PerfectStar

Focus Controller

by Wa-chur-ed Observatory

USER MANUAL

Thank you for purchasing a PerfectStar Focus Controller. PerfectStar provides absolute position control for a telescope focuser using a stepper motor. This means that you can know the precise position and change it in precise increments. When used with third-party software, it also allows automated focusing that is accurate and repeatable. The controller can be used with PerfectStar Focus Motors or with a wide range of third-party motors. The controller can also be used either in manual (stand-alone) mode or connected to a computer via a USB port.

This document describes the system setup, software installation, and general use of the PerfectStar Focus Control system.

WARNING

PLEASE BE VERY CAREFUL WHEN USING A BATTERY TO POWER PerfectStar! EVEN A SMALL LEAD-ACID BATTERY CAN EXPLODE, CATCH FIRE, OR RELEASE STRONG ACID IF HANDLED INCORRECTLY. NEVER SHORT THE TERMINALS OR ANY WIRES CONNECTED TO THE TERMINALS OF A BATTERY. USE ONLY INSULATED TOOLS WHEN MAKING CONNECTIONS TO A BATTERY. IF YOU HAVE ANY UNCERTAINTY ABOUT THESE INSTRUCTIONS PLEASE CONTACT A QUALIFIED ELECTRICIAN.

The above warning relates to the greatest danger you will likely encounter in using the PerfectStar system. Please refer to section 6 of this manual for additional precautions and more detailed information on safe use.

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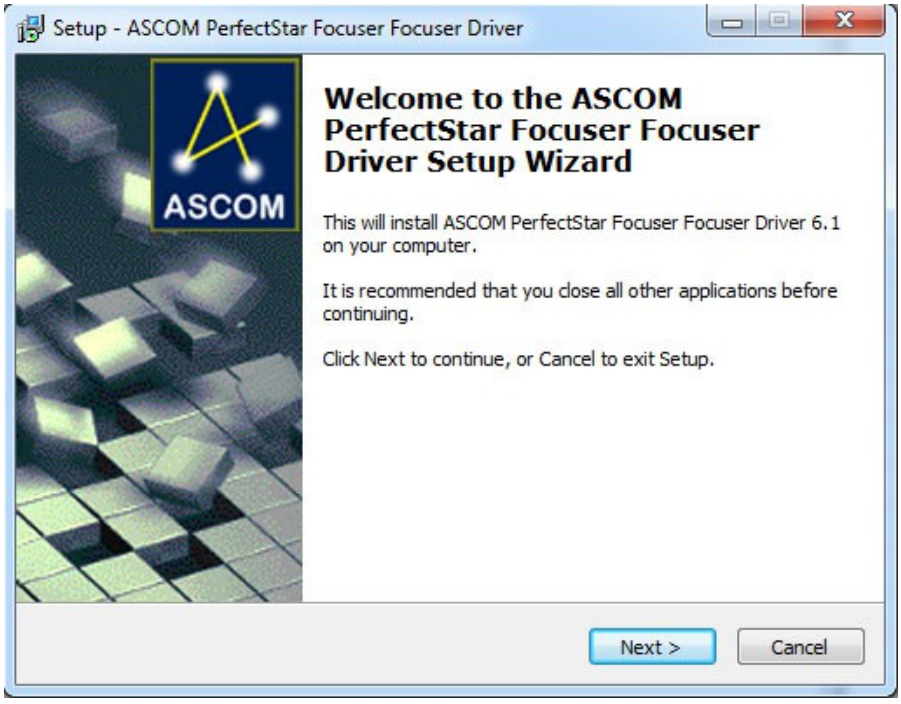
1 SOFTWARE INSTALLATION

1.1 Preparation

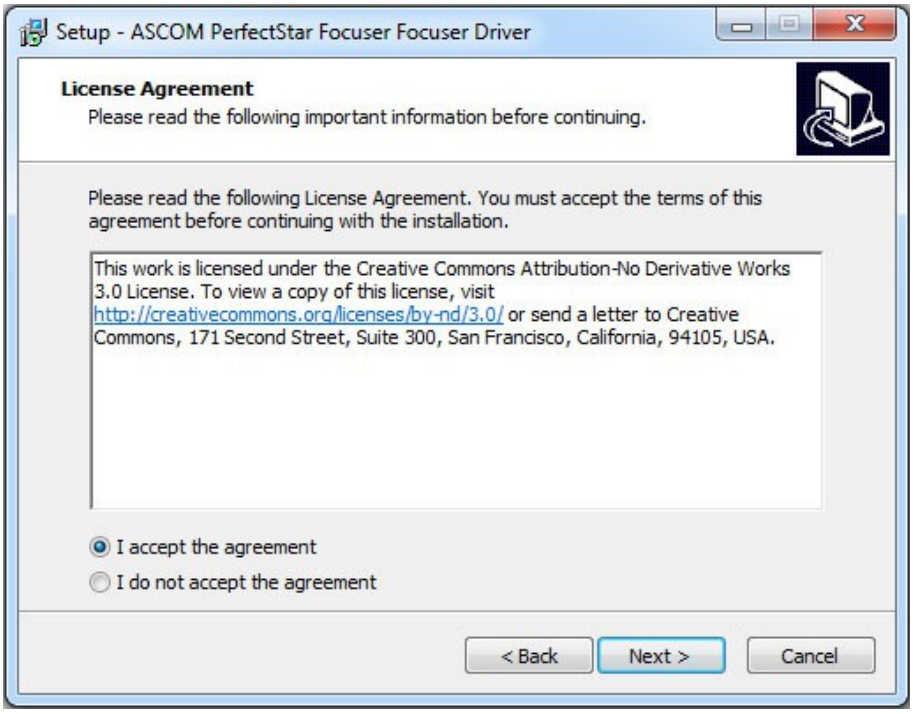
To use the PerfectStar Focus Controller with a computer you must have ASCOM platform 6 installed and it should be installed before installing the PerfectStar ASCOM driver. If you do not have version 6 (or higher) of the ASCOM platform installed already, you can download it from http://ascom-standards.org. Note that the ASCOM platform requires Microsoft's .NET framework, which is included and enabled with some versions of Windows, but not all. Refer to the Platform Installation Notes at the above web site.

