Scopedog

eFinder Live

Advanced Digital Finder

User Manual Version 1

Manual contents

System Description

eFinder Live is an add-on Digital Finder for Dobsonian. or other telescopes. The eFinder Live system comprises a single unit incorporating,

- Camera and lens
- Processor
- OLED display
- 5 way navigation switch
- 3 axis accelerometer
- GPS module
- Micro USB port

The eFinder Live uses plate-solving to measure exactly where the eFinder Live camera is looking. A semi-automatic calibration routine determines the offset between the eFinder Live 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 Live is primarily designed to be used with a wifi connected device running a planetarium App such as SkySafari. The eFinder Live can generate an RA & Dec solution on user demand, or run continuously.

The eFinder Live includes a three line OLED text display and a 5 way navigation toggle switch. The display can show the solved position, a focus utility, status information and setup parameters.

The accelerometer can automatically determine how the eFinder Live has been mounted on the telescope and invert the display and navigation buttons to suit. This is optional and can be set via the config file.

The eFinder Live should be powered from a standard 5V USB supply. On power up, after failing to find a Nexus DSC on the USB cable, the eFinder Live will be started.

Installing and Connecting eFinder Live

All components should be installed where they are protected from knocks and direct rain or heavy dew. The eFinder Live system can be configured to suit most installations, if in doubt please contact efinder@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 eFinder Live 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 Live is not obscured by parts of the main telescope.

Use a micro USB to USB A cable to connect the eFinder Live to a USB 5V supply.

The eFinder Live incorporates a tilt sensor, such that regardless of which side of a telescope it is mounted, the display and switch orientation is corrected. This can be omitted or overridden in the config file.

For full functionality, a device running a planetarium App such as SkySafari should be connected to the eFinder over wifi. See page 10 for more detail.

eFinder Live settings

Using the display and 5-way switch, the user can adjust:

Camera exposure time and gain: Typically an exposure of 0.5 sec and gain of 10 will produce reliable solves. If solves consistently fail, then try varying these a little. Use of the focus utility will help greatly. Failure to solve is more usually down to scope movement or lens out of focus.

Enter Test Mode: Selecting '1' sets the eFinder Live 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' an image near M14 in Ophiuchus is used. For Offset Calibration an image of the Polaris region is used.

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.

Wifi: On power-up the eFinder Live will attempt to connect to the pre-configured infrastructure wifi network. If not possible, it will generate its own wifi Access Point. Once running, the wifi connection can be switched between Access Point and Infrastructure mode (if available). This is done via a long OK press on the status display screen.

Initial alignment

On powering up, the eFinder Live code starts. For about 20 seconds the eFinder Live screen will be blank while the internal processor loads its operating system. You may have to wait a while for it to acquire gps lock so that its date, time & location are accurate.

Offset Calibration

First task is to calibrate the offset correction between eFinder Live 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 Live 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. If the expected star isn't displayed, try adjusting exposure time (using the focus screen utility), as over exposed stars can be ignored by the solver.

Observing

General use of the Handpad

Navigate to the eFinder Live solution screen.

A short press of the ‘OK’ button will start a capture and solve cycle. After a successful solve, the screen will show the solution as RA & Dec. Also the number of stars found and how long the solve took. The first solve after power up always takes a little longer as data is transferred from the SDcard. Solve time should then generally be less than 0.5 seconds and find at least 40 stars. The focus utility can be used to adjust settings if required.

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

A long OK press will start a continuous capture, solve & display process. The loop repeats as fast as the current exposure time allows.

Again, the display shows solved RA & Dec, the number of stars and the time taken to solve. If the eFinder Live senses telescope motion (using its internal accelerometer) then the display shows “scope moving” until the telescope is again stationary or tracking. The continuous looping can be stopped by pressing the ‘up’ button.

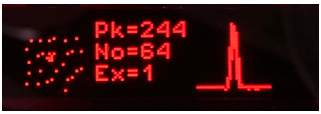
Connected Planetarium App

A connected device running a Planetarium App such as SkySafari can show the telescope position. This is best done with the eFinder Live in continuous looping mode. If a goto target is selected in the App, then the eFinder Live will show the distance for the telescope to be moved to reach the target (in degrees). The readout rate in the App should not be set faster than 2 per second.

Use of the Focus Utility

Navigate to the Focus Utility screen. Press ‘OK’ to grab an image from the camera with the current settings. The eFinder Live will attempt to find stars in the image. At the left of the screen is a crude image of the patch around the brightest star. In the centre is displayed, number of stars found, and

the peak intensity of the brightest star (0-255). At the right of the screen a PSF (point spread function) of that star intensity is plotted.



