DEEP SPACE COOLER OPERATING INSTRUCTIONS

Please read all of the instructions and warranty information below before using your Deep Space Cooler modified DSI camera. These instructions pertain to the Deep Space Cooler standard, Plus and Extreme models.

USING THE DEEP SPACE COOLER

Operation of the Deep Space Cooler is easy. Simply connect the handheld temperature controller to the Deep Space Cooler with the five pin cable which will snap tightly into the receptacle on the bottom of the DSI camera near the USB port. It will only plug in one way. Then plug the power supply into a wall socket or DC to AC power inverter. Connect the power supply to the handheld temperature controller and you are ready to go. The temperature controller display will turn on and show the current temperature of the camera (note that the temperature may be slightly different than that indicated by the Meade software due to the location of the temperature sensors). If you plug the power supply and the handheld temperature controller in before the controller is connected to the camera, the display will read EEEE. This just indicates that there is no sensor connected to the controller. The display will change to the current camera temperature once the controller is connected to the Deep Space Cooler. When you are finished imaging, just unplug the Deep Space Cooler.

The Deep Space Cooler may also be powered from a DC battery power supply. You will need to supply your own power cable to do this. Keep in mind that the thermoelectric

cooler at the heart of the Deep Space Cooler can be fairly power hungry (12 volts DC at 3 amps) so you may only get a few hours of operation from your battery depending on its rating.

There are four keys on the front of the handheld temperature controller, 

,  ,  and  .

Temperature Setting

To set the desired temperature, use the  and  keys. Holding a key down for five to ten seconds will cause the temperature to scroll quite rapidly. A couple of seconds after you release the  or  key the display will revert to the current temperature. To view the set temperature, just briefly press the  or  key.

It may take up to 20 minutes for the cooler to stabilize. It will typically overshoot the set temperature by up to 1.0 degree before it stabilizes. There is no specific suggested temperature setting for the Deep Space Cooler. A good way to decide on the temperature to set the Deep Space Cooler at is to determine what the dew point is going to be in your area and set the Deep Space Cooler to a couple of degrees above that temperature. Depending on where you live you may be able to get the projected dew point from various internet sources, or find a website that will help you calculate the dew point based on temperature and humidity levels. Setting the Deep Space Cooler at a temperature above the dew point will help avoid condensation on the front of the CCD. Another possibility is to determine the average dew point for your area and try to use one temperature setting that will always be at least slightly above that temperature so that the same temperature setting can be used for multiple imaging sessions. If, while operating the camera with the Deep Space Cooler, you observe significant condensation forming on surfaces of the camera, it is strongly recommended that the operating temperature be increased to avoid potential damage to the DSI should condensation form on the circuit board in the camera (see warranty terms below).

Decreasing the air space directly in front of the CCD chip cover will help to decrease fogging when operating the Deep Space Cooler below the dew point. One way to decrease the air space is to use an adapter on the front of the DSI Pro like the one from ScopeStuff. That adapter allows you to insert a filter like an IR filter or a plain optical glass filter very close to the front of the CCD chip cover. Sealing around the adapter with silicone sealing will then decrease the amount of moisture that can reach the coldest exposed part of the DSI. A rubber gasket has been included (or installed) to place between the camera and a ScopeStuff adapter to help provide a better seal with a filter.

The Deep Space Cooler's full cooling capability will be dictated by the ambient temperature since the thermoelectric cooler can only cool to maximum of approximately 45 ºF below ambient. Thus, if it is 100 ºF outside, the maximum cooled temperature will be higher than if it is only 80 ºF outside. Furthermore, the higher the ambient temperature, the harder it is for the thermoelectric cooling system to dissipate heat through the heat sink so the full temperature range of the Deep Space Cooler may be reduced. Also, keep in mind that the camera produces an additional 10 to 15 ºF of heat that must be dissipated by the Deep Space Cooler and thus, if the outside temperature is 80 ºF, the true ambient temperature from which you are cooling is actually at least 90 to 95 ºF so that the approximate maximum cooled temperature would be 45 to 50 ºF.

The most efficient maximum cooled operating temperature to set the Deep Space Cooler is 2.5 to 5 ºF or more above the maximum capability of the Deep Space Cooler since this allows the Deep Space Cooler stabilize the temperature and adjust for changes in the ambient temperature (which may come from air temperature or more likely from CCD heat generation.

