DAYSTAR FILTERS CALCIUM QUARK

Congratulations on your purchase of a Quark Calcium “Eyepiece” solar filter, designed specifically for compatibility with F/7 or greater Refractor telescopes. Please read this manual before using the product.

To use the filter, plug in the included power supply. Then insert the Quark and insert an eyepiece or camera in the rear of the Quark. Turn the knob to point straight away from the light. When the light turns green in about 5-15 minutes your viewing experience can begin.

To prevent damage, we strongly recommend using a UV/IR cut filter over 80mm of aperture.



Warnings:

Do not disassemble the filter, the blocking element is separated from the etalon and the complete assembly must be used together for safe viewing.

Do not power the filter from a computer or cell phone charger as the Quark requires a high current power supply (> 1.5A) for operation.

For assistance:

Call: 1 (866) 680-6563 Email: service@daystarfilters.com
Visit: http://www.daystarfilters.com

Cautions & Warnings:

There are no user serviceable parts inside the Quark. Do not disassemble the unit. Certain components are under pressure and disassembly can cause permanent damage. All elements are required for proper operation and removal of any internal component will cause a malfunction that could result in unfiltered light which can cause blindness or damage to equipment.

Solar Observing with a telescope is sensitive to certain risks.

- Caution and care of the telescope and filter is advised in assembly, use and dismantling at all times.
- Telescope owners must use caution when affixing the filter to the telescope never to point any telescope at the sun without the solar filter safely installed first.
- While observing, owners must take care and caution that all parts of the filter and telescope assembly are properly affixed and that no pieces have been opened, tampered with or removed.
- **Owners must also use caution when the telescope is being assembled and dismantled to assure the telescope is never pointing at the sun without the solar filter properly installed.**
- Responsible owners will be prudent to inform guest or novice observers of the special nature of the telescope configuration so not to imply that telescopic observing of the sun is safe without proper filtration.

A few very important points that owners and operators must understand:

- DayStar Filters are interference filters. **If light reaches a DayStar Filter at an angle, it will cause wavelength wing shift.** For our application on a telescope, DayStar owners need F/7 to F/30 light. This model of Quark is designed only for use on F/7 or slower refractor telescopes.
- **DayStar filters are temperature sensitive.** Changing the temperature will change the wavelength (CWL) that the filter will transmit. Users need to be aware of temperature tuning issues.

USAGE:

The Calcium Quark has a standard eyepiece snout so that it can be inserted directly into the eyepiece drawtube.

The filter must be plugged in using the supplied power supply. The etalon cavity is precision heated to regulate the wavelength of the filter output.

Any other USB power source you wish to use must be rated for at least 1.5 amps at 5 volts. Computer USB ports and cell phone chargers do not normally support this much power.

After letting the filter come up to temperature and settle, the light will turn green and viewing can begin.

Because the Quark requires additional backfocus, you will need to dial the focus knob inward quite significantly. Included with the Calcium quark are three front snouts that will allow you you extend or compress the amount of backfocus used by the Quark by changing which snout is threaded onto the front of the Quark:

Standard configuration (silver 1.25” snout): 67mm backfocus
2” front snout: 61mm backfocus.
1.25” black extension snout: 99mm backfocus. Remove diagonal.

If your telescope has limited focus travel and none of the included snouts permit reaching focus, you may need to use a 1.25” diagonal instead of a 2” diagonal, or you may need to remove the diagonal entirely in order to reach focus.

Knob tuning:

A knob is provided to adjust the center wavelength of the filter. Turn the knob counter clockwise to lower the wavelength towards the blue by up to 0.5Å. Turn clockwise to raise the wavelength towards the red by up to 0.5Å. Each click of the knob is 0.1Å.

Little change will be visible within 1.0Å of CWL range, as the Calcium II H line is very wide.

Additional tuning can be performed, just keep in mind that after every adjustment of the knob the filter must settle in temperature for approximately 5-10 minutes before your change becomes effective.

Tuning can also be used to observe Doppler shifted features moving towards or away from you. A feature moving towards you will be brighter in blue (counterclockwise) wing shift, away from you will be reddened (clockwise knob tuning).

ENERGY REJECTION:

Energy Rejection Filters reduce the heat load on your filter assembly by absorbing or reflecting UV and/or IR light and transmitting light in the visual spectrum.