1.2 ASCOM driver installation

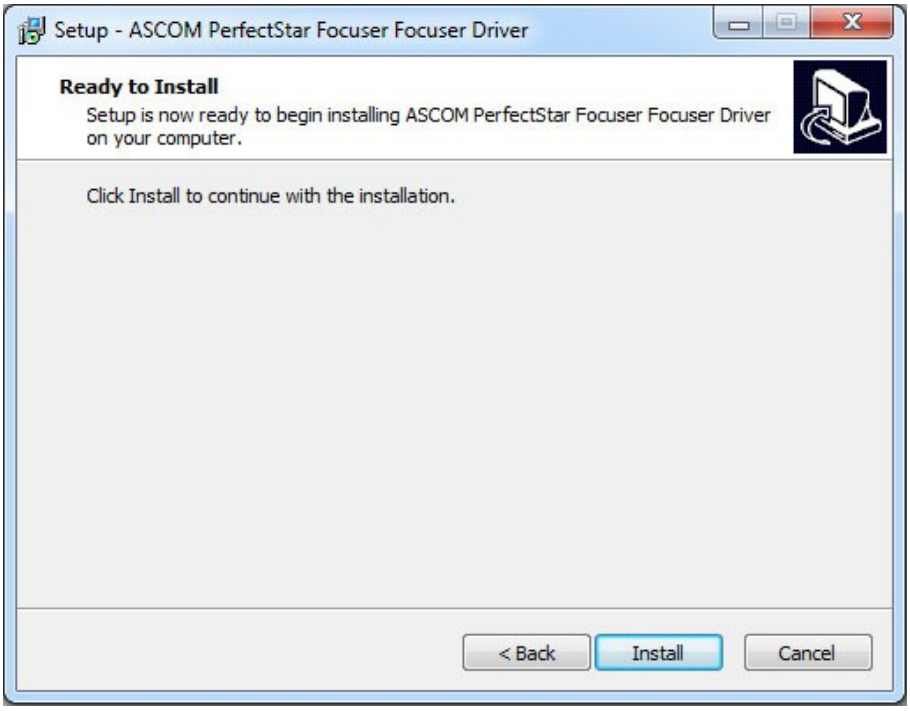
Once the ASCOM platform is ready, please install the PerfectStar ASCOM driver by launching the "PerfectStar_Setup.exe" program and follow the on-screen instructions. At the initial window simply click 'Next' to continue.



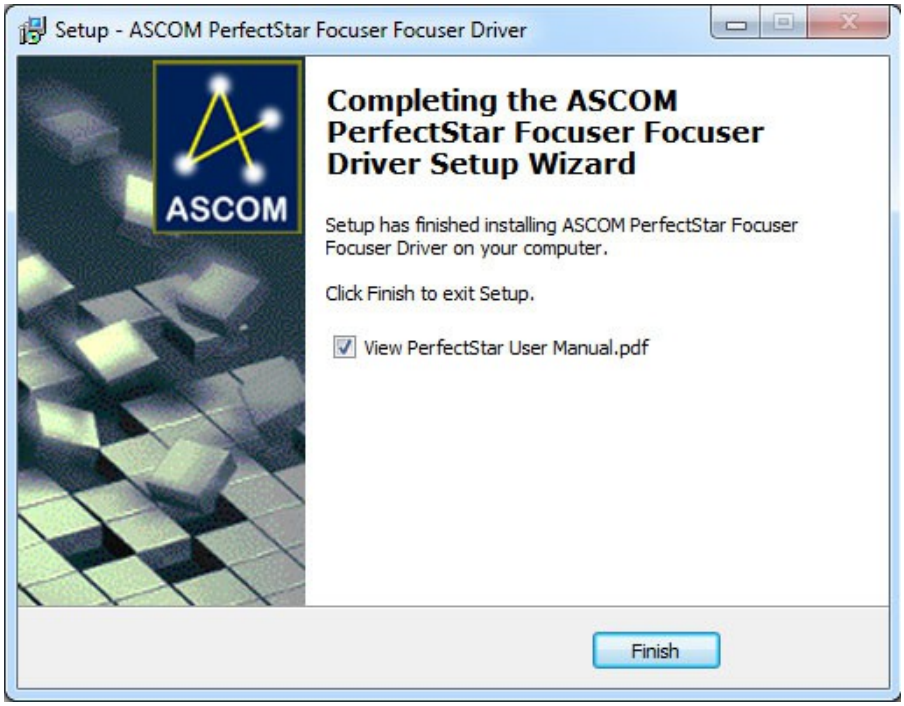
Click the button next to 'I accept the agreement' then the 'Next' button to continue.



In the next window, just click the 'Install' button to begin installation. The installer will automatically remove any previous version of the driver and will ask you to confirm that the old driver will be removed if you had this or another version of the driver previously installed.



When the installation is complete you will see the window below. By default, the installer selects to display this document. You are already looking at it, so feel free to de-select it and click the 'Finish' button.



The driver is ASCOM compliant, so any application supporting an ASCOM focus controller can be used. Please refer to section 5 for more information on using the driver.

2 Hardware Set Up

2.1 Power Connection

To use PerfectStar with either a host computer or with the hand set, connect a 12V DC power source to the 5 x 2.5mm power jack of the controller. Either a 12V battery or the (optional) AC adapter can be used. Please use the supplied power cord or AC adapter to ensure proper polarity. There is a self-resetting fuse inside to protect from short circuits. The actual power consumption of the system will depend on the specific motor used, but should not exceed 12 watts (1 amp at 12 volts).

2.2 Hand Set Connection

To use the hand set, connect one end of the 6-conductor flat cable to the RJ-11 jack on the controller (see above figure) and the other end to the hand set. It does not matter which end of the cable goes to each device.

2.3 Computer Connection (via USB)

To connect the controller to a computer (after installing the driver), connect a USB cable from the controller to a USB 1.1 (or higher) port on the computer. Communications will be at the USB 1.1 "full speed". Do not use a cable of more than 5 meters in length. The controller is NOT powered from USB and must always have 12V DC supplied to operate. A hub may be used as long as the total length from computer to PerfectStar does not exceed 5 meters.