Using the Variable Fan Speed Mode

The Deep Space Cooler will arrive set to normal, high-speed fan mode. This mode provides the greatest amount of cooling capability. When using the Deep Space Cooler while imaging objects like double stars and planets with high power (e.g., on a long focal length scope like a 10-inch SCT without a focal reducer and/or with a Barlow), it may be advantageous to have the fan run at a lower speed to reduce the potential for vibration

(some scope and mount combinations may experience vibration while some will not). On lower-power, wide-field imaging vibration generally will not be an issue but the variable fan speed mode may still be used if desired. However, the maximum cooling capability of the Deep Space Cooler will likely be reduce when using the variable fan speed mode.

To use the variable fan speed mode complete the following steps:

1. Decide on your desired set temperature (for example, 65.0F).
2. Plug in the power to the controller without connecting it to the camera.
3. The display will read "EEE.E." Use the ▲ or ▼ keys to select your set temperature.
4. Press SET and the display will read "0000." Use the ▶ key to move to the forth character of the display.
5. Use the ▲ key to change the forth number of the display to the number "1" so that the display reads "0001."
6. Press SET and the display should read "Su." (If you press SET here the controller will display your set temperature).
7. Use the ▲ key to change the display to "AH1" and press SET.
8. Use the ▲ or ▼ keys to change this digit to "0."
9. Use the ▶ key to move to the to the right one digit and then use the ▲ or ▼ keys to change this digit to the first digit of your set temperature. (Note: you will generally never set the first digit to a "-" except if you are cooling below zero F or C).
10. Repeat the same for the third and forth digits of the display (e.g., "065.0"). Once the display is set to your set temperature, press SET.
11. Use the ▲ key to change the display to "AL1" and press SET.
12. Repeat the procedure from 7 and 8 above to set a temperature one degree above your set temperature (e.g., "066.0"). When finished, press SET.
13. Use the ▲ key to change the display to "End" and press SET.
14. Plug the controller into your camera and begin cooling as described above.

The Deep Space Cooler with now cool to your set temperature (and a little below) and then stabilize. When the cooler reaches the set temperature, the fan will switch from high speed to low speed. The fan will continue to operate a low speed until either the cooler temperature rises at least one degree above your set temperature and then it will return to high speed. When you turn off the Deep Space Cooler and the temperature rises to at least one degree above your set temperature, the cooler will automatically return to high speed mode. However, the AH1 and AL1 temperatures that you set will remain the same so that the next time you turn the Deep Space Cooler on, it will return to the same set temperature and fan mode.

To return the Deep Space Cooler to normal, high-speed fan mode, repeat the steps 4 through 13 above only this time, set "AH1" to any temperature well above ambient (for example, 166.0F) and set "AL1" to the same temperature. The Deep Space Cooler will now operate in normal, high-speed fan mode only.

Switching the Controller Between Fahrenheit and Celsius

To change between Fahrenheit and Celsius display complete the following steps:

1. Press SET then use the ▶ key to move to the third character of the display.
2. Use the ▲ or ▼ keys to change the third number of the display to the number "8".
3. Press ▶ again and use the ▲ or ▼ key to change the fourth number of the display to the number "9". The display should then read "0089."
4. Now use the ▲ or ▼ key to scroll until the display shows "CorF".
5. Press SET and then use the ▲ or ▼ key to change between "1" and "0" where "1" will display temperature in Fahrenheit and "0" will display temperature in Celsius.
6. Once you have made your selection, press SET again and use the ▲ or ▼ keys to scroll to "End" and press SET again.

CAUTION: DO NOT CHANGE ANY OTHER SETTINGS IN THIS MODE.

If you accidentally change one of the other values the following table depicts what the values should be.

Code	Setting
IntY	P10.0
outY	2
AtdU	10
PSb	0
rd	1
CorF	1 or 0

Operating the Camera Without the Deep Space Cooler Operating

While the camera may still be operated without the Deep Space Cooler turned on, doing so is not recommended. Without the Deep Space Cooler turned on, the camera will have little ability to dissipate heat generated by the CCD chip since the camera back is now insulated and the heat sink is separated from the camera by the ceramic thermoelectric cooler. Thus, heat will tend to build up and the noise level will increase. The actual heat generated by the camera is relatively minor so there should be no harm to the camera, just noisy pictures. However, continued operation of the camera without the Deep Space Cooler may over time effect the camera's performance.