Note that Red and Yellow glass ERFs are NOT compatible with the Calcium Quark as they do not pass the Calcium wavelength, by the nature of colored glass.

Please note, a Herschel Wedge or white light filter cannot be used with the Quark. Those filters block 99.999% of all light, including the desired Calcium H light.

REFRACTORS:

For brief observing sessions using refractors with less than 80mm of aperture when not using a tracking mount, no rejection is necessary. Be alert for any rise in temperature of your telescope, diagonal, or Quark.



For telescopes under approximately 150mm of aperture, a screw in UV/IR cut filter can be employed in front of the telescope diagonal. The UV/IR cut filter reflects UV and IR light back out the front of the telescope, reducing temperatures inside. Note that Calcium falls outside the passband of some UV/IR cut filter designs, so always verify that a prospective UV/IR filter passes 397nm before purchasing.

Observing with over 150mm of aperture requires consideration of multiple factors, please consult with DayStar for advice specific to your situation.

Calcium H versus Calcium K:

Traditionally, university research has employed the Calcium K line for studies of Calcium on the Sun. These studies have been instrumental in determining depth of the solar atmosphere. Calcium offers TWO strong absorption lines at 393.3nm and at 396.9nm, known as the K and H lines. Researchers originally avoided the H line for academic research, as it is very close to the Hydrogen Epsilon line.

However, as the visual spectrum ends at approximately 400nm, the further we venture below this wavelength the more difficult it is for observers to visually see the image. For visual observations the H line is closer to the visual spectrum and easier to see in high contrast violet color while offering the same features as K line. We have found many older viewers are able to see H visually when they cannot see K. For imagers, H offers improved quantum efficiency, higher glass transmission, and superior performance from typical antireflection coatings. H line offers slightly more visible features due to the Hydrogen contribution. For strong wing shifts, H offers spectroscopically cleaner wings than K, simplifying data interpretation at H. Stunning images from the Hinode spacecraft and Dutch Open Telescope have further popularized the H line in recent years. For all of these reasons, we are offering the Calcium Quark in H line.

How it works:

Light from the telescope enters the blocking filter, where wavelengths near Calcium H are transmitted while the rest are reflected back out. Violet Calcium H light then passes through the Etalon. The Etalon passes a very narrow range of light wavelengths, but it is sensitive to temperature and light angle. In the Quark, the Etalon is heated to approximately 100-150°F to control the wavelength passed, and the slow focal ratio of the telescope controls the angle of light entering the Etalon.

Care and cleaning:

While not in use, we recommend that users store the Quark with its end caps on, in a climate controlled environment. The optical filter life expectancy is extended up to 2-3 times by climate controlled storage.

Do not touch the internal, optical elements of the filter assembly. While the exterior glass surface coatings are durable, they are easily scratched. A few specks of dust will have no effect on the quality of the image, and may be gently blown off with a squeeze bulb. Do NOT use compressed air cans to blow dust off any optical surfaces. Small amounts of residual 'film' will not affect visual performance. Fingerprints, smudges and smears must be cleaned off. Preferred cleaning method is to return the Quark to the DayStar Filters laboratory for proper factory cleaning.

Do not unscrew, open or separate your Quark filter assembly. The optical elements are held under pressure by design and will become damaged if opened. Opening the optical filter assembly will void your warranty. The safest cleaning method is to moisten a very soft, lint-free tissue, cloth or "Qtip" with a pure acetone, methanol, or Isopropyl Alcohol (reagent grade) and gently whisk away the stain. Do not apply solutions directly to the glass surface. Stroke from the center of the aperture outward only. After each cleaning stroke, use a fresh applicator. The fewer strokes, the better! The metal housing and other non optical parts are anodized surfaces and can be cleaned with Windex.

Maximizing the viewing experience:

Daytime viewing results in stray light entering your eye that can make it hard to see through the filter. We recommend a viewing hood or cloth be placed over your head to limit the stray light that enters your eye, allowing fainter prominences and more surface detail to be observed. A comfortable chair also improves the experience, allowing the eye to stay steady for longer periods so as to pick out more subtle details on the surface of the Sun.

Eyepiece Selection:



Daystar Recommends Tele Vue Plossl series eyepieces of 12mm to 32mm.

Remember that at long focal ratios, a high powered eyepiece can exceed Dawes' limit. Observers will find best results with an eyepiece which is 12mm or greater to avoid this. Eyepieces of higher power will result in a fuzzy disk without the ability to focus well.