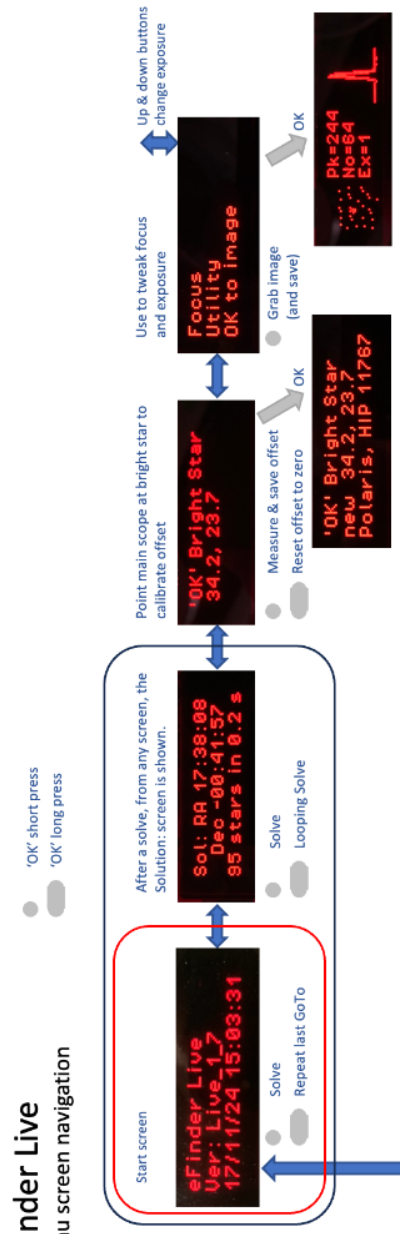
With an exposure of about 0.5 seconds on a reasonable dark sky, a focused image should produce between 40 and 150 stars. If none or very few stars are found then try adjusting focus. Make a small adjustment and take another measurement. Repeat as necessary until stars are resolved and brought into sharpest focus. If the focus is a long way off then this may take some time, but thereafter should not need significant change, if at all. Use the locking screw on the camera lens to fix the set focus.

After good focus has been achieved, the utility is then useful to refine exposure time. You should aim for a peak intensity no more than about 200. Stars that saturate and become extended will be ignored by the star detection process. Avoiding this is key during the Offset Calibration routine, else the bright star being used for alignment may be ignored.

Save Image

A long OK on the set exposure screen will cause the eFinder to save the last image to the sdCard. This can then be retrieved using a filesharing App or viewed using a web browser. See the section on wifi connecting on page 10

eFinder Live Handpad Menu Screen Navigation



WiFi access to eFinder Live

The eFinder Live can be configured to join a known WIFI (infrastructure mode) or create its own WIFI Access Point. The eFinder Live status screen shows the current network hostname and IP address to aid setting up connections.

eFinder connected to infrastructure wifi

eFinder connected to infrastructure wifi

A long OK press on the status screen will cause the eFinder Live to attempt to flip wifi connection.

A connected device running a planetarium App such as SkySafari can display the telescope position. In the App telescope connection settings, enter the IP address shown and port 4060. Set a readout rate no faster than 2 per second.

A device on the same network can view and update the eFinder.config file (Appendix A) and view the latest saved image, (refer to the next section for details).

Save and View camera images

If desired the camera image can be saved and/or viewed.

After a successful capture and solve, the solution screen will show the result. A long press of 'OK' while on the Exposure set screen will save the last captured image to /home/efinder/Solver/images/image.png. This is overwritten on subsequent saves. The latest image can be retrieved using Samba file sharing over the network. It can also be viewed immediately by browsing to efinderLite.local on a connected device.

While using the Focus Utility screen, the image captured is automatically saved to /home/efinder/Solver/images/image.png and can be retrieved or viewed in the same way. This image includes an additional window showing a magnified section of the brightest star. Unlike the basic solution image, the focus image is contrast stretched to enhance the star images.

Appendix A

Edit eFinder.config file

Connection method A
On a computer or device, connect to the eFinder Live via wifi (page 10). Enter efinderLite.local in the browser address (assuming you kept ‘efinderLite’ as the efinder Lite hostname during setup). You should see a web page like …

efinder.config file

d_x	34.19	Finder to Main scope x offset, set automatically
d_y	23.66	Finder to Main scope y offset, set automatically
Brightness	100	OLED display brightness, 1 to 255
Exposure	0.2	Default camera exposure time
Gain	10.0	Default camera gain
Ramdisk	True	set to 'True' to use RAM for temporary image storage (recommended), else 'False'
Camera	RPI	Enter 'ASI' or RPI' as appropriate
Flip	left	Enter 'auto', 'right' or 'left' as appropriate
Drive	none	Enter 'scopedog', 'servocat' or 'none'
Test_mode	1	Enter '1' to cause eFinder to use test images for solving (ie not the camera), else '0'
Goto++_mode	0	Enter '1' to enable automatic GoTo++ mode' else '0'
Lens_focal_length	25	Enter camera lens focal length, in millimeters

Save Config File

Values can updated, and saved using the ‘Save Config file’ button. Always hit the ‘Save Config File’ button before leaving the page or closing browser, even if no changes have been made.

Connection method B (advanced)
Follow the instructions on page 10 of the manual to establish a remote computer connection to the eFinder Live via wifi. Use the remote computer 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 this image.

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.

