduction drive, micro-stepping
- Low weight (<300g)

CHOOSING A STEPPER MOTOR DEPENDS UPON A NUMBER OF FACTORS

- Focal ratio of telescope (the smaller the number the more steps per revolution you will need)
- Weight of optical train (heavier requires a stepper motor with higher torque or a geared drive)
- 12VDC
- Maximum current around 400mA

Choosing the right stepper motor is also combination of voltage, current, steps per revolution, inertia torque, holding torque, size and weight). The voltage and current requirements are controlled by the driver board being used (or you could build your own driver circuit to supply higher voltages and currents).

If you decide not to use the recommended motors suggested here, then make sure that the current rating of your stepper motor (x2) does NOT exceed that of the driver board you have selected. For example, if you selected a 1.4A stepper motor, then the current draw when both coils are energized is 2.8A, which exceeds most of the driver boards listed here.

TYPICAL STEPPER MOTOR CHARACTERISTICS

The number of steps per revolution required is directly related to the focal ratio of the telescope and hence the CFZ. For focal ratios of f7 or lower, a geared stepper motor (or belt drive system) such as the PG27 is preferred.

Stepper	Current	Voltage	Steps Per Revolution
28YBJ-48	320mA	5-7.5V	2038
NEMA17	400mA	12V	200
NEMA17-PG5	400mA	12V	1028
NEMA17-PG27	400mA	12V	5370
NEMA14	400mA	12V	400

The Nema17 stepper motor provides much greater torque than the 28BYJ-48 stepper motor. The Nema17-PG27 provides the highest torque; the most number of steps per revolution and is suitable for heavy imaging trains.

When using NEMA17 stepper motors with the L293D Motor Shield and L298N driver boards (and the ULN2003 with the 28BYJ-48), the number of steps per revolution must be specified in the Arduino firmware file. For all other driver types, this is not necessary.

const int stepsPerRevolution = 1028;
// NEMA17-PG5 motor
// you need to change the above line to reflect your stepper motor, examples below

AVAILABLE/RECOMMENDED STEPPER MOTORS

The following stepper motor is recommended for heavy imaging trains
Gear Ratio 27:1 Planetary Gearbox with Nema 17 Stepper Motor 17HS13-0404S-PG27
http://www.omc-stepperonline.com/gear-ratio-271-planetary-gearbox-with-nema-17-stepper-motor-17hs130404spg27-p-249.html
$28.29USD
5370 steps per revolution full-step, 10740 steps per revolution half-step
*ample torque and suited to fast telescopes f2 – f8

Other stepper motors
http://www.omc-stepperonline.com/gear-ratio-51-planetary-gearbox-with-nema-17-stepper-motor-17hs130404spg5-p-140.html
Gear Ratio 5:1 (5.18:1) Planetary Gearbox with Nema17 Stepper Motor 17HS13-0404S-PG5, $27USD
1036 steps per revolution full-step, 2072 steps per revolution half-step
*ample torque for heavy imaging trains and enough steps for f7 telescopes

http://www.omc-stepperonline.com/nema-17-stepper-motor-34mm-12v-04a-26ncm37ozin-17hs130404s-p-166.html
8.28USD, 200 steps per revolution full-step, 400 steps per revolution half-step
*steps per revolution is not enough for accurate focusing < f7 (would need to use gears or belt drive)

http://www.ebay.com/itm/261110217491?_trksid=p2060778.m2749.l2649&ssPageName=STRK%3AMEBIDX%3AIT
1.06USD, FULL STEP = 2038 steps per rev, HALF STEP = 4076 steps per rev (only with L293D Shield)
* May not have enough torque for heavier imaging trains
* Operate on 7.5VDC else motor will overheat if using Coil Power ON

Keep in mind that the stepper motor will be the single most expensive item, and it is best to get a stepper motor that will give great results. The stepper motors recommended here are excellent choices.

CONCERNED ABOUT STEPPER MOTOR SIZE AND WEIGHT

An alternative is the NMEA14 which is much lighter but uses 0.9° 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.

Nema 14 Bipolar Stepper Motor .9deg 0.4A 11Ncm 14HM11-0404S

START HERE

Decide on the stepper motor and controller board you will use. If you have not, we recommend the below

We recommend you use the NEMA17PG27 stepper motor [17HS13-0404S-PG27].
We recommend you use the myFocuserPro2E-DRV controller with NEMA motors

myFocuserPro2 CONTROLLER COMPARISON

Controller	Typical I	Peak I	Typical V	Max V	Steps	Stepper
DRV8825[3]	**1.5A**	**2.2A**	**12V**	**45**	**F** $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}$	**Nema17PG5/PG27 or NEMA1414HM11-0404S**
ULN2003	350mA	500mA	12V	12	F $\frac{1}{2}$	28BJY-48

The firmware to use for each driver board is shown in the table below

Controller	Firmware
DRV8825_HW203[3]	**FocuserPro2E_DRV_xxx**
ULN2003	Focuservxxx_ULN2003

STEPPER MOTORS

MICROSTEPPING

It is important to get a sufficient number of steps per revolution as this will determine the accuracy of focusing. The number of steps required depends on the focal ratio of the telescope. It is possible to determine what is best for a particular telescope (see the section on Critical Focus Zone).

One method of increasing the number of steps per revolution is to use a gear system with a flexible belt drive. Another way to increase the steps per revolution is to use micro stepping (stepping the stepper motor in-between full steps) or a geared stepper motor (PG5, PG27).

Please note that the ULN2003 option does not support half-stepping. The L293D shield supports half stepping on both the 28BYJ-48 and the NEMA17-PG5 stepper motors.

If you have an f6 or f7 refractor telescope, then half-stepping should be used with the NEMA17-PG27 unless the stepper motor has been attached using a belt drive and reduction gears.

The downside associated with half-stepping is the decrease (30%) in available torque.

A NOTE ABOUT TORQUE

Torque is a measure of how much force the stepper motor can exert on an object. The higher the torque value the greater the force that can be exerted. Torque is dependent upon voltage, current, number of coils, the efficiency of the motor, strength of the magnets used and other factors.

- Bipolar stepper motors provide 40% more torque than an equivalent unipolar stepper motor
- Choosing to operate the stepper motor in HALF-STEP mode will result in a 30% reduction of torque
- Torque can be increased significantly by using a gear reduction or pulley/belt drive system, but there are trade-offs
- It requires more torque to drive a focuser when the telescope is in the vertical position. The system should always be tested with the telescope pointing at Zenith to see if the stepper can drive the focuser inwards without any issues (such as missed steps or failure to move)
- For a small telescope with a light focuser and light camera, the 28BYJ-48 stepper should have enough torque to drive the focuser
- Increasing the voltage or current is not really an option. The L293D Motor Shield cannot readily support higher currents than 400mA continuous
- For the L293D Motor Shield, the AF_MOTOR library supports SINGLE and DOUBLE parameters when stepping the motor, with DOUBLE resulting in more torque. The controller code uses DOUBLE
- With any system, the user must ensure that the stepper motor does not attempt to drive the focuser either below or beyond the focuser mechanical limits

There are really two different types of torque that you need to consider. The first is the inertia force, the amount of force that the stepper can apply when attempting to drive a stationary motor so that the stepper motor can overcome the inertia of the system, weight of focuser, imaging train and friction and begin to move.

The second is the holding torque, which is the force the stepper motor exerts to prevent the motor from turning when the motor is stationary. This is done by applying power to the coils (referred to as coil power in the software). If the holding torque is low then the focuser imaging train could have enough weight to move or slip either during a move command or once the move command is finished. A geared motor with coil power ON is preferred for heavier imaging trains or imaging near the Zenith.

