FocusAide and PCFocus User's Guide

February 23, 2002

Aquest, Inc.
Boca Raton, FL

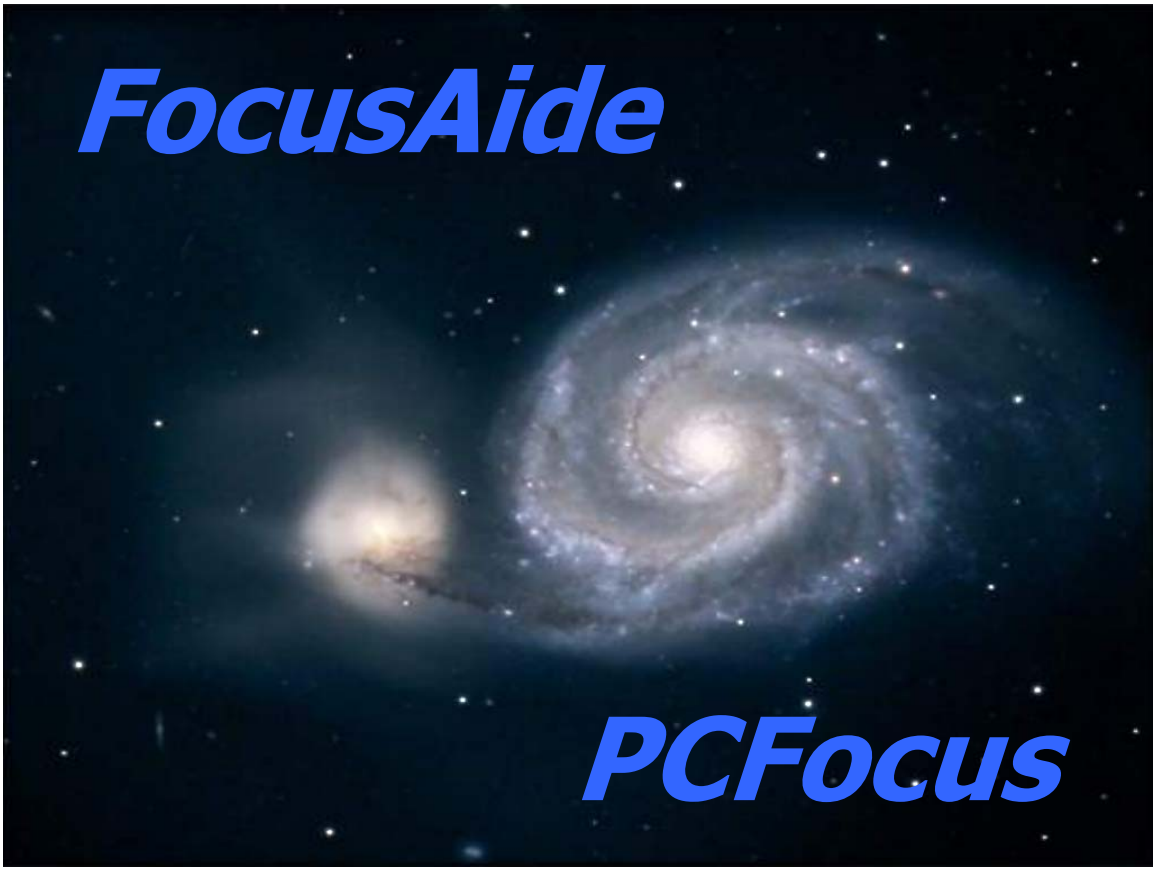

TABLE OF CONTENTS

FocusAide

PCFocus

FocusAide

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Introduction

Thank you for purchasing FocusAide™.

When FocusAide is used with PCFocus™ you will be able to precisely control your JMI™, Optec™, or RoboFocus™ focuser from any personal computer, either locally or remotely (yes, even over the Internet, if you wish). What's more is that you will be able to take full control of your focusing tasks.

FocusAide is a completely automatic focusing system and is designed to utilize the features of PCFocus and most popular CCD cameras. By integrating control of the camera and your focuser, FocusAide can take the difficulty and guesswork out of your focusing. It provides many focusing tools including fully automatic and highly accurate focusing under a wide range of focal ratios and seeing conditions.

All of the PC and remote control functions of PCFocus are available with FocusAide.

Software Installation

The software is designed to run under Windows 95, 98, Me, 2000, and XP.

Note: The hardware does not need to be connected to install the software.

To install the software:

1. Insert the PCFocus or FocusAide CD in the CD-ROM or DVD-ROM drive (A fully functional trial version of FocusAide is included with on the PCFocus CD)
2. Click Start
3. Click Run
4. Type <drive letter>**:**Setup and press Enter (where <drive letter> is the letter of your CD-ROM drive)
5. Follow on-screen directions

To run the program:

1. Click Start
2. Select Programs
3. Select FocusAide
4. Click FocusAide

<u>Registration</u>

FocusAide will operate fully for 15 days to allow you time to contact your dealer to obtain a registration code. Your dealer will require the information presented on the registration screen (Registered To Name, Product Code, Use, and PCFocus Serial Number if PCFocus is used). Simply start FocusAide, click the **Register** button on any of the **Settings/Status** tabs and enter the information. The Product code will be generated for you. You may copy and paste the information into an email and send it to your dealer by

using the Copy to Clipboard button. When you receive the registration code simply enter it in to the registration screen and press Enter or click OK. Your software is now fully functional and the registration screen will no longer appear when the program starts up. If you need to refer to the registered name or product code, click the **Register** button on the **Settings/Status** tabs.
Note: FocusAide will cease to function if not registered in 15 days.

CCD Camera Plug-ins

FocusAide is supplied with camera plug-ins for many popular CCD cameras. These are installed as part of the FocusAide installation. New and updated camera plug-ins will be developed and are freely available. To install a plug-in, simply copy the DLL file into the folder where you installed FocusAide. FocusAide will search for all camera plug-ins when it starts and will show which are available in the camera drop-down list. Eliminating any plug-ins you are not going to ever need can make the start-up process faster. To do this, simply delete any plug-ins you are not interested in. Plug-ins are named by camera reference and, if appropriate, with interface such as USB or parallel port. They are always DLLs. An example of a plug-in file name is MX916_USB.dll (Note: Do **not** remove the mx7drv.dll or mx5drv.dll files)

Note: SBIG camera support is based on version 4.x drivers from SBIG. These are automatically installed for you during the installation. Most other software for SBIG cameras is still based on version 3.x drivers. Do not eliminate the version 3.x drivers from your system, as this will cause problems with other software that require the 3.x drivers. The version 3.x and 4.x drivers can live happily together on your system.

Hardware Setup

FocusAide utilizes the same setup and adjustment procedure as PCFocus. The PCFocus control unit is required for FocusAide control of the motorized focuser you are using except the Optec TCF-S or RoboFocus focusers. The **Manual Focus** tab of FocusAide includes all of the functions provided by the PCFocus software utilizing the same set up parameters

We recommend that you install PCFocus and perform the set up and adjustment procedures listed in the PCFocus User's Guide. Best use of FocusAide will occur if you thoroughly familiarize yourself with PCFocus operation. The focuser parameters obtained from that setup can be directly entered into the FocusAide Focus Control parameter section.

Please refer to the PCFocus User's Guide for details.

Connection Information

The connection diagrams that follow depict the required connections for both FocusAide modes of operation (Direct and LX-200). The diagrams are repeated from the PCFocus User's Guide for your convenience.

Either Direct or LX-200 mode can be used with FocusAide. Better results will be obtained with Direct mode but if it is more convenient to use LX-200 mode, a careful fine-tuning of focuser parameters will optimize LX-200 mode performance.

If you are using FocusAide with either an Optec or RoboFocus focuser connect it as directed in the respective focuser manual. Further, all set-ups, initial positioning and other functions (e.g. temperature compensation) are done using the Optec or RoboFocus supplied software and/or hand boxes. Do not run FocusAide at the same time as the RoboFocus utility or when powering on the Optec system.

Note: Optec has designed their system so that if a communication session with a computer (e.g. FocusAide) is established, the hand box buttons are disabled. The readout on the unit will continue to operate however.

Both Optec and RoboFocus systems have there own absolute position reference that is stored in the non-volatile memory in these systems. FocusAide uses relative focus position based on the position it finds the focuser at when FocusAide is started or a focus scan or auto-focus run is initiated.

An example of the use of RoboFocus with FocusAide is as follows:

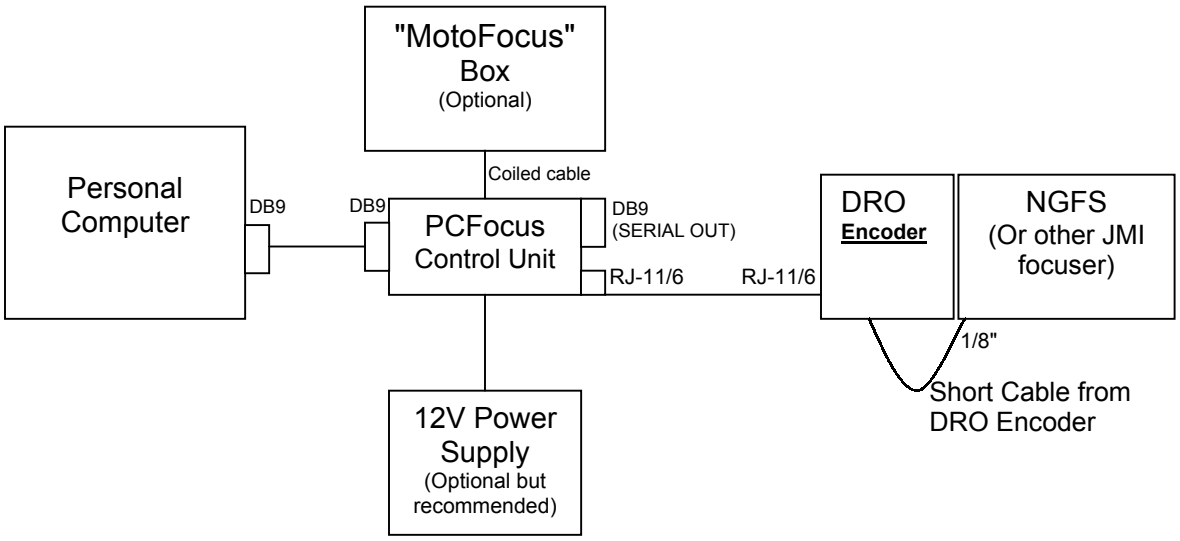
- Start the RoboFocus Control Program (RFCP) and establish settings such as backlash, max travel, and direction, etc. Assure you are at crude focus or centered in the focuser travel you wish to use and then stop the RFCP.
- Leaving the RoboFocus system powered-on, start FocusAide. Assure that the RoboFocus focuser is selected in the Device/Ports tab of FocusAide.
- Establish that the Reverse Focuser Direction checkbox is checked appropriately to how you set up the RoboFocus using the RFCP. Be sure to click Update Parameters and Save Settings
- Use FocusAide to focus scan, auto-focus, etc. The buttons on the RoboFocus box will operate and FocusAide will display the current position. Voice annunciation is not activated for manual focuser movements.
- When finished, stop FocusAide and restart the RFCP. If temperature compensation is to be used, enable it and let the RFCP take over focuser operation including minor adjustments to position as temperature changes occur.

Optec TCF-S operation is similar but all pre and post FocusAide control is done using the Optec control and readout unit.