USING THE DEEP SPACE DRIER, SINGLE-STAGE AIR DRIER (DSC Plus Model)

The Deep Space Drier, Single-Stage Air Drier, is supplied with the Deep Space Cooler Plus and is very easy to use. It consists of a small aluminum water vapor condenser chamber (aluminum box with two hose barbs) connected to an air pump and the camera. The Deep Space Cooler may be used according to the instructions above with or without the Deep Space Drier. You will need to obtain a small beverage cooler (any type will do) and some 1/8" ID flexible vinyl tubing. I recommend using the kind found at pet supply stores for fish tank air pumps as it is thinner walled and more flexible than that found at

most hardware stores, however, any kind will suffice. The amount of tubing you will need will depend the distance you need to travel from the air pump to the water vapor condenser to the Deep Space Cooler modified DSI (probably no more than 10 feet depending on your setup). The beverage cooler can be used as it is or you can drill two holes in it sufficient to allow you to run the tubing through.

To use the Deep Space Drier complete the following steps before starting the Deep Space Cooler:

1. Connect the air pump to either one of the hose barbs on the water vapor condenser using the tubing.
2. Connect the other hose barb on the water vapor condenser to the small hose barb located on the bottom the Deep Space Cooler modified DSI. The hose barb is located on the opposite side of the USB connector from the Deep Space Cooler controller connector.
3. Place the water vapor condenser in the beverage cooler and fill the cooler with ice.
4. Plug in the air pump and ensure that none of the tubing is kinked.
5. Shield all electronics below the DSI (e.g., alt/az mount electronics) with plastic and a cloth.
6. Start the air pump.
7. Start up the Deep Space Cooler following the instructions above.

Because water may condense on the outside of the DSI (depending on how low you set the temperature and how high the dew point is), you should shield any electronics beneath the DSI with a piece of plastic and a cloth to ensure that no water gets to the electronics. It is also a good idea to make sure that there is a drip loop (i.e., a low spot in the cable) in the USB and Deep Space Cooler controller cables to ensure that no water can run down them and into electronics.

That's it! Water vapor will condense from the air in the water vapor condenser chamber and the dried air will then be pumped through the camera and over the front of the CCD keeping the inside of the camera and front of the CCD free from dew. If you are using a DSI Pro with a ScopeStuff adapter and filter wheel, you can either leave a filter attached

to the ScopeStuff adapter (as long as the adapter has been raised from the camera body to allow air flow) or you can allow the dried air to exit through your filter wheel. If you are using a DSI Color then you may need to remove the standard Meade IR filter from under the telescope adapter in front of the CCD for air flow if you find that the IR filter tends to fog up. The CCD beneath it will not fog up.

When you are finished imaging, there will be water in the water vapor condenser. The water can be removed by removing the water vapor condenser from the beverage cooler and continuing to run air through it until it is dried out; removing the top from the water vapor condenser and pouring and/or wiping the water out; heating the water vapor condenser slightly (100 F to 150 F) in an oven to evaporate the water; or any combination of these methods.

USING THE DEEP SPACE DRIER, DUAL-STAGE AIR DRIER (DSC Extreme Model)

The Deep Space Drier, Dual-Stage Air Drier, is supplied with the Deep Space Cooler Extreme and consists of a desiccant air drier used in conjunction with the Deep Space Drier, Single-Stage Air Drier.

To use the dual-stage drier complete the following steps before starting the Deep Space Cooler:

1. Refer to the instructions for the single-stage air drier above.
2. Connect the air pump to either one of the hose barbs on the aluminum water vapor condenser chamber using a piece of air tubing.
3. Connect the other hose barb on the water vapor condenser to the “INLET” hose barb on the desiccant drier using a second piece of air tubing.
4. Connect the “OUTLET” hose barb on the desiccant drier to the small hose barb located on the bottom the Deep Space Cooler modified DSI using a third piece of air tubing. The hose barb is located on the opposite side of the USB connector from the Deep Space Cooler controller connector.
3. Place the aluminum water vapor condenser in the beverage cooler and fill the cooler with ice.