STEPPER MOTOR WIRING (FRITZING PCB)

DRIVER Jx-STEPPER HEADER 4P	RS232 Pin	NEMA17PG27/NEMA17PG5	NEMA17	14HM11-0404S
DRV8825/A4998/DRV8825-HW203				
Jx-Pin1	4	RED (Coil2)	GREEN	RED
Jx-Pin2	3	BLUE (Coil2)	BLUE	BLUE
Jx-Pin3	1	GREEN (Coil1)	BLACK	BLACK
Jx-Pin4	2	BLACK (Coil1)	RED	GREEN
L9110S				
B+	4	RED (Coil2)	BLUE	BLUE
B-	3	BLUE (Coil2)	GREEN	RED
A-	1	BLACK (Coil1)	RED	GREEN
A+	2	GREEN (Coil1)	BLACK	BLACK
L293D-MINI				
A+	4	RED (Coil2)	BLACK	BLACK
A-	3	BLUE (Coil2)	RED	GREEN
B+	1	BLACK (Coil1)	GREEN	RED
B-	2	GREEN (Coil1)	BLUE	BLUE
L298N and TB6612FNG				
B1	4	RED (Coil2)	BLACK	BLACK
B2	3	BLUE (Coil2)	RED	GREEN
A2	1	BLACK (Coil1)	GREEN	RED
A1	2	GREEN (Coil1)	BLUE	BLUE

PRECAUTIONS

Never disconnect or connect the stepper motor when the myFocuserPro2 Controller or external power is ON. This will result in damage to the controller.

Never disconnect or connect the temperature probe when the myFocuserPro2 Controller or external power is ON. This may result in damage to the controller.

WHICH WAY IS IN AND OUT?

Normal convention is that IN moves the imaging train (or eyepiece) IN - closer to the telescope, and OUT moves the imaging train (or eyepiece) away from the telescope.

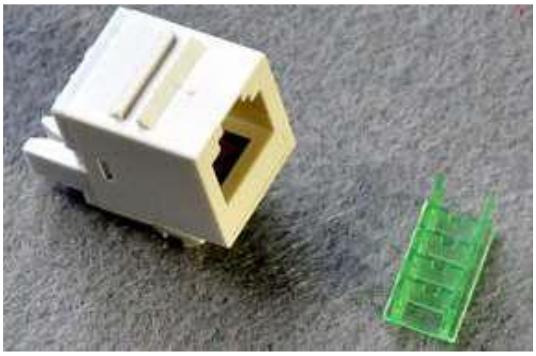
Depending on the wiring of the stepper motor coils to the driver board or the way in which the stepper motor is physically connected to the focuser, pressing the IN button or sending an IN command (using the Windows or ASCOM driver) could move the focuser in the wrong direction. If this is the case, check the Reverse Direction checkbox to ensure that when an IN command is sent or the IN button pressed, that the focuser moves INWARDS.

TEMPERATURE PROBE (Optional)

One temperature probe (DS18B20) is supported. The default resolution is set by the controller to 10-bit giving 0.25 degree of resolution (the resolution can be changed). The accuracy of the measured temperature is within 0.5 degrees Celsius.

Temperature Probe Connection

The prototype controller using 1 3pin stereo audio connection for the temperature probe (Tip=Yellow, Ring=Red, Sleeve=Black). Some users reported damaging their controller when removing or connecting the temperature probe with power ON.



The probe connects to an RJ11 6P4C panel mount female connector. *Disconnection or reconnection of the probe must be done when power is OFF*. VCC and GND are wired separately.

The controller automatically detects the DS18B20 probe on start-up or reset. If no temperature probe is connected the temperature is set to 20 (Celsius).

The temperature probe is optional.

myFocuserPro2 firmware files that support a temperature probe have a suffix of _F or _MT

Temperature Probe Placement

The sensor end of the probe is fitted so that it is on the *metal tube of the telescope* about ½ way between the optics and the focuser (perhaps secured using tape or plastic tie). Cable length of the purchased probe from Ebay is 1 or 2 meters (though you can extend this by wiring an extension cable with suitable connectors).

Temperature Probe Calibration

The ASCOM driver and Windows application can add an offset value to the value returned by the temperature probe. This provides a means of calibration for the probe, and the offset value is remembered by the Windows application and the ASCOM driver.

Warning - Never Plug-In or Unplug the Thermometer Cable When Power is ON

CONNECTING THE STEPPER MOTOR TO THE FOCUSER

There are two ways to connect the stepper motor to the focuser

1. Direct to the focuser shaft (use the single speed knob only) using a flexible coupler
2. Using a pulley-belt or gear type system giving a gear reduction and possible increase in torque

A direct connection has the least noticeable backlash of any method used to connect the stepper motor to the focuser unit and gives the best repeatable results.

Pulley/gear systems may slip intermittently if the weight is too much and this will result in lost steps and inaccurate movement. These systems also suffer from increased backlash. *They are ideal if you want to control the focus of a DLSR camera lens where direct connection of the stepper motor is not.*

A direction connection requires the use of a mounting bracket (normally L or U shaped) that permits connection of the stepper motor shaft to the focuser shaft via a flexible coupler. The bracket aligns the center of the focuser shaft with the center of the stepper motor shaft and provides space to connect the shafts via a flexible coupler. Slots in the bracket provide the necessary adjustments in order to line the stepper motor correctly as well as attaching it to the focuser body.

Once connected with a flexible coupler, you cannot move the focuser manually. You must remove the Focus Lock screw or keep the screw loose.

The photo shows an L-bracket (bolted to bottom of focuser) that allows the direct connection of the stepper motor to the focuser shaft using a flexible coupler.

The L-bracket which attaches to the base of the focuser holds the stepper motor. The slots provide ample room for aligning the stepper motor with the focuser shaft.

For more information on bracket design and connection methods, please see Appendix B.

Should I Connect the Stepper Motor to the Fine Focus Knob?

NO. There is a misconception that driving via the 10-speed reduction is safe. This is not good idea as the mechanics and manufacture of the mechanisms employed mean that they are not robust enough to have that level of force (from stepper motors) consistently applied to them. There are small gears (normally plastic or cheap metal) involved that do not have the strength to handle the force a stepper motor can apply. Over time this results in increased wear and tear in the small gears, leading to increased backlash, or if the focuser limits are exceeded, the complete breakdown of the fine focus mechanism by catastrophic failure (breakage) of the gears - in other words, not a good idea.

So why do some users try connecting to the fine focus knob? The answer is that it already provides a 10:1 reduction so this increases the resolution without any cost. The downside is the cost in replacing the focuser mechanism when the 10:1 reduction is damaged by the stepper.

If you need to drive the fine focus mechanism (FFM) then it would be better using a belt drive to prevent damage in the event of exceeding the focuser limits. It is not recommended.

The axial loads placed on the FFM by the focuser will be excessive over time and end in permanent damage to the FFM.