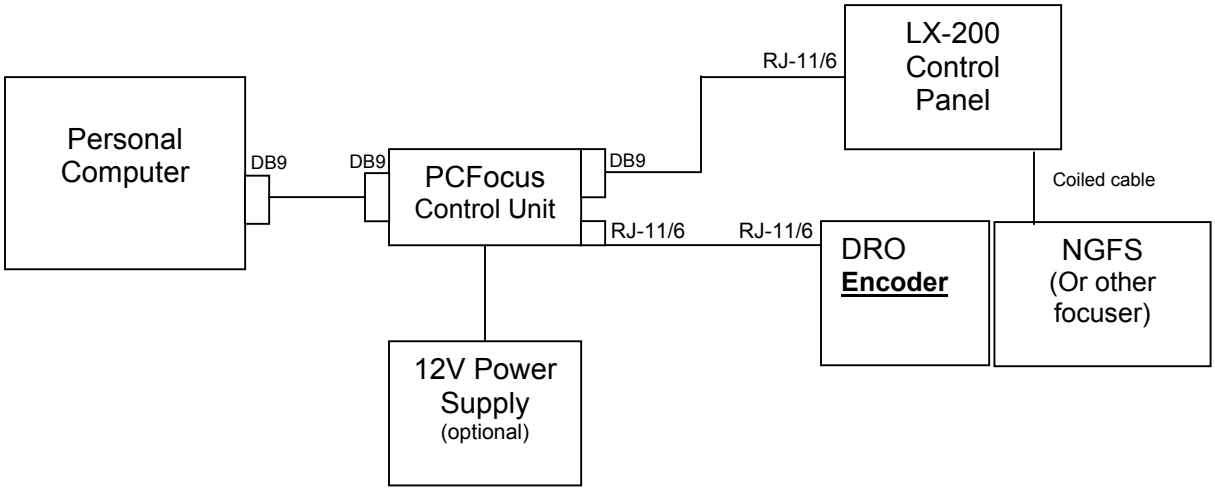
Warning: FocusAide will "function" in controlling RoboFocus focusers driving the primary mirror of SCTs directly. Results may be unsatisfactory, however, owing to mirror shifts and flop. Some SCTs are such that they have a small amount of mirror movement as the manual focus knob is turned and, in this case, the moving of the primary mirror for telescope focus will allow auto-focusing to succeed. If your telescope does not have low mirror shift/flop you will either have to do maintenance on the telescope to correct this situation or purchase a Crayford type focuser. There is nothing that FocusAide can do otherwise since if the focus star is moving or, worse, moves off the chip altogether, there is no data for FocusAide to use in its algorithms.

CONNECTION DIAGRAMS

DIRECT MODE CONNECTION:



LX-200 MODE CONNECTION:



WARNING! ***Do not plug the 6-wire modular cable from the PCFocus Control Unit into anything but the JMI DRO Encoder connector or damage will likely result to the incorrectly connected equipment.***

Basic Operation of FocusAide

The process of automatic focus provided in FocusAide consists of a few basic steps:

1. Obtain a rough focus of the optical system and camera with the motorized focuser midway in its travel range
2. Take a short exposure image with the CCD camera and select the focus star of interest
3. Optionally, perform further manual focus and/or a focus scan plot of focus quality vs focuser position.
4. Run a best focus search to automatically find the optimum focus position
5. Repeat step 4 as many times throughout the imaging or observing session as desired.

It is best to not run FocusAide and other CCD camera control software (e.g. AstroArt, Maxim CCD, etc.) simultaneously unless it is certain that these programs release the parallel port, serial port, and/or USB port when not actively downloading CCD data. No harm is done in testing for concurrent operation except a possible system hang requiring a reboot. If such a test establishes that concurrent operation is possible, use it if desired.

A word on various cameras, ADC bits, and binning:

There are many different CCD cameras and a plug-in is required for FocusAide to obtain main and focus images from the camera. Cameras typically have either 16-bit or 12-bit analog to digital converters (ADC). FocusAide left justifies 12-bit data and handles all data internally as 16-bit data.

Cameras come in various resolutions and binning modes. The binning mode selected by FocusAide for use in acquiring the main image can be 1x1, 1x2 (Starlight Xpress camera Fast Mode), 2x2, or 3x3, etc. The selection is made simply to keep the entire image in the main exposure window. The Focus window, however, is always 1x1 (or interpolated/resampled to be so). For this reason the pixel intensity values will sometimes be different between the main and focus images. In general, don't try to correlate between the main and focus images. The main image is solely for selecting a focus star and should not be used for much else than that. You may find that with some plug-ins the pixels as displayed are not square. There is no consequence to that as FocusAide accounts for pixel dimensions in all of its calculations.

Some cameras, while having 16-bit ADC's may not use all of the dynamic range for various modes. For example, in a specific mode, a camera may use 32767 as the maximum (saturated) value even though 65535 is the maximum for 16-bit ADCs. You will need to understand these modes of your camera as you adjust exposure times for any of the FocusAide modes.

Measuring Focus - Figures of Merit

FocusAide incorporates multiple, user selectable methods to measure the quality of focus. The calculated values resulting from these methods are referred to as Figures of Merit (FOM). For all FOMs, smaller numbers indicate better focus quality. Peak Value is different in that as focus improves it increases. FocusAide calculates all of the FOMs and uses them in a relative fashion. For a variety of reasons the absolute values of these metrics cannot be accurately determined. They are close but not exact. For this reason, the absolute values should not be used. Since FocusAide uses these measurements in a relative sense, very precise focusing can be accomplished. A brief explanation of each FOM follows with some information on the pros and cons of each.

FWHM

Full Width Half Maximum is a measure of how wide the plot of light is at one-half the maximum brightness. If a plot of light from the star is made along a line through the star it will show a curve that looks similar to a bell shaped curve. If the maximum value measured at the peak of the bell-shaped curve is halved the width of the curve at this halved-value it is the FWHM value. The better the focus, the steeper the sides of the bell shaped curve will be and the lower the FWHM value.

FWHM is a widely used metric for measuring focus quality but suffers from the fact it cannot be used on badly defocused (e.g. donut stars on an SCT). It also suffers if the number of pixels representing the star is small. FocusAide attempts to account for CCD chip pixels are not square by calculating the xFWHM and yHWHM, applying correction factors for pixel dimensions, and averaging the x and y values.

xFWHM, yFWHM

These are values used to derive the overall FWHM number. They are useable by themselves if so desired.

Peak Value

As the star becomes more tightly focused its maximum or peak intensity increases. Maximizing this value provides another relative method of determining focus. This is probably the worst of all FOMs as it is subject to large variations from instantaneous seeing, etc.

HFD - Half-Flux Diameter

Larry Weber and Steve Brady have invented a new metric that has properties that make it as good as if not better than FWHM. Larry and Steve have generously provided the concept and algorithm to professional and amateur astronomers and assisted in integrating HFD into FocusAide.

If one thinks of a star's image with a surrounding circle centered on the unfocused star, the HFD metric is the diameter of the circle in which one-half the total star flux (brightness) is inside the circle and half is outside. The HFD value gives a single number, in units of CCD pixels, that is relatively insensitive to variations in seeing, star flux, thin clouds, or sky glow. HFD's best attribute is that it works equally well for closely

focused stars or "donut stars". As is the case with FWHM, it suffers if the number of pixels in the star image is small.

In general the FWHM and HFD values should be reasonably close in magnitude. They will depart if the star is initially very defocused (in which case HFD should be used) or if the star's brightness is low (typically you would use FWHM in this case).

Note: HFD will not work correctly if the **Remove Background** checkbox is not checked. This checkbox, unlike any of the image or focus stretch controls, actually affects the star image and FOM calculation. Stretch controls only affect what you see on the screen and image data and calculation is unaltered. **Remove Background** is mandatory for HFD and can improve other calculations by removing sky glow from light pollution or high, thin clouds. FocusAide will automatically check this box for you if HFD is selected as the FOM.

Software Organization

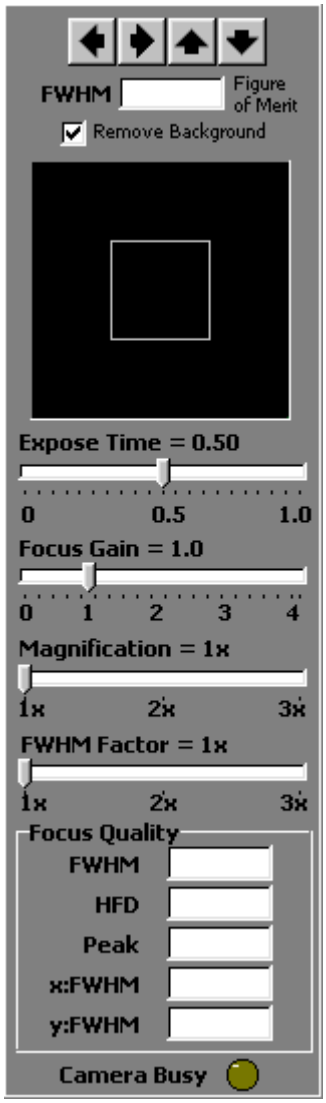
The FocusAide software is organized into "tabs" which correspond to the above steps. The four main tabs of the program are:

The Status Setting tab has more tabs (along the right side of the window). These will be described shortly.

All tabs except the Status/Settings tab contain the **Focus Control Panel** that appears on the right side of the program window. The panel is as shown below.

As you can see, the essential information about focus is all in this one panel. It is here you will set various focus parameters which all functions of the program use. A dynamic focus view port or window shows each focus frame as it is downloaded from the CCD camera.

Various parameters depicting the quality of focus for the last downloaded focus frame are shown



Move Focus Frame with respect to the focus star (only if Magnification = 1x)

Figure of Merit that has been selected is shown here

Remove Background affects the actual data used in the focus calculation. It is essential for HFD calculations and can benefit others.

Exposure Time is in seconds.

Focus Gain is a multiplier applied to the pixels in the focus frame. Gain and Exposure Time are adjusted for approx. 1/2 max ADU value.

Magnification applies to the visualization of the focus image. Double-clicking in the focus window will open a Zoom window which can be sized and placed anywhere on the screen.

FWHM Factor is normally set to 1x but as the system approaches a critically or under-sampled condition it is useful to multiply the resulting FWHM measurement so it is not so close to unity to be difficult to ascertain differences.

Right clicking anywhere on the **Focus Control Panel** (except inside the focus window) will pop up the local menu allowing changes to Figure of Merit and ROI function.

The bottom of the every FocusAide window contains a status bar. Here you will find statistical information, progress, and other information pertinent to the current operation of the software.

Detailed Description and Use of Program Tabs

In the following sections each tab of FocusAide will be shown and thoroughly described. You may wish to start FocusAide and follow along with the software operating.

Most of the settings in the program have adjustable default values allowing you to customize the program to suit your typical needs. All of these custom settings can be changed for the duration of the current program run or saved in a configuration file for re-use when FocusAide is run the next time.