4. Plug in the air pump and ensure that none of the tubing is kinked.
5. Shield all electronics below the DSI (e.g., alt/az mount electronics) with plastic and a cloth.
6. Start the air pump.
7. Start up the Deep Space Cooler following the instructions above.

Because water may condense on the outside of the DSI (depending on how low you set the temperature and how high the dew point is), you should shield any electronics beneath the DSI with a piece of plastic and a cloth to ensure that no water gets to the electronics. It is also a good idea to make sure that there is a drip loop (i.e., a low spot in the cable) in USB and Deep Space Cooler controller cables to ensure that no water can run down them and into electronics.

While desiccant drier may be used without the aluminum condensation chamber, the use of the condensation chamber greatly extends the life of the desiccant so that it does not have to be regenerated as often (see instructions below) or replaced when it is spent as often (desiccant has a finite life span and can only be regenerated a certain number of times before it significantly looses its effectiveness. If no ice is available, the desiccant drier may be used alone and will be more than sufficient to dry the air pumped through the system. However, depending on the humidity, the desiccant may need to be regenerated after only a single full night's use without the condensation chamber.

Regenerating the Dual-Stage Drier Desiccant

The desiccant used in the desiccant drier is a color-indicating brand by the name of Drierite. Information on the desiccant, including the Material Safety Data Sheet ("MSDS") can be found at www.drierite.com. The desiccant starts off blue in color and changes color from blue to pink as it is expended (generally from the bottom of the desiccant drier to the top). Once all the desiccant has changed pink, it must be regenerated in order to continue working.

Regeneration is not difficult but the nature of the Drierite desiccant requires that some precautions be taken. First, the desiccant contains cobalt and **SHOULD NOT BE**

INGESTED and dust from the desiccant **SHOULD NOT BE BREATHED**. A conventional oven may be used to regenerate the desiccant by spreading the desiccant out uniformly on a cooking sheet or cake pan and placing the pan in the oven at 425ºF for one (1) hour (heating at less than 425ºF will do nothing no matter how long it is heated and heating at temperatures significantly above 425ºF may damage the desiccant making it unusable). The top of the desiccant chamber is removed by turning the handle until the plug comes loose. Once the plug is removed, take out the spring and pour the contents of the chamber onto the pan you intend to use. **DO NOT LOSE THE SMALL PERFORATED METAL DISK OR WHITE FILTER PAD AND REMOVE THEM BEFORE HEATING THE DESICCANT.**

DESICANT WILL PRODUCE A CERTAIN AMOUNT OF DUST THAT SHOULD BE AVOIDED. IT IS RECOMMENDED THAT POURING OF THE DESICANT INTO AND OUT OF THE DESICCANT CHAMBER BE CONDUCTED OUTSIDE OR IN THE GARAGE WHERE IT IS NOT WINDY. HANDS SHOULD BE CLEANED AFTER HANDLING THE DESICANT.

Placing the desiccant on a piece of heavy-duty aluminum foil on the baking sheet or pan may help when it comes time to pour it back into the desiccant drier. It is recommended that the cooking sheet or pan used be dedicated for this purpose or used with heavy-duty aluminum foil and then thoroughly cleaned afterwards to avoid ingesting any of the Drierite desiccant.

When regeneration is complete, the Drierite will be purple to blue in color. **ALLOW THE DESICCANT TO COMPLETELY COOL BEFORE PLACING IT BACK INTO THE DESSICANT CHAMBER.** You can cover the desiccant with more aluminum foil while it cools to minimize moisture absorption during cooling. Carefully pour the desiccant back into the desiccant chamber. A funnel may be used for this purpose but it should have a large and opening as possible in order to help ensure that the desiccant pours into the chamber randomly and does not create preferential pathways for air to flow through the system.

Tapping the desiccant chamber on a hard surface will help to settle the desiccant in the chamber so that the level of the desiccant is below the outlet hose barb. Once the desiccant is settled and level, place the filter pad on top of the desiccant and the perforated disk on top of the filter pad. Replace the spring above the metal disk and press the plug into the top of the desiccant chamber and secure it by tightening the handle.

The desiccant chamber is now ready to be used again. When the desiccant gets to the point that it will no longer regenerate, replacement Drierite can be obtained directly from Drierite.