Not all eyepieces are designed for the Calcium wavelength. Antireflective coatings may not be efficient at this wavelength. Lens prescriptions may not be optimized for the lowest possible aberrations at Calcium. Experimentation is recommended for best results.

We have tested a number of eyepieces over the years. We performed a comprehensive eyepiece comparison between various brand names and eyepiece styles. Naglers, zooms, radians and other "fast" eyepieces typically perform very badly on DayStar applications.

Other brands do offer Plossl eyepieces and they can give a respectable performance in lieu of a Tele Vue. We have also found some of the very old wide field "Erfle" eyepieces aren't bad for an experienced observer. It should be noted that repeatedly in side-by-side tests, we found Tele Vue brand Plossl eyepieces to offer the highest contrast, most even view and widest exit pupil. In Solar Observing, contrast is achieved by control of scattering. Tele Vue Plossls stand out in superior design. Furthermore, the adjustable eye cup offers additional contrast by allowing the user to dark adapt during sunny days.

Eyepiece features we found to increase performance include:
- "Fully Multicoated" - Of those eyepieces which did better than others, those marked "fully multicoated" offered better views from less internal scattering.
- Blackened optical edges - Tele Vue and other eyepieces which performed better all had blackened edges of their optical elements. This also reduces internal scattering within the eyepiece.

About Seeing Limitations and Resolution:

Solar observing seeing conditions vary greatly from nighttime conditions. During the daytime, radiant heating from the sun affects seeing significantly. Characterized by turbulence or shimmering as seen over a hot street, seeing can cause significant impact on quality of solar observations.

- Bad seeing is caused by air of different temperatures mixing. This typically happens within the lowest 10 feet of air. It occurs most often over pavement, dark objects, rooftops and sometimes trees.
- High cirrus clouds or “scuzz” will cause scattering of sunlight in the high atmosphere which often makes for bad viewing conditions. A classic sign of high cirrus clouds is the inability to achieve focus, or the need to “chase focus”, or a lack of contrast. Calcium is particularly susceptible to poor transparency.

- A jet-stream moving overhead can also hurt seeing conditions even on a clear day.

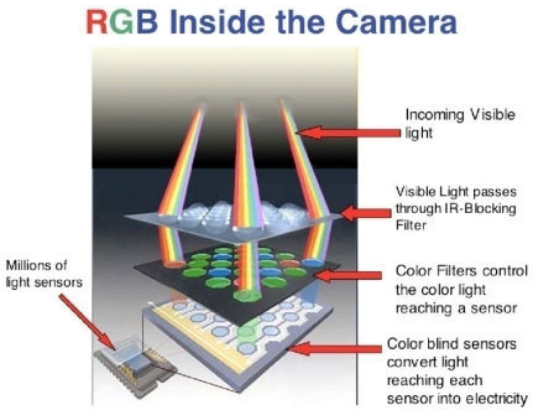
DayStar Filters are high power viewing platforms and this high resolution can be susceptible to seeing issues. Solar Observers using high powered, high resolution telescopes and DayStar filters should heed daytime seeing. While many of these conditions are beyond our control, observing in an area with ideal conditions, without pavement in the direction of viewing, and on days with no high cirrus will offer best results. Grass is the best environment for daytime seeing stability.

Each observing location offers different behavior for daytime seeing cells at different times of the day, as the air through which one views changes with movement of the sun. Some locations benefit from best seeing in the morning, while many have best seeing in the afternoon. Because most heat variation between air and ground surfaces occurs within the first 10 feet above the ground, often a high observing platform will offer superior seeing. This might include a second story deck which overlooks grass.

Solar Imaging Tips:

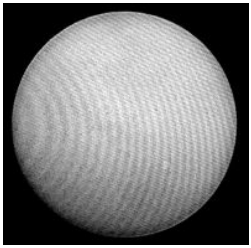
Daystar recommends MONOCHROME CCD imaging whenever possible for best results. The recent availability of CCD cameras and DSLR cameras has offered a simple opportunity for solar observers to image the Sun in Hydrogen Alpha or Calcium with a Digital SLR camera.

Please be advised, however, that due to the nature of monochromatic light and its effects on a CCD camera, certain negative effects are likely to occur.



The DSLR imager must be aware that most camera manufacturers (Canon and Nikon) use an IR blocking filter which greatly reduces the transmission of Hydrogen Alpha light. DSLR cameras without this IR blocking filter will have better sensitivity imaging in Hydrogen Alpha.

