

Handbook for the SX 'Oculus' high resolution all-sky camera



Thank you for purchasing a Starlight Xpress 'Oculus' all-sky camera. We hope that you will be very pleased with the performance of this product.

The Oculus is a high resolution, very compact wide-field camera assembly, which is powered and operated via a single USB2.0 computer connection. It is intended for full-sky monitoring of weather, meteors, satellites etc. and will provide high quality images and video files, while operating unattended for long periods. The 'megapixel' resolution F/2 fish-eye lens provides horizon to horizon coverage with very little star image distortion across the entire field.

The Oculus utilises a sensitive Sony 'SuperHAD' CCD (the ICX205AL) with an array of 1392 x 1040 pixels in a 'half-inch' format. Although the chip is not cooled, it has a very low dark signal and very little readout noise, so it can be used to image faint stars with a very short exposure time. The small pixel size and high resolution lens give excellent definition and a good sized screen image format. A strong polycarbonate hemispherical dome houses the lens assembly and this dome is easily removed for cleaning, when necessary. A 12v DC input socket is also provided to permit an internal heating resistor to be powered up to prevent dewing of the lens and dome on humid nights. The entire assembly comes equipped with a standard tripod bracket for mounting.

The Oculus specification:

- CCD type: ICX205AL Sony SuperHAD interline CCD with low dark current and vertical anti-blooming.
- CCD Full resolution pixel data: Pixel size: 4.65uM x 4.65uM, Image format: 1392 x 1040 pixels
- CCD Image area: 6.4mm (Horizontal) x 4.75mm (Vertical).
- CCD quality: Grade 1
- Spectral Response: QE max at 520nm (~50%), 30% at 420nm and 670nm.
- Readout Noise: Less than 10 electrons RMS - typically only 7 electrons.
- Full-well capacity: Greater than 15,000 e- (unbinned)

- Anti-blooming: Overload margin greater than 1000x.
- Dark current: Less than 0.1 electrons/second @ + 10C ambient.
- Data format: 16 bits.
- System gain: 0.3 electrons per ADU
- Lens details: 1.55mm FL F/2 180 degree 'Fish Eye'
- Computer Interface: Built-in USB 2.0 compatible interface.
- Image download time: Typically 0.6 seconds at full resolution using USB 2.0.
- Power requirements: Camera is USB powered, dew heater requires 12v at 1 amp max.
- Input connection: 'Mini B' USB socket for USB2.0 and a 2.1mm jack for +12v heater supply.
- Cooling system: Ambient air cooling.
- Viewing dome: High quality polycarbonate hemisphere (replaceable)
- Overall size: 150mm tall x 95mm diameter

Installing the Oculus:

A new 32 bit XP installation will require the driver files SXVIO.sys and Generic.sys, plus the SXVIO_Oculus.inf file. A 64 bit machine will require our 64 bit driver package 'BlockIO64.zip' or the new Windows 8 version. I recommend using the new 'signed' Windows 8 drivers for any machine running Windows 7, or above (32 bit versions are included in the download). All are available from our web pages, if required (<http://www.sxccd.com/drivers-downloads>).

Running the 'Setup.exe' file on the supplied CD, will install the drivers and operating software automatically. If you are installing manually, copy the appropriate files into a convenient folder on drive C and then connect the USB cable to the Oculus. Point the installer at this folder when it asks for the location of the drivers and you should see it set up the hardware as a 'BlockIOClass' device in Device Manager.

The Oculus control software is Oculus_USB.exe and the latest version may be downloaded from the Starlight Xpress web site <http://www.sxccd.com/drivers-downloads>, if necessary. Copy the exe file and dlls into a folder on drive C and run the exe file to start the software. You need Oculue_USB.exe, bwcc32.dll and wsc32.dll to run the program. If any files are missing, you can find them on our downloads web page. Alternatively, 'PHD', 'AstroArt' and 'MaximDL' support the Oculus (as the H9 or SuperStar) and may be preferred. Note that the Oculus may show up as an 'SXV-H9' or as 'Unknown' in some software, but it should still work OK.