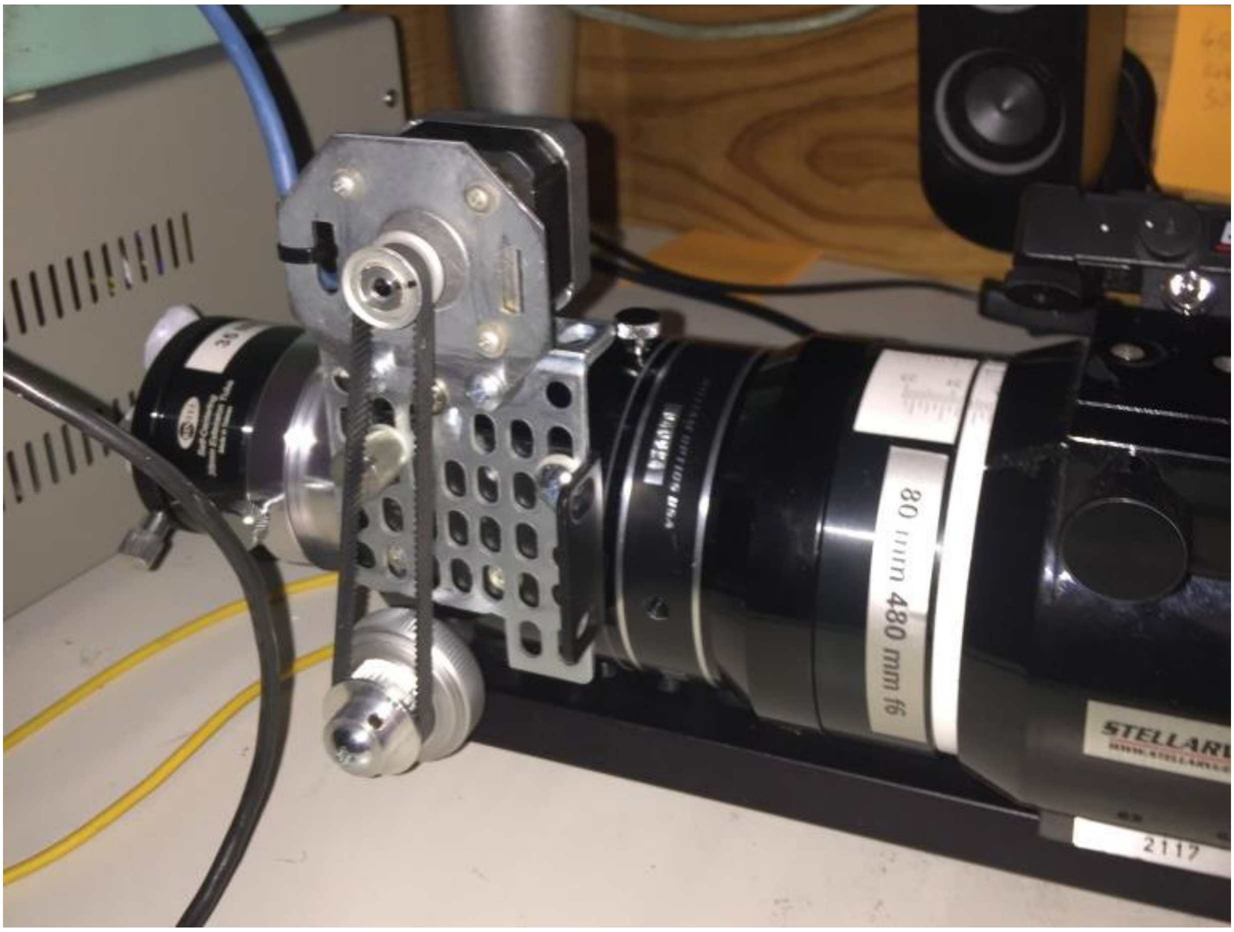
Remember NOT to use the Focus Lock Screw on your focuser; leave the screw loose or remove it. The Stepper motor will hold the focuser in place. If you leave the screw in and accidently tighten the focus lock screw, then serious damage can occur to the stepper motor or focuser.

HOW DO I CONNECT THE STEPPER MOTOR TO THE FOCUSER?

You will need to find a way to connect the stepper motor to the focuser. You will probably need to make a mounting bracket. How you affix the stepper motor will also vary depending upon telescope type (SCT-MAK, Refractor, Newtonian).

The following ZIP file has a lot of user submitted photos showing how they attached their stepper motor to their focuser. You will find many different ways in which this can be done.

https://sourceforge.net/projects/arduinoascomfocuserpro2diy/files/Documentation/Mounting%20Examples.zip/download



I AM USING GEARS. HOW DO I CALCULATE THE LENGTH OF BELT REQUIRED?

The following spreadsheet is a belt length calculator. If you are using gears, use this calculator to determine the length of the belt you require

https://sourceforge.net/projects/arduinoascomfocuserpro2diy/files/Documentation/Belt%20Length%20Calculator.xlsx/download

DO NOT MANUALLY MOVE THE FOCUSER ONCE SETUP

Manually moving the focuser position between sessions invalidates the saved focus position in the controller. For example, a user uses the Windows application to set the focus position as 4605. That position is saved by the controller as the last known position when the application is closed.

A few days later, the user turns the focus knob manually by hand half a turn. Then the user starts the application software, which defaults to the last known position of 4605, which is now invalid (not the same) because the physical position was altered.

DO NOT CHANGE THE STEP MODE SETTING ONCE SETUP

The positions of 0 and maxStep, once set, are related to the step mode in use at the time. If you have done all your calculations for step size and CFZ then you will know the step mode to use during initial setup of the focuser controller.

Once you have determined your step mode setting – do not change it.

Consider the case where the focuser has been set up as 0 to 6000 maxStep and the focuser is currently at position 4000. The step mode is Half steps. Using some maths, this means there are 2000 half-steps available before the maximum position is reached (or in terms of full-steps, 1000).

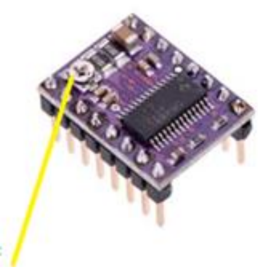
The user decides to change the step mode to Full steps and then issues a Goto to focuser position 5500. This equates to 1500 full-steps from the current position of 4000. So the focuser will attempt to drive to position 5500 using full steps (doing some maths that is 3000 half-steps or a final real position of 7000). This could damage the focuser by driving beyond the maximum safe position.

ADJUSTING THE POT ON THE myFocuserPro2E-DRV FOR CURRENT MAXIMUM

This only applies to myFocuserPro2 controllers. You will need to adjust the POT on the DRV8825 chip to get optimal stepping of the stepper motor. This pot adjusts the current that flows in the coils of the stepper motor.

Note that this has been set before delivery but if you use a non-supplied NEMA stepper motor, then this may require adjustment by you.

DRV8825



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. Set the step mode to what you have calculated as needed for your system

3. Enter a focuser position of 5000 and click the Goto button
4. Wind the pot all the way anticlockwise until the motor stops moving
5. 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
6. 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
7. It should now be close enough
8. 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 current is set, the stepper 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.

THE FOLLOWING ONLY APPLIES TO myFocuserPro2E-DRV CONTROLLERS.

If you are using a stepmode which is $\frac{1}{8}, \frac{1}{16}, \frac{1}{32}$ or greater then you will need to have the diodes in place else the stepper motor may have trouble moving smoothly at the selected step mode.

7-4: Initial Setup of maxSteps

Make sure you have done the previous steps 1-3. To set the maxStep setting, enter the maxStep value and then click the set button to the right of the maxStep text box. The value will be sent to the controller and remembered for later use.

8: CHECK THE SPEED SETTINGS

The next step is to check the speed settings of Slow, Medium and Fast.

a) Enter 0 and the focuser position and click Set Position
b) Enter 5000 as maxSteps and click Set
c) Set the stepmode to what you have calculated as best for your focuser
d) Select the SLOW motor speed from the menu
e) Click the +500 button and check the motor moves smoothly
f) Repeat for the MEDIUM and FAST motor speeds

9: Testing Direction

Now that the focuser has the correct values, you can test the direction setting to ensure the focuser is moving in the correct direction.

This assumes that you have set the stepper current correctly if using a DRV8825/EasyDriver/RAPS128 or A4998 driver board.

a) In the focuser position text box, enter 0 as the current focuser position and click the SET POSITION button to send the position to the controller
b) Ensure that external power is ON to the stepper motor. The focuser is currently at position 0
c) Click the +100 button
d) If the focuser does not move at all, then click the Reverse Direction button to enable that setting, then click the +100 button again
e) The focuser should move 100 steps outwards

f) Clicking any + button should move the focuser outwards and any – button the focuser should move inwards towards 0

10: Set Coil Power

If you are using microstepping then Coil Power should be left ON. This is because with micro-stepping the stepper motor can only hold its position if current is flowing in the stepper motor coils. If coil power is OFF, then the stepper will move to the closest full step, and over time this results in the real focuser position not being accurate.

The controller will remember stepsize, maxSteps, stepmode, coil power, reverse direction and focuser position.

You can also set other defaults such as Motor Speed, LCD Display Time and other settings at this time.

