Scopedog

eFinder

Advanced Digital Finder

User Manual Version 2.5

Manual contents

System Description

eFinder is an add-on Digital Finder for Dobsonian or other telescopes. The eFinder system includes,

- Camera and lens, with a 6 deg field of view
- eFinder Control Box
- Handpad
- Cables

The primary user interface is via the handpad. A more advanced control is available through a pc or tablet.

The eFinder uses plate-solving to measure exactly where the eFinder camera is looking. A semi-automatic calibration routine determines the offset between the eFinder camera and the main telescope field of view, and this offset is saved and applied throughout the session. Therefore, the displayed RA & Dec solution is that of the main telescope.

The eFinder can be used,

1. Connected to a Nexus DSC (original or Pro).
2. Connected to a Nexus DSC and telescope drive system.

In mode 1, the eFinder communicates with the Nexus DSC exchanging data. During initial telescope 2-star alignment, and a subsequent Local Sync, the eFinder sends the plate-solved solution to the Nexus DSC in place of using a catalogue object. Thus the alignment can be done on any part of the sky, not requiring an actual target object. This greatly simplifies the process and is very accurate.

Mode 2, in addition to the functions described above, it includes a GoTo++ feature, by which a normal drive goto is finished with a plate-solved refinement. Typically positioning the telescope to about an arc minutes of the intended target.

The eFinder handpad includes a three line OLED text display and a 5 way navigation toggle switch. The display can show the Nexus DSC position, the solved position, the Nexus DSC error, and setup parameters.

Use of the GUI App on a tablet or pc, gives the user ability to see the captured image, and overlay eyepiece field of view, offset, and various catalogue object annotations.

Installing and Connecting eFinder

All components should be installed where they are protected from knocks and direct rain or heavy dew. The eFinder system can be configured to suit most installations, if in doubt please contact scopedog@astrokeith.com. Final system performance depends on the stability of the camera mounting and the accuracy of the mount and any drive components installed.

The camera should be rigidly mounted to align with the main scope as far as is practicable. Care should be taken such that the field of view of the eFinder is not obscured by parts of the main telescope.

The diagram opposite illustrates how the eFinder components are interconnected.

If using wifi cables should be kept away from the front of the eFinder control box (opposite end to the connectors), as this may interfere with the wifi performance.

The joystick hand box may be plugged into any available USB port. The camera should be plugged into one of the USB3 sockets (blue).

The eFinder has a trailing USB cable to connect to the USB socket on the Nexus DSC. For ServoCat systems, the cable from the ServoCat box to the Nexus DSC USB port, should be moved to a USB socket on the eFinder.

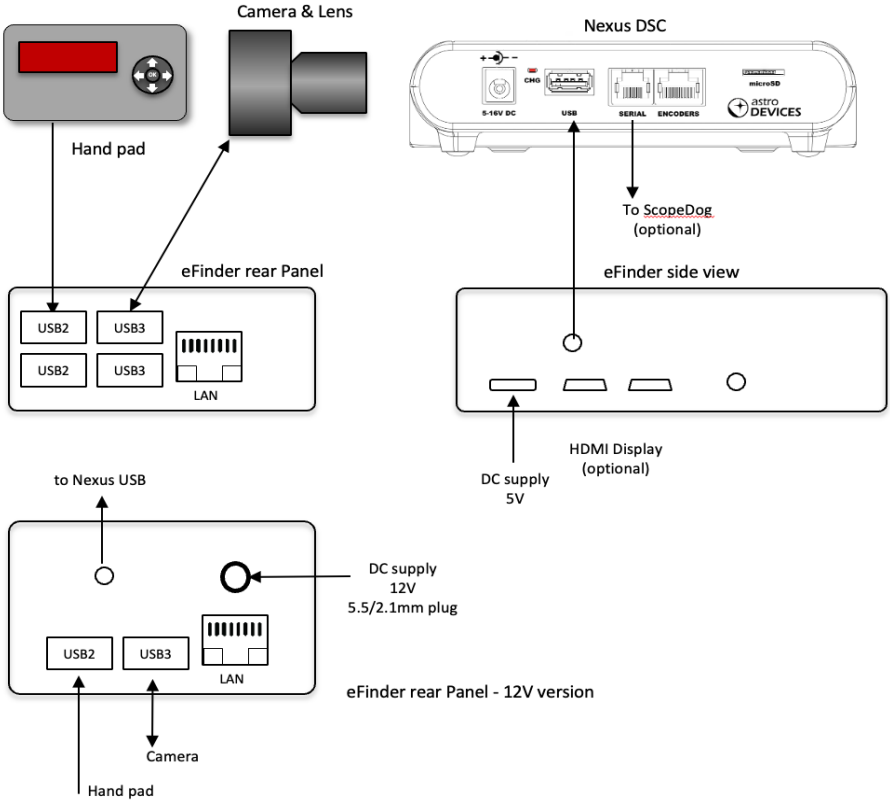
The Nexus DSC firmware will need to be at least ver 1.4.14 or with a Nexus DSC Pro, ver 1.1.20. Copies of these are available from AstroDevices.com or scopedog@astrokeith.com.

