TCF-LSI 2-inch Focuser Installation

Step-by-Step Instructions for Installing the TCF-LSI 2-inch Focuser on any telescope Optical Tube Assembly (OTA).

Introduction

The TCF-LSI continues the long tradition of the TCF-S focuser - a robust, 2-inch Crayford style focuser capable of handling 10-lb. (4.5 kg) camera packages without flexure. As a true absolute ASCOM homing focuser, the TCF-LSI is capable of fully unattended telescope focus control with unprecedented positional accuracy.

The TCF-Si focuser was introduced as a standalone variant of the original TCF-S. Similarly, the TCF-LSI is a standalone version of the TCF-Lynx focuser having full compatibility with Optec’s popular FocusLynx controller system. The TCF-LSI features a standard USB/Serial connection to any control computer. By installing the ASCOM Alpaca driver, the TCF-LSI can be controlled by PC, Mac, Raspberry PI, or any Linus based computer.

Mechanically, the TCF-LSI 2-inch provides the strength and durability that TCF-S owners have come to expect from Optec instruments. Like its predecessor, the TCF-LSI features a full 2-inch bore with 0.6-inches (15.2mm) of drawtube travel. With a step resolution of 2.2-microns per step, the TCF-LSI works elegantly with any auto-focus software application. Like all TCF Temperature Compensating Focusers, a precision digital temperature sensor is included to mount directly on to the telescope OTA for the most precise temperature measurements available. A FocusLynx compatible controller circuit board is enclosed in the small box mounted directly to the motor housing. The TCF-LSI board has three bottom connectors for input power, USB/Serial connection via our RJ12 6P6C socket, and a 6-pin DIN socket to receive the included temperature probe.

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Standard Optec Interfaces

The telescope side interface for the TCF-LSI is Optec’s standard 2.4-inch dovetail system known as the OPTEC-2400. The camera side interface is a 2-inch bore that allows any 2-inch eyepiece or camera adapter to be inserted. Optional 2-inch accessories include a 1-1/4” compression adapter, T-thread, M54 x 0.75mm, and STL-threaded adapters.

TCF-LSI Package Contents

Confirm the contents of your TCF-LSI 2-inch focuser package. Telescope mounting plates are sold separately. The package should contain the following items:

- TCF-LSI 2-inch focuser,
- Precision temperature probe,
- USB/Serial communication cable,
- 12VDC power supply with cord,
- 5/64” ball driver hex key tool.

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TCF-LSI Options

Remote In/Out Keypad

Optec’s original red Remote In/Out Keypad wand temporarily replaces the temperature probe for use at the telescope. This is an ideal low-cost solution for the TCF-LSI during visual use.

Optec stock item #17680 is available for purchase separately and is fully compatible with all TCF focusers having the 6-pin DIN temperururе probe socket.

Virtual Hand Controller

For visual users, the ASCOM Alpaca driver can also be used and configured as a virtual hand controller using any smartphone or tablet. See ASCOM Alpaca Driver Setup below for more information.

TCF-Si Upgrades

For owners of the original TCF-S or TCF-Si focuser, Optec offers a special upgrade package that replaces the original unipolar stepper motor with a high-torque bi-polar motor and LSI circuit board compatible with the FocusLynx controller. Specify Optec stock item #17725 for upgrade option. Requires return of TCF body to Optec for upgrade.

Contact Optec Sales for additional details.

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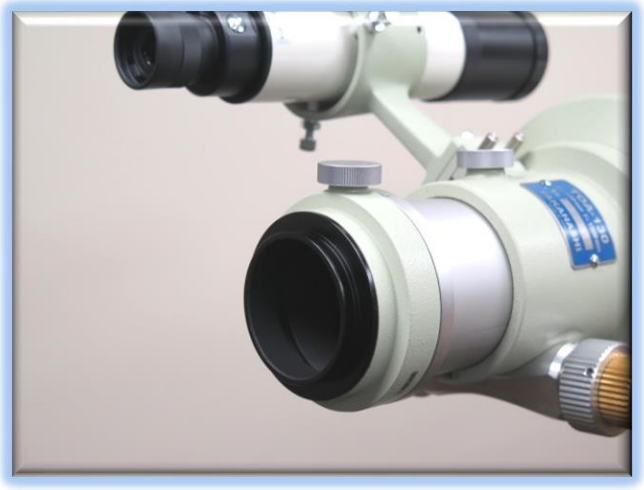
Installation Procedure: Step-by-Step