FROM THIS POINT ON, DO NOT CHANGE THE STEP MODE OR ENTER A NEW FOCUSER POSITION AND CLICK SET POSITION AS THIS WILL ALTER THE CONFIGURATION OF THE STEPPER AND RESULT IN LOSS OF ACCURACY OF POSITION AND ALSO POSSIBLE DAMAGE TO THE FOCUSER OR STEPPER MOTOR.

If you need to set up backlash, consider doing this once you have your focuser configured and working. Please see the section on backlash to determine how these settings can be determined and configured.

CONGRATULATIONS: Your focuser is now ready to use!

myFocuserPro2 COM SERVER

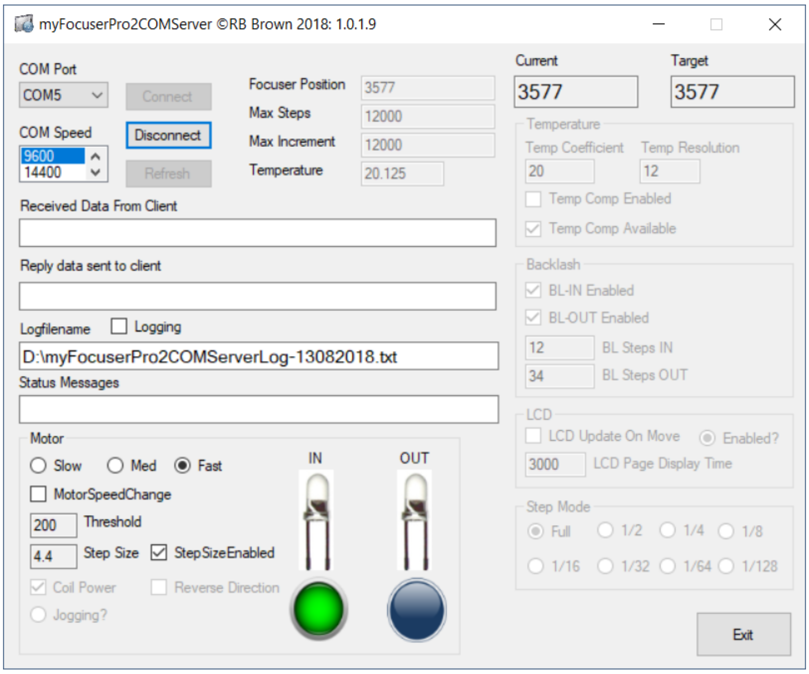
This program is a myFocuserPro2 controller emulator which I use for testing purposes. To use the application first install Com0Com from http://com0com.sourceforge.net/

The output to CNCA0 port should be the input from CNCB0 port and vice versa. But you have to use the COMx and COMx associated with the CNCA0 and CNCB0 ports, which on my system CNCA0=COM7 and CNCB0=COM6.

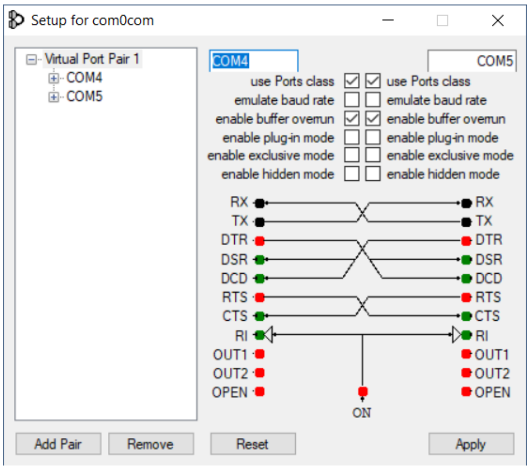
To run this
1. Start this program
2. Select COM6 as the com port and connect
3. Start the myFocuserPro2 windows app and connect to COM7 as the com port

and away it should go

Avoid trying to change parameters in this program when it is running



COM0CM SETTINGS

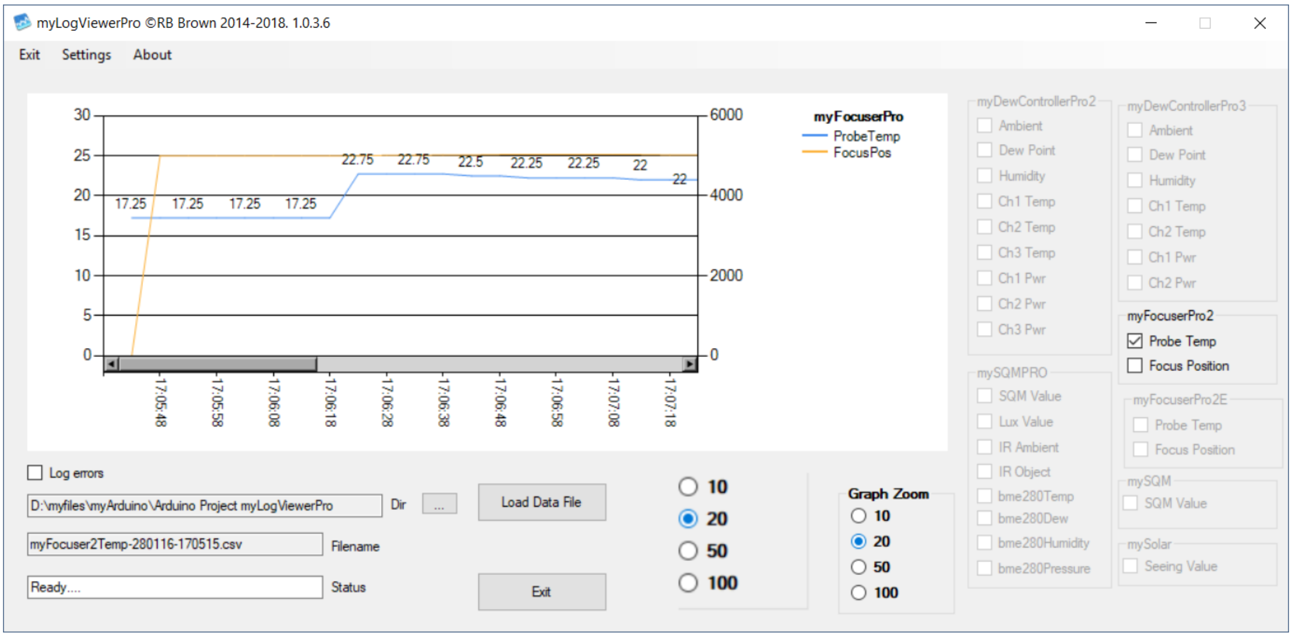


DATA LOG VIEWER

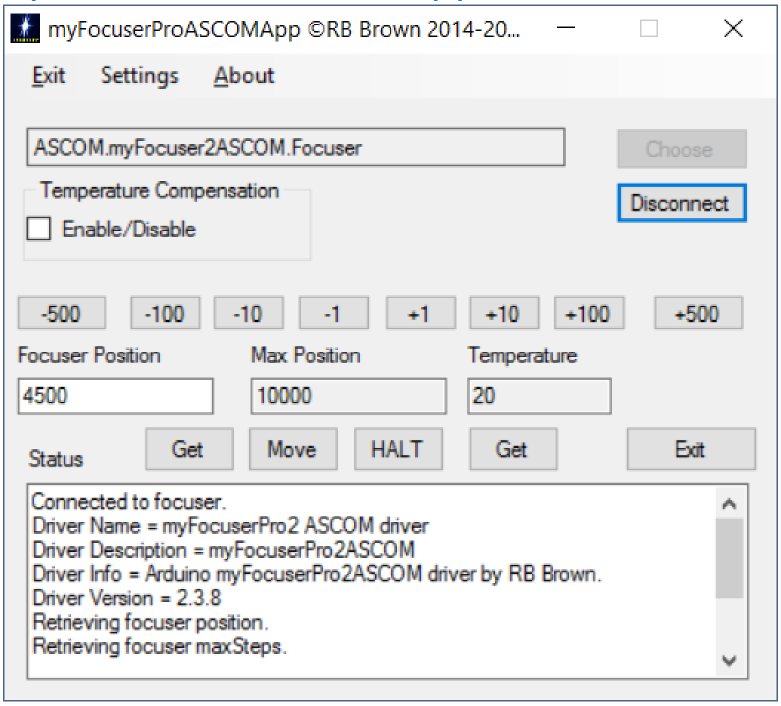
The option "**Log Temperature and Position**" allows the user to save the temperature probe reading and the focuser position value to a log file for later analysis (such as determining temperature compensation values for your focuser setup).