The imager should also appreciate that even after considering IR blocking filters, that the COLOR CCD chip is constructed in a way that only 1 in 4 pixels detect red light. The other 3 sensors only detect blue and green because the pixels are actually permanently covered with a colored dye for each corresponding color. So a color CCD chip (in a DSLR or a CCD camera) will only offer 1/4 the sensitivity and 1/2 the resolution of a monochrome chip.



Another effect present in CCD imaging of monochrome light of Hydrogen Alpha or Calcium H is the interference pattern - or Newton's Rings. The effect is similar to interference testing of an optical surface between two flat surfaces. The sensor and cover slip cause a small interferometer inside the camera and cause a Newton's Ring moire' pattern. The CCD chip must be tilted to a minor degree to prevent this pattern. Recent advances in aftermarket adapters offer a simplified solution for the issue. This effect is a concern for both color and monochrome sensors.

An optional accessory is available from DayStar (MG-0408) which can be used between the DSLR and Quark to adjust the light angle and extinct the interference pattern.

Exposure time:

Imaging solar vs. nighttime astrophotography is very different. Dark sky imaging requires long exposure times to capture enough light. Solar imaging offers ample light, so exposures should be very short. Plus, fluctuations in seeing dictate that short <1/10 second frame rates will be better, as seeing cells move quickly to distort the image and can come and go during a long exposure.

- Short exposure webcam imagers are better than long exposure CCD cameras when imaging the sun.
- Because the sun has a range of brightnesses, automatic exposure doesn't work well. A software interface that allows the user to control the exposure settings manually is very important.

Exposures for prominences taken through a DayStar with a webcam style camera might be about 1/15 – 1/100th of a second. Exposures for surface detail would be even shorter exposure with about 1/300 to 1/500th of a second.

Bit depth:

Solar activity encompasses a wide dynamic brightness range from bright solar flares to faint eruptive or floating prominences quite a distance from the solar limb. In order to capture all these features, we recommend the use of 12 bit or 16 bit cameras. Normal 8 bit cameras can be used, but will typically only be able to image either the surface or prominences, necessitating multiple bracketed exposures and subsequent recombination in a computer. 12 bit or 16 bit cameras enable capturing these features in the same exposure, simplifying the image processing.

Focal reducers:

Because of the long effective focal length at the output of the Quark, the image scale will be quite large and small (1/2" or below) image sensors will only capture a fraction of the whole solar disk in one frame. Large pixel sizes (9 microns and above) will enable a larger field of view.



Alternatively, a focal reducer can be employed between the Quark and the camera. Simple 1.25" screw in focal reducers can be attached to the camera nosepiece to allow a wider field of view with small (1/2", 1/3", ¼") sensor cameras. More distance between the focal reducer and camera surface will result in more focal reduction and larger field of view.

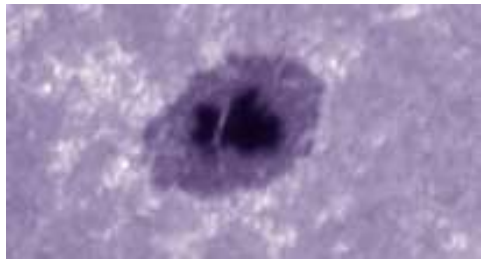
Features of the Sun in Calcium:



By observing the sun with a narrow bandpass filter tuned to 3968.5Å, we can observe the behavior of the Sun's **Chromosphere**. The chromosphere is like a shell of gas around the Sun's photosphere, always moving and changing. The chromosphere's structure behaves differently in active regions than quiet areas, where magnetic field lines are stronger. Thought to be tied to the photosphere, the chromosphere is governed by magnetic forces and, yet it still has its own IntraNetwork (IN) of material oscillating every 5 minutes.



Plages/Faculae: Most of the active region area is occupied by plage. Considerable atmospheric heating takes place in the plage. It is bright in everything from Halpha to the Calcium H and K lines. This heating is thought to account for an absence of spicule. While absent over plage, spicule are prominent around its edges.