Step 1 – Identify OTA mount

To attach the TCF-LSI focuser to your telescope, you first need to identify the most appropriate mounting surface on the telescope OTA. For example, the Takahashi TOA-130NS telescope shown at right includes an M72 x 1mm threaded dust cap. Removing the cap reveals a female M72 thread where we can attach the TCF-Lynx.

We can add an adapter to convert this female thread to the OPTEC-2400 2.4-inch dovetail onto which the TCF-LSI 2-inch focuser will mount.



Optec's stock item #17453 is the correct adapter to make this mechanical conversion and is shown attached to the Takahashi OTA at left.

Bear in mind the available back-focus for your particular OTA. The TCF-LSI body will consume between about 84 and 99mm of back-focus with just over 15mm of drawtube travel. For the Takahashi shown, the TOA-130 has plenty of back-focus and the native rack-and-pinion focuser can be used to set the TCF-Lynx into the desired range. Similarly, the popular Schmidt-Cassegrain Telescope design features a coarse focus knob that should be used to set the TCF-LSI into a suitable focal zone for imaging and auto-focus.

Optec offers a wide variety of stock OPTEC-2400 adapters to fit most any telescope OTA. Contact Optec Sales (sales@optecinc.com) or visit the Optec website for a full list of available adapters:

http://www.optecinc.com/astronomy/optec-2400_adapters.htm

Occasionally, a custom adapter must be made to fit the TCF-Lynx to the telescope OTA. Optec recommends Precise Parts to quickly provide a suitable adapter. Visit www.preciseparts.com for details.

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Step 2 – Attach Focuser

With a suitable OPTEC-2400 telescope mount in place, slip the TCF-LSI body over the mount. You may need to loosen the three setscrews around the base of the focuser slightly first. Use the included 5/64" ball driver to loosen as necessary.

Step 3 – Align and Tighten

Align the focuser body for suitable clearance and preferred orientation. Tighten three setscrews using the 5/64" ball-driver hex tool. Be sure to tighten each setscrew securely against the dovetail on the OPTEC-2400 telescope mount.

Step 4 – Attach Power

The TCF-LSI includes a standard 12VDC power supply with 2.5 x 5.5mm plug with center pin positive. Plug the power cord into the socket of the TCF-LSI and connect to your local standard wall cord. The TCF-LSI will immediately begin the homing sequence and the Power LED on the circuit board will blink until homing is complete.

Alternatively, you may wish to connect to a battery or other power distribution device. Optec offers an optional cigarette light plug cord (stock item #17068), a 2.5x5.5mm power plug with 6-ft. tinned leads for Anderson PowerPole type connectors (#17063), and a 2.1mm to 2.5mm power plug converter (#17071) for power distribution systems using the smaller center pin standard.

Step 5 – Attach USB/Serial cable

Next insert the 6-pin RJ12 (6P6C) modular plug into center socket of the TCF-LSI and insert the flat USB A connector into your control PC or USB hub. Note the included cable is USB 2.0 compliant and may require the FTDI driver download for proper function.

Optec provides a fully tested version of the FTDI driver available from our download site: https://optecinc.com/astronomy/downloads/usb-to-serial.htm.

For operating systems other than Windows, visit the FTDI driver website directly: https://ftdichip.com/drivers/vcp-drivers/.

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Step 6 – Attach Temperature Probe

The TCF-LSI temperature probe has a 6-pin DIN style plug for connection to the circular port on the bottom side of the box containing TCF-LSI circuit board. Use the included thermal foam to adhere the temperature sensor to the side of the optical tube assembly. In almost every instance the most linear zone of temperature response for any telescope is the tube. As aluminum and even carbon fiber tubes cool down they tend to shrink causing the focus to shift.

Optec's Gerald Persha was granted an original U.S. Patent in May 2000 in which he described the temperature / focus effect and how the Temperature Compensating Focuser can automatically correct for temperature induced focal shifts. The key to successful temperature compensation is to find the linear zone of the telescope and place the temperature sensor there.