This feature is **enabled** only when the **automate** feature is enabled. During the automatic update (when the automate check box is checked), the routine will get the current temperature and focuser position from the myFocuserPro2 controller. If the temperature logging file is enabled, then these values will also be written to the associated log file.

Below is an example of the application **myLogViewerPro**, which can display both myDewControllerPro3 and myFocuserPro2 data log-files for analysis.



myFocuserProASCOMApp APPLICATION TESTER



The myFocuserASCOMAPP is a Windows software application that is actually an ASCOM client and will talk to any ASCOM focuser driver and allow you to control the focuser.

The settings menu has a number of options, similar to those provided by the Windows Application and the Windows Mini Application for controlling the myFocuserPro2 controller.

This is a client program and you can use it to test any of the features of the myFocuserPro2 ASCOM driver, including temperature compensation.

HOW TO RUN TWO FOCUSERS

What happens if you have two telescopes and want to have two myFocuserPro2's, one on each scope?

There are some simple rules.

1. You can only run one instance of the myFocuserPro2 Windows application at any time
2. You can only run once instance of the myFocuserPro2Mini application at any time
3. You can only run one instance of the ASCOM driver at any one time (but you can run both the ASCOM and ASCOM1 drivers at the same time)

Here are some options for running two focusers

Scope	Option 1	Option 2	Option 3
Scope 1: Orion ED80	myFocuserPro2 App	myFocuserPro2 App	ASCOM driver
Scope 2: SV102T	MyFocuserPro2Mini App	ASCOM Driver	ASCOM1 driver

You **cannot** use two instances of the same Windows application to control both scopes. The reason for this is because the Windows application uses an application setting file that stores certain settings and these settings need to be different for each scope (such as com port) and hence the application can get confused as to which controller it is communicating with. As indicated above, Option 3 indicates controlling both scopes using the ASCOM and ASCOM1 available drivers.

Please see the following video
https://www.youtube.com/watch?v=sEvvWYNMCFs

TEMPERATURE COMPENSATION

Temperature compensation is the automatic adjustment of focus position based on changes in temperature. It will be different for each telescope. This feature is turned ON or OFF by an **ASCOM client** by sending the correct command to the ASCOM driver. The Windows application can talk directly to the controller and enable/disable temperature compensation.

Each user must determine their own compensation value for their equipment. This means calculating a **temperature coefficient** value, which is the number of steps the focuser needs to move to best focus when the temperature changes by 1 degree.

The user waits for the telescope optics to achieve thermal equilibrium and then takes a series of measurements over a period of temperature change. These measurement results are readings of focuser position versus temperature which can be plotted on a graph. The slope of the graph then is the temperature coefficient (ideally the graph should be a linear line but this might not be the case).

Generally, as temperature drops over the course of the evening, the focuser position will move inwards. We are going to record the in movements over changes in temperature.

Generally, temperature compensation is only applied in one direction (inwards or as a fall in temperature reading), though some systems might have compensation in both directions.

Assuming we only do temperature compensation in one direction, this also avoids backlash issues which might accrue from a reverse change in focuser direction.

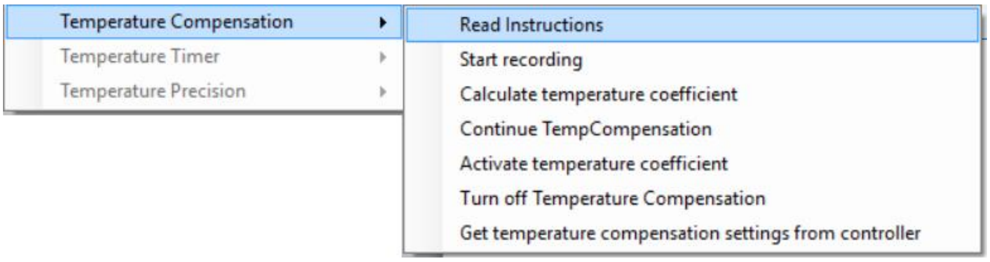
So, manually, we might do the following
1. Wait for the temperature to stabilize (thermal equilibrium)
2. Slew to a target star, enable mount tracking and guiding software
3. Use a Bahtinov mask (or FWHM value) to get the best focus
4. Wait for the temperature to drop by a specified amount (3 degrees)
5. Refocus
6. Record the temperature and the focus position
7. Calculate the temperature coefficient
8. Update the controller settings and enable temperature compensation
9. Remove the Bahtinov mask and start imaging

The following pages outline how to do this with the myFocuserPro2 controller and application software.

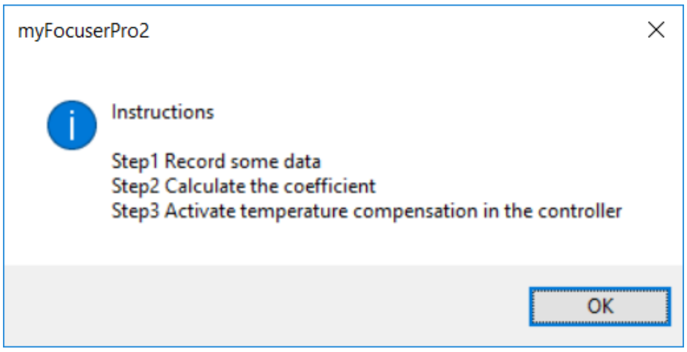
Step 0 Read the Instructions

The following assumptions are
1. The temperature probe is located near the optics of the telescope (for a refractor this would be near the front lens cell)
2. The telescope has reached thermal equilibrium. This may take up to 30 minutes or more to occur and varies depending on the conditions and telescope type and size
3. The myFocuserPro2 controller is connected and the Windows Application is running
4. The telescope is at optimal focus and tracking the target star

The first step is to access the **Read Instructions** option from the Temperature Compensation menu of the myFocuserPro2 windows application. Select the Read Instructions option

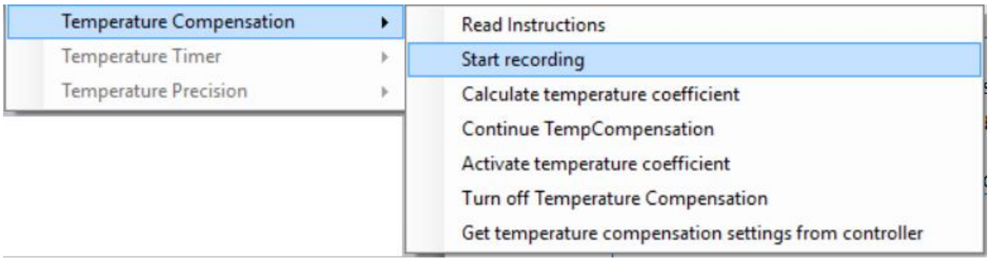


This displays the following MessageBox of the steps you must follow to determine and apply a temperature coefficient value and enable temperature compensation for your myFocuserPro2 controller. The steps are performed one after the other in order. If you make a mistake, simply start again from Step 1.