On-line Help is available by pressing the **F1** key at anytime. This User's Guide is provided on the installation CD in Adobe PDF and is installed along with FocusAide. If Help is selected, the User's Guide will be displayed if Adobe Acrobat is installed on your computer. If you do not have the Acrobat Reader installed you may install it from the Installation CD or download it directly from Adobe at:

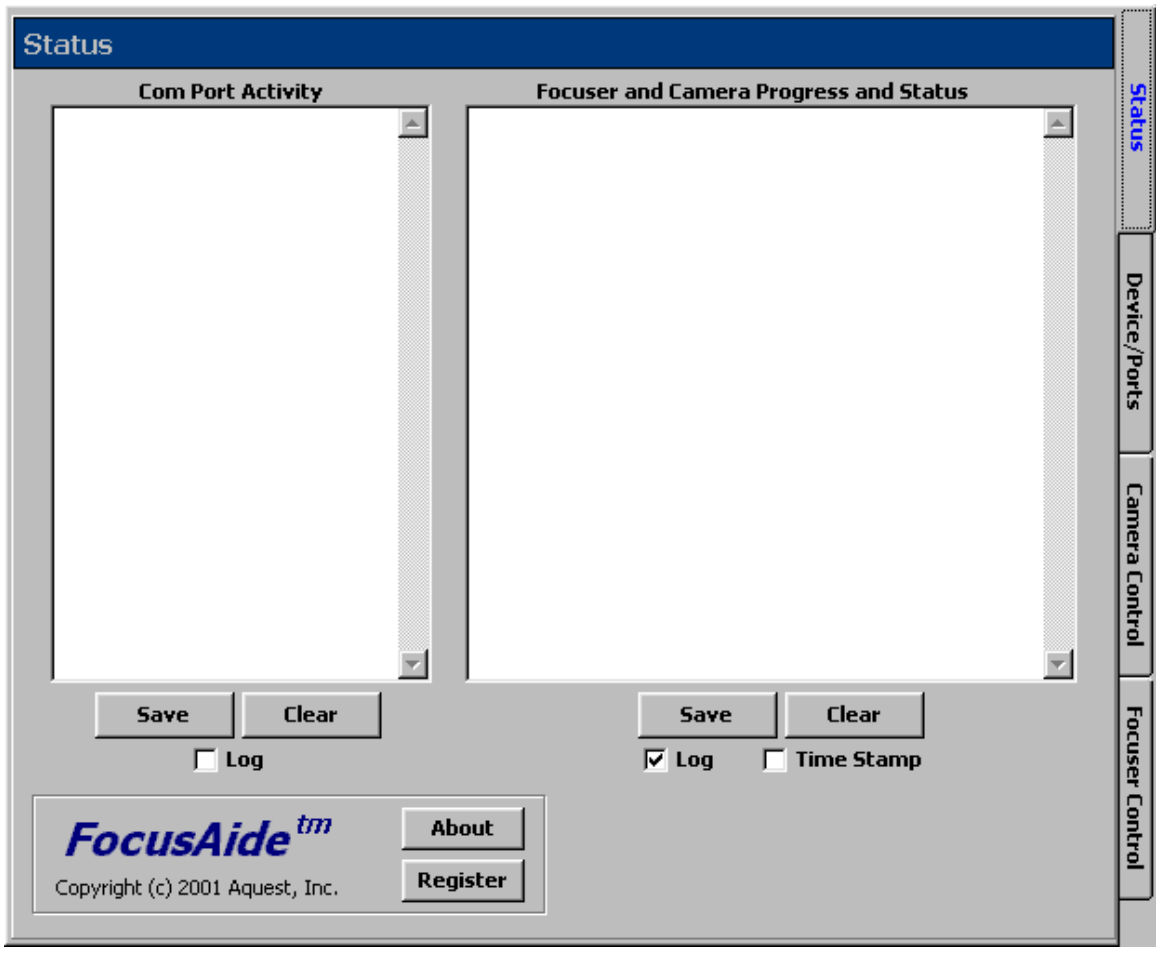
http://www.adobe.com/products/acrobat/readermain.html

To install from the installation CD, open the Acrobat folder and double click on:
Acrobat Reader Install.exe

Status/Settings Tab

The Status/Settings tab has multiple "sub-tabs". We'll discuss each one individually. Each Tab is selected along the right side of the window and each have a title bar at the top of the tab window. Most of the settings have descriptive hints that will appear when the mouse cursor is hovered over the control.

Status

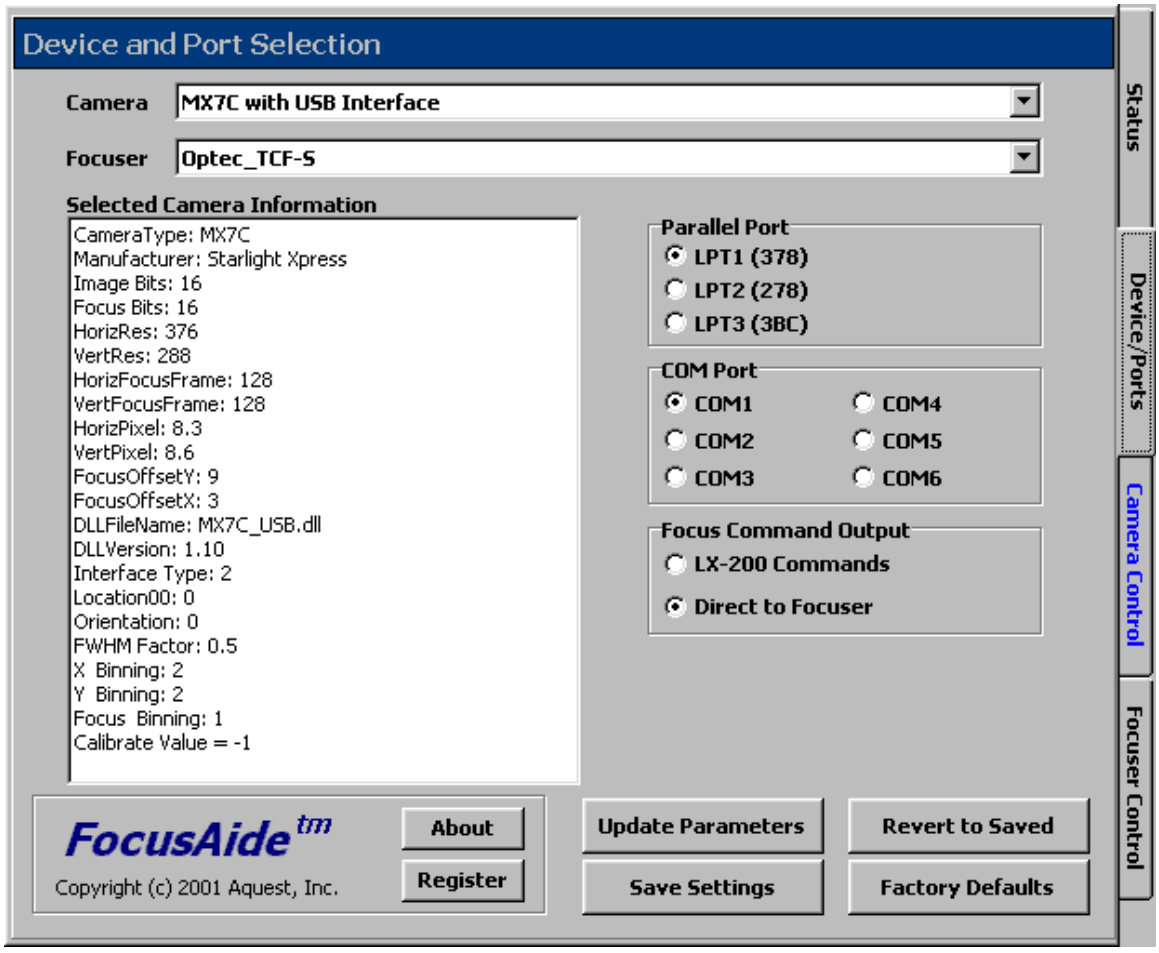


The Status tab provides for two forms of logging to occur during program operation. Checking the Log checkboxes can individually enable each log. Data can be cleared or saved to a file if desired.

The **Com Port Activity** window is used primarily in LX-200 mode, with Optec and RoboFocus Focusers, and for troubleshooting tasks. Normally, this log should be disabled as it may interfere with operation of the program on slower personal computers.

The **Focuser and Camera Progress and Status** log will display each step of a focus scan or auto-focus run. Saving this data to a file is a useful record of focus operations and quality for an imaging or observing session. This log can be left on at all times if desired. You may optionally have FocusAide time stamp each entry in this log by checking the **Time Stamps** checkbox.

Device and Port Selection



This tab is where you select the focuser and camera plug-in you wish to use. These selections are made from the **Camera** and **Focuser** combo boxes at the top of the window. The combo boxes are automatically populated with plug-in names found by FocusAide when it was started.

The **Selected Camera Information** window is information returned from the camera plug-in and is provided for reference only. The information is not updated until the **Update Parameters** button is clicked. (The four buttons in the lower right of all of the settings tabs are discussed below).

The **Parallel Port** for camera interface and **COM Port** for the PCFocus control unit are selected in the appropriate boxes.

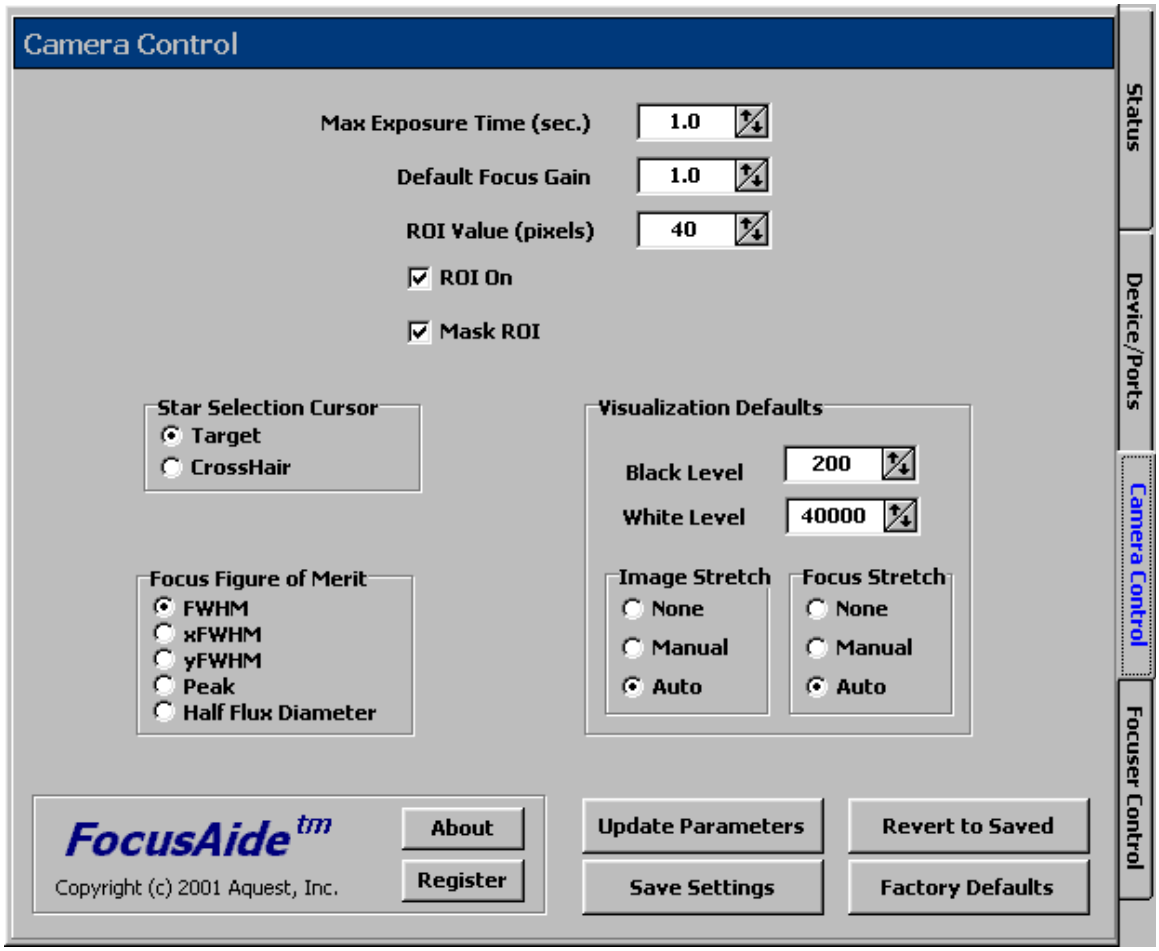
One of the four buttons at the bottom of the screen must be clicked for any action to be taken. Operation of the buttons is as follows:

- Update Parameters - changes the settings only for the duration of the current run of the program. Restarting the program will reset the settings back to the saved values.