The Nexus DSC must be set to '2 star align w/o alt ref' in Setup/Align.

Adjusting the camera lens

The camera aperture should be opened to maximum. Using either the eFinder GUI application on an attached pc or tablet, or ASICAP (download from the ZWO ASI website) to view the captured image, adjust the lens focus to achieve sharpest image on stars. Use the locking screws on the lens to fix the aperture and focus positions.

ScopeDog eFinder System Interconnections



Nexus DSC settings

Follow the Nexus DSC manual to set your encoder resolutions etc.

In Settings/Align, set Align Method to 'Two stars w/o Alt Ref'
In Setting/Communications/USB, set to LX200, 9600, 1, 8, None
If using with a ScopeDog drive, in Setting/Communications/Serial, set to ScopeDog, 9600, 1, 8, None. For other drive systems refer to their instructions.

If using Wifi to connect (ie no USB cable), set Wifi protocol to LX200, port 4060, JNow.

eFinder settings

Using the hand pad, the user can adjust: (all values are saved):

Camera exposure time and gain: Typically an Exposure of 1 sec and Gain of 25 will produce reliable solves. If solves consistently fail, then try varying these a little. Inspection of the actual image will help greatly. Failure to solve is more usually down to scope movement or lens out of focus.

Enter a Test Mode: Selecting '1' sets the eFinder into a mode where pre-captured images are used instead of live camera shots. This can be useful for user familiarisation or to help resolve problems. For 'solve' and 'align' actions, an image of the M31 area is used. Expect very large Delta values unless the Nexus DSC is also pointed at the region. For Offset Calibration an image of the Polaris region is used. In this case the solve takes a while longer as the eFinder does additional work to identify and display the bright star by name.

Adjust display brightness: The OLED text display brightness can be adjusted (see screen Navigation Map). While adjusting the brightness changes immediately. On start up, the display starts at near full brightness. It will stay at that level until the lower status screen is accessed, whereupon it changes to the set value.

Initial alignment

Offset Calibration

Turn on the Nexus DSC first. If the Nexus DSC has not been used for sometime, wait for it to acquire gps lock so that its date,time & location are accurate.

On powering up, the eFinder code starts, and looks for and connects to the camera, Nexus DSC and handpad.

First task is to calibrate the offset correction between eFinder and your main telescope.

Point your main scope as accurately as possible at a bright star. Polaris is best but not essential. Go to the 'OK Bright Star' screen on the handpad.

Any previous measured offset will be displayed (x&y in arc minutes). Press the 'OK' button. eFinder will take an image and determine the brightest star in the image. It will then display that star name, and the new offset. This offset will be saved and used until a new measurement is made.

The solve process takes a little longer than normal as the eFinder does more steps to extract and name the brightest star.

If using the remote GUI display, more flexibility around the use of new or old measurements is available.

Telescope Initial Alignment

Scroll to the 'OK Aligns' screen on the handpad. Now point the telescope at two parts of the sky well separated in azimuth. At each point, press the 'OK' button and wait for the Nexus DSC to beep, signifying alignment coordinates received.