Updating entries

The following explains the lines and valid entry options

1. d_x & d_y: This is the latest offset measurement in arc minutes. Should not be manually changed.
2. Brightness: OLED display brightness, 1 to 255
3. Exposure: Camera exposure value. Set via eFinder Live screen
4. Gain: Current camera gain. Set via eFinder Live screen. Refer to camera specification for acceptable values
5. Ramdisk: True or False. Recommend True so that the eFinder Live stores temporary working files in RAM rather than potentially wearing out the micro SD card.
6. Camera: The eFinder Live should recognise most models within the specified manufacturer's range. Enter ASI or RPI.
7. Flip: The display and button orientation change depending on which side of the scope it is mounted. Enter 'auto', 'left' or 'right'
8. Drive: none
9. Test mode: 1 or 0. (= True or False) Set via handset
10. Goto++_mode: 0
11. Lens_focal_length: camera focal length in millimeters.

Item 1 is set by the system
Items 2,3,4,5 & 9 can be set via the display & navigation switch.

Record of settings:

	Initial Value	user update
LAN hostname	efinder	
Initial password	efinder	
New password		
eFinder Live firmware		
Exposure	1	
Gain	25	
Ramdisk	True	
Camera	RPI	
Flip	auto	
Drive	none	
GoTo++ mode	0	
Lens focal length	25	

Note: the username 'efinder' cannot be changed.

Appendix B

Understanding eFinder accuracy

eFinder will improve your pointing accuracy, but it's not a silver bullet! Here's an explanation …

Let's assume Polaris is used for the offset measurement routine. You centre Polaris in the main scope (accuracy required!). The eFinder routine finds and saves where in the captured image Polaris is (the offset). It can do this to better than a pixel, so about 15 arc seconds depending on your eFinder lens focal length. So far so good. So from now on, the eFinder uses that offset to guide the drive or the manual 'pusher'. It is the offset that is used to sync the Nexus DSC.

When you do a sync (aka align) the Nexus gets what should be the scope RA & Dec, using the offset. In fact it gets the eFinder camera image RA & Dec and infers the main scope RA & Dec using the offset. So the stability of the offset is critical. Things that can affect the offset …

- eFinder Live / eFinder camera mounting stability
- Primary mirror movement
- Secondary mirror movement (eg. sag with changes in altitude)
- Tube/truss movement

Normally the user isnt aware of these, just knows that encoders dont always find the target. The eFinder exposes them! You can measure them using the offset measurement function in eFinder. After initial collimation, do a series of offset measurements, noting the results, for a few stars spread in azimuth and altitude. Typically you will get a 'settling down' at first (primary mirror moving on support, and secondary mirror adjustment mechanism relaxing). Then you get movement as you move the telescope, especially in altitude. I personally reviewed a large number of eFinder installations and found an enormous range of movement. Up to a degree!

However the eFinder is a good diagnostic tool and helps remedy these problems.

Next we have to consider the encoders. When you do an eFinder sync, the Nexus DSC now knows where it is pointing (notwithstanding the offset error above), and will calculate the distance to the object. The distance on the Nexus display will be accurate. But when you move the scope to zero out the distance, the Nexus is using the encoders to continually display the new distance. Problems here are …

- Encoder resolution. 10k encoders give 2 arc minute steps for instance. As you move the scope the Nexus might see in worse case up to 2 arc minutes at the start and 2 at the end.
- Encoder mounting. The tangent arms on which the encoders are mounted often have a little play at their 'free' end.
- Mount. Eg. Typically scopes can move a little in azimuth by skewing on the altitude teflon pads. Slack in azimuth centre spindle can be a major cause.
- Encoder noise. Not that common, but some ServoCat & SiTech installations have shown this (shorten encoder cables and keep them away from motor cables.)

eFinder and two 'star' alignment. Normal 2 star alignment requires the scope to be pointed at 2 actual stars with accuracy. The accuracy is required so that the DSC can compute the orientation of the mount. It could be argued that DSC accuracy isn't required when an eFinder is used, but it is still worth doing the process as accurately as possible to improve the rest of the observing session.

During the 2 'star' alignment process, the eFinder sends to the DSC the RA & Dec of the main telescope (albeit with a small offset accuracy error), so no aligning on actual stars is required at this stage. This both speeds up the process and improves accuracy. The improvement in accuracy comes from the same small offset accuracy error being applied to both 'stars', rather than a random error generated at each real star alignment in the normal process.

Finally the drive, if you have one. Goto++ works by syncing the Nexus DSC when near the target and then repeating the last goto. The drive has a known starting point now, but is again relying on the encoders to tell it when it has reached target. Now we have the encoders errors above, plus the drive 'backlash'. This 'backlash' is a number that when reached the drive stops trying anymore. Typically this is a couple of encoder steps.

From the above you can see that the overall pointing accuracy is dependent on many factors. After a little use of eFinder you will know what accuracy you are able to achieve. If desired then you can work through the sources to reduce them, using the eFinder to check progress. Go for 'the low hanging fruit' approach. Most systems I have looked at have had only one or two big error sources, tackle these and perhaps live with the rest. Nearly all systems I have help commission have been got to the region of 1-5 arc minutes. My own, after reworking 4 times is about 15 arc seconds.