

User Guide



Features/Specifications:

- OLED Graphic Display:
 - Voltage Meter
 - Temperature Display (Ambient and Optics)
 - All settings can be viewed on a single screen.
- Operating Voltage: 12V DC (12.6 - 13.8V DC nominal)
- 4-Channel Heater Ports: each independently programmable, with 2 ways to control heater output:
 - Temperature Sensing (Ports 1 & 2)
 - Duty Cycle (0-100%) for each of 4 heater ports.
- User replaceable power cord (we recommend Anderson Power Poles)
- Maximum Amperage Output:
 - Cigarette Lighter (fused) Plug: 7 Amps max.
 - User supplied plug: Up to 15 Amps
- On-Board auto-reset 15 Amp "Poly" Fuse
- Reverse Polarity Protection†
- Low Voltage Warning (warning @ 11.9V / shut-down @ 11.6V)



- Disable Low Voltage Cut-Off... we don't recommend it, but if you're willing to ruin your battery, you can drain it dry if you wish by turning this feature OFF.
- Dimmable Lights
- Lights (and graphic display) Auto Shut-Off (after 20 seconds) Press a button to turn on lights again. Lights and graphic display can also be programmed to remain ON.
- DC Accessory Ports (2):
 - 1 constant 12V, 7 Amp Max
 - 1 adjustable 8V/12V (8V is DSLR battery voltage), 1.5 Amp Max

DC Accessory Port Plug Specs: Switchcraft 761K (threaded locking ring) OD 5.5mm / ID (center pin) 2.5mm / Barrel Length: 12mm. **NOTE:** Earlier DigiFire (8 and 12) models used a different 2.1mm connector.

† Reverse Polarity Protection is limited to the main circuit board and variable DC Accessory Port (8V/12V). The Heater Ports and 12V constant DC Accessory Port is NOT protected (heaters don't care about polarity)

Included with this controller:

- Power Cord – 70" (180cm) Cigarette Lighter version with replaceable 7 Amp fuse
- 2 Temperature Sensors and 2 each of 6' (183cm) Sensor Cables: 1 Ambient, 1 Optics (optional 2nd optic sensor also available).
Note: The DigiFire FX-Pro comes with 1 Ambient and 1 Optic tensor. A Temperature Sensor for a second optic (telescope) is NOT included, but is an available option (SKU: 2001-12-SCBL6).
- Velcro adhesive mounting pad

Physical Dimensions: (including mounting tabs):

- 3.25" X 6.75" X 1.147" (82.5mm X 171mm X 29mm) weight (excluding power cord and sensors: 5.8oz (164 grams))

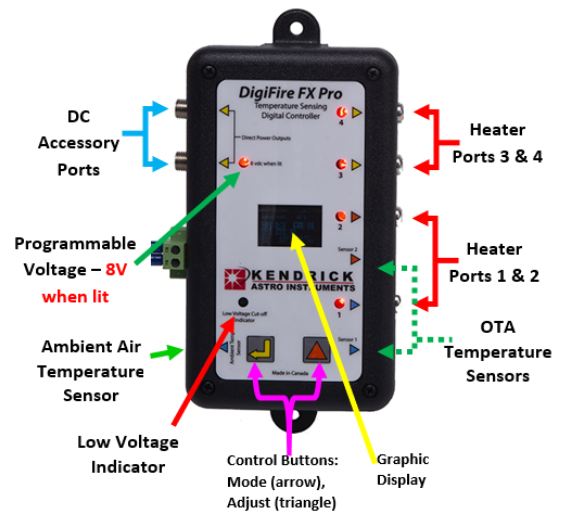
Optional Accessories:

- Additional Optics Temperature Sensor (SKU: 2001-12-SCBL6)
 - DSLR Camera Battery Adapter – Available for most Canon and Nikon DSLR models.
<http://www.kendrickastro.com/powerpanels.html#DSLR>
- Anderson Power Pole kit with 15Amp Contacts (208-IPP-ACKIT) allows you to convert the power cord cigarette lighter plug. Plug orientation works with Kendrick Power Packs and Power Panels. Otherwise, choose SKU 208-IPP-AC-UF (non-welded).
- A spare Power Cord (SKU: 2001-DF812-PWR)



Device Layout Legend:

- **Graphic Display:** Virtually every setting is displayed on the screen.
- **DC Accessory Ports (2)** can power other equipment:
 - 1 constant 12V, 7 Amp Max
 - 1 variable 8V/12V (8V is DSLR battery voltage), **1.5 Amp Max.** Max Amp limit is true whether set to 8V OR 12V
- Programmable Heater Outputs 1 & 2 – Temperature Regulated OR Duty Cycle
You will need to purchase 1 additional Temperature Sensor to use Temperature Regulation on a second telescope.
- Programmable Heater Outputs 3 & 4 – Duty Cycle Only
- Control Buttons: Mode/Enter (arrow), Adjust (triangle)
- 8V DSLR Camera Power Confirmation Indicator Light. When this light is ON, it means voltage output is set to 8V.
- Low Voltage Warning Light
- Ambient and OTA Temperature Sensor Ports



Display Features

All settings can now be seen on a single screen.