USING THE DEEP SPACE COOLER EXTREME WATER COOLER

The Deep Space Cooler Extreme may be used with or without the water cooler. Use of the water cooler may allow the camera to be cooled to well below freezing. **WHEN USING THE WATER COOLER IT IS CRITICAL TO USE THE DUAL STAGE DRIER TO ENSURE THAT CONDENSATION DOES NOT FORM INSIDE OF THE CAMERA WHICH MIGHT DAMAGE THE CAMERA'S ELECTRONICS.**

To use the water cooler complete the following steps before starting the Deep Space Cooler:

1. Connect one piece of ¼ inch tubing from the supplied water pump to the hose barb on the water block (aluminum block under the cooling fan).
2. Attach a second piece of tubing ("return tubing") of at least equal length to the other hose barb on the water block.
3. Place the water pump and the end of the return tubing in a large container of water or ice water. A Styrofoam ice chest works well for ice water while a five-gallon bucket works well for tap water.
4. Start up the dual-stage air drier as discussed above.
5. Start up the water pump.
6. Start up the Deep Space Cooler following the instructions above.

Significant cooling may be achieved using only tap water. Ice water will allow even further cooling. In either case, the water will warm over time as heat is transferred from

the cooler to the water so that the water may need to be replenished to maintain the set cooling level.

Be sure that the water tube connections to the water block are secure and not leaking before using the system. Be careful to shield any electronics below the camera from condensation dripping from the camera. Depending on how low you try to cool the camera, frost may form on the outside of the camera. As long as the air drier is working this should not be a problem. **HOWEVER, WHEN YOU ARE READY TO SHUT DOWN THE SYSTEM, THE AIR DRIER SHOULD REMAIN RUNNING UNTIL THE CAMBER IS FULLY WARMED TO ROOM TEMPERATURE AND ALL FROST IS GONE FROM THE OUTSIDE OF THE CAMERA.** Any remaining condensation on the outside of the camera should be wiped off before putting the camera away.

When switching between water-cooled and air-cooled use the of the Deep Space Cooler Extreme, the cooler controller should be recalibrated ("autotuned") to account for the differences in the cooling characteristics of the system. To do this, start the cooler and camera in whichever mode you will use. Once everything is running, press and hold down the  key until the red "OUT (AT)" light on the left side of the numeric display begins to flash on and off evenly. The controller will then be in autotune mode where it will adjust itself to the current operation of the system. This will take a few minute to complete. During autotuning the cooler temperature will rise and fall one or more times by itself. This is basically telling the controller how hard it must work to keep the cooler at the set temperature. When complete, the "OUT (AT)" light will stop flashing evenly and the cooler will return to normal operation. This only needs to be done when switching from using the Deep Space Cooler Extreme between water-cooled and air-cool modes.

WARRANTY

The Deep Space Cooler and its components such as the Deep Space Drier are warranted to the original purchaser for a period of 12 months from the date of delivery. The warranty covers only the Deep Space Cooler and its components and its continued operation when operated in accordance with this instruction manual. The warranty does not cover the DSI camera and its operation. Operation of the DSI camera is not changed by the installation of the Deep Space Cooler or the Deep Space Drier. The only modification to the camera circuit board is the attachment of a small temperature sensor which has no effect on camera operation. The modification of the DSI camera with the Deep Space Cooler will obviously void any manufacturer warranty on the DSI camera. The customer takes full responsibility for the continued functioning of the DSI camera.

While it may, depending on the ambient temperature, be possible to cool the camera down well below the dew point and even below freezing, doing so for significant periods of time without the use of a Deep Space Drier may cause condensation of water inside of the camera since it is not possible to completely seal the DSI camera body or evacuate the air from the camera body. Significant condensation could lead to eventual damage of the camera circuit board. It is up to the user to ensure that the proper Deep Space Drier is used or the DSI is not operated below the dew point if a Deep Space Drier is not used. Damage to the DSI camera as a result of condensation is not covered by the warranty. It is the camera owner's sole responsibility to choose the proper and desired operating temperature for the Deep Space Cooler.

If you have any questions or warranty issues, please contact me via e-mail at dsproducts@cox.net and I will get back to you as soon as possible.

Your business is greatly appreciated,
Ed Thomas
Deep Space Products