The display shows the total number of aligns performed and the alignment status report from the Nexus. 'AN0' signifies in AltAz mode and not yet aligned. 'AT2' signifies 2-star alignment complete.

Note: In the top right corner of the Home screen is displayed a 'N' for not aligned, or 'T' for aligned (T = Tracking).

Note: the same process is used on the eFinder for both initial alignment and subsequent Local Syncs. The Nexus DSC takes the first two received as initial alignment points, and thereafter takes them to be Local Syncs (and also stores these for an MPoint analysis).

Observing

General use of the Handpad

The *'OK'* button will start the capture and solve process from any screen, except the Align, Polaris or Reset screens.

After a successful solve, the screen will show the Delta in arc minutes. This is the delta with respect to that determined by the Nexus DSC and hence displayed on SkySafari if connected. Also shown is the time taken to compute the solve. This should be between 1.5 and 4 seconds. If not, it suggests bad observing conditions, the scope was moving during the exposure, dew on the

lens, not focused, or some other issue. The remote GUI can be used to help resolve the problem.

If a solve fails, usually due to the scope moving, then the screen shows the 'solution' screen, but "no solution" is displayed.

The Delta x & y in arcminutes are relative to eyepiece field of view. y is the same as Altitude. x is not the same as Azimuth { = deltaAzimuth * cosine(Altitude) }

If the Delta numbers are significant, ie greater than quarter of the telescope true field of view (TFOV), then clearly scope position as indicated on the Nexus DSC or SkySafari will not be accurate enough. A 'local sync' may then be appropriate. Scroll to the Align screen and press *'OK'*.

Use of the 'Home' screen (bold outline box on page 10 diagram).

The Home screen shows a live relay of the Nexus DSC RA & Dec, updated every half second.
A short 'OK' press will action a Nexus DSC align/local sync, after which the displayed RA & Dec will be very accurate.
A long 'OK' press actions a repeat of the last goto (not a goto++).
This allows the observer to stay at the eyepiece while exploring the region around a target, and be able to return to the target easily.
It is also useful for searching for a comet say from ephemeris data.
Also at top right is a 'N' for not aligned, or 'T' for aligned.

Goto++ *(only available if connected to a compatible drive system)*

After a normal goto, the telescope is likely to be 10-20 arc minutes away from target. This is due primarily down to a combination of initial alignment and mount build errors.

After such a normal goto, the Nexus DSC and scope drive will 'think' it is at the target though. Performing a local sync, and repeating the goto will bring the scope to the actual correct RA & Dec.

A longer press on the *'OK'* button causes the eFinder to read the current goto target & RA & Dec, perform a local sync, and then resend the original target back to the Nexus DSC and command a goto. Since this new goto starts with the scope near to the target and accurately aligned, the result will be very accurate. This action is called a 'GoTo++'.

Using the remote GUI display

To use the remote GUI display, a PC or Tablet (hereafter both are described as 'device') must be connected to the eFinder. Suggested methods are,

1. Ethernet cable from eFinder to a router, on which the device is connected.
2. WiFi from eFinder to a router, on which the device is connected. The eFinder wifi isn't powerful and so the router should be close to the telescope.
3. Use the Nexus DSC wifi as a router. This is OK for occasional setting up type connections but if SkySafari is also using that wifi then the total load will cause 'lag'. This method is not currently possible on the Nexus DSC Pro.

For options 2 or 3, a cable connection will need to be made first so as to configure the eFinder wifi to connect to the chosen wifi (ie select SSID & enter password).

The device should be running a VNC Viwer. RealVNC is recommended. In the VNC address window, enter 'efinder.local'. The VNC should connect and ask for username and password. Both are initially set to 'efinder'.

You should then see the eFinder 'desktop', a version of the standard Raspberry Pi. Wifi connections can be set up using the network icon at lower right of the screen.

To run the remote GUI display, select 'eFinderGUI' from the main menu.