- Save Settings - Saves all of the settings to the FOCUSAIDE.INI file which is read when the program starts. The saved file information sets up all the settings to the saved values.
- Revert to Saved - Reads the settings file and restores any changed values to the settings in the FOCUSAIDE.INI file. Update Parameters must be pressed to put the restored settings into effect.
- Factory defaults - Restore the settings shown to the factory fresh level. Update Parameters and/or Save Settings must be pressed to put the factory settings into action or save them for future runs of the program.

The installation configures the software in Direct Mode and with parameters for a JMI NGFS focuser. Even if you are using an NGFS, it may be necessary to adjust the focuser control parameters. See the PCFocus User's Guide for details.

Camera Control



All settings pertaining to image and focus frame acquisition and visualization are made from this tab. All of these settings are "default settings" which are provided for you to customize the start-up configuration of FocusAide. Any of them can be changed during

software operation or stored in the configuration to become the settings for all subsequent runs of FocusAide.

The settings available are:

Star Selection Cursor: After an image is acquired the mouse is used to select a focus star of interest. The cursor can take one of two shapes of your choice.

Figure of Merit: The FOM refers to the calculated value of focus quality. Multiple methods of measuring how well a star is focused are available. See the Measuring Focus Quality - Figures of Merit section for more detail.

Max Exposure Time: Sets the max range of the exposure slider in the Focus Control Panel. FocusAide will start up with the slider set to midrange.

Default Focus Gain: The position of the Focus Gain slider on start up.

ROI Value: The ROI is the region of interest within the focus window and all other information outside of the ROI is ignored. This is useful if there is more than one star in the focus window that may confuse the software.

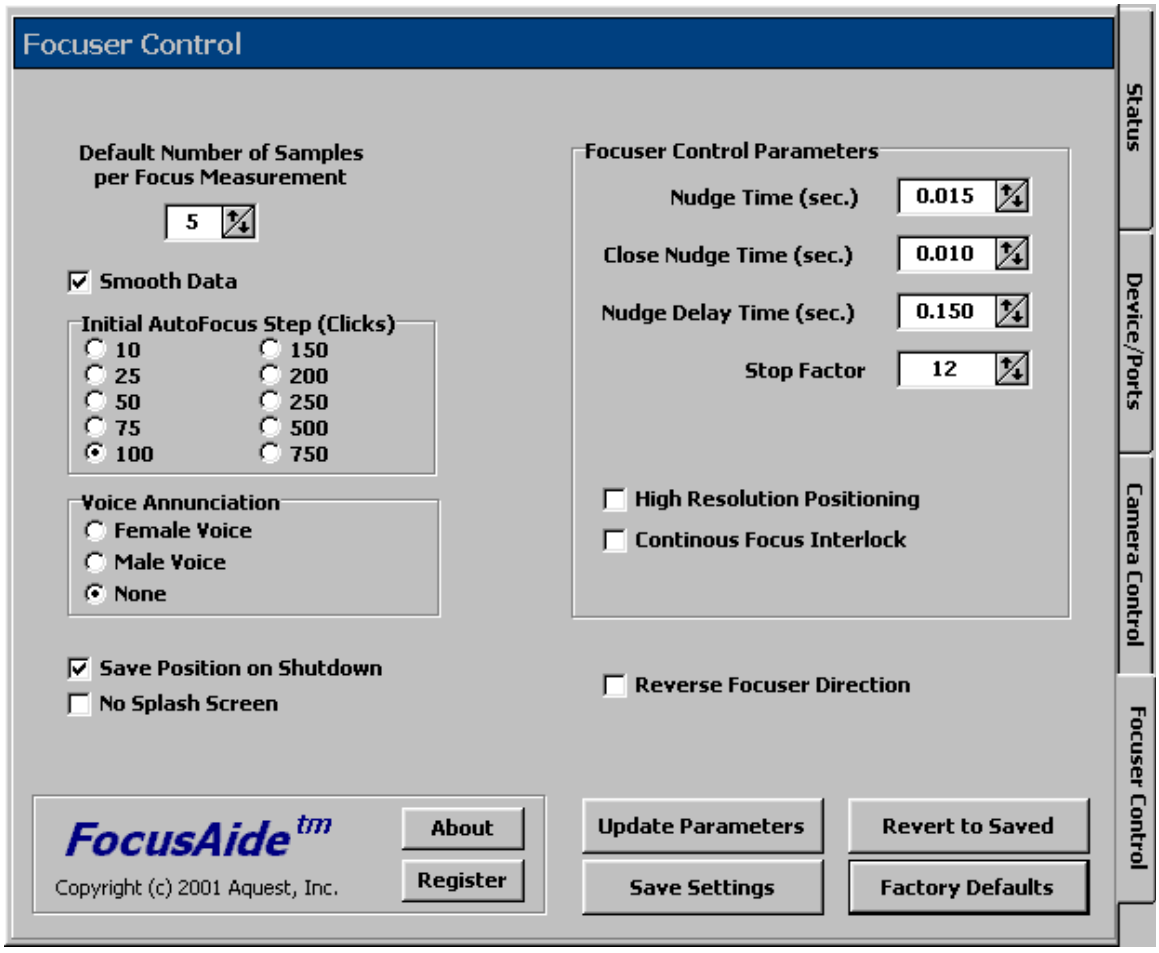
ROI On: Turns the ROI function on or off

Mask ROI: Within the focus frame window, only data inside the ROI is displayed and the rest forced to black if this box is checked.

Visualization Defaults: FocusAide starts with these default values but all are adjustable during program operation.

Remember to click one of the four buttons at the bottom of the window to have your settings take effect or be saved.

Focuser Control



All of the Focuser Control parameters are the same as in PCFocus. They can be simply copied from PCFocus set up to this screen. If, however, you change from Direct Mode to LX-200 Mode or vice-versa you must re-establish the settings.
The other settings on this tab are just defaults that control how FocusAide starts up and can be easily changed during FocusAide operation. These other settings are as follows:

Default Number of Samples: During focus scan or auto-focus operation, FocusAide will take this many samples for each focuser position and average them together.

Smooth Data: If this box is checked FocusAide will discard the highest and lowest reading in a set of samples and average the rest. If unchecked, all samples taken are included in the average.

Initial Auto-Focus Step: The first thing the auto-focus routine does is to bracket the current position of the focuser to assure that optimum focus is between the extreme focuser positions. This setting controls how far the focuser travels to take the bracket readings.

Voice Annunciation: The focuser position readout will be announced in a female or male voice with the appropriate setting. Select None to turn off the annunciation feature. The annunciation does not apply to focuser movement via the external button box or the LX200 handset. Your computer must be equipped with a sound card and speaker(s) for the voice feature to work.

Save Position on Shutdown: FocusAide will remember where it was positioned on the screen and restart in this position unless this checkbox is not checked

No Splash Screen: Checking this box prevents the splash screen from displaying when FocusAide starts. Note that bypassing the splash screen does not appreciably shorten start up time. A major effect on start up time is the number of camera plug-ins in the FocusAide folder. Delete any unused plug-ins to shorten start up time.

Continuous Focus Interlock: SBIG camera drivers disable all computer interrupts during camera operations. This means that during these times both Windows and FocusAide are basically blind to any activity. For example, the Windows system clock will stop running during these times. FocusAide resets the clock automatically for you after every image or focus frame download.

Unfortunately, there is one case where FocusAide has problems when interrupts are turned off and this is while in Continuous Focus mode. This is the only time when both focuser movement and focus frame downloads may occur at the same time. On some systems, the SBIG driver interrupt disabling will cause the focuser movement to be erratic and possibly inaccurate in seeking to a specific position.

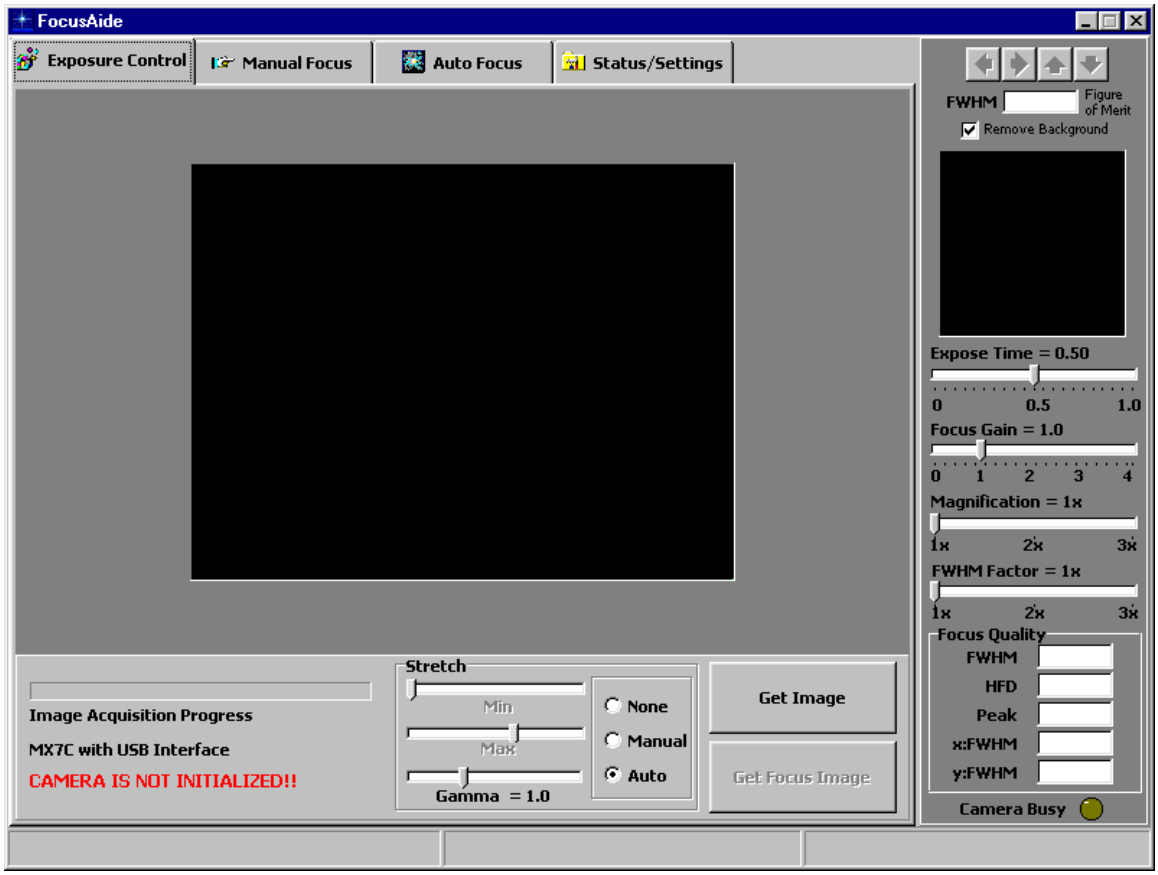
If an SBIG camera is being used with a JMI focuser and the PCFocus control unit, FocusAide cannot always reliably detect information from the PCFocus unit on where the focuser is since data it needs is blocked by the lack of interrupts. **Continuous Focus Interlock** is a sophisticated thread synchronization algorithm that prevents the focuser and camera concurrency but has the disadvantage that the focus downloads will be somewhat slower overall and some response degradation to pressing buttons may occur. The interlock is inactive at all times unless in continuous focus mode and therefore will not affect focus scans or auto-focus operations.