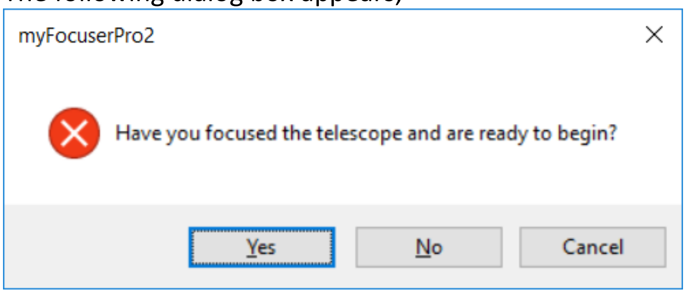


Step 1 Start Recording

The next step is to access the **recording** option from the Temperature Compensation menu of the myFocuserPro2 windows application. Select **Start recording**

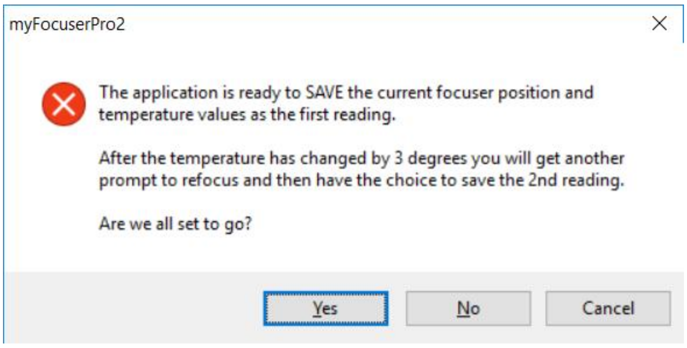


The following dialog box appears,

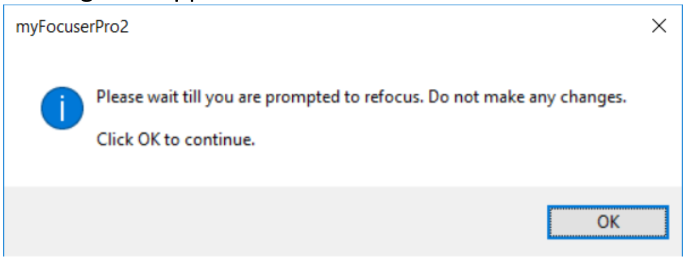


If you have already focused the telescope within the last few minutes, click **Yes**, else click No and refocus the telescope before starting again.

After clicking **Yes**, the following dialog box appears,



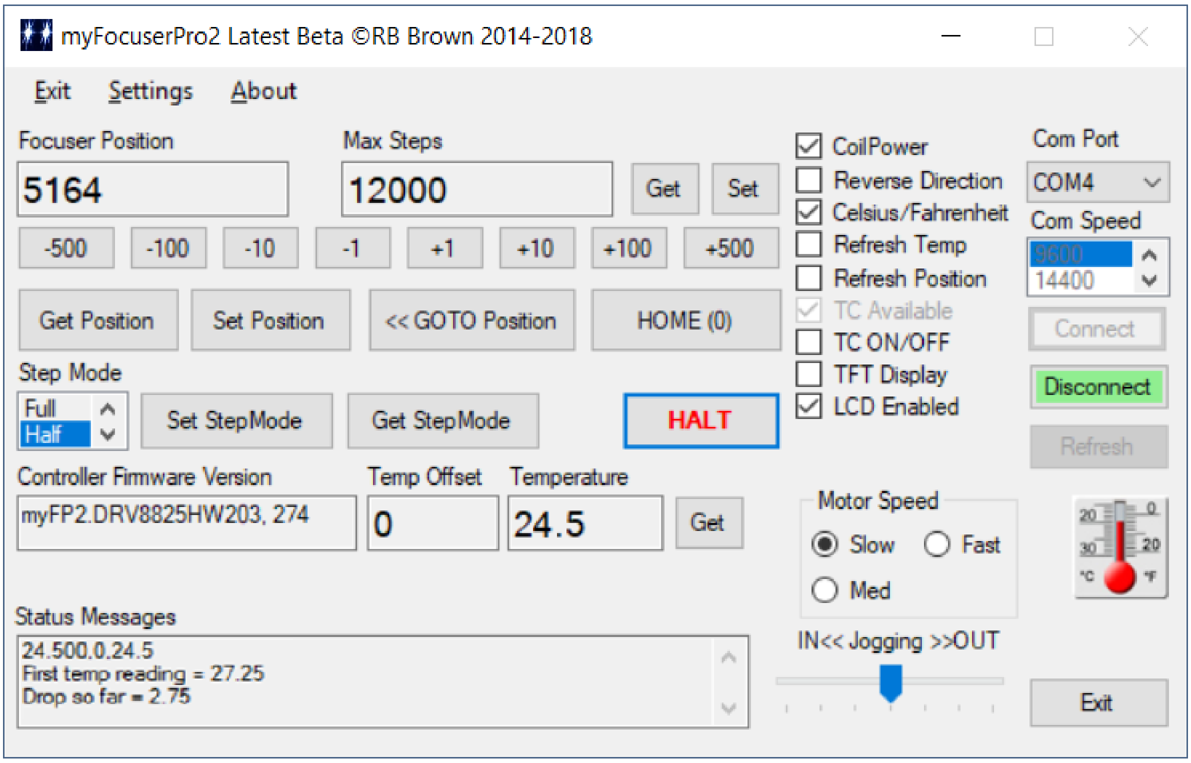
When you click **Yes**, you will be automatically taken to the record dialog option and the following MessageBox appears.



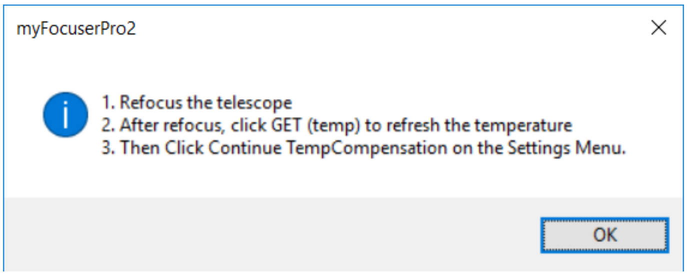
At this point, the program has automatically

- saved the current temperature and focuser position
- started the auto refresh timer for the temperature updates and enabled it to a 10s refresh cycle
- started to monitor the temperature change

Just wait for the application to monitor the temperature and prompt you when ready. During this time interval DO NOT MAKE ANY CHANGES TO ANY SETTINGS. You will be able to see the progress in the Rx textbox, as indicated below

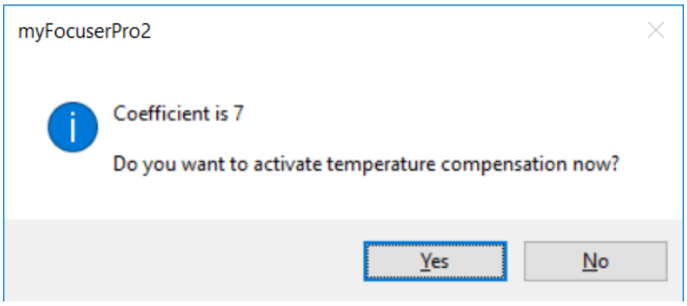


Once the program detects a 3 degree change in temperature, a new dialog MessageBox will automatically appear asking you to refocus the telescope. Click **OK** and then refocus the telescope.

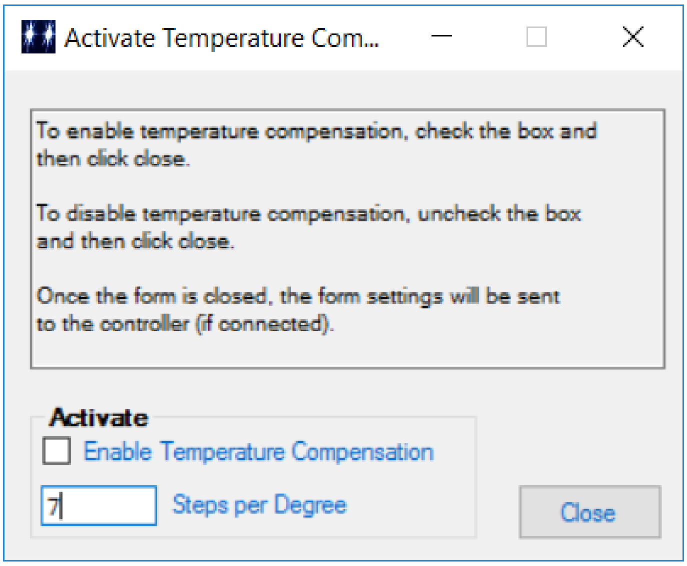


After refocusing, get the latest temperature reading by clicking the GET button for temperature. Once the new temperature value is displayed, click the **Continue TempCompensation** menu option on the settings menu under Temperature Compensation.