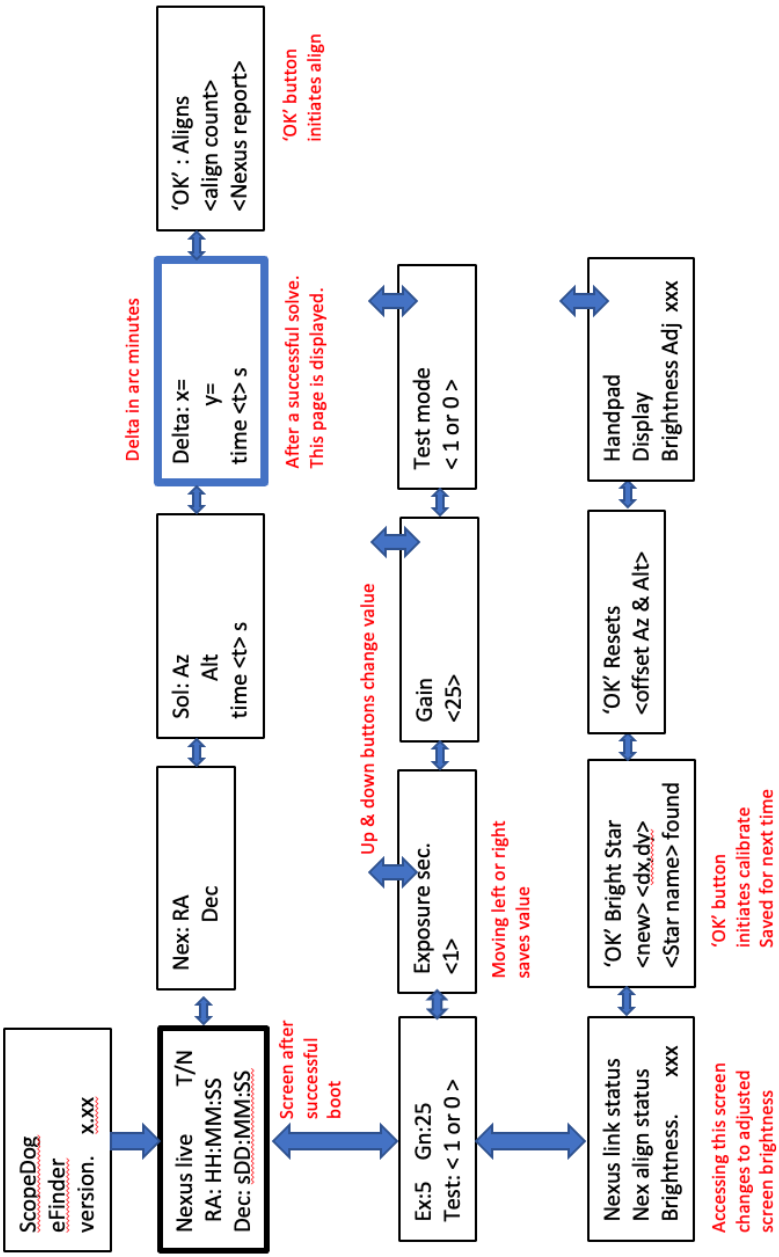
Note: While the GUI display is running, a limited functionality remains at the handpad. Press *'OK'* to solve, press *up* to Align, and *down* to GoTo++.

The GUI display should be terminated by clicking on the 'X' at top right of the window. This will ensure all parameters are saved.

Appendix A describes the many features of the GUI display.

The handpad version eFinder.py, can also be re-started from the desktop main menu.

eFinder Handpad Menu Screen Navigation



eFinder Accuracy

The plate-solved solution will be accurate to about 1/2 of a camera pixel. Thus for 3.75micron pixel camera (typical mono guiding or planetary camera) and 50mm lens, the accuracy is about 8 arc seconds. The displayed solution includes the offset as calibrated. Using Polaris and a short focal length reticule eyepiece, a calibration of around 20 arc seconds can be readily achieved. Thus a total or error of around 1/2 an arc minute.

There is a further error that may occur due to flexure of the telescope components during the session that disturbs the alignment between the finder and main telescope. This will be unknown but can be estimated by repeating the offset calibration routine during the session and noting any change.