While using the temperature probe is not required for operation, most users find the **TC at Start** feature of the TCF-Lynx will put their scope right at or near the best focus each night. Subsequent auto-focus routines can confirm best focus. While in temperature compensation mode, additional focus should not be required thereby increasing your total imaging time on your target each clear night.

Temperature Compensation has been proven to maintain focus effectively during temperature changes throughout an evening's observing session. See the section on Temperature Compensation below for configuration and usage details.

Contact Optec Sales for a replacement temperature probe or additional thermal foam.

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Step 7 – Add a Camera Adapter

The TCF-LSI 2-inch drawtube can accept any 2-inch diameter accessory such as star diagonals, 2-inch eyepieces, telecompressors, and camera nosepieces. We recommend using the Optec 2-inch Drawtube Adapters available from our website here:

http://www.optecinc.com/astronomy/2-inch_adapters.htm

Notice the TCF-LSI includes a notched drawtube that matches a precisely machined brass screw included with each Optec telecompressor or 2-inch accessory. The purpose of the notch and screw arrangement is to ensure repeatable rotational alignment when re-installing a camera each night. For example, the Optec 2-inch nosepiece with T-thread can couple to a Canon bayonet mount as shown. Note the brass registration screw mounted in the flange and rotate the camera until the screw drops into the notch. This makes removing and re-installing cameras simple and repeatable – even in the dark.

Your TCF-LSI focuser is now installed and ready for software configuration. For Windows users, Optec's FocusLynx Commander and ASCOM driver software is available any time by download directly from our website.

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FocusLynx Commander Software Setup

Visit http://www.optecinc.com/astronomy/downloads/focuslynx.htm for the latest version of FocusLynx Commander and ASCOM driver. Consult the ***FocusLynx Quick Start Guide*** available on the same page for guidance when installing the FocusLynx Commander software. After installation, you should configure FocusLynx Commander for your new **TCF-LSI** focuser. Configuration within FocusLynx Commander will also configure the ASCOM driver so that the same settings will apply when using auto-focusing software such as Maxim D/L, TheSky X, Sequence Generator Pro or FocusMax.

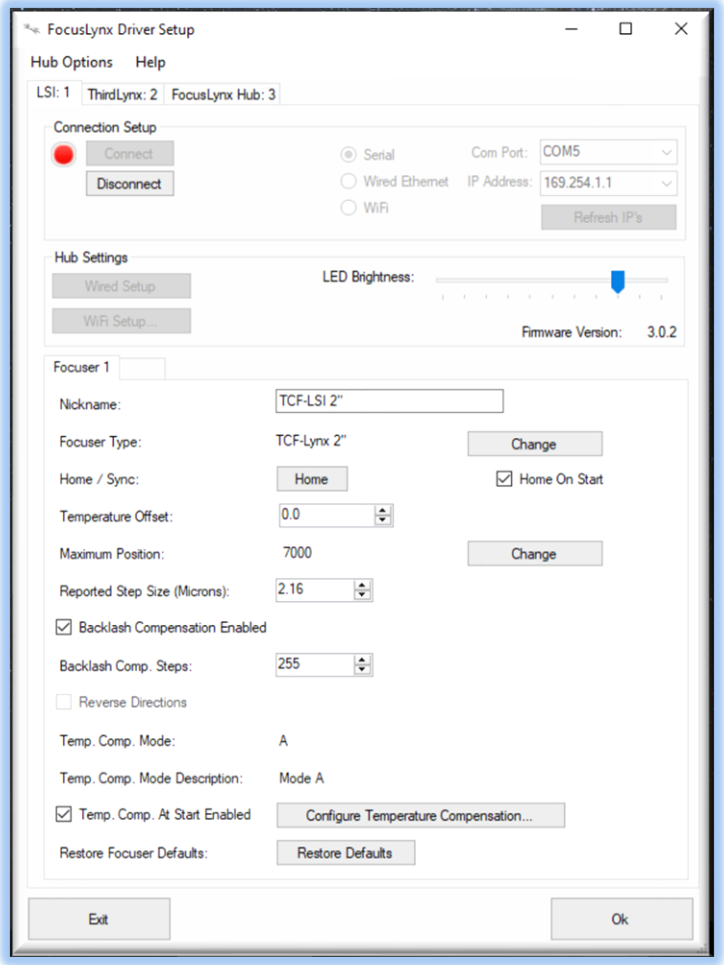
FocusLynx Commander Focuser Type selection