Setting up and using the Oculus:



The best site for your Oculus camera will depend to a great degree on your surroundings and nearby sources of artificial light. An all-sky lens will image everything in your area and the reflections of artificial lights in the dome and lens can be objectionable. Try to locate it in a shadowed area with as

good a view of the sky as possible. If you cannot avoid stray light getting into the field of view, then raising the effective horizon is an option. Starlight can supply a 'horizon ring' which slips over the dome retaining ring and which cuts off light from below about 15 degrees above the true horizon. Alternatively, you can construct your own from lightweight metal or plastic sheet. I recommend making the horizon ring at least 300mm in diameter to minimise the lost field, while still blocking stray light from the dome. If available, a high location on a roof or tall pole will minimise stray light problems and improve your low altitude view.

Mounting the camera assembly is usually done by using the $\frac{1}{4}$ Whitworth tripod screw hole in the attached bracket. A camera tripod will provide an adequate mounting for temporary use, or a suitable mast and fixing screw can be erected to permanently mount the Oculus several feet above the ground. It is wise to mount the unit as high as possible, so that the effects of low-hanging fog and dew are reduced and stray light is minimised. It is also helpful if the camera is positioned above a source of warmth, such as a house roof, to help keep the dew at bay.



A simple setup with the Oculus mounted on an old tripod

The minimum setup requires only a USB cable to the monitoring computer. This should be as short as is practical, but it will probably be necessary to have a fairly long lead if the Oculus is mounted high on

a mast or roof. As the camera power is taken from the USB cable, any long leads should be as heavy as possible to reduce the internal resistance. An optimum setup would use a high quality USB extension cable with AWG 20 power cores, plus a short A to mini B cable at the Oculus end. Active cables can work OK, but make sure that the cores are AWG 20. The mini B cable is anchored into the back plate by a 'Heyco' clamping bush, but this can be extracted from the plate by compressing the clamp and re-fitted to your new cable, as necessary.