If you experience erratic or inaccurate focuser movement during continuous focusing try using the interlock feature.

Note: Optec and RoboFocus focusers and/or non-SBIG cameras do not have these problems and **Continuous Focus Interlock** will do nothing.

Exposure Control Tab

The first step in either manual or auto-focusing is to acquire an image and select a focus star. The **Exposure Control** tab provides all of the facility needed to do this.



To acquire an image, set the desired exposure time in the **Focus Control Panel.** The range of the exposure time slider is adjustable in the settings section. Click the **Get Image** button. The **Image Acquisition Progress** bar will begin to update and the **Camera Busy** light will be lit. (Note: the first time an image is acquired the progress bar will only be approximate until it calibrates itself to the real download times).

Typically, you will use auto-stretch but you can adjust various visualization parameters in the **Stretch** box.

When the image is ready it will appear in the window and some statistics about it displayed in the status bar. Moving the mouse over the image will cause one of two cursors to appear. The Star Selection Cursor you selected in the settings section will appear when you are within the acceptable selection rectangle over the image. If you are too close to the edge the cursor will change alerting you to this fact. While moving the cursor around the image, the status bar will show the coordinates and intensity of the pixel the mouse is over. When you are over a star you wish to use for focusing, simply

click the mouse. If the star you want is not selectable, move the telescope to better center the desired star and take another image

If the ROI feature was enabled in the setting section, the ROI will be shown around the star you selected and in the focus window. The status bar will show the coordinates and intensity of the selected pixel.

At this point, you may click the **Get Focus Image** button to download a single focus frame. The selected star should appear in the center of the focus window ROI.

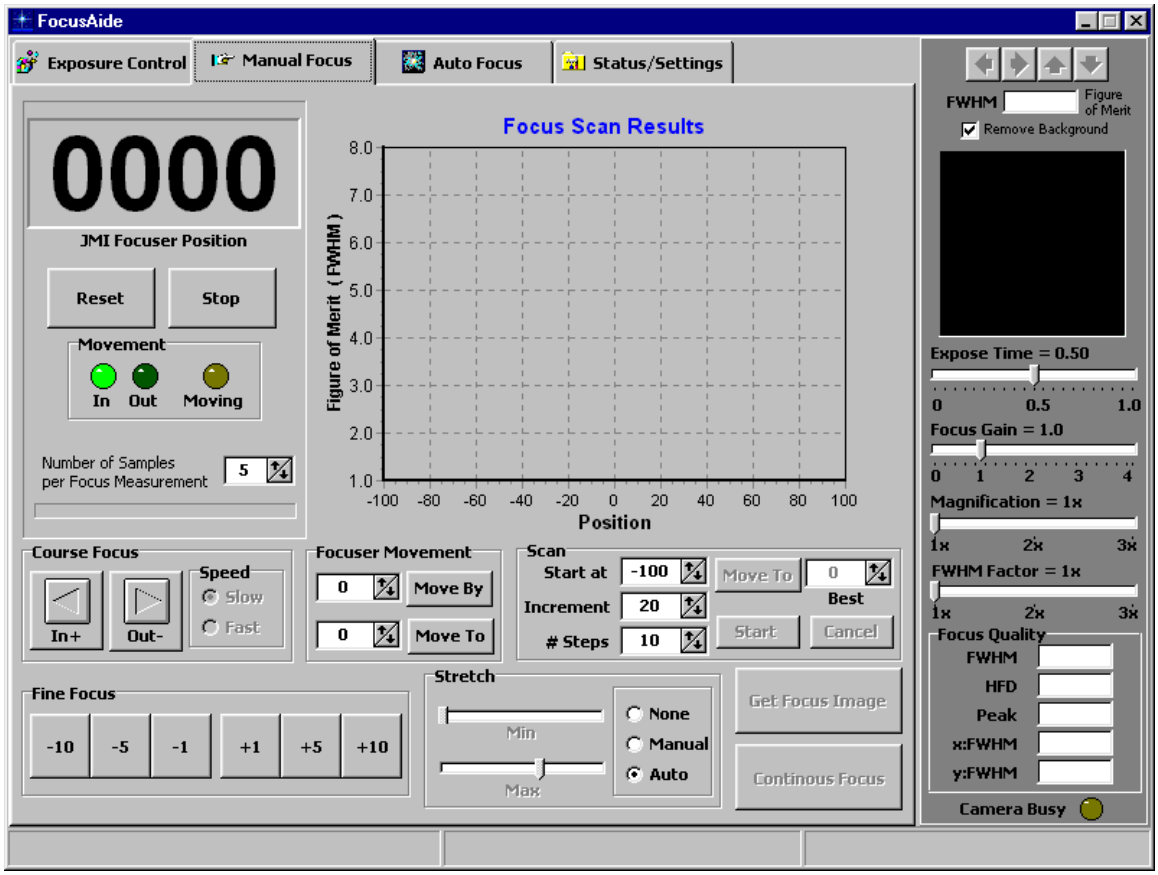
You could continue to download single focus frames from the **Exposure Control** tab and adjust the **Focus Gain**, **Magnification**, and most importantly, the **Peak Value.**

It is easier if you move to the **Manual Focus** tab at this point.

Manual Focus Tab

This tab provides all of the function of PCFocus and much more. The PCFocus functions are grouped on the left side of the window.

Note the **Get Focus Image** and **Continuous Focus** buttons in the lower right. The **Get Focus Image** button is identical to the one on the **Exposure Control** tab.



The **Continuous Focus** button is a toggle button and will cause focus frames to be downloaded until it is pressed again. You use it just as you would in any CCD control software. You can adjust any of the **Focus Control Panel** sliders while focus frames are begin downloaded and see the results dynamically.

Your objective is to crudely focus by using the **Course**, **Fine Focus**, and **Focuser Movement** controls and getting the Peak Value to approximately 50% of full ADU range for your CCD camera (e.g. approx. 32000 for a 16-bit camera as well as a 12-bit camera since FocusAide left justifies 12-bit data. Note some cameras do not use all of the available 65535 values. Consult you camera's instructions to establish where 1/2 the maximum value is).

Note: This step is very important for focus scans or auto-focusing since if the focus star saturates the CCD, large errors will occur during the desired operation. If your rough focus is not close at this point you should set the peak value for even lower than 50% as the peak value will increase significantly as the optimum focus point is reached.

If your crude focus is reasonably close you can proceed to the **Auto Focus** tab. If you wish to get a feel for the seeing conditions or other focus factors or simply to get your crude focus a bit closer prior to the auto-focus step, run a focus scan.

The focus scan will provide you with a plot of focus quality vs focuser position.

Several parameters controlling the focus scan can be set in the **Scan** box:

- **Start At**: This is a selectable value of the left most point on the x-axis of the graph. When the scan commences the focuser will move to this value and start the focus scan from there.
- **Increment**: The step size for focuser movement. Note the "Number of Samples per Focus Measurement box below the Movement "lights". At each increment, this many focus readings will be taken. If there is poor seeing this number should be increased to obtain more readings to average.
- **Number of Steps**: How many increments that the focus will be moved before the focus scan is complete.
- **Move To (Best)**: At the end of the scan the **Best** box will display the best focus point (but only to within +/- one **Increment**). Click to **MoveTo** button to return the focuser position to this best point. Note that the focuser is left at the position at the end of the scan so clicking the **MoveTo** button will move to the best focus point.
- **Start** and **Cancel**: Start the scan or cancel it at any point by clicking these buttons. Note: The focuser may not stop immediately when the cancel button is clicked

Note that the scale on the graph changes as you modify these parameters.

The graph can be rescaled, re-centered, magnified, and scrolled. See the Tips and Techniques section below for details.

Also note that by using the controls in the Stretch box you may control the focus window stretch parameters.

The **Reset** button resets the focus position readout to **0000** and also stops the focus movement if the focuser is moving. If a focus scan or auto-focus run is in progress the appropriate Cancel button should be used to completely cancel the operation.

Auto Focus Tab

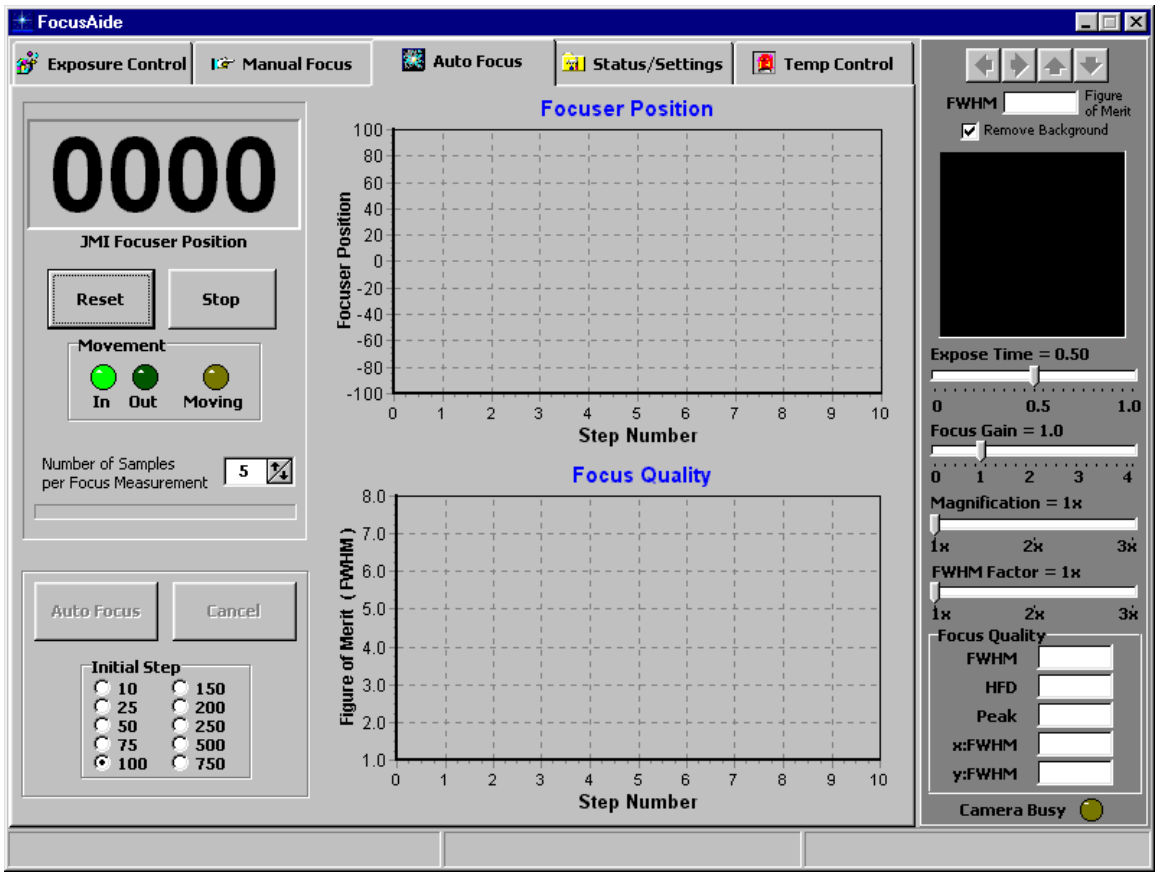
All of the previous steps may seem like a lot of work to just get to the point of starting the auto-focus process. That's not the case, in that you could

1. Roughly focus (even visually)
2. Download an image and select a star
3. Run an auto-focus operation

The key to success here is in the selection of the **Initial Step** (lower left corner of the window) to correspond to the quality of initial focus.