2.4 Motor Connection

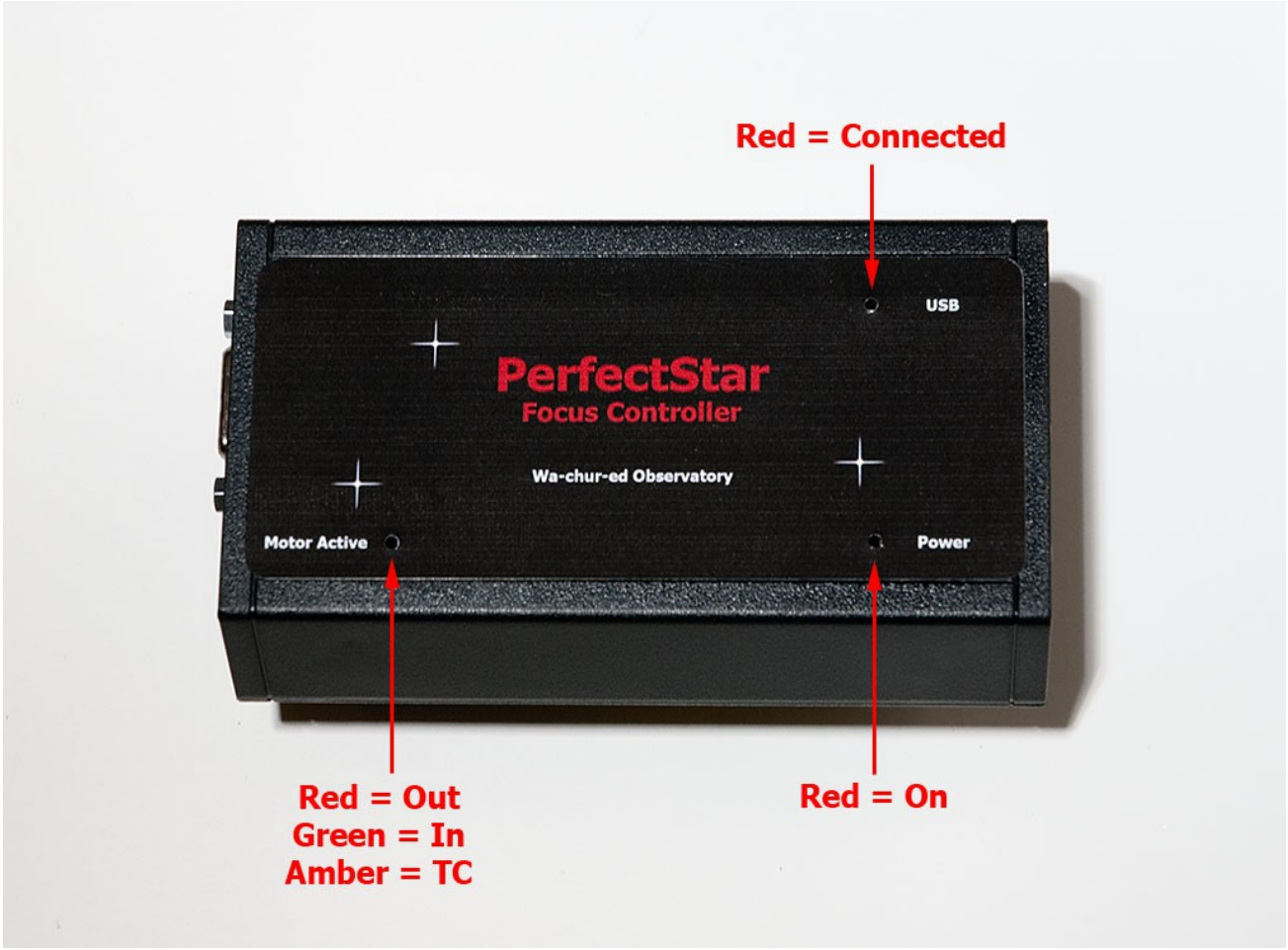
Connection from the controller to your focus motor is simple if your motor was prepared by Wa-chur-ed Observatory or if it is one of the many compatible types: Simply plug one end of the 9-conductor cable (supplied with motor) to the controller and the other end to the motor unit. Tighten the screws to ensure a reliable connection. The motor cable has a male connector on one end and female on the other, so it is not possible to connect it backwards.

To use a non-standard motor, please contact us for assistance.

3 Manual Operation

3.1 Indicator LEDs

The controller has 3 LED indicators on the top:



All of the LEDs are flush with the top surface and might not even be noticed when not lit. They are also all fairly small and dim, so as not to disturb night vision adaptation. The power indicator lights up in red whenever power is supplied. Note that this does not necessarily mean that the voltage is adequate to power either the motor or internal electronics.

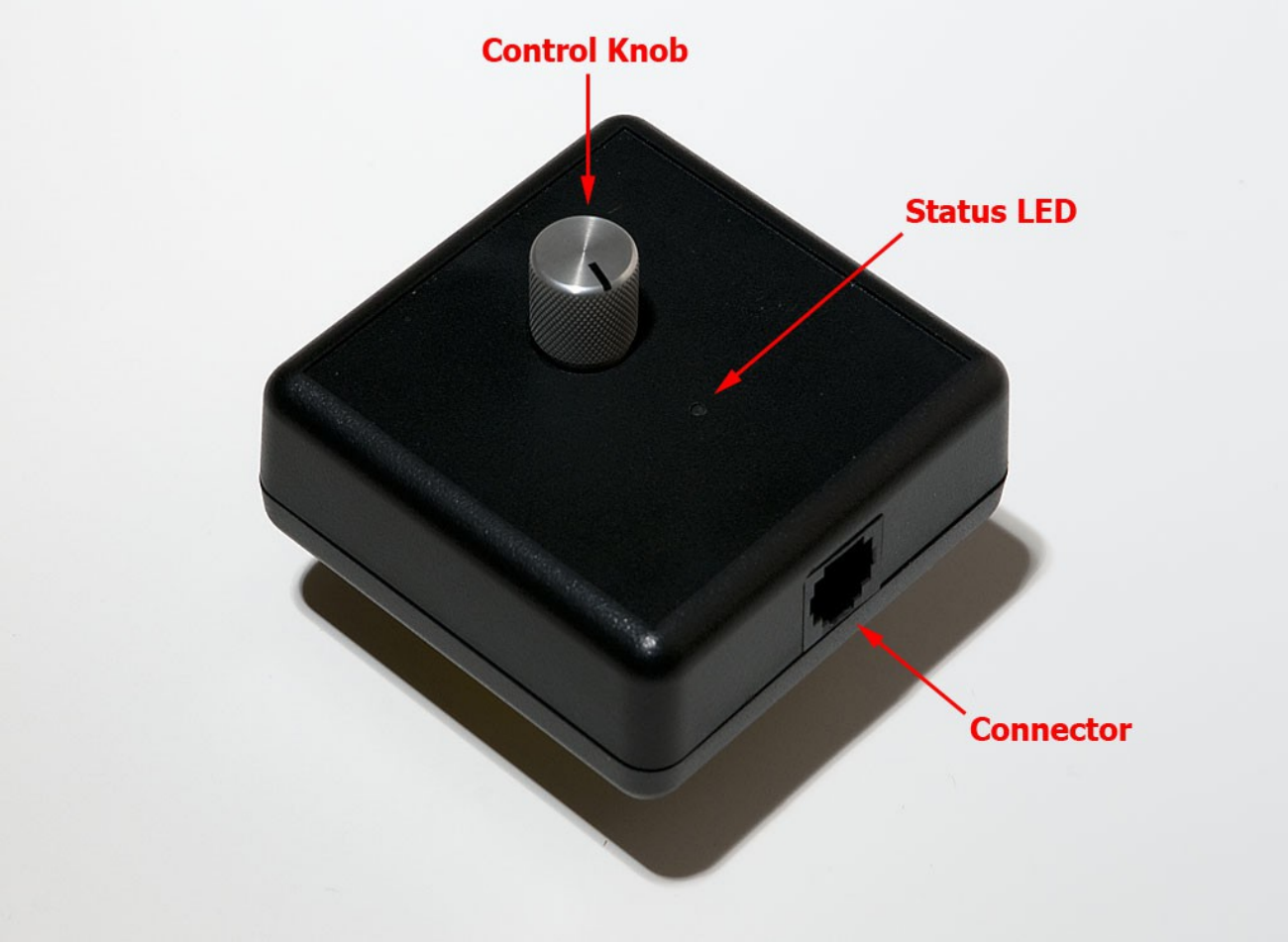
The "USB connect" indicator lights red when a connection is established to a computer.