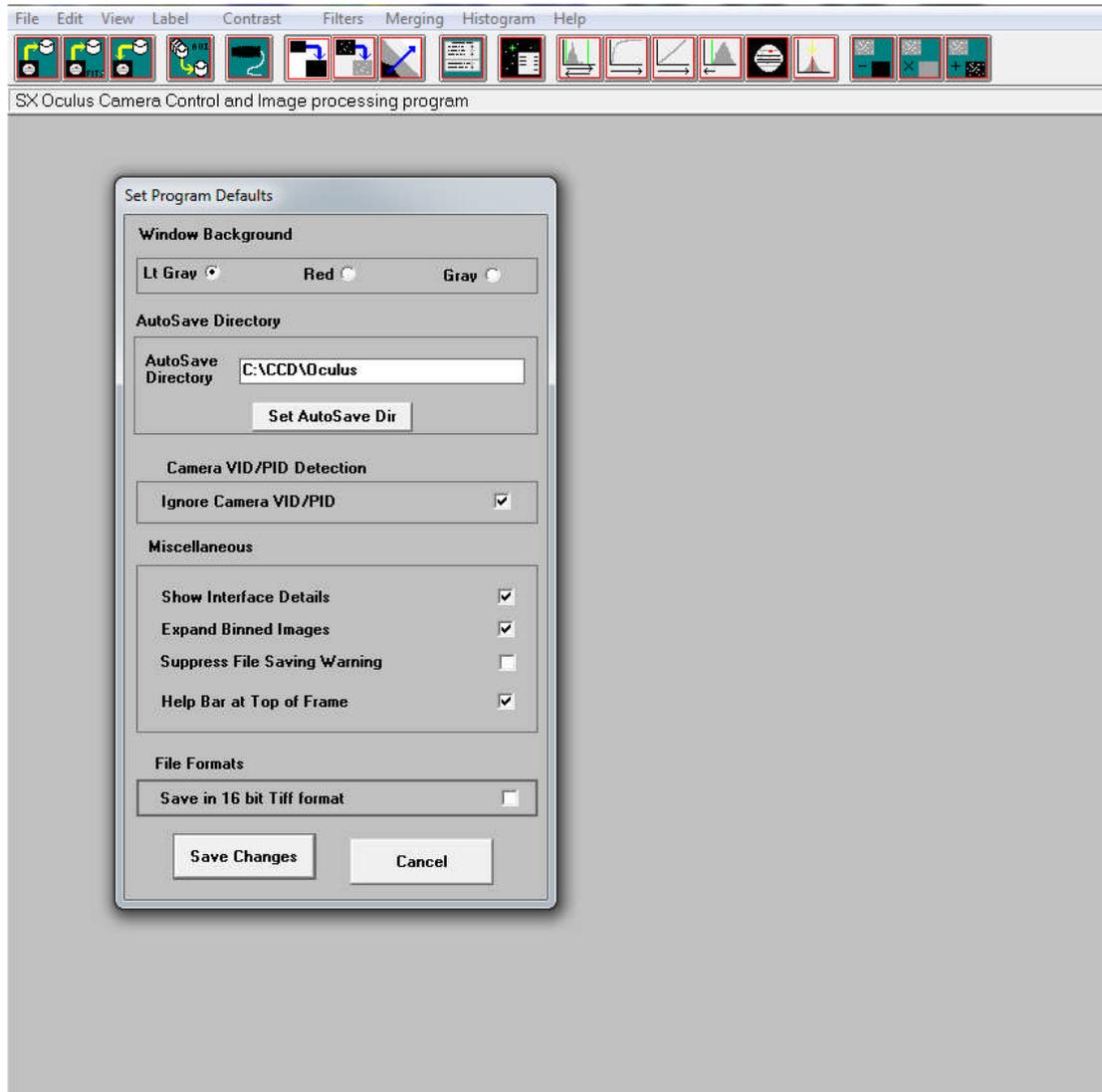
The Oculus is designed to minimise any lens and dome dewing problems, but these are very common in optical systems that are cooled by radiation to the sky. It is very likely that you will have dewing on humid nights unless the dome is kept warm by powering the internal heater via the 12v socket on the rear of the assembly. This socket can accept a 2.1mm coaxial power plug from any 12v DC supply capable of driving at least 1 amp - the polarity is not important. Heating will increase the dark signal of the camera, so be aware that the heater is best used only when necessary. The voltage to the dew heater can be varied to alter the amount of heat supplied. At 12v input about 10 watts is dissipated, but 6v input will reduce this to around 2.5 watts when dewing is less of an issue. Don't exceed 15v, or the heaters may be damaged.