The auto-focus algorithm operates by first bracketing the endpoints of the focuser travel to be sure that the point of optimum focus lies within this range. If optimum focus lies outside of this range it is, of course, impossible for the auto-focus algorithm to find optimum focus. The endpoints of the range are +/- the **Initial Step**.

So, if you did a rough focus, selected a star, and came directly to the **Auto Focus** tab you could likely succeed in having the optimum focus point lie in range if you select a large **Initial Step**. FocusAide will advise you if the optimum focus in not in range and ask you to improve the manual focus a bit and restart the auto-focus. On the other hand, if you used the Continuous Focus feature on the Manual Focus tab or ran a focus scan and moved the focuser to the **Minimum**, you could probably select a much smaller **Initial Step**.

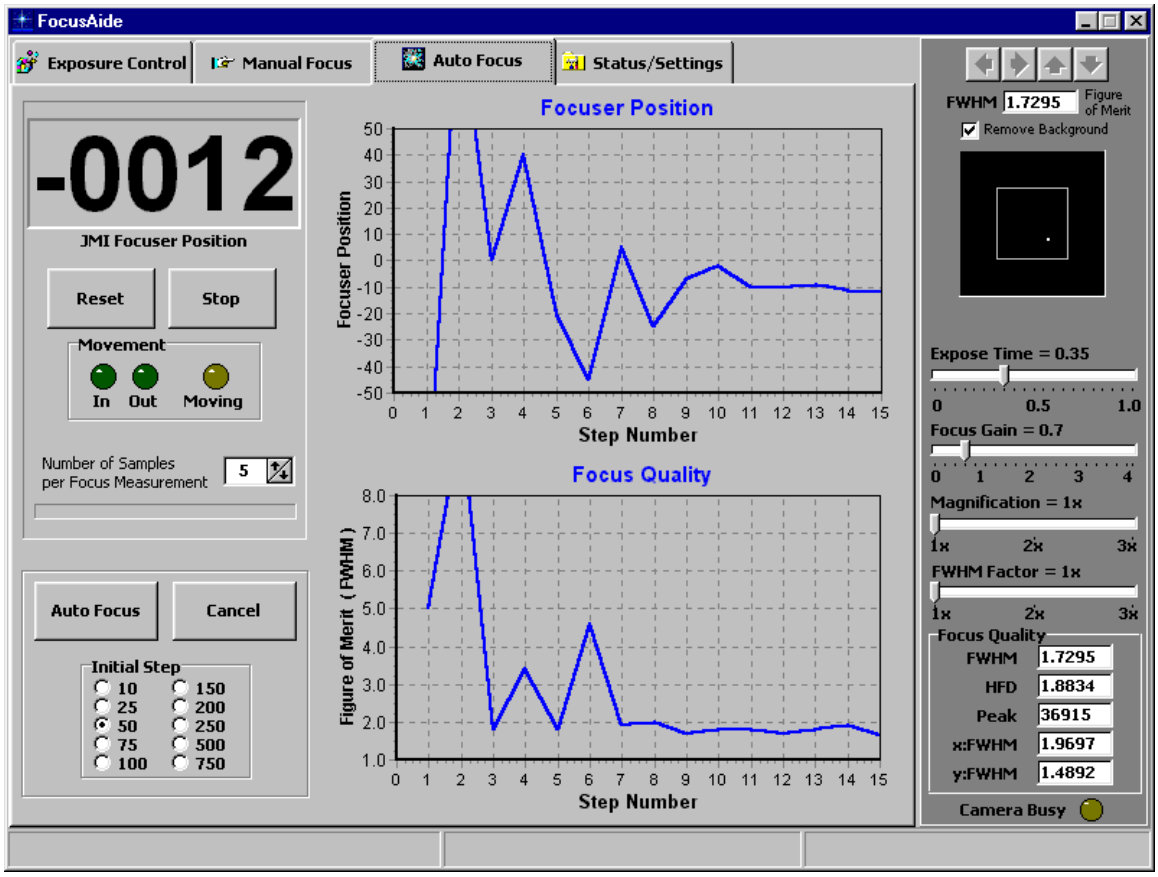


It is important to assure that the focused star does not saturate the CCD. Auto-focus will typically fail if this occurs. If you see the Peak Value hit the max (e.g. > 65000 for a 16 bit camera) you should click the **Cancel** button to stop the auto-focus algorithm, reset the **Exposure Time** and or **Focus Gain,** and restart the auto-focus routine. At times, it may be possible to dynamically adjust the exposure time and gain while the auto-focus proceeds as long as it is done before saturation is reached.

The two graphs on the **Auto Focus** tab plot the progress of auto-focusing as it is happening. The upper graph is the focuser position at each step in the process. The lower graph is focus quality (or figure of merit). The figure of merit is the measurement you selected as your focus quality reference (e.g. FWHM, Peak Value, etc.).

The graph can be rescaled, re-centered, magnified, and scrolled. Because there are two graphs it is possible to get the step axis out of sync between them. They can be reset easily without losing the data. See the Tips and Techniques section below for details.

An example of data from a real focusing session:



Note how the focuser is commanded to first move -100 and then to +100 (the initial step points) and then back to the starting point (zero) to assure the best focus is between these points. It then proceeded to use a highly efficient search algorithm to "zero-in" on the best focus point. Use of a large initial step does not really increase the search time very much but does take somewhat longer as the focuser has more distance to travel and moves at a constant speed.

In this example the number of samples per focus measurement was set to 5. In poor seeing and/or with high "magnification" this number may need to be increased to 10 or higher. Under those conditions it is virtually impossible to manually find the optimum point but, given enough sample data, the auto-focus search algorithm can succeed in finding a crisp focus.

In general, the auto-focus search algorithm can do a significantly better job than you can manually. Since it typically take 1-2 minutes to run a complete auto-focus it can be done several times during an imaging session to account for mirror shift, temperature changes, etc.

Tips and Techniques

- Use the PCFocus User's Guide and software to initially test and adjust parameters for your focuser if the PCFocus Control Unit is required for your focuser.

- Use the Reset button to establish a "virtual home" position at the point of optimum focus or the center of the range of focuser travel.

- The Focus Scan and Auto Focus functions reset the focuser "virtual home" prior to beginning their respective operations.

- Always have the focuser midway in its travel before starting a focusing session. While a Crayford type focuser will not be damaged it if "hits the stops", a focus scan or auto-focus run will be ruined if this happens.

- The main image acquired on the Exposure Control tab or the Focus Frame can be saved to a bitmap by right clicking on the image. These saved bitmaps may not necessarily be correct depending on the screen resolution and color depth your computer is operating at.

- Increase the "Number of Samples per Focus Measurement" value to adjust for focal ratio changes, seeing conditions, and other factors which require a better average of focus data.

- A second auto-focus operation can be run using a smaller initial step size and more samples per measurement to achieve a potentially tighter focus.

- The values displayed in the Focus Control Panel during continuous focus or during an auto-focus run are the instantaneous values obtained from each focus frame that is downloaded and measured. At the end of the auto-focus run these values are the averaged measured values at optimum focus.

- In general, rough focus should be good enough so the stars do not have "holes" in them (i.e. donut stars) unless the figure of merit is Half Flux Diameter which is tolerant to severely de-focused stars.

- For severely under-sampled systems stars become single pixel in size. Under these conditions, focus operations will be erratic (at best).

- Clicking on the Focus Window will open a resizable and moveable Zoom Focus window. The Zoom window respects the magnification setting. It is possible to get the focus star to be extremely large using the combination of the Magnification slider and the Zoom window.

- The In/Out buttons will move the focuser faster if clicked with the mouse whereas pressing the "I" or "O" keys on the keyboard will cause it to go slower owing to the "typeamatic" operation of keyboard keys when held down.

- FocusAide will always start up in the same position on the screen as where you left it. You can disable this feature in the settings section.

- On all of the settings tabs, hovering the cursor over a particular control or group of controls will display a hint explaining what the setting is for.

- The Speed selection group is only available in LX-200 mode.

- Always have the control unit powered off when re-booting your computer or using other software that may send a command effectively moving the focuser.

- Remote control of the focuser and FocusAide is easily accomplished with remote control software such as PCAnywhere, VNC, etc. Remote control can be on a serial, LAN, or Internet connection. VNC is free and available from: http://www.uk.research.att.com/vnc/index.html

- When optimum focus is reached and FocusAide is about to be shut down, it is best to turn the PCFocus control unit off in case the serial port glitches and moves the focuser away from your hard-earned focus point. Experiment with this and if your PC does not move the focuser when FocusAide shuts down then this is not a concern (as long as the software environment doesn't change).

- The graphs on the Manual and Auto Focus tabs can be scaled, scrolled, magnified, etc. Use the mouse to achieve these changes as follows:

    - Click and hold the left mouse button while dragging down and to the right to "draw" a zoom window. When the mouse button is released the graph will resize to the zoom window drawn.
    - Right-click, hold, and drag the mouse vertically to scroll the y-axis of the graph.
    - Right-click, hold, and drag the mouse horizontally to scroll the x-axis of the graph.
    - Click and hold the left mouse button while dragging up and to the left to reset the graph to the normal state.

- The About button on the settings tabs will display program information including version number.

- The Focuser and Camera Progress and Status logs are like "NotePad". You can add you own information in addition to what is automatically put there by FocusAide and then save to a file.

- FocusAide will respect the Windows Desktop theme and can therefore be made to be gentle to night vision by allowing itself to be colored red.

- Pressing F1 anywhere in the program can open the FocusAide User's Guide.

- FocusAide is designed to run at 800x600, 1024x768, 1280x960, 1400x1050, or 1600x1280 screen resolutions. With Windows Large Fonts set in Display Properties the display will expand accordingly. To see the full FocusAide screen

at 800x600 it will be necessary to set the Task Bar to Auto-Hide.

- While it is best to run on an external 12VDC power source such as the included wall transformer, if you do run from the internal battery always use a high quality alkaline 9V battery.

- The Focuser.ini file that is provided contains the standard parameters for various focusers. These may be adjusted and changed on the Focuser Settings tab. FocusAide reads this file when it starts execution and populates the Focuser drop down box on the Device/Ports tab. It is possible to create "presets" to easily return to if desired. To do this make a backup of the Focusers.ini file and edit the current file as follows:

    - Create an entry in the [Focusers] section of the file with the preset name followed by an "=" (no quotes). Blanks are not allowed in these names. e.g. "JMI_33Reducer=" (no quotes)
    - Add a section with the name just added (e.g. " [JMI_33Reducer] " (no equal sign or quotes) with all of the lines as in the other sections and modify the values to what you want your preset to have. It is easiest to cut and paste an existing section and edit it accordingly.
    - Save the file.