Open the Focuser Hub Setup dialog for Focuser 1 and choose the **TCF-Lynx 2"** Focuser Type option. The Focuser Device Type option will automatically set the correct step size and full travel of 7,000 steps.

In the Nickname field, type a description to easily identify which telescope OTA is being focused. This nickname will appear in FocusLynx Commander and the FocusLynx Alpaca webpages.

A Home button will appear below the Focuser Type selection. The Temperature Offset allows you to calibrate your temperature sensor, set the LED brightness, enable backlash compensation, or configure temperature compensation all from this Setup dialog box.

To reset to the original factory settings, click the Restore Defaults button and click Yes.



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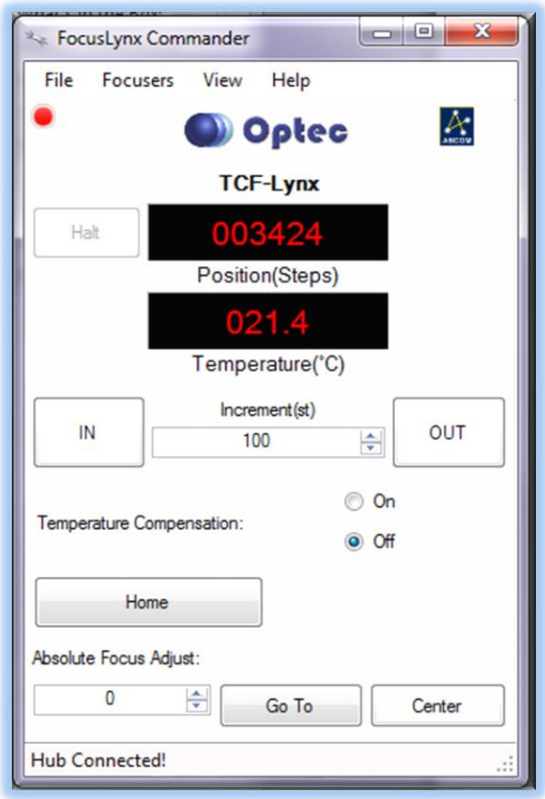
Set the Position Units

In the main form of the FocusLynx Commander window, you may left-click directly on the red Position digital read-out to toggle units between Steps, Microns, and Millimeters. Note that only the step count is passed through to the ASCOM driver. The iFocuserV2 standard for ASCOM absolute focusers relates all focuser movements to actual step counts with the higher level client responsible for making the conversions to real-world measurements. The FocusLynx Commander client extends the property to easily convert the units to mm and microns.



Set the Temperature Units

Like the Position units, you can left-click directly on the red Temperature display at any time to toggle through degrees Celsius, Fahrenheit, and Kelvin.

Step Range

The TCF-LSI has a fixed number of total steps. Full IN is at step position 0 while full OUT is at step position 7,000. Upon initial power up the focuser will move to position 0 and then outward to the last parked position at the last power down. We recommend you begin the session by moving to the center position (click the Center button) of 3,500. Once at center, adjust your telescope's coarse focus knob (if available) or use spacer rings to achieve best focus. This ensures your normal focal travel is within the available travel range for the TCF-LSI drawtube which is about 15.2mm.

Homing Procedure

Upon power up, the TCF-LSI control circuit will automatically home the focuser by moving all the way in to position 0. The controller will force the motor to move over 7,000 while a mechanical limit will stop the drawtube travel at position 0. It is normal for the large gear to spin against the mechanical stop before moving outward. The TCF-LSI is very stable and you may wish to uncheck the Home On Start option which is checked by default.

At any time you may wish to re-home the focuser and move to Center for coarse focus adjustment. Simply click the Home button the main FocusLynx screen. If you do not have enough travel, you will need to add or remove spacers between the focuser and camera package.