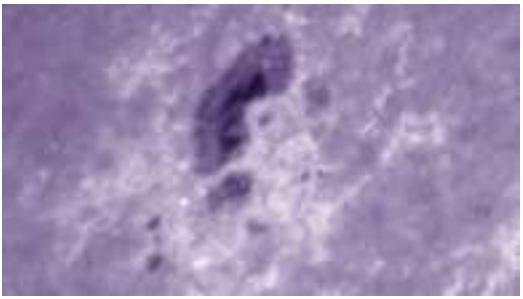


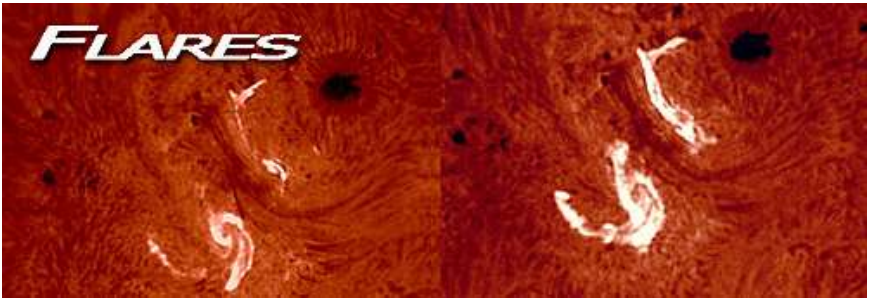
Sunspots: Dark spots on the Sun are areas of high magnetic fields which have a cooler temperature. The darkest central region is called the umbra, and the lighter region ringing the umbra is the penumbra.

On the limb you may see **prominences**, a detail of the chromosphere projected against the dark black contrast of space. Prominences are typically much fainter in Calcium than in Hydrogen Alpha. Filaments are Prominences seen on the disk of the Sun and are a challenging observation at Calcium.



Active Regions are a concentration of magnetic acitivity with several types of features contained in a close area.





Solar Flares are intense, abrupt releases of energy which occur in areas where the magnetic field is changing by flux emergence or sunspot motion. Stresses in lines of force build up slowly and are released in flares. They occur most frequently at neutral lines where a filament is supported by horizontal sheared field lines. This event can only take place along a magnetic inversion line. When many lines of force are involved, two ribbons of emission appear, brightening simultaneously.

Troubleshooting:

Blank, featureless disk:

Ensure power is applied and LED is green.

Try moving focus in and out significantly, up to three inches (76mm). It may be necessary to remove your diagonal, and view straight through.

Make sure a 12 to 32mm eyepiece (not included) is installed.

Ensure knob is pointing straight away from the power jack.

Check for droop, all connections between telescope and Quark must be tight and square.

Dim, dark view:

Ensure UV/IR cut filter passes 397nm with a good transmission.

Wear a hood to block ambient light.

Reconfigure telescope to a faster focal ratio.

Poor contrast:

Check that optical surfaces are clean. Dust specks do not affect the view, check for smudges such as oil from fingerprints.

Try adjusting wing shift knob up 3-4 clicks clockwise past center and wait 5-15 minutes. If that does not improve the view, try down 3-4 clicks below center and wait 5-15minutes.

Atmospheric seeing or transparency may be poor, try again later.

Blurry image:

Blurry views are typically due to poor seeing. Poor seeing can be caused by the presence of heat waves from concrete, asphalt, or machinery. Weather effects like the jet stream can also cause blurring. Try moving to a different location or else observe on a day when weather conditions are improved.

Yellow LED indication:

Your filter is adjusting to the wavelength chosen by the knob. Wait approximately 5-15 minutes for the temperature to adjust and then light should turn green, indicating that the filter has settled to its required temperature and is on band for viewing.

Yellow, never goes green LED indication:

If after 20 minutes of the same knob position setting the LED has not turned green, the ambient temperature may be too hot or too cold for the Quark to regulate the temperature. However, the filter may still be usable while slightly mistuned and performance may not be affected.

This can also occur if plugged into a computer USB port, which causes the filter heater to reduce its current draw. Use the supplied power adapter or a source rated for 1.5 amps, not a data USB port.

Red LED indication:

This usually indicates that the Quark is not receiving enough voltage. If powered by battery, recharge the battery. Make sure to use the supplied AC/DC wall adapter, as cell phone chargers and PC USB ports do not have enough current capability for the Quark.

Red indication can also mean an electrical fault in the Quark electronics. If power source changes do not resolve the red indication, please return the Quark to DayStar for inspection and repair.