- Updates to the PCFocus software and/or AstroArt plug-in are available free from your dealer's Web site.

- Updates to the FocusAide software are available free to registered users from your dealer's Web site.

Enjoy FocusAide!

PCFocus

PCFocus User's Guide

February 23, 2002

Aquest, Inc.
Boca Raton, FL

Introduction

Thank you for purchasing PCFocus™, the world's only fully compatible and reliable motorized focuser control system. With PCFocus you will be able to precisely control any JMI™ focuser from any personal computer, either locally or remotely (yes, even over the Internet, if you wish). If you wish to have the focuser position "read" to you, voice annunciation is included.

There's more! Once the PCFocus system is installed many personal computer and remote controlled focuser applications are enabled. FocusAide™, a complete automatic focusing system, has been designed to utilize the features of PCFocus and most popular CCD cameras. By integrating control of the camera and your focuser, FocusAide can take the difficulty and guesswork out of your focusing to provide completely automatic and highly accurate focusing under a wide range of focal ratios and seeing conditions. A fully functional trial version of FocusAide is included on the PCFocus installation CD.

Also included on the CD is a version of PCFocus that can be used as a "plug-in" for AstroArt 2.0™ from MSB Software.

Software Installation

The software is designed to run under Windows 95, 98, Me, 2000, and XP.

Note: The hardware does not need to be connected to install the software.

To install the software:

6. Insert the PCFocus™ CD in the CD-ROM or DVD-ROM drive
7. Click Start
8. Click Run
9. Type <drive letter>**:**Setup and press Enter (where <drive letter> is the letter of your CD-ROM drive)
10. Follow on-screen directions

If AstroArt is installed on your computer, the installer will attempt to find it and ask if you wish to install the PCFocus AstroArt plug-in. If you click **Yes,** the plug-in will be installed automatically. If you wish to manually install the plug-in, do so by copying the piPCFocus.dll file in your C:\Program Files\FocusAide folder (or wherever you installed PCFocus) to the AstroArt program folder.

To run the program:

5. Click Start
6. Select Programs
7. Select FocusAide
8. Click PCFocus

Note: *A free, 15-day fully functional trial version of FocusAide is included on the PCFocus CD. You may purchase FocusAide by contacting your dealer for a registration code. Refer to the FocusAide User's Guide for the procedure for unlocking the FocusAide software by obtaining a registration code*

Hardware Setup

Focuser Requirements

Any JMI motorized focuser can be controlled by PCFocus as long as it has a "DRO Encoder" installed. The encoder tells the control unit the position of the focuser in its travel. Some JMI focusers operate from 9V and others operate from 4.5V. PCFocus can accommodate either by use of a small jumper in the PCFocus unit. The unit ships with the jumper in the 9V position so change it before powering up the PCFocus unit. In addition, some JMI focusers have the motor wired such that the travel is opposite to what PCFocus expects. The PCFocus software has a means to accommodate this.

Note: Optec™ TCF-S and RoboFocus™ focusers can be controlled with FocusAide.

Any motorized focuser with a DC motor can be easily controlled with PCFocus provided it is fitted with some sort of shaft or linear encoder. Contact you dealer for more information on use of PCFocus with focusers other than JMI.

Modes of Operation

There are two ways to connect and use PCFocus:

- Direct Mode
- LX-200 Mode

In both modes, the PCFocus control unit is used to convert commands from your computer into control signals commands your JMI or other DC motor-based focuser understands.

In Direct Mode the PCFocus unit controls the motor of the focuser directly whereas, in LX-200 mode, serial commands are sent to the LX-200 that, in turn, controls the focuser motor. Direct mode provides the most precise control of JMI focusers for auto-focusing and other applications.

Note: The focus parameters on the Settings screen will need to be adjusted if LX-200 Mode is used. The installation assumes Direct Mode and installs the parameters

accordingly. It is recommended that you install and test your system in Direct Mode and then change to LX-200 if you will be primarily using that mode.

Powering the Control Unit

The control unit can be powered from either the included 9V alkaline battery, the included 12V wall transformer, or directly from any 12VDC source. It is recommended that the internal 9V battery only be used in LX-200 mode as battery life is significantly shortened if used in direct mode. The polarity of the 12V power connector is center pin positive.

Manual Control

In the diagrams that follow, note that "manual" control of the focuser is still available (and the on-screen readout of focuser position is still operative). In Direct Mode you may optionally plug the small hand box with buttons supplied by JMI into the PCFocus control unit. In LX-200 mode you may still use the Prev/Next keys on the LX-200 handset while holding down the Focus key (5 Key). Voice annunciation will not function if the focuser is manually moved via the focuser hand box or the LX200 handset.

Serial Port Usage

PCFocus has been designed to coexist with other usage of your PC serial port. In general, most devices will operate correctly if connected to the SERIAL OUT connection if the system is configured in Direct Mode and the PCFocus control unit power is off. The power can be left on as long as the device connected is not using the serial port hardware control signals as these will, of course, cause the focuser to move. Likewise, if the PCFocus control unit is powered on while the PC is booting, spurious, uncontrolled focuser movements may occur as Windows configures and initializes the COM ports. On the other hand, some programs may be operated with the control unit powered on as long as these programs or devices only utilize the Receive and Transmit lines. Some examples are: AstroArt CCD control including Starlight Xpress STAR2000 guiding and True Technology Color Wheel control, SkyMap Pro, etc.

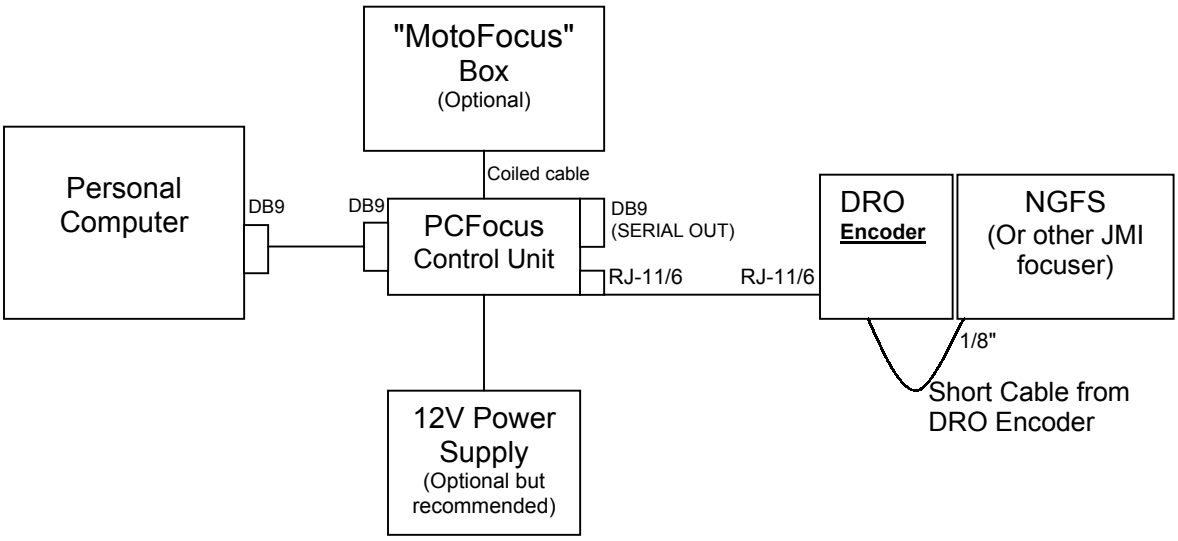
PCFocus operates well with USB to serial converters that support hardware handshake signals.

Connection Information

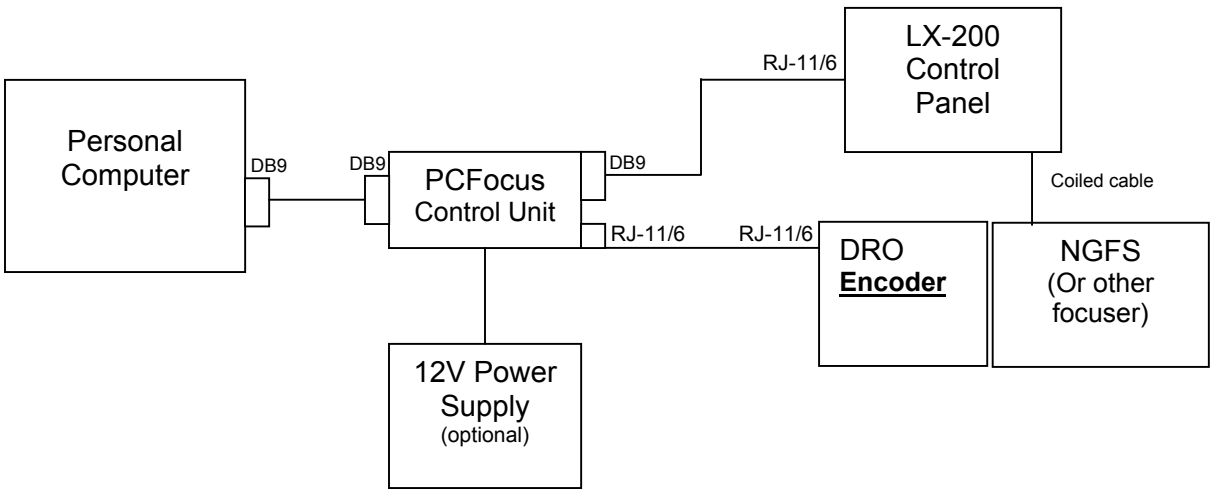
The connection diagrams that follow depict the required connections for both PCFocus modes of operation (Direct and LX-200). It is recommended that you continue reading this manual and follow the "Initial Tests and Adjustments" section before turning on the PCFocus control unit and beginning use.