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Temperature Compensation

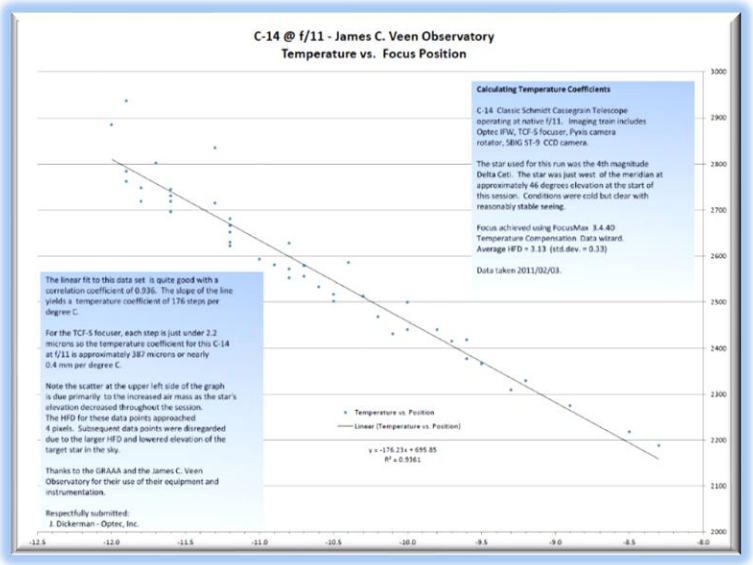
TCF-LSI includes a precision temperature probe for temperature compensation. Within FocusLynx Commander click File – Temp Comp Wizard to automatically determine the "TC" or Temperature Coefficient for your particular telescope configuration. After completing the wizard, turn on temperature compensation by selecting "On" just above the Sync button. The FocusLynx controller will automatically adjust the telescope focus for changing temperatures.

The Temperature Coefficient or TC is the slope of the line connecting two or more data points on a graph of position vs. temperature. The temperature coefficient is calculated as,

$$TC = (P2 - P1) / (T1 - T2)$$

where P1 is the position at start and T1 is the temperature at start. P2 and T2 denote the second position and temperature respectively. The slope of the line connecting these two points is most accurate when the temperature differential is at least 5 to 8 degrees C. Note that the TC is calculated as the negative value of the slope because for most telescopes, the focal position P increases as the temperature T decreases.

For a more rigorous approach to calculating the temperature coefficient, a linear regression of many data points collected over an evening's observing session can be calculated with TC equal to the negative of the slope of the regression line. See chart below.



Temp Comp at Start

After completing the Temp Comp Wizard and calculating an accurate TC, you may enable the **Temp Comp at Start** checkbox to direct the TCF-Lynx to calculate the best focus after a power cycle. The TCF-Lynx will measure the current temperature and, based upon the slope and intercept of the linear equation defined by the Temp Comp Wizard, will calculate the best focus. FocusLynx will then drive the focuser to this best focus position and temperature Compensation will remain enabled.

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ASCOM Alpaca Driver Setup

For many years ASCOM has been the definitive standard for astronomy device control. The ASCOM Initiative defines the standard interfaces that device drivers expose, allowing client applications to use them without any device specific code. Up until now these drivers are built only on COM, a Windows software technology that allows a program written in any language to control the device. However, COM is limited as this technology only capable of running on Windows.

Alpaca is a new technology, supported by the ASCOM Initiative, which is built on the foundation of these standards. Instead of COM, Alpaca uses REST to allow clients to communicate with devices. Unlike COM, which is cross language but not cross platform, REST is both cross platform and cross language. Even beyond that, computers on the same network can control Alpaca devices as if the hardware was directly attached. Because REST can operate across a network any devices exposing the Alpaca standard have a great deal of flexibility. A device can be attached to one computer (like a Raspberry Pi) and controlled by a separate computer.

Optec offers Alpaca drivers for several different platforms. In addition, clients on the same network can access these drivers for device control without needing to install anything. Currently Optec is offering drivers (depending on the device) for Windows, Linux (including Raspberry Pi) and MacOS.