The "Motor Active" LED is illuminated while the motor is moving. Red indicates outward motion and green inward (note that this refers to the 'logical' direction of movement, while the physical direction might need to be inverted using the system setup parameters described in the Driver Manual). When temperature compensation is enabled the Motor Active LED will be amber when idle, but still flash red or green when moving out or in, respectively.

3.2 Using the Hand Set

3.2.1 Motion Control Knob

The hand set is a simple box with 1 knob and a tri-color LED indicator.



Turning the knob clockwise normally produces clockwise motion of the focuser and counterclockwise produces counterclockwise motion. The relationship between knob direction and "in/out" motion depends on the mechanical design of the telescope, but it can be changed in the set up of the focus controller. Refer to section 5.2.7 for details.

Turning the hand set knob is like turning the focus knob on the telescope, except that it has "detents" (20 per full revolution) so that you can precisely control how far it moves.

3.2.2 Speed Selection / Status LED

Pressing the knob in (as you would click a mouse button) changes the "speed" of the motion control. What it actually does is to select the number of steps the motor will move for each detent of rotation. The speed is indicated by the color of the LED:

OFF = 1 step (speed 1)
RED = 10 steps (speed 2)
AMBER = 100 steps (speed 3)
GREEN = continuous (speed 4)

From power on the selected speed will be "continuous" (green) and each press of the knob switches the controller to the next lower speed. When at 1 step per detent the next press will go back to "continuous". The reasoning here is that you usually start at high speed to make coarse adjustments, then proceed to finer adjustments.

The continuous speed is used for very large movements, such as starting from the "zero" position and going to the approximate focus position. A single detent turn in either direction begins movement in that direction. Pressing the knob down (clicking it) or turning it in the opposite direction one detent will stop the motion. Note that in continuous mode the motor moves at twice the normal speed, which may reduce the torque applied. In most cases this will not present any problems, but if you want to ensure that the stop position is reported accurately (for example, if you set the position to zero at the "full in" position and want to precisely measure steps from that reference point), you should move the telescope to a nearly horizontal position before starting the move so that the motor is not overloaded by gravity.

The knob on the hand set is a "virtual" focus knob. The motor will generally not move as fast as your hand (unlike the physical focus knob), but will end up at a position proportional to the amount of rotation you have applied. Since the actual speed is limited by the motor, you will not get there any sooner by selecting a faster 'speed', but it will reduce the amount of turning you need to do. If you accidentally start a large movement and want to cancel it there are two ways to do it: Turning the knob in the opposite direction will "subtract" from the accumulated step count, which may result in movement in the other direction. Or, press the button at any time to cancel all pending movements. Using this stop command will also change the speed selection as described above.

3.2.3 Extended Press Functions

As described above, pressing the knob in (like clicking a mouse button) is used to change the speed selection. Pressing and holding the knob invokes secondary functions – the "extended press functions". Which function is invoked depends on the current color/speed selection, so you use short clicks (less than 2 seconds) to change the color of the LED, then press and hold (more than 3 seconds) to use the function associated with that color:

OFF = Report the current position
RED = Enter "Lock" mode (also prepares for shutdown)
AMBER = Toggle temperature compensation on/off
GREEN = Zero the current position

In each case, after holding the knob down for 3 seconds the LED will flash rapidly in red until you release the button. This indicates that the extended press has been recognized. Releasing the button starts the extended function, each of which is described in more detail below. When the extended press function is complete the controller returns to the same mode it had been in, except for the "lock" function, which is a special mode.

3.2.3.1 Report Current Position

Since the controller does not have any display screen, a host computer is generally used when you want to know the absolute position value. However, it is sometimes useful to be able to know the position without using a computer. PerfectStar can do this by flashing the LED to indicate the count for each digit. Note that the controller supports positions of over 1 million steps, but this function is limited to 999,999 so it can take up to six digits to report the position. Leading zeros will not be displayed. A good way to use this feature is in combination with the "zero current position" function: Zero the position a short distance "in" from the best focus position so that the position report will only have to display two or three digits.

To show the current position, select speed 1 (LED OFF), then press and hold the button for 3 seconds (that is, until it starts flashing RED rapidly). The position report will then begin.

The report starts with N (1 to 6) flashes of red to indicate that there will be N digits, followed by zero to nine flashes of green for each digit, separated by a pause that waits for you to click the button. This pause gives you time to memorize (or write down) the digit value that was just shown. For example, if the current position is 123 the report will be:

RRR p G p GG p GGG R----

That is, 3 flashes of red (for 3 digits), pause, 1 of green, pause, 2 of green, etc. "R----" indicates that the LED stays red until you click the button. This indicates the end of the report. Any "0" digit (other than a leading zero) is displayed as a long green flash. Short flashes are about ¼ second and the long flash is about ¾ second. So the value "102" is:

RRR p G p G+ p GG R---- (where "G+" means a long flash of green)

The value "0" displays as:

R p G+ R---- (that is, "0" is shown as a single digit)

After the full position is displayed and the button is clicked once more, the controller will go back to normal operation at speed 1.

3.2.3.2 Enter "Lock" mode & Prepare for Shutdown

The motor can be "driven" even when not in motion so as to hold the current position (this is the default case, but it can be turned off in the driver setup). If you prefer to physically lock the focuser, you can enter "lock mode" using the hand set: Select the RED speed, then press and hold the button for 3 seconds. After releasing the button the LED will slowly flash red, indicating that the controller is locked. In this mode the controller will not respond to any requests to move, whether from the hand controller, the host computer, or temperature compensation. To exit from lock mode simply press and hold the button for 3 seconds again.

It is recommended that you physically lock the focuser before entering lock mode. This helps to ensure that the focuser doesn't slip while locked. While in lock mode the motor is not driven (saving power) and the LED continues flashing red to remind you.

Note that if you are using a host computer it is also possible to set the controller to turn off the motor when it is idle. If the motor has a high reduction ratio it might not need to stay energized to hold the position – friction serves that purpose instead. This reduces power consumption for the focus system to almost nothing, but might not be as precise as either leaving the motor active or using lock mode.

A side effect of entering lock mode is that the current position is saved in non-volatile memory. This value will be restored the next time the controller is turned on, so lock mode can also be used to prepare to shut down the system: Physically lock the focuser, enable lock mode, and turn the power off. The next time you turn it on the controller will "know" the correct position, assuming the focuser has not been manually moved since the shut down.