Specifications:

Wavelength:	3968.5Å (H line)
Tuning knob:	Wing shift +/- 0.5Å in 0.1Å increments.
FWHM:	5Å.
Compatibility:	F/7 to F/30 Refractor telescopes in full aperture.
Backfocus:	Requires refocusing 61, 67, or 99mm inwards.
Blocking filter:	Integrated 25mm blocking filter
Clear aperture:	19mm clear etalon aperture
Full disk:	Passes full solar disk for focal lengths under ~1800mm.
Aperture limit:	None, usable on large telescopes for high magnification. For apertures over 80mm, suggest UV/IR cut filter.
Sun side:	1.25” snout, 1.25” extension snout, or 2” snout.
Eyepiece side:	1.25” female drawtube. Brass compression ring to protect eyepiece. Optional 2" and SCT accessories available.
Power:	USB power, 5v 1.5amp, female Micro-B connector. Power is required for proper operation.
Wall adapter:	90-240VAC wall adapter, includes US, UK, Euro and Australian plugs.
Opt. battery:	Optional 8-hour battery pack available.
LED indicator:	Yellow: temperature settling. Green: ready to observe, filter on band. Red: fault such as low voltage.
Settling time:	Approximately 5-15 minutes after power up or change of wing shift.
Temperature:	Ambient temperature range 40°-100°F
Dimensions:	55mm diameter x 71mm x 91mm long.
Includes:	Quark filter, wedge adapter, power supply, user manual.
Warranty:	5 years

*All dedicated solar tracking applications should employ energy rejection

FCC Notice:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna. Increase the separation between the equipment and receiver. Connect the equipment into an outlet on a circuit different from that to which the receiver is connected. Consult the dealer or an experienced radio/TV technician for help.

Correct Disposal of This Product:



(Waste Electrical & Electronic Equipment)
(Applicable in the European Union and other European countries with separate collection systems)
This marking shown on the product or its literature, indicate that it should not be disposed with other household wastes at the end of its working life. To prevent possible harm to the environment or human health from uncontrolled waste disposal, please separate this from other types of wastes and recycle it responsibly to promote the sustainable reuse of material resources. Household users should contact either the retailer where they purchased this product, or their local government office, for details of where and how they can take item for environmentally safe recycling. Business users should contact their supplier and check the terms and conditions of the purchase contract. This product should not be mixed with other commercial wastes for disposal.

Copyright:

This manual copyright © DayStar Filters 2016-2026, all rights reserved.

Warranty:

Blockers and trimmers are considered a wear item and only warranteed on a pro-rated five year term.

Warrantor: DayStar Filters LLC
Elements of Warranty: DayStar warrants, for five years of the original retail purchase owner, this Product to be free from defects in materials and workmanship with only the limitations or exclusions set out below.
Warranty Duration: This warranty to the original user shall last for one year of the original user. The warranty is invalid if the Product is (A) damaged or not maintained as detailed in Operating and Maintenance Manual (B) modified, altered, or used as part of any conversion kits, subassemblies, or any configurations not sold by DayStar, or (C) serviced or repaired by someone other than the DayStar Filters Service Center for a defect or manlfunction covered by this warranty. This warrantee includes shipping to and from any point inside the United States. Insurance upon that shipping and/or international shipping and/or any customs and/or import duties attached are the sole responsibiltiy of the owner.
Statement of Remedy: In the event that the product does not conform to this warranty at any time while this warranty is in effect, warrantor will repair the defect and return it to you without charge for parts, service or any cost incurred by the warrantor in connection with the performance of this warranty. THE FIVE YEAR WARRANTY SET FORTH ABOVE IS THE SOLE AND ENTIRE WARRANTY PERTAINING TO THE PRODUCT AND IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES OF ANY NATURE WHATSOEVER, WHETHER EXPRESS, IMPLIED OR ARISING BY OPERATION OF LAW, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. THIS WARRANTY DOES NOT COVER OR PROVIDE FOR THE REIMBURSEMENT OR PAYMENT OF INCIDENTAL OR CONSEQUENTIAL DAMAGES.
Procedure for obtaining performance of warranty: Upon discovery of flaw, we require that the user communicate by telephone and/or email to the DayStar Service department to report the failure of equipment. Should technical support be unable to resolve the conflicts of the product, it should be packaged in its original packaging and returned with evidence of original purchase and note describing defect to include owner contact information. The product should be shipped freight pre-paid by traceable means or delivered to warrantor at:

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