CONNECTION DIAGRAMS

DIRECT MODE CONNECTION:



LX-200 MODE CONNECTION:



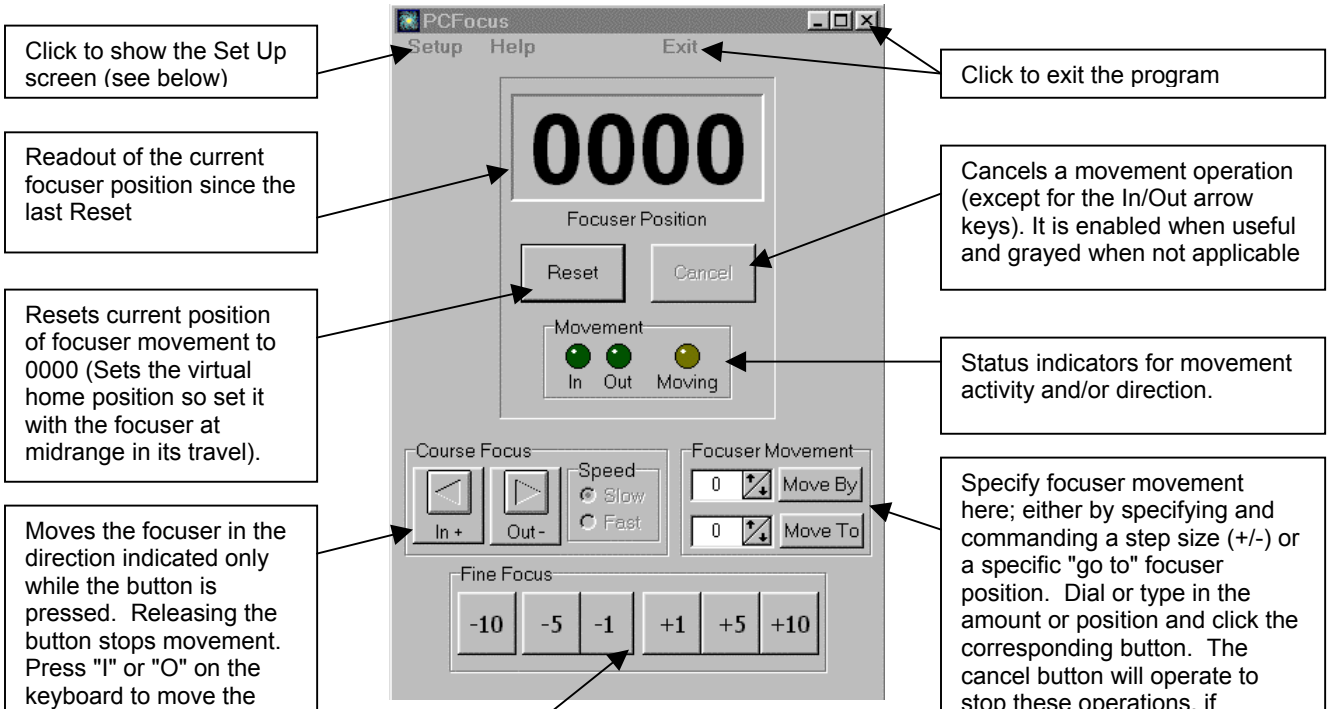
WARNING! ***Do not plug the 6-wire modular cable from the PCFocus Control Unit into anything but the JMI DRO Encoder connector or damage will likely result to the incorrectly connected equipment.***

Tour of the Software

Operation of the PCFocus software is straightforward and intuitive. The following is a description of each of the major screens of the program and how to use them. Our recommendation is that you run the PCFocus software initially with the control unit powered off, familiarize yourself with the operation of the program, and then proceed to the "Initial Tests and Adjustments" section.

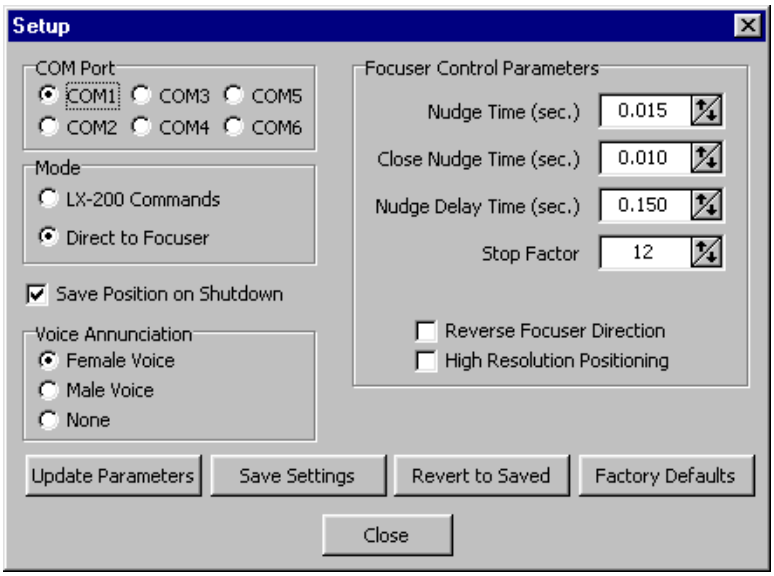
The Main Screen

The main screen of the PCFocus software looks like this. Shown is a brief description of what each control on the screen does.



The Settings Screen

The Setup screen allows for setting changes for the current session or saving settings for future sessions. Explanations of settings will pop-up as hints if the mouse cursor is hovered over the control. The Set Up screen looks like this.



One of the four buttons at the bottom of the screen must be clicked for any action to be taken. Operation of the buttons is as follows:

- Update Parameters - changes the settings only for the duration of the current run of the program. Restarting the program will reset the settings back to the saved values.
- Save Settings - Saves all of the settings to the PCFOCUS.INI file which is read when the program starts. The saved file information sets up all the settings to the saved values when the PCFocus program starts.
- Revert to Saved - Reads the settings file and restores any changed values to the settings in the PCFOCUS.INI file. Update Parameters must be pressed to put the restored settings into effect.
- Factory defaults - Restore the settings shown to the factory fresh level. Update Parameters and/or Save Settings must be pressed to put the factory settings into action or save them for future runs of the program.

The installation configures the software in Direct Mode and with parameters for a JMI NGFS focuser. Even if you are using an NGFS, it may be necessary to adjust the focuser control parameters. Modifying parameters is discussed in the next section.

Note: Your computer must be equipped with a sound card and speaker(s) for the voice annunciation feature to work.

Help

On-line Help is available by clicking **Help → PCFocus Help** or by pressing the **F1** key at anytime. This User's Guide is provided on the installation CD in Adobe PDF and is installed along with PCFocus. If Help is selected, the User's Guide will be displayed if Adobe Acrobat is installed on your computer. If you do not have the Acrobat Reader installed you may install it from the PCFocus Installation CD or download it directly from Adobe at: http://www.adobe.com/products/acrobat/readermain.html

To install from the installation CD, open the Acrobat folder and double click on:
Acrobat Reader Install.exe

The **Help → About PCFocus** selection provides version information

Initial Tests and Adjustments

Initial Tests

It is recommended that you test and adjust your system in Direct Mode and using the 12V wall transformer provided. When complete, you may change to LX-200 mode by re-cabling the system appropriately and fine-tuning the focuser set up parameters.

The PCFocus system can position the focuser in normal or high-resolution mode. In high-resolution mode, the steps the focuser is moved are 1/2 those of normal mode. Choose which mode you want now as the settings may be slightly different depending on which positioning resolution you chose. Typically, high resolution is the preferred option but may be troublesome in some situations such as auto-focusing where seeing and other variations may result in a situation where the focus algorithm doesn't converge or takes an extremely long time to do so. You can change the resolution setting at any time but you may need to adjust the focuser parameters somewhat.

Assure the focuser is approximately midway in its travel. You may wish to run the focuser to each end of the travel and temporarily mark these positions and then affix a mark approximately midway between them. This mark will be handy later in using the system, especially with the FocusAide auto-focusing software. If the focuser is mounted to the telescope, set the OTA approximately horizontal. If the focuser is detached from the telescope, arrange for it to have its travel axis to be approximately horizontal.

With the control unit powered, off start the PCFocus software and select **Setup.** Select the COM port you will be using, click **Update Parameters and** click **Save Settings.**

Turn on the PCFocus control unit and momentarily click both the **In** and **Out** buttons. The focuser should move in and out accordingly. ("In" is where the barrel of the focuser is moving more and more into the main housing of the focuser body). If the direction of travel is reversed from the button clicked, check the **Reverse Focuser Direction** box and click the **Update Parameters** button. Verify that the focuser travel now matches the button clicked. Click the **Save Settings** button to record the settings thus far.

Likely the rest of the focus parameter settings are fine as default values. To test this proceed as follows:

Dial or type 50 into the **Move By** box and dial or type -25 in the **Move To** box. Click the Move To button. The focuser readout should increment to -25 and stop. (Be prepared to click cancel if the focuser goes in the wrong direction or continues on and on past the final -25 point). Note whether the focuser position overshoots or, conversely, takes a long time (more than a few seconds after getting close) to get to the final value. If either of these conditions exists, we'll correct them shortly in the Adjustments section below.

If the focuser promptly got to -25 and stopped, click the **Move By** button. The focuser should go to +25 and stop.

If the focuser got to the -25 and +25 points successfully, set up is complete. You can test the **Fine Focus** buttons for proper operation.

One other test to make is that of the "MotoFocus" hand box (the one supplied with your focuser. It only has two buttons, a small knob, and a coiled cable). Plug this into the PCFocus control unit and assure you can control the focuser position and the on-screen readout moves correctly. Note: The "Speed" control on the MotoFocus box is inoperative when used with PCFocus.

Adjustments

*Warning: In all of the adjustments below, be sure to click the **Update Parameters** button or no changes will be made. When you are happy with the settings, click the **Save Settings** button. Also, in the test and adjustment process make sure the focuser hasn't reached the end of its travel as unpredictable results will occur if this happens.*

If the focuser began incrementing and continued on and on past the commanded point, there is a good chance the focuser direction is backwards. Try changing the **Reverse Focuser Direction** checkbox and repeating the tests above. If reversing focuser direction does not fix the problem, increase the **Stop Factor** by 6-8 as a test. If this fixes the problem, reduce the **Stop Factor** to 1-2 above where the run-on problem re-occurs

If the focuser position went 1-3 clicks beyond the commanded value, increase the **Stop Factor** by approximately the overshoot value.

If the focuser position went more than 3 clicks beyond the commanded value, adjust the Nudge Time (make it lower) and/or Nudge Delay (make it higher) settings. Rarely will the Close Nudge Time require changing but it can be modified as desired but should be less than or equal to the Nudge Time setting. All of these settings interact so it is best to adjust one at a time, gauge the effect, and make further adjustments as required

If the focuser ended up at the commanded value but seemed to take a very long time to arrive at the final value, adjust the Nudge Time (make it higher) and Nudge Delay (make it lower) settings. Again, settings interact so make one adjustment at a time. Using the +5 or -5 buttons is a good way to test the effects of your adjustments but you should expect a longer delay if you reverse direction to allow the automatic backlash correction to operate.

Again, be sure to press the **Update Parameters** button after each adjustment and then the **Save Settings** button to record the settings for future use of the system

Tips and Techniques

- Use the Reset button to establish a "Virtual Home" position at the point of optimum focus or the center of the range of focuser travel.

- The In/Out buttons will move the focuser faster if clicked with the mouse whereas pressing the "I" or "O" keys on the keyboard will cause it to go slower owing to the "typeamatic" operation of keyboard keys when held down.

- PCFocus will always start up in the same position on the screen as where you left it. You can disable this feature on the Setup screen.

- The Speed selection group is only available in LX-200 mode.

- While it is best to run on an external 12VDC power source such as the included wall transformer, if you do run from battery always use a high quality alkaline 9V battery.

- Always have the control unit powered off when re-booting your computer or using other software that may send a command effectively moving the focuser.

- Remote control of PCFocus (and hence your focuser) is easily accomplished with remote control software such as PCAnywhere, VNC, etc. Remote control can be on a serial, LAN, or Internet connection. VNC is free and available from: http://www.uk.research.att.com/vnc/index.html

- Pressing F1 anywhere in the program can open the PCFocus User's Guide.

- FocusAide provides extensive focusing functions for use with your CCD camera. Focus scanning, i.e. a plot of focus quality vs focuser position and *fully automatic* focusing are provided. All of the PCFocus features are available with FocusAide as well. A free, fully functional trail version of FocusAide is provided on your installation CD. The trail is time limited so you may wish to get everything set up with PCFocus prior to using FocusAide for the first time. All of the focus parameters from PCFocus will apply and can be easily set up by copying them into the FocusAide set up.

- PCFocus will respect the Windows Desktop theme and can therefore be made to be gentle to night vision by allowing itself to be colored red.

- Updates to the PCFocus software and/or AstroArt plug-in are available free from your dealer's Web site.

Enjoy PCFocus!