Although the driver does not have a "lock" function (because it is not defined in the ASCOM standard), the driver does let the controller know when it is disconnecting and the controller will prepare for shutdown at that time – without going to lock mode.

3.2.3.3 Toggle Temperature Compensation On/Off

Temperature Compensation (TC) automatically adjusts the focuser position to maintain critical focus as the temperature changes. Using TC requires calibrating your system, which produces a temperature coefficient that specifies the number of steps needed per degree of temperature change. This coefficient is generally accurate over a wide temperature range and does not change as long as the hardware (telescope, focuser, and motor) do not change. A host computer connection is required to set the temperature coefficient in the controller, where it is stored in non-volatile memory. Once the coefficient is stored, TC can be used in manual operation.

The "motor activity" LED on the controller indicates whether TC is currently on or off. While the motor is idle (not moving) the LED is OFF if TC is disabled or AMBER if TC is enabled. When TC is first enabled the controller must define a "reference point" (position and temperature) from which future compensation will be made. If no temperature reading is available this point cannot be defined, but the controller will remember that TC enable has been selected and will start performing compensation as soon as a valid temperature reading is available. While waiting, the "motor activity" LED will flash AMBER. The status of TC Enable is available through the ASCOM driver. However, applications might not read this status and therefore wouldn't recognize when the status has been changed via the hand controller. That is because most applications treat TC as a feature that is strictly under their control, while PerfectStar provides this feature to the user without a computer.

TC enable is toggled by selecting AMBER speed on the hand controller, then doing an extended press. When the button is released the TC mode will change from off to on or on to off.

More details on the operation of TC can be found in section 5.2.5.

3.2.3.4 Zero Current Position

It is often useful to set the current position to a particular value without actually moving the motor. The ASCOM driver allows setting any position, but with just the hand controller you can set the position to zero. This is commonly used to define a known reference point (such as where the focuser is racked in all the way) or to define a point near the best focus position so that the reported position is a relatively small number. However, please remember that the position is an unsigned value and the controller will never have a "negative" position. When using the hand controller, if the position becomes negative it is simply redefined as zero. Through the computer interface the controller will stop when it reaches zero. Thus, setting a zero position also defines a travel limit in the inward direction. When connected to a host computer you can also define a "Max position", which acts as a travel limit in the outward direction. The outward travel limit applies to both computer and hand set operation.

Note that PerfectStar also supports the use of travel limit switches to safeguard against driving the focuser beyond its physical limits. However, this feature is generally not needed, so it is available only as a custom option. Since inward movement with the hand controller is not limited, please be careful not to drive the focuser to its physical limit. Small and brief movements against the limit will generally not harm anything and this technique can be used to "find" the physical limit.

To zero the current position, select the GREEN speed and do an extended press. There is no explicit acknowledgment of the setting, but you can use the "report position" function to confirm it if desired.

4 Firmware Updates

The firmware in the PerfectStar controller is stored in flash memory and can be updated through the USB interface. Check the www.wa-chur-ed.com site for announcements of available updates. When/if an update is released, a ".hex" file will be available for download. Have this file handy before initiating the update. You should also have the "HIDBootloader.exe" program and related files from the CD that came with your controller. There is no installation needed for this program, but it must be run from the directory where it and the associated files are located.

4.1 Initiating Update Mode

To initiate an update, disconnect the controller from your computer and turn the controller off. Ensure that the hand set is connected. Press and hold the button on the hand set as you turn on the controller. Instead of the usual start-up behavior, the controller will enter a special mode, which is indicated by the USB connect LED being on (even though it is not yet connected). The controller will not respond to the hand set in this mode, so you should click the button to ensure that it does not respond. If it does respond (by changing the LED color), turn the power off and try again.

Once you have succeeded in getting the controller into update mode, connect it to your computer with the USB cable. The device should be recognized and a driver automatically installed. At that point the controller will flash both the USB connect LED and the green motor active LED.

To ensure that the update process does not fail, it is recommended that all other applications on the computer be closed and network connections (including wireless) be disabled.

4.2 Flashing the Code

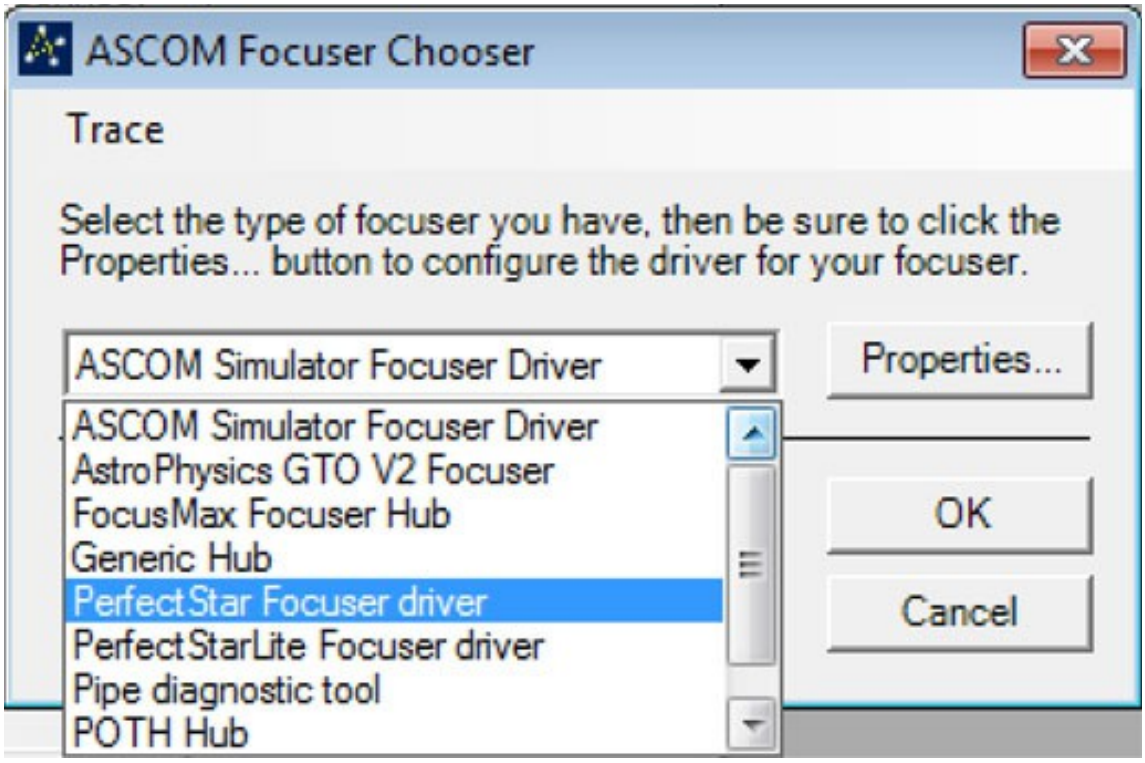
Run the HIDBootloader.exe program and click the "open file" icon. Navigate to the location containing the "PerfectStar xx.hex" file (where "xx" is the version number) and select it. WARNING: The program might be able to load ".hex" files intended for other devices, but attempting to update the controller with such a file will almost certainly not produce a good result, including the strong possibility of overwriting the code that allows firmware updates. If that happens the controller will be completely non-functional and will need to be sent back to Wa-chur-ed Observatory to be reprogrammed. Once the correct file is loaded, click the "Erase/Program/Verify" button to flash the controller. It usually takes just a few seconds to update the firmware, but it is very important that you not turn off either the PerfectStar controller or your computer or disconnect them until the process is done. Once the update is done, disconnect the USB cable and power cycle the PerfectStar controller. It should then be running the new firmware version. You can confirm the version number in the driver setup dialog.