Alpaca Driver Download

Visit the Optec FocusLynx download page to obtain the installer package to match your control computer operating system.

https://www.optecinc.com/astronomy/downloads/focuslynx.htm

Full documentation for setup and use of Alpaca drivers is available separately in the Optec Alpaca Quick Start Guide available for download here:

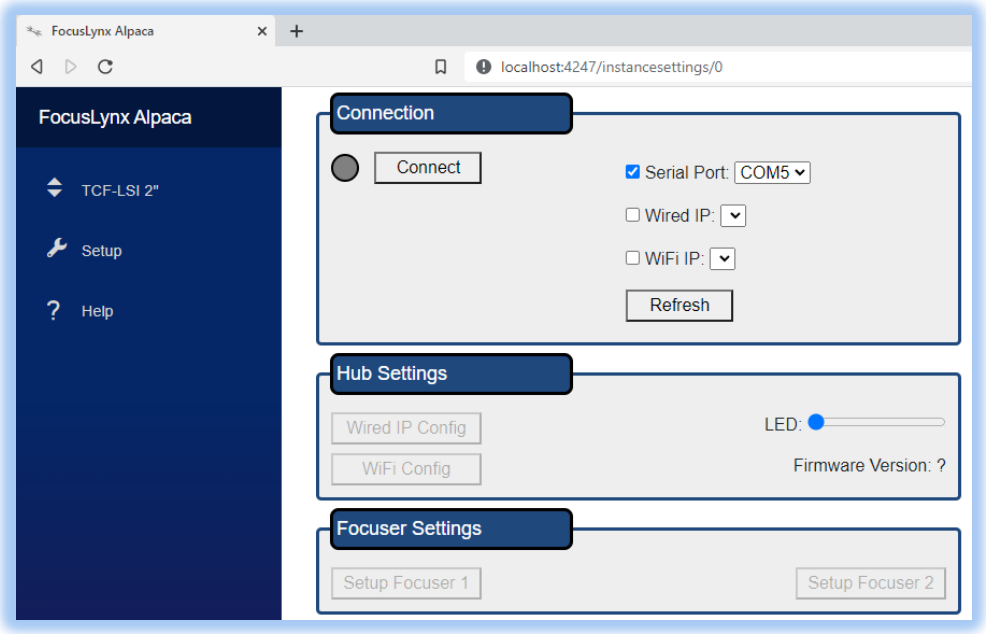
https://optec.us/resources/documents/Alpaca/Alpaca_Quick_Start_Guide.pdf

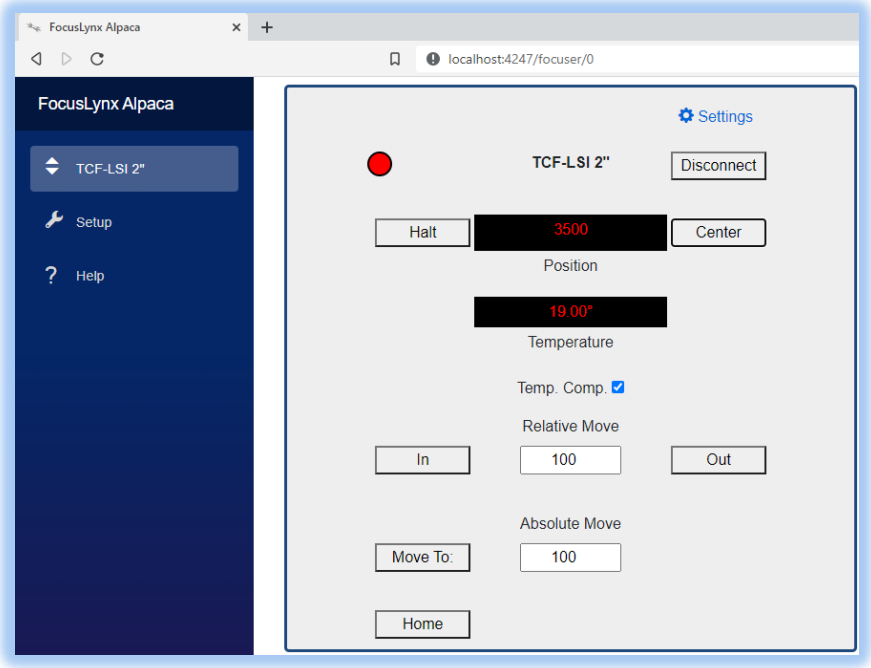
Focuser Selection and Setup

For the TCF-LSI, setup can also be performed through the Alpaca webpage interface. Alpaca drivers create a local webserver that can be accessed through any browser. After installing the FocusLynx Alpaca application, open the localhost webpage. For example, in Windows, click the start button – **Optec** – **FocusLynx Alpaca**. Your default browser will open a webpage similar to the one shown on the next page.