The accuracy achieved by a GoTo++ will depend almost entirely on the performance of the telescope drive and encoder system. The biggest contributions to any errors are backlash in the motor drives and flexure and backlash in the encoder mounting. Noting the results of GoTo++ (the delta display) over a few sessions will indicate what is being achieved.

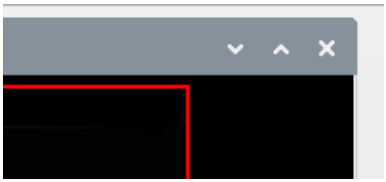
Note the delta display, in arc minutes is dx & dy at the scope position. dy will be equal to d-altitude. dx is equal to d-Azimuth x cos(scope altitude). dx & dy are more useful as they relate to the TFOV as seen through the eyepiece at that time.

Notes:

	Initial Value	user update
log-in username	efinder	
Initial password	efinder	
New password		
eFinder firmware	21_11	
GUI firmware	21_12	
Handbox firmware	eF1_6	

Appendix A eFinder GUI Manual

Always close the program using the GUI window close function. This will ensure any changed set up parameters are saved.



The GUI Application can be run from the desktop main menu.

Main features of the GUI App
The display of:

- Captured image, and a choice of overlays. These include efinder and main scope sightlines, eyepiece field of view and orientation, goto target position, and catalogue object annotation.
- Display of RA, Dec, Az & Alt of the Nexus, Solution and Target, with deltas.
- Display of Date, UTC, Local Sidereal Time, Longitude & Latitude.
- Enhanced control of offset calibration data.
- Separate control of capture, solve & goto processes.
- Rolling console display of system reports

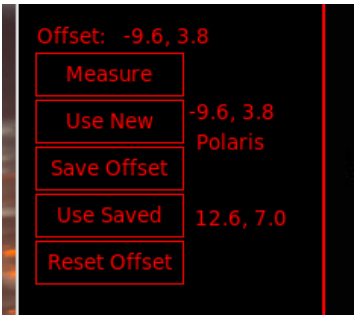
Location and time
The eFinder will read this information from the Nexus DSC at power up.

Exposure & Gain
Select the values you find work best. Suggested you start with 1 second and Gain of 25. Your selection will be saved if you close the program using the top right close window button.
The range of values presented can be changed in the efinder.config file.

Polaris Image
Check this option to 'capture' and solve a reference image of Polaris. This image can also be used to test and practice measuring the Offset function.

Test image
Check this option to 'capture' and solve a reference image of M31. This image file is stored as test.jpg in the ~/Solver folder.

Offset

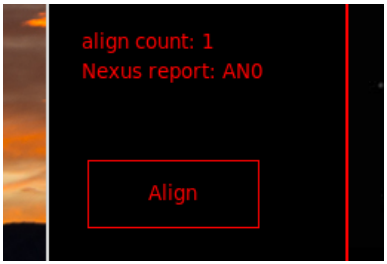


The eFinder can measure, apply and save the angular offset between the finder and main telescope.
At the top of the display section is shown the currently applied offset, in arc minutes: dx, dy. 'Measure' will cause the eFinder to capture an image, find the brightest star, and display the star name and offset from that star to the finder centre field. If 'Graticule' is enabled, then the main scope crosswire should be over the star in the image. Thus if the main scope is pointed accurately at a bright star, this function will accurately measure the finder-main scope offset.

If the correct star name is displayed, then 'Use New' will apply that offset to all future solves and aligns. The current applied offset can be saved to disk, using 'Save Offset'. The currently saved value (if one has been saved) is displayed to the right of the 'Use Saved' button. This button will cause the currently applied offset to be the saved value.

'Reset Offset' will set the applied offset to be zero.

Align



The Align button causes the eFinder to capture and solve an image, apply any offset, and send the value (RA & Dec) to the Nexus DSC.

The Nexus DSC will take the first two aligns, to be the initial two-star alignments (assuming two-star alignment has been set in the Nexus setup.) After these two have been successful, the 'Nexus report' will change to AT2. A = AltAz mode, N = not aligned, T= aligned, 2 = number of alignment stars.