The application will automatically calculate the temperature coefficient and display the value in a MessageBox (example below) and include an option for you to now update the controller and enable temperature compensation.



Click **YES** to Goto the next step. The application will now display the Apply Coefficient Form as shown below.



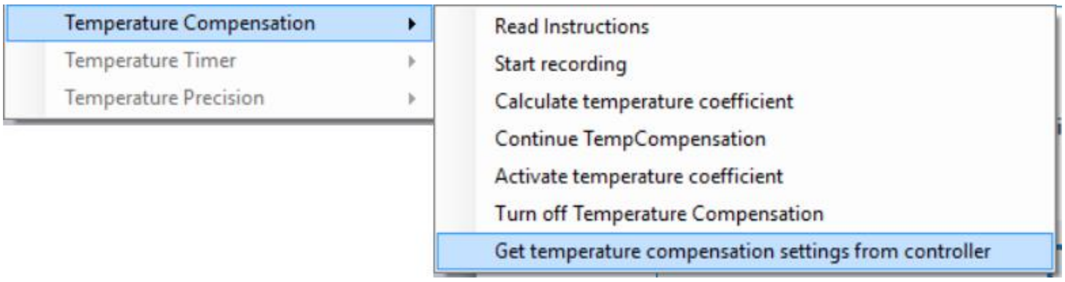
The Steps per Degree is automatically preloaded from the previous calculation. To send this value to the controller, and enable temperature compensation, check the box **Enable Temperature Compensation** and then click the **Close** button.

Note: If you know the temperature coefficient value for your focuser, you can access this menu directly and enter the Steps per Degree value manually.

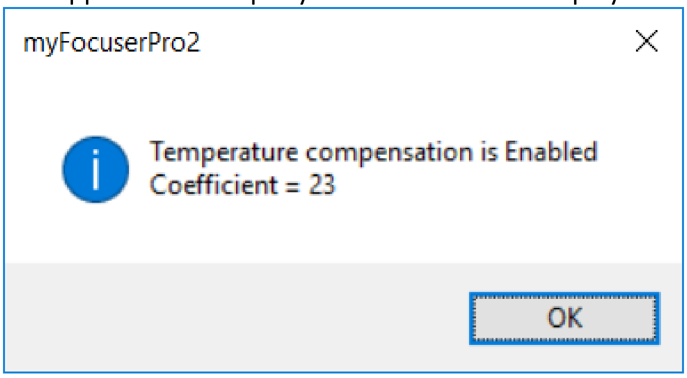
The values are sent to the myFocuserPro2 controller and temperature compensation is enabled. The push buttons are disabled when temperature compensation is enabled in the controller.

Display the Current myFocuserPro2 Controller Temperature Compensation Settings

To display the current temperature compensation settings, select the **Get temperature compensation settings from controller** option



The application will query the controller and display the current settings.



The Windows Application and ASCOM driver support temperature compensation. However, the controller handles the changes internally when enabled.

EEPROM USAGE

The myFocuserPro2 controller remembers important focuser settings in the EEPROM of the controller. A smart algorithm is used to minimize the number of EEPROM writes.

Whenever you make an important change, the controller will wait 30s before saving the value in EEPROM. You have to wait 30s before disconnecting and reconnecting or power off.

If you cannot wait 30s, then use the settings menu - option is - Write focuser settings to EEPROM - this does the save immediately.

The myFocuserPro2 controller code, on power up or reset, restores the focuser settings from EEPROM.

It is very unlikely that the contents of the EEPROM will wear out even after years of use.

MANUAL AND AUTOMATED FOCUSING OPTIONS

Manual Focusing

Several programs allow you to see the peak intensity or FWHM (full width half maximum) profile of a star. Examples of these are MaximDL, Nebulosity, PHD2, ScopeFocus, APT and others.

In general, you would
1. slew the telescope to a star
2. enable sidereal tracking so the star does not drift out of view
3. adjust the exposure time of the camera so the star is not overexposed
4. display the star profile and watch the FWHM value
5. adjust the focus till the FWHM value is lowest

In step 5 you would move the focuser by sending commands to the myFocuserPro2 controller to move IN or OUT (I prefer to go OUT first till the star is out of focus, then slowly move IN). This means
1. looking at the star profile and FWHM value
2. letting the values settle for a few exposures to take into account variations in seeing
3. moving in (perhaps by 5 or 10 steps depending on how many steps are within the critical focus zone of your focuser setup)
4. repeat 1-3

Manual Focusing with a Bahtinov Mask

A Bahtinov mask is a valuable focusing tool which is easy to use to find good focus. To achieve focus using a Bahtinov mask
1. slew the telescope to a star (mag 4-5)
2. set the focuser to approximate focus position
3. enable sidereal tracking so the star does not drift out of view
4. adjust the exposure time of the camera so the star is not overexposed
5. place the mask over the objective end of the telescope
6. Adjust focus till the center diffraction is centered (ignore any FWHM or other values as a mask is being used)

Bahtinov Mask Focusing with Nebulosity

1. Start Nebulosity and connect to camera and focuser
    a. Turn on reticle grid – View – Overlay – Grid
    b. Preview 1s exposure, ensure star is centred in FOV
    c. Click Frame and Focus – Use ZOOM if necessary, center star in FOV, adjust focus for best result
    d. Abort
    e. Preview, Click on star
    f. Click Fine Focus
    g. Adjust focus for best results (center Diffraction spikes)
    h. Abort
2. Remove Bahtinov mask

Also see https://www.youtube.com/watch?v=rcGQ7FhlrNQ

Bahtinov Mask Focusing using Bahtinov Grabber And Nebulosity

1. Start Nebulosity and connect to camera
   a. Turn on reticule grid – View – Overlay – Grid
   b. Preview 1s exposure, ensure star is centred in FO
   c. Click Frame and Focus –ZOOM to 100% and center star in FOV by using sliders, adjust focus for best result
2. Run Bahtinov Grabber
   a. Set capture area over the star in Nebulosity
   b. Enter telescope data related to OTA and camera
   c. Eg; Telescope ED80, f=0.480, D=0.080, pixelsize=4.54
   d. Eg; Telescope SV102T-25SV, f=0.714/, D=0.102, pixelsize=4.54
   e. Config – choose ASCOM focuser, 1, AF Speed=3.00 (allows for download)
   f. Autofocus
   g. Quit
3. Nebulosity
   a. Abort
   b. Preview
4. Remove Bahtinov mask

Automated Focusing

Right now, out of the box, you can do automated focusing on stars with any myFocuserPro2 controller fitted to a telescope. You can use the controller with MaximDL, APT and Scopefocus. You could also use FocusMax v3 which was the last free version of Focusmax before it became commercial. We recommend FocusMax v4.

Scopefocus is free at https://scopefocus.blob.core.windows.net/scopefocusbeta/publish.htm

Automated focusing requires that you first configure or train your system to determine the slope for each side of focus and enter details related to your OTA, camera and focuser configurations. These can then normally be saved in a "profile" settings file. After entering the required details, it is then necessary for the focusing program to learn about the focuser by taking a number of exposures at different settings, which are used to create a V curve (an upside-down bell shaped curve that plots how focus of the star is related to focuser position). A number of V curves are generated and averaged to create a V curve for that configuration. This V curve can then be used to automate focusing.