Click **Settings** to configure the COM port assigned to the USB/Serial cable and then click **Connect**.

Once connected, you can click the Back button or the TCF-LSI 2” label in the left panel to reload the main page. From here you have all the functionality of the FocusLynx Commander windows interface. However, these pages are available to any computer or smart device attached to the same network.





Refer to the Alpaca Quick Start Guide for additional details regarding set up and use of the FocusLynx Alpaca interface.

Importantly, Alpaca exposes the TCF-LSI and FocusLynx drivers to ANY client connected to the same network.

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Telescope Auto-Focus

Auto-focus in astronomy is a bit more challenging than typical digital camera auto-focus because of the extremely low light levels available with astronomical imaging. Steve Brady pioneered a technique of measuring the HFD or Half Flux Diameter which is similar to the Full-Width Half Max measurement of the Gaussian profile of a single star's light. By creating a calibration profile known as the "V-curve" software can fairly quickly take a series of short exposures and move the focuser to best focus.

This technique has been proven over the years to be extremely effective for unattended auto-focus operations and is the basis for FocusMax. A full discussion of the technique is beyond the scope of this document but full details are available here:

http://www.focusmax.org/Documents_V4/Precision%20Focusing%20Using%20FocusMax.pdf

Many high level observatory control packages use this same V-curve technique for auto-focus including Maxim D/L, TheSky X, and Sequence Generator Pro to name a few. Software Bisque has developed a new technique for TheSky X called @Focus3 that uses FFT calculations to determine best focus. Consult your imaging software documentation for the best way to configure your software for auto-focus operations.

Video Channel

Optec is developing videos for installation and configuration of our many products for various software packages. Visit our Rumble video channel by searching "Optec" or clicking the link below.

https://www.optecinc.com/video

Optec User Group

The Optec User Group is now located at Groups.io which provides a forum to communicate with other users of Optec instruments. Other end-users can often provide answers to specific configuration questions and Optec staff routinely follow and answer many questions as well. Click the banner below to subscribe.

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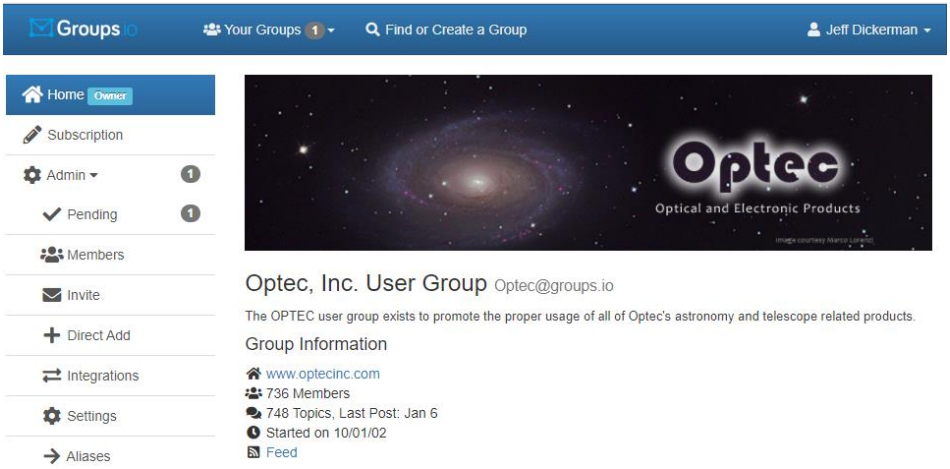

Or visit the Groups.io Optec User Group here: https://groups.io/g/Optec.

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