Thereafter the aligns are treated as 'local syncs' by the Nexus DSC.

Note: the align or local sync can be performed without actually centring on an actual star. The eFinder will send the RA & Dec of the scope, as if it was a star.

The align count shows how many times this function has been used. This is useful when deciding whether to try an MPoint analysis on the Nexus DSC. Note: The

Nexus may have rejected some of the aligns if they were too far from the expected values.

Capture
This button starts the acquisition and display of an image, using the selected exposure and gain values. If the Polaris or M13 options have been checked then no capture will take place and a test image will be displayed instead. The current Nexus DSC RA & Dec is read and displayed.

Solve
This causes the current displayed image to be solved (or attempted). The result is displayed, along with the elapsed time taken for the solve. The first solve is a little slower as the index files are initially read from the SD card.

Two columns of deltas may be displayed. Between the Nexus data and Solution data, the delta x,y in arc minutes is shown. If a Target has been set, (see below) then a delta x,y between Solution and Target will also be show.

Nexus
The Nexus button will immediately read and display the current Nexus RA & Dec, and computed AltAz.

Target
This button reads from the Nexus the current 'Target'. This is using the LX200 protocol and will therefore display either the last align coordinates, or the last goto target coordinates, whichever was actioned most recently via the LX200 communication channel.

The delta in x&y in arc minutes is displayed also. This is convenient when judging the performance of a goto for instance.

GoTo
This button can be used to command a GoTo to the target coordinates shown in the Target column. This column can be populated by downloading from the Nexus current goto target, or uploaded from the text box at the bottom of the column. (If SkySafari has been used to set a GoTo target, that will downloaded from the Nexus)
This conventional GoTo will usually result in the scope pointing at where the Nexus/Scope Drive thinks the target is, but will have an error due to alignment and mount tolerances. This error is typically in the range 10-60 arc minutes.

If Auto Goto++ is checked, the conventional goto will automatically be followed by a plate-solve, local sync and repeat goto. Usually resulting in a poiting accuracy of around 1 arc minute.

Performing the Local Sync cancels out any alignment or mount errors, and since the 2nd GoTo is very small, the final position will now be as accurate as your drive can achieve - normally just limited by backlash compensation.

Display
The 'Display' button causes the displayed image to be refreshed with any new selected options. These options are:

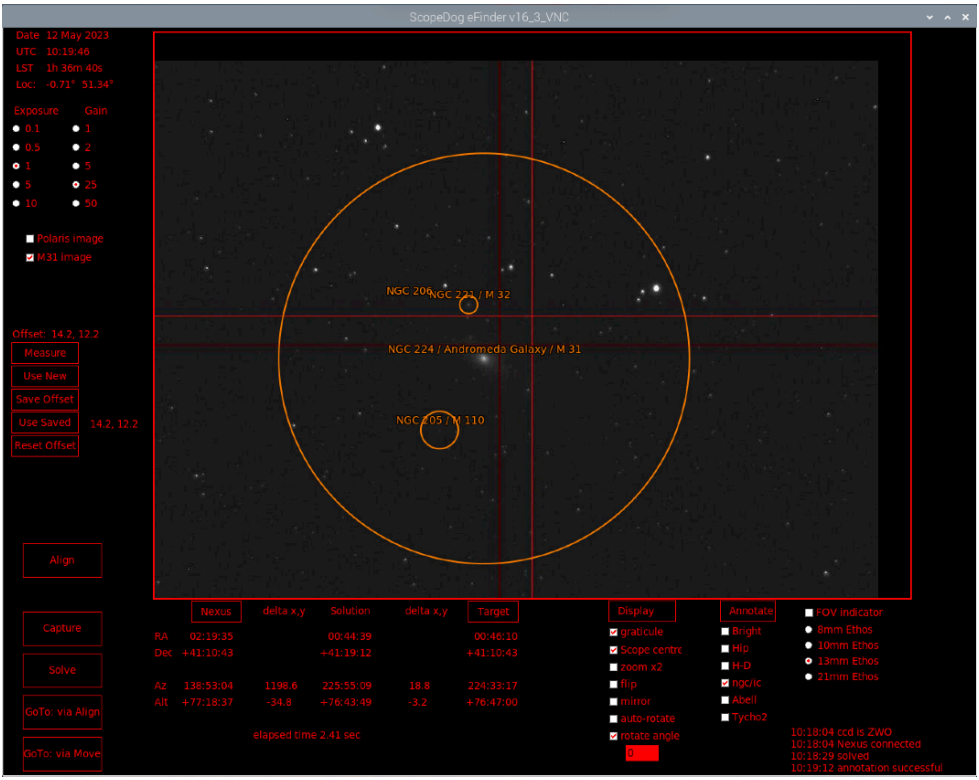
Graticule	Show the crosswires (with any applied offset)
GoTo Target	Show the posiiton of the current GoTo target as dsipalyed in the Target column.
Scope Centre	Shift the displayed image such that the main scope centre is now in the display centre.
zoomx2	Zooms the displayed image by 2.
flip	Flips the image vertically
mirror	Flips the image horizontally
auto-rotate	Automatically rotates the displayed image according to telescope altitude to show an 'eyepiece view'. Not yet tested.
rotate angle	Rotates the display clockwise by the number of degrees entered in the box below.
FOV indicator	Shows a circle, centred on the main scope sightline, indicating the chosen eyepiece AFOV. These can be set up in the efinder.config file.