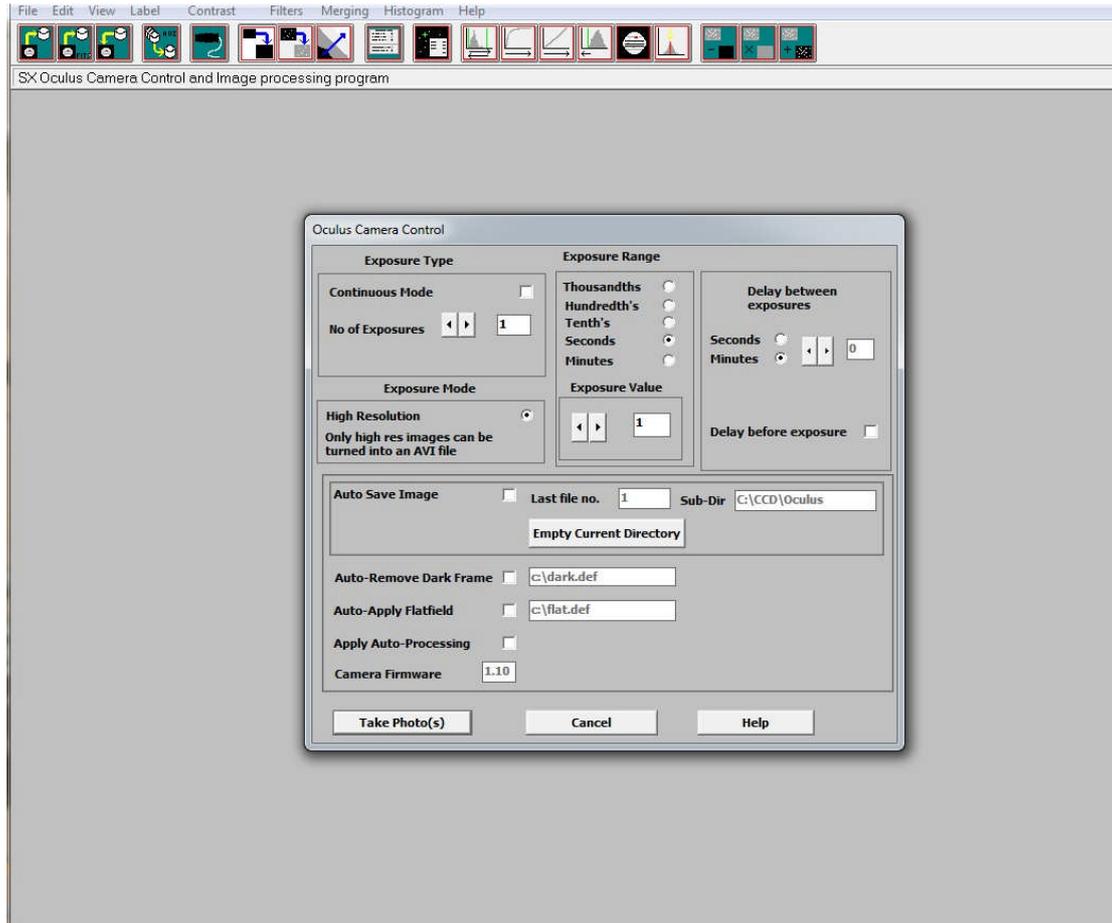
A rear view of the Oculus, showing the heater socket and USB cable.

Imaging with the Starlight Xpress software

With the Oculus connected to the PC, open 'Oculus_USB.exe' and find the 'Set program defaults' menu under the 'File' heading. If this is the first run of the software, you will get a warning about the 'ini file not found', but ignore this and click on OK – then open 'set program defaults' from the text icon . You should now see a screen similar to the one shown below:

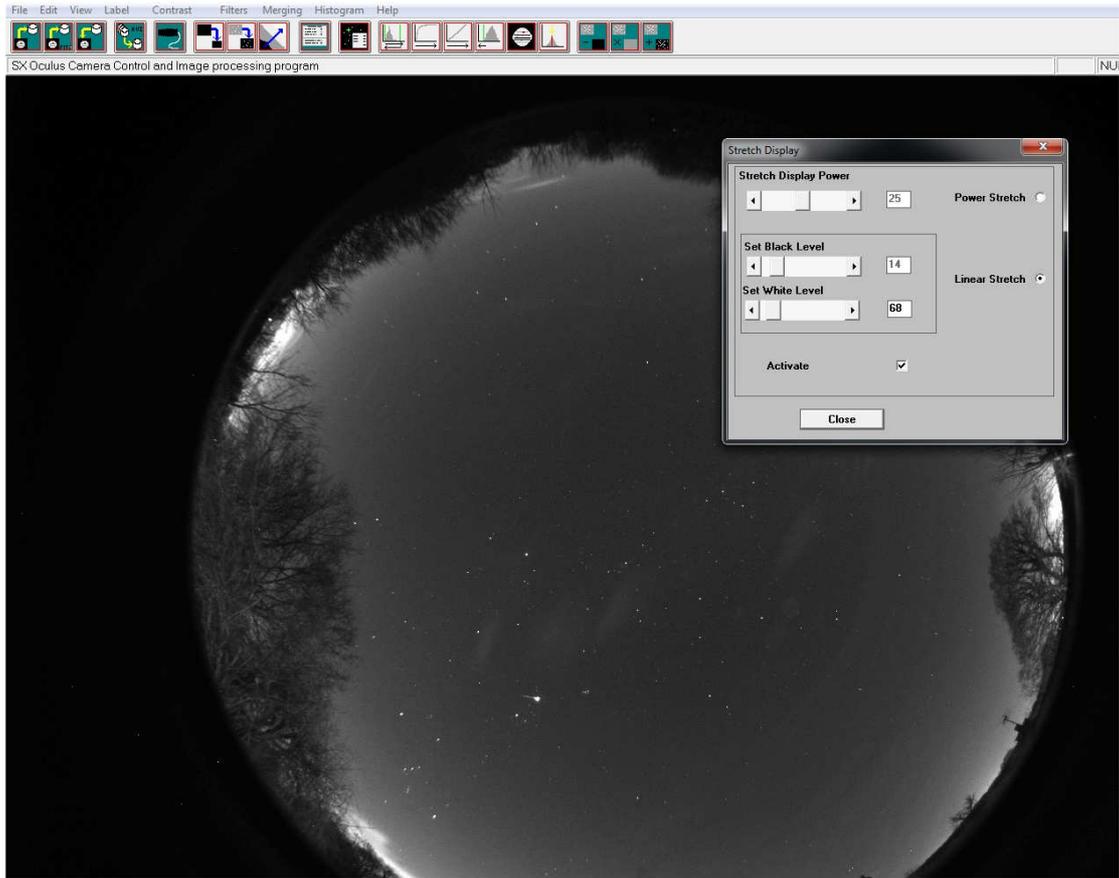


The defaults shown above are a typical example, but you can change the settings to suit your preferences. The main thing to do is to set up the address of the 'Autosave' folder, so that your images will be saved to a defined location. The 'Ignore VID/PID' may be selected if the software fails to recognise your Oculus camera, but is not normally necessary. Once the defaults have been set to values which you think will be approximately correct, save the settings and open the camera interface by pressing the camera icon in the top menu. You will see something like this:



If this is an initial setting up session, set the 'Autosave' to off and select 'Continuous' mode. The exposure time for a dark sky can be 20 seconds, or more, but for initial alignment and testing, set 5 seconds and press 'Take Photo(s)'. You should see a sequence of images on the display and you can experiment with the Oculus orientation and location to get the best views. The focus should be good, as supplied, but if necessary it may be adjusted by unscrewing the large outer ring and lifting off the dome. Loosen the small lock screw on the lens and gently rotate the top lens ring to refine the focus. Re-lock the lens when satisfactory and replace the dome.

You can greatly improve the image brightness and contrast by setting up the 'Max palette stretch' option in the 'View' menu. I recommend using the 'Linear' stretch and adjusting the black and white levels for the best view.