5 Using the ASCOM Driver

This section describes how to use the features of the PerfectStar ASCOM driver. Before it can be used, please refer to sections 1 and 2 for instructions on installation of the software and set up of the hardware.

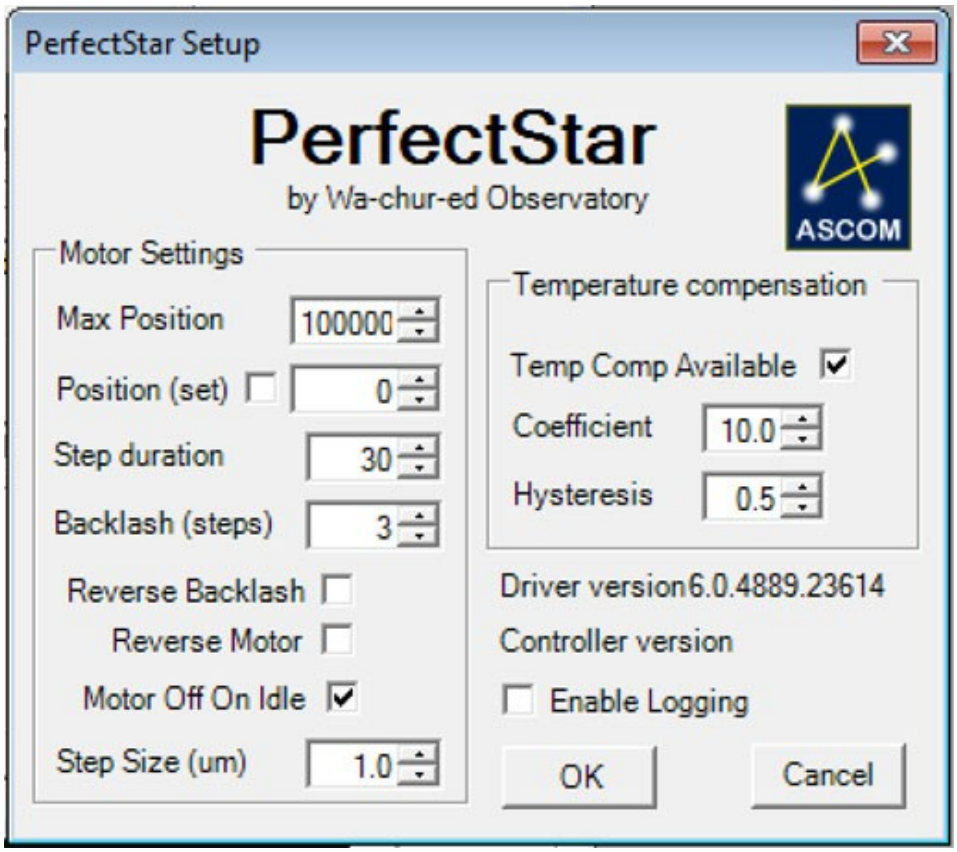
5.1 ASCOM Chooser

Each application has its own way of accessing the controls for ASCOM devices such as the PerfectStar focus controller, so you will have to refer to the documentation for your application. At some point, you will be presented with the ASCOM "chooser", a dialog box that allows you to select which specific device within a category (in this case, focus controllers) you want to use. It will also have a "properties" or "set up" button. After selecting "PerfectStar Focuser" from the drop down menu, click on the properties button to set it up.



5.2 Set Up

The setup screen contains a number of parameters that you can change. Most of these values are saved on the computer so that you don't have to re-enter them each time you use the driver. Many of the values are also sent to the controller and saved in internal non-volatile memory there. In some cases the values saved by the driver take precedence and over-write the values in the controller, but it is important that the controller also remember the values so that they apply to manual controls as well.



5.2.1 Max Position

The maximum position is a limit on the position applied by both the driver and the hardware. That is, the focuser will not be allowed to move to a position beyond the specified value. It is usually not necessary to change this from the default value of 100,000 steps. However, if you need more than 100,000 steps to reach the full travel of your focuser you may want to increase it. Another situation is that you want to prevent the controller from trying to move past the maximum position that the focuser can reach to prevent mechanical strain on the motor or focuser. In this case, you should determine the correct value by setting the position value to zero with the focuser racked all the way in, then carefully move the focuser out to find the maximum position you want to allow.

Note that there is also a "minimum" position of zero. That is, neither the driver or the hardware will allow the focuser to move to a negative position.

5.2.2 Position Set

Click the check box and enter a value to force the "current position" to the specified value. This sets the value of the internal variable without moving the motor at all. This is most commonly used to specify the zero point, but can also be used to specify any arbitrary point, such as "1000". The value will be transferred to the controller when the connection is made.

5.2.3 Step Duration

Stepper motors have multiple coils and move by activating these coils in a specific sequence. The amount of time that is required for each step depends on many factors, including the motor model and the load it is moving. Selecting a value for this step duration is a trade-off between torque (how much force the motor can apply to move the focuser) and the speed with which it can move. Beyond a certain duration there is no additional torque to be had. Since speed is generally not very important, the best value for step duration is the smallest value that will produce the full torque available. For motors from Wa-chur-ed Observatory (and probably most others) this is around 30 to 40. You can test for maximum torque by applying weight to the focuser and seeing how low you can set the duration before the motor fails to move accurately (that is, it fails to lift the load by the requested amount). A value somewhat larger than indicated is recommended. Note that the value has no specific units. You can think of it as milliseconds, but this is not at all precise. Also, the motor uses half the specified duration in "continuous" move operation, so be sure that it works correctly in that mode as well.