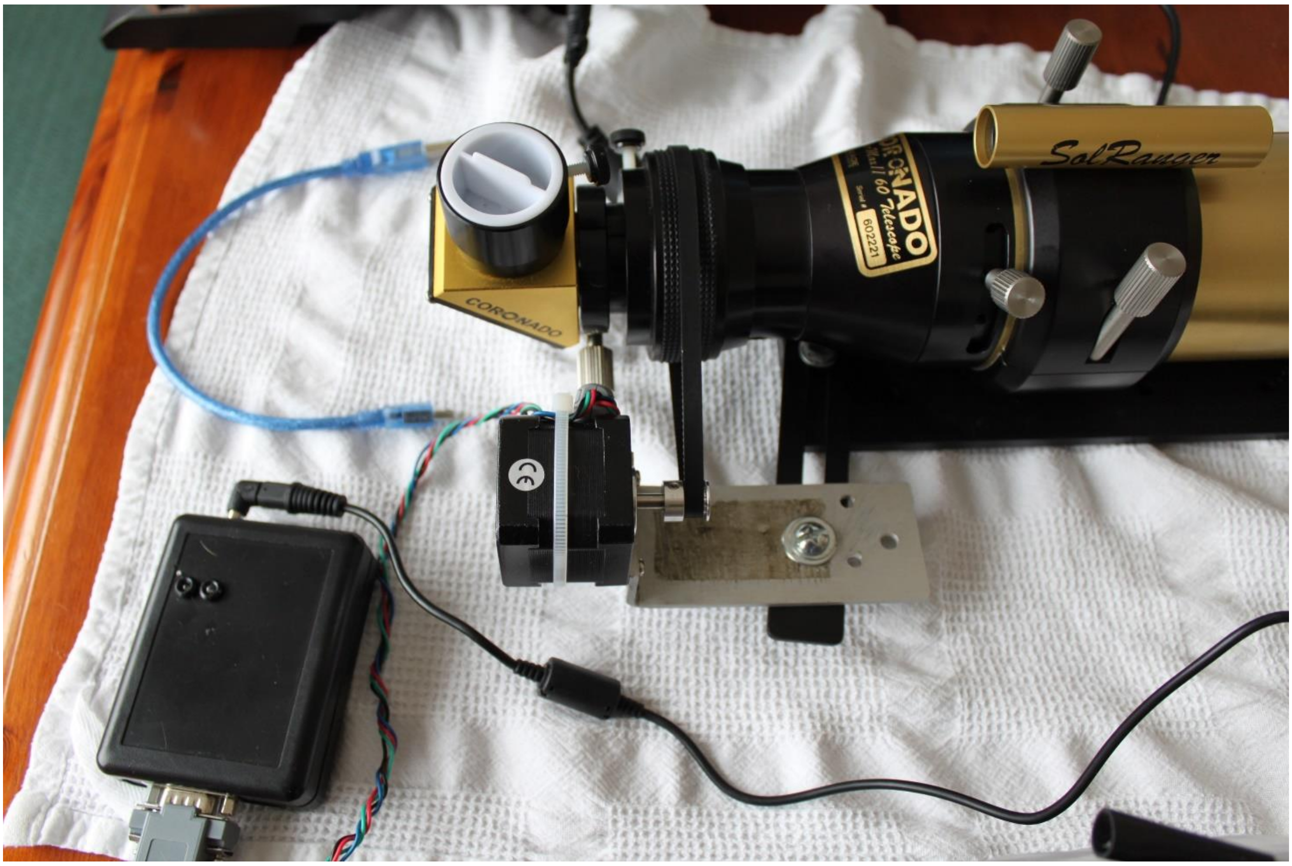
In automated focusing, the focuser will first move to one side of focus and off focus. The star profile is then measured and compared to the V-curve plot. Now the program has a good estimate of where the best focus position will be and will move the focuser close to that position and recapture the star profile. A few further small adjustments may be necessary.

The advantage is quicker focusing, no need for a Bahtinov mask or having access to the telescope (which could be hundreds of miles away in a remote location).

The downside is the time required to train your system, as well as the generated V curve only works for that particular configuration. Change anything like adding a focal reducer or a different telescope or a different camera and you have to start all over and generate new V-curves.

If you want to do automated focusing on DLSR lens that is a different issue. APT is best for this.
Below are photos of a belt drive for a Coronado SolarMax and DLSR which shows you how to attach the stepper motor. You would need to make a suitable bracket. Be aware that focusing a DLSR lens is much more difficult as the steps between focus and out of focus occur over such a small range it is at best, problematic.


Nema 17 with belt drive as a focuser for a Canon EOS Lens (f2.4)

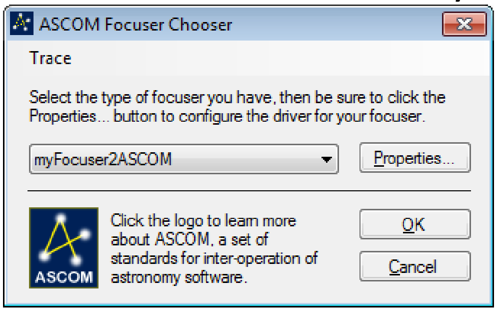


Nema 17 with belt drive as a focuser for a Coronado SolarMax telescope

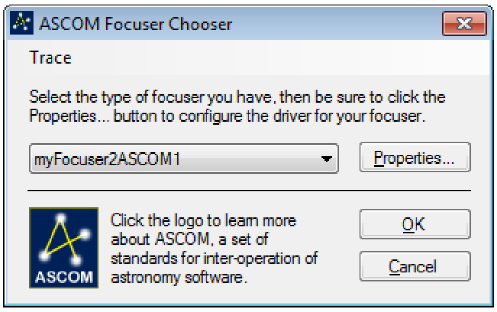
RUNNING TWO FOCUSERS

The ASCOM driver is not re-entrant so multiple instances cannot be run. This means that to run two myFocuserPro2 controllers on the same computer requires two separate ASCOM drivers.

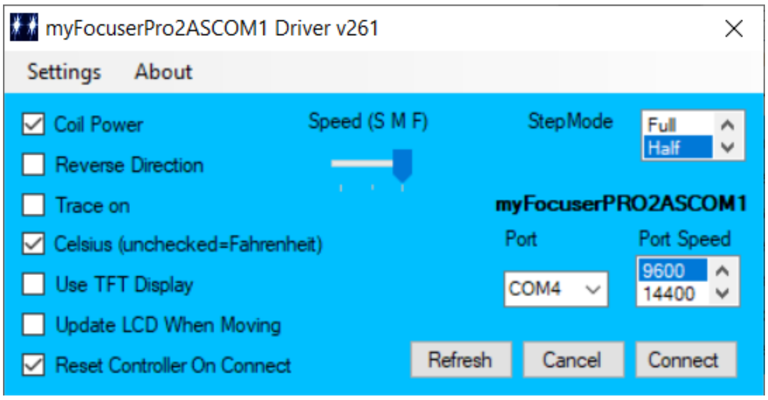
The **first** ASCOM driver is known as **myFocuserPro2ASCOM** in the chooser.



The **second** ASCOM driver (if installed) is known as **myFocuserPro2ASCOM1** in the chooser (and must connect to a different focuser controller than the first driver).



Consider the case where you have a DRV8825 controller on COM PORT3 and a second ULN2003 controller on COM PORT 4. To set this up, you would connect the myFocuserPro2ASCOM to the DRV8825 controller by specifying COM PORT3 under properties, and specify myFocuserPro2ASCOM1 to the ULN2003 controller by specifying COM PORT4 under properties for that driver.



You can then work with both focusers independently.

To install the second ASCOM driver, run the setup program for the second ASCOM driver (myFocuserPro2ASCOM1Setupxxx.exe)

The second ASCOM driver setup dialog box is in a different colour and labelled so you can easily identify it is the second driver as is called **myFocuserPRO2ASCOM1**.

Remember that there are additional settings accessible from the “Settings” menu.

Please see the video
https://www.youtube.com/watch?v=sEvvWYNMCFs