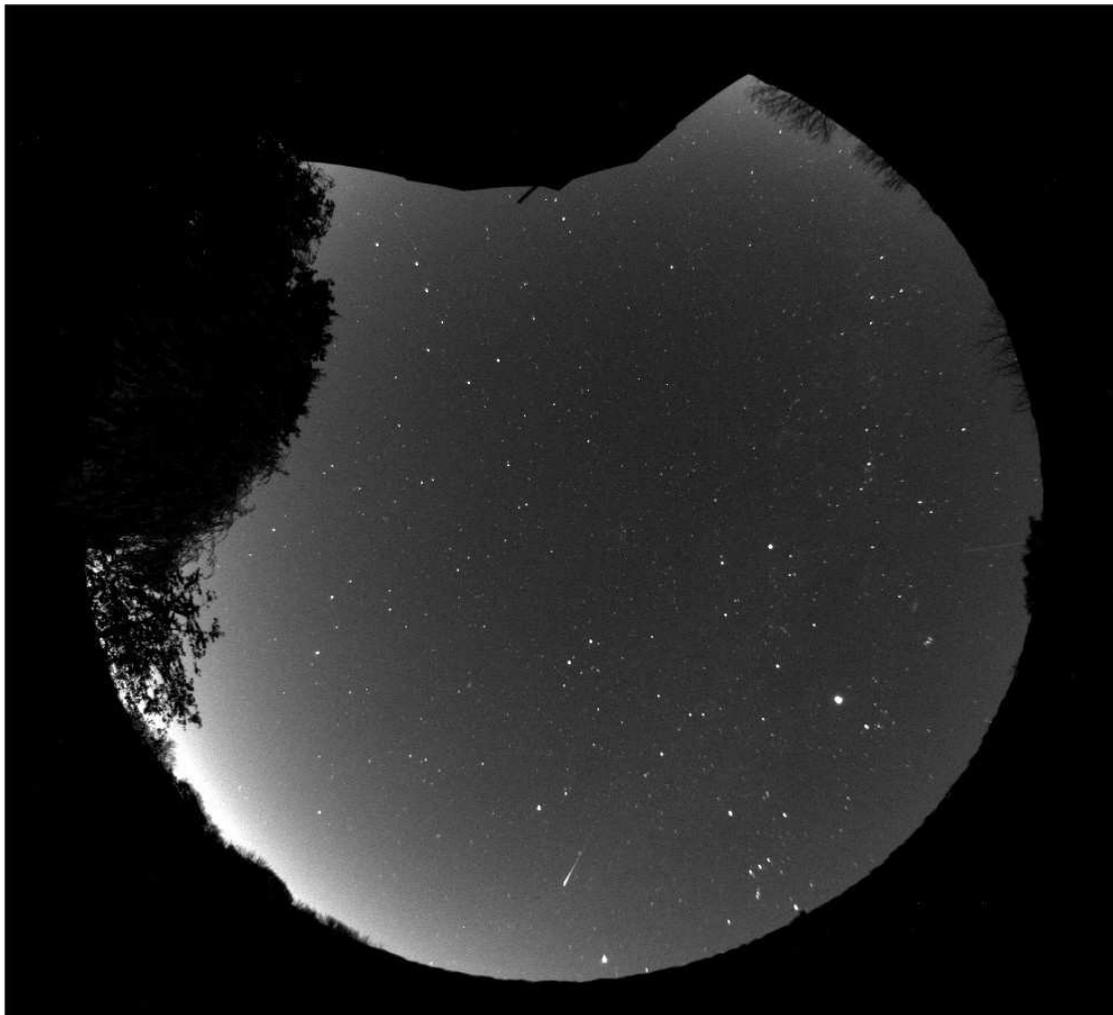
Once the position and focus are good, try running an image sequence in 'Autosave' mode. An exposure time of 30 seconds is generally good for basic sky monitoring, but shorter exposures might be better to minimise sky glow when meteor imaging. Set up a suitable number of image frames in the 'No. of exposures' box and check the 'Autosave' box. Pressing the 'Take Photo(s)' button will now start a sequence and save the images as FITS files into your chosen Autosave folder. Clearly, a lot of images will occupy a great deal of hard disk space, so make sure that you have plenty available! The maximum autosave number for AVI creation, is 1000 images and this will cover about 8 hours of 30 second frames, while filling about 1GB of hard disk space. For tidiness and avoiding any mixing of old and new images, I recommend pressing the 'Empty current directory' button before starting your sequence. **If you want to keep a previous session of saved images, you must move them to another folder before starting a new sequence with the Oculus.** Your images will be saved in the Autosave folder as numbered FITS files – IMG1.FIT, IMG2.FIT etc. and will be added to any that are already there.

Most users will probably not need dark frame subtraction to get a satisfactory result, but this option is available if you need to suppress any hot pixels etc. Cover the Oculus dome with a black cloth or opaque container and then take an exposure to match the length being used in your image sequence. The resulting dark frame should be saved to c:\dark.def and the 'Auto remove dark frame' check box selected in the camera menu. The dark will then be subtracted from all future images. Note that the dark noise is temperature sensitive and so you will get cleaner images if the Oculus is cold. Unfortunately, if the air is humid, this is also likely to lead to dew or frost forming on the dome, so you might find that running with the heater on is often necessary, and this is where dark frame subtraction can be particularly useful. Another option is to create a 'Hot pixel map' and apply this to your images when creating an AVI file and this will be described below.