Annotate
This button causes the eFinder to re-solve and annotate the image - as currently displayed. Thus despite any display actions eg flip or rotate that have been applied, the annotated text will be still be 'right way up' and easily legible.

If 'Scope centre' has been applied with a large offset, or a large rotate angle has been set, then the annotate may fail. This is a function of the solver not being able to cope with large parts of the image 'blank'. Six catalogues are available to apply annotations.

FOV indicator
Depending on the efinder.config file, a list of eyepieces is presented. Select the 'FOV indicator' and an eyepiece to display a circle on the display. If the image has already been captured, then use the 'Display' button to apply the indicator.

Console Box.
At the bottom right is a scrolling window showing various system reports.



Appendix B

Edit efinder.config file

Follow the instructions on page 9 of the manual to establish a remote comouter connection to the eFinder and display the Pi desktop.

Use the file manager to display the contents of the folder /Solver/

You will find a file efinder.config – right click and select text editor, which will open the file ready for editing. It should look like the image below.

When editing a line, only change characters to the right of the colon and ensure no extra spaces before or after your text have been entered.

The following explains the lines and valid entry options

d_x & d_y: This is the latest offset measurment in degrees. Should not be manually changed.

Lat & Long: Only used for eFinder ver 22, the 'Minimalist'

Exposure: Current camera exposure value. Set via handset

Exp_range: The range op exposure value options displayed on the GUI. Can be changed, but keep the commas and five options in total

Gain: Current camera gain. Set via handset. Refer to camera specification for acceptable values

Gain_range: As for Exp_range.

Ramdisk: True or False. Recommend True so that the eFinder stores temporary working files in ram rather than potentially wearing out the micro SD card.

Camera Type: The eFinder should recognise most models within the specified manufacturer's range.

Pixel scale: This is the apparent size of the eFinder camera pixels, in arc seconds. Change if you are not using an ASI120 and 50mm lens.

Drive ~: Enter your scope drive type or 'none'

Test mode: 1 or 0. (= True or False) Set via handset

Goto++ mode: 1 or 0. Set via handset

Buttons ~: Unless you have a very early unmodified handset, leave at 'new'

Scope_focal_length: in millimeters. Used by the GUI to display reticules.

Eyepiece~: Enter any eyepieces for which you want to have recticules displayed on the GUI. Format is 'name,focal length mm,AFOV degrees' . Up to 4 eyepieces can be saved.

default_eyepiece: This defines the eyepiece reticule that will be selected by default on the GUI. Enter the product of focal length and AFOV for your chosen eyepiece. Eg for the example shown, it is the 13mm Ethos, so 13 x 100.

Frame: Defines the rectangular frame that can be displayed as a reticule on the GUI for any separate imaging camera. Arc minutes.