5.2.4 Backlash Compensation

All mechanical systems using gears will have a certain amount of "backlash", which is the additional movement required to take up the gap in gears when changing direction. The PerfectStar controller can automatically compensate for this error in the mechanical system by applying a previously measured number of steps. The user must specify the amount of backlash (in units of single steps of the motor). The correct value can be determined by moving the focuser in one direction a significant distance (to ensure that any backlash has been taken up), then counting the number of single steps needed in the opposite direction before the focuser actually moves. Detecting this small motion can be tricky. A dial indicator or micrometer on the draw tube is ideal. The most general approach is to use a Bahtinov mask (ideally with 'Bahtinov Grabber' software) to observe the change in focus. After critically adjusting focus, move the focuser a significant distance in either direction, then back to best focus in the opposite direction. From there, again reverse the direction in single step moves until a change is detected. This is best done under excellent seeing conditions and with long exposures (>3 seconds) to average out the effects of seeing. It is better to under-compensate than over-compensate, so enter 1 less than the count of steps before you detect motion.

Backlash compensation is accomplished in two different ways, depending on whether the movement is requested through the host computer or the hand controller. The ideal backlash compensation defines a "preferred direction", which is generally "in" for a telescope focuser because that is the direction in which the motor is working against gravity. When movement is requested for the preferred direction the controller just moves the specified amount. But when movement in the non-preferred direction is requested, the controller moves an amount equal to the requested amount plus the backlash amount, then moves back in the preferred direction by the backlash amount, thus ending every request with a movement in the preferred direction.

For manual control it is wasteful to apply this type of backlash compensation on every step and we don't know how many steps there will be. So for manual control backlash compensation uses a different technique: If the requested movement is in the same direction as the most recent movement, it is executed directly. If it is in the opposite direction, the backlash amount is added to the requested movement size (number of steps). In this case it is up to the user to make the final movement in the preferred direction so that gravity cannot cause the focuser to slip through the backlash amount.

If for some reason you need to specify that the preferred direction is "out", click the "reverse backlash" check box (see section 5.2.6). This has no effect on manual control.

Note that the reported position is unaffected by backlash compensation. That is, steps taken to compensate for backlash are not included in calculating the new position. The "halt" methods (such as pressing the knob on the hand controller) will not stop a backlash compensation movement and halting in the middle of a movement requested by a host computer in the non-preferred direction will still be compensated with a movement in the preferred direction. Movements requested by temperature compensation are not corrected

for backlash.

5.2.5 Temperature Compensation

Temperature compensation is possible only if you have a temperature sensor connected. Since the driver cannot reliably tell whether you have a sensor at setup time, it is up to you to select whether or not to make TC available to the application. There is no danger in making TC available or even turning it on in the application. As with the hand set, you can enable TC at any time, but it does not become active until a valid temperature reading is available. The "available" check box simply reduces confusion by telling the application whether or not you want to attempt to do compensation.

Note that TC movements are calculated based on the "reference point" established when you click the "enable" check box. That is, the current position and temperature are saved at that time and used for all TC calculations rather than simply calculating the change from the most recent event. The latter method is imprecise because of the accumulation of rounding errors. This means that the reference position must be adjusted if the position is changed by either manual control or host-driven movement. Therefore, although it may be necessary sometimes to "tweak" the focus while TC is enabled, this will not cause errors in the calculation of TC corrections.

Backlash compensation is not applied to TC movements. That is because the typical case requires moving the focuser "out" as the temperature drops, while the preferred direction is "in". If backlash compensation were used it could result in relatively large movements of the focuser in the middle of an exposure. It is recommended that TC be used only with systems having backlash of less than half the size of the critical focus zone.

TC also involves a heated philosophical debate, if you'll pardon the pun. The issue is whether corrections to compensate for temperature changes should be reflected in the reported position. The argument against reporting is that the "actual" position (the distance from the telescope objective to the image sensor or eyepiece) does NOT change because TC is holding it constant by increasing the draw tube extension as the OTA dimension shrinks, for example. In fact, under this philosophy the position value DOES change with temperature if TC is NOT enabled. This might make a lot of sense if the reported position were actually the focal length of the telescope (perhaps in millimeters). Since the usual case is either reporting the extension of the draw tube in millimeters or in the somewhat arbitrary unit of "motor steps", I think that the opposing philosophy is preferable: PerfectStar reports the number of steps out from a user-defined zero point, including any adjustments made for temperature compensation.

5.2.5.1 Temperature Compensation Coefficient

Temperature compensation requires the optional temperature sensor. You can set the coefficient and hysteresis parameters at any time, but the "enable" check box may be grayed out in some applications until the driver gets a temperature report from the hardware. Note that the initialization of the temperature sensor can take a minute or two after turning on the PerfectStar controller or attaching the sensor. After that, the temperature is updated frequently.

The temperature coefficient is the number of steps needed to compensate for a 1 degree Celsius change in temperature. Normally, a falling temperature requires moving the focuser "out" as the length of the telescope tube shrinks. Therefore, positive values of the temperature coefficient produce increasing position with decreasing temperature. In case you need the opposite, simply enter a negative value for the coefficient.

To measure the temperature coefficient, critically adjust the focus and record the position and temperature at that time. When the temperature has changed a significant amount (5 to 10 degrees, preferably), critically adjust the focus again and note the final position and temperature. Calculate the change in position divided by the change in temperature, rounding off to the nearest tenth of a step.

5.2.5.2 Temperature Compensation Hysteresis

The hysteresis value defines how large a change in temperature is allowed before a correction is applied to the focus position. Setting it to "0" means that a new position is calculated every time that the temperature is measured (approximately every 5 seconds). However, if the resulting position change is less than 1 step no action is taken.

Normally, the hysteresis is set to something larger than "0" because it is not necessary to make such small changes and moving the focuser unnecessarily is a risk. Good quality focusers will not shift the image when focus is changed even a large amount, but there is no point in risking it when the adjustment will not improve anything.

To determine the optimal value for hysteresis, use this formula:

TC hyst = ((CFZ / SS) / 4) * (1/TC coef)

where CFZ is the "critical focus zone" for your telescope, SS is the linear step size for your focuser and motor (the distance the focuser actually moves for a single step of the motor), and "TC coef" is the temperature coefficient determined in the previous section. CFZ and SS must be in the same units (typically microns) and TC coef and hysteresis are both in degrees C. The idea here is that no correction should be made until the resulting movement is at least a quarter of the critical focus zone. For example, if CFZ = 100 microns, SS = 5 microns per step, and TC coef = 10 steps per degree, the suggested TC hyst value would be:

TC hyst = ((100 / 5) / 4) * (1/10)
= 0.5 degrees

5.2.6 Reverse Backlash Check Box

This is covered under backlash compensation (section 5.2.4). To summarize, if this check box is checked the "outward" direction is considered the preferred direction for purposes of backlash compensation. This is usually not the case.