After an imaging session, you will probably want to view a movie of the entire sequence to look for interesting events. This is easily done by creating an AVI file from the stored FITS images. Open the 'File' menu and select the 'Create AVI from FITS files' option. The best results will be obtained if you adjust the visualisation of a sample image to give the best view, using the Max palette stretch options in the 'View' menu. Adjust the brightness and contrast to give a nice result and then run the AVI create. The program will use your view settings on all the images while creating the movie file. The AVI

generator will add an image file number at the bottom left of your AVI images and this can be useful when searching for frames that contain interesting events. Some software, such as 'Windows Media Viewer', will sometimes hide this legend behind their control slider and so I recommend checking the 'Frame label offset' option to shift it up by about 200 lines. You will see that a 'Hot pixel map' can be applied to your AVI frames during AVI generation. This will remove the random hot pixels which are always present in CCD images, without affecting the rest of the image frame, and so may be preferred to dark frame subtraction. To use the hot pixel removal, you need to record a fairly long exposure dark frame (say 60 seconds) and then open the hot pixel map generator from the 'Edit' menu. The slider will permit you to set a threshold for the hot pixels and you should adjust this so that it detects no more than 100, or so. Setting it too low will damage your image quality. Record the resulting map and then select this from the AVI generator menu.

As your source images are unaffected by the creation of the AVI, you can search through them for meteors, satellites etc., as seen in the AVI, and then select, process and save these images to another folder.



Oculus maintenance

The Oculus head is designed for a long and reliable lifespan and needs very little maintenance to keep it in good working order. The only common issue is with dust and dirt particles which collect on the dome and can shade areas of the image field. These are best removed with a quick blast of compressed air from a 'Dust off' aerosol, or similar air blower. More permanent marks may be removed with a drop of spectacle lens cleaner on a soft cloth. Try to avoid vigorous rubbing, especially when removing

gritty dirt, or you may scratch the plastic. A spare dome is supplied with the Oculus and replacements may also be purchased from our dealers.

The Oculus dome is spaced off from the base ring by small pads. This allows air to circulate through the vent holes and inside of the dome, to reduce the tendency for dew to condense on the inner surface. Please ensure that these pads remain in place when removing the dome for cleaning.

Dear User,

Thank you for purchasing a Starlight Xpress CCD Imaging product. We are confident that you will gain much satisfaction from this equipment, but please read carefully the accompanying instruction manual to ensure that you achieve the best performance that is capable of providing.

As with most sophisticated equipment a certain amount of routine maintenance is necessary to keep the equipment operating at its optimum performance. The maintenance has been kept to a minimum, and is fully described in the manual.

In the unfortunate instance when the equipment does not perform as expected, may we recommend that you first study the fault finding information supplied. If this does not remedy the problem, then contact Starlight Xpress for further advice. Our message board service on the Starlight Xpress web site will often provide solutions to any common problems.

The equipment is covered by a 12-month guarantee covering faulty design, material or workmanship in addition to any statutory Consumer Rights of Purchasers.

CONDITIONS OF THE GUARANTEE

- 1) The equipment shall only be used for normal purposes described in the standard operating instructions, and within the relevant safety standards of the country where the equipment is used.
- 2) Repairs under guarantee will be free of charge providing proof of purchase is produced, and that the equipment is returned to the Service Agent at the Purchaser's expense and risk, and that the equipment proves to be defective.
- 3) The guarantee shall not apply to equipment damaged by fire, accident, wear and tear, misuse, unauthorised repairs, or modified in any way whatsoever, or damage suffered in transit to or from the Purchaser.
- 4) The Purchaser's sole and exclusive rights under this guarantee is for repair, or at our discretion the replacement of the equipment or any part thereof, and no remedy to consequential loss or damage whatsoever.
- 5) This guarantee shall not apply to components that have a naturally limited life.
- 6) Starlight Xpress's decision in all matters is final, and any faulty component which has been replaced will become the property of Starlight Xpress Ltd.

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