5.2.7 Reverse Motor Check Box

Stepper motors turn in a direction defined by the sequence of coil activations and the direction can be reversed by changing the sequence. By default, the motor turns such that the focuser shaft to which it is attached is driven in the same direction that the knob on the hand set is turned. Note that when you look at the motor you will usually be seeing it from the opposite perspective, so the motion appears to be backwards. However, when using most focus control software the important relationship is which sequence produces 'in' versus 'out' movement. Since this depends on the telescope design (and, in some cases, how the motor is coupled to the focuser), it may be necessary to use this check box to get the proper relationship. Note that reversing the motor direction for software use also changes the relationship with the hand set knob, so you might end up having the knob behave opposite to what the physical focus knob did with regard to in/out directions.

5.2.8 Off on Idle Check Box

In default operation the PerfectStar controller leaves one coil of the motor energized when idle (not moving). This acts as a magnetic brake to hold the motor in the specified position. For maximum positional accuracy this is recommended. However, if there is adequate friction in the system (as may be the case with motors that employ large gear reduction ratios) it might not be necessary to leave the motor energized. When this check box is checked the motor will be de-energized when idle. In addition to reducing power consumption (dramatically: almost all the power used by PerfectStar goes to the motor), this greatly reduces heat build-up in the motor. Although motors from Wa-chur-ed Observatory are designed to minimize heat transfer from the motor to the focuser, it cannot be completely eliminated and other motors typically have no such feature. The actual power consumption varies with the motor design, but for our motors (and many others) it is 2.9 watts.

5.2.9 Step Size (um)

The step size parameter is not used by the controller at all, but may be used by the application so that the position (which PerfectStar reports in units of motor steps) can be displayed in conventional units of microns or millimeters. To determine the correct value to enter here you need to make a fairly large movement (perhaps the full range of travel) and divide that distance (in microns – 1/1000 of a millimeter) by the number of motor steps it took to make that movement. If your application software displays the position only in microns (rather than steps), temporarily set the step size to "1". The display will then be in steps. Divide the total distance moved by the number of steps to determine the actual step size, then change the parameter to that value.

5.2.10 Driver and Firmware Version Numbers

The setup dialog reports the version numbers from both the ASCOM driver and the controller firmware. The purpose is just that you can confirm whether you are running the proper versions. The controller firmware version is actually read from the controller over the USB connection, so it will be blank if the controller is not connected (as was the case for the image shown above).

5.2.11 Enable Logging Check Box

If checked, all transactions between the ASCOM driver and PerfectStar controller will be recorded on your computer. Each time a connection is established with this box checked a text file is created in "Documents/ASCOM/Logs <date>". Depending on how often the application program polls for information (current position, temperature, etc.) this file can rapidly become quite large, so it is usually a good idea to leave it unchecked.

5.3 Disconnect Operation

When you click the "disconnect" button for PerfectStar in your application's ASCOM interface, the driver tells the controller to prepare for shutdown. The controller responds by saving the current position in non-volatile memory. If you then turn off the power and do not manually move the focuser (you may want to tighten the lock knob on the focuser), the next time you turn the controller on the position will be restored, so it still knows the correct position.

6 SAFETY PRECAUTIONS

PerfectStar FOCUS SYSTEMS RUN ON 12VDC AND PROVIDE THIS VOLTAGE TO THE EXTERNAL MOTOR THROUGH A USER-ACCESSIBLE CONNECTOR. CONTACT WITH THIS VOLTAGE, EITHER DIRECTLY OR THROUGH OTHER SYSTEMS, CAN CAUSE SERIOUS PERSONAL INJURY OR DAMAGE TO PROPERTY. USE CAUTION WHEN HANDLING THE POWER SOURCE, THE CONTROLLER, THE MOTOR UNIT, AND INTER-CONNECTING CABLES.

FOR AC POWER OPERATION USE ONLY THE AC ADAPTER SUPPLIED BY WA-CHUR-ED OBSERVATORY. THIS IS A UL LISTED DEVICE AND IS COVERED BY ITS MANUFACTURER (NOT WA-CHUR-ED) FOR WARRANTY AND LIABILITY.

FOR DC POWER OPERATION USE ONLY THE DC POWER CORD SUPPLIED BY WA-CHUR-ED. THE 'CIGARETTE LIGHTER' CONNECTOR CONTAINS A 5 AMP FUSE. DO NOT BYPASS THIS FUSE OR REPLACE IT WITH A FUSE OF HIGHER RATING. USE EXTREME CAUTION WHEN CONNECTING TO A BATTERY, SINCE BATTERIES CAN PROVIDE VERY LARGE AMOUNTS OF CURRENT, RESULTING IN OVER-HEATING, FIRE, OR EXPLOSION. DO NOT MAKE BATTERY CONNECTIONS WHERE FLAMMABLE GASES MAY BE PRESENT, SINCE EVEN NORMAL CURRENT FLOW CAN PRODUCE SPARKS WHILE CONNECTING OR DISCONNECTING. NOTE THAT LEAD-ACID BATTERIES PRODUCE FLAMMABLE HYDROGEN GAS WHILE CHARGING OR DISCHARGING AND SHOULD ONLY BE USED WHERE ADEQUATE VENTILATION IS PROVIDED.

THE CONTROLLER ALSO INCLUDES AN INTERNAL SELF-RESETTING FUSE RATED AT APPROXIMATELY 1.5 AMPS. HOWEVER, BOTH THIS INTERNAL FUSE AND THE FUSE IN THE DC POWER CORD ARE OF THE 'SLOW BLOW' TYPE, SO SIGNIFICANTLY GREATER CURRENT MAY FLOW FOR SOME PERIOD OF TIME BEFORE ONE OR BOTH FUSES OPEN. THIS WILL HAPPEN IF THE 12V POWER IS SHORTED TO GROUND.

DO NOT CONNECT THE CONTROLLER TO ANY POWER SOURCE WITH REVERSE POLARITY. THE CENTER PIN OF THE COAXIAL POWER CONNECTOR MUST BE CONNECTED TO THE POSITIVE SIDE OF A 12VDC POWER SOURCE. EXCEPT FOR THE SELF-RESETTING FUSE THERE IS NO PROTECTION AGAINST REVERSE POLARITY CONNECTION.

DO NOT USE ANY MOTOR OTHER THAN A 12V UNIPOLAR STEPPER MOTOR WITH PROPER CONNECTIONS. DO NOT CONNECT THE CONTROLLER TO A MOTOR THAT DRAWS MORE THAN 0.5 AMPS PER WINDING (RESISTANCE MUST BE 24 OHMS OR MORE PER WINDING).

THE MOTOR CONNECTOR ON THE CONTROLLER IS A FEMALE DB-9 TO MINIMIZE THE EXPOSURE OF THE 12V SUPPLY OUTSIDE THE CONTROLLER. CABLES SUPPLIED BY WA-CHUR-ED WILL ALSO USE FEMALE CONNECTORS AT THE EXPOSED END. DO NOT USE CABLES THAT EXPOSE THE CONTACTS. DO NOT INSERT ANYTHING INTO THE CONNECTOR OR CONNECT TO ANYTHING OTHER THAN AN APPROVED MOTOR.