Ambient (outside) Air Temperature (23.4)

Port 1 & 2 OTA Current Optics Temperature and Offset Setting (CH1: 25.6 TMP: 2.0, CH2: 27.5 TMP: 4.0)

Port 3 & 4 Duty-Cycle Setting (CH3 PWR: 100, CH4 PWR: 100)

Low-Voltage Cut-Off ON=Enable OFF= Disable (VX On)

Voltage Set-Point for programmable DC Accessory Port (AUX: 8V)

Power Source Voltage (BATT: 13.5V)

Owners of previous DigiFire 7/8/10/12 models will notice that the DigiFire FX-Pro has an impressive number of new features. Programming the DigiFire FX-Pro is similar to earlier models, but there are some notable changes. Mainly:

- All settings can now be seen on a single graphic OLED display screen
- All but 1 setting (voltage output on programmable DC Accessory Port) can be adjusted “Anytime” after the unit is powered-up. The Low Voltage Cut-Off feature can now be disabled (not recommended) and will now retain that choice on next start-up.

Operation Instructions

Attach the Power Cord



The standard power cord uses a cigarette lighter plug at one end and a special “terminal block” plug at the other. The device plug has 2 screws that secure it to the controller. A jewellers (small) slotted screw driver works well.

The device has an internal 15 Amp auto-reset fuse, but the (any) cigarette lighter plug can only handle 7 Amps and is internally fused with a standard glass 7 Amp fuse. To get the full power capability (15 Amps) we invite you to modify the power cord with a plug that can handle 15 Amps (we like Anderson Power Poles). Read on for more details.

How to Adjust Controller Settings

There are 2 groups of setting modes:

- 1) **Anytime settings.** All but 1 setting (voltage output on programmable DC Accessory Port) can be changed at any time.
- 2) **At Power-Up setting. Variable DC Output Voltage can be set to either 12V OR 8V (DSLR Power voltage).** Adjustments for this setting is done during Power-Up. The DigiFire Controller will remember your last setting for DC Variable voltage and an LED light will be ON to indicate that 8V was selected.



Anytime Settings

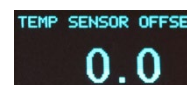
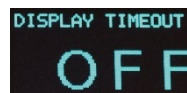
Adjustments begin by “waking up the lights” (the LED lights now automatically shut-off after 20 seconds).

Touching either of the 2 buttons (**Mode or Adjust**) buttons will turn the lights (and display) back ON. Once the lights are ON Press **BOTH** the **Mode** and **Adjust** buttons at the same time and hold for 5 seconds (lights will blink when ready).

MODE Button (arrow/left-side button). Pressing this button skips to the next “mode”. When entering “Programming Mode” the device starts at “MODE 1” and programming is not finished until you cycle through all 10 modes. If you do NOT want to make changes for a given Mode, just press the MODE Button to cycle to the next Mode. For Heater Port Settings (modes 1-6), a **red LED light** will turn ON beside the heater port that is ready to accept adjustments.

Mode Order:

1. **Port 1 (bottom port) Duty-Cycle** 0-100% where 0=OFF
2. **Port 2 Duty-Cycle** 0-100% where 0=OFF
3. **Port 3 Duty-Cycle** 0-100% where 0=OFF
4. **Port 4 (top port) Duty-Cycle** 0-100% where 0=OFF
5. **Port 1 (bottom port) Temperature Offset** (Delta) – 0.0-10.0°C where 0=OFF
6. **Port 2 Temperature Offset** (Delta) – 0.0-10.0°C where 0=OFF
7. **Low Voltage Cut-Off:** Enable = ON / Disable = OFF .
 - Low-Voltage Warning: light will “blink” when voltage falls below 12.0V
 - Low-Voltage OFF when voltage falls below 11.6V. Heater ports will turn OFF unless Low-Voltage Cut-Off is disabled. Warning light will still be lit (blinking or full-ON).
8. **Brightness** 0-100% in 5% increments. 0% will turn LED Port Lights OFF but display will remain ON (until time-out).
9. **Display Time-Out:** OFF = Remain ON. ON = Display AND LED Port lights will turn OFF after 20 seconds. Press any button to wake-up lights. LOW VOLTAGE light still turn ON when power supply voltage drops below 11.9V
10. **Temperature Calibration †:** Adjusts displayed temperature.
†Temperature Calibration is just for folks who are obsessed with accuracy and insist on knowing how cold it is outside. This feature will have no effect on performance (we only care about the difference in temp), but if you want to use it as an outdoor thermometer, you can calibrate the displayed temp by +1.0/-1.0 °C in 0.1 degree increments. You will need an accurate thermometer to do this.



ADJUST Button (triangle/right-side button).

The OLED graphic display shows the current setting. Pressing the ADJUST button adjusts the setting UP for the MODE you are currently in. Each press of this button advances the setting by 5% for duty-cycle, or 0.5°C for temperature settings. When the setting reaches 100%, the next button press sends the setting back to 0% (OFF). If you do NOT want to adjust the setting of the current mode, press the MODE Button (left, arrow) to advance to the next mode. For Temperature Settings (MODE 6 & 7), each press of the “ADJUST” button advances the temperature differential by 0.5°C to a maximum of 10°C.

At Power-Up Settings (Programmable DC Accessory Port)

There is only 1 setting here. The programmable DC Accessory Port (the lower one) can be set to output either 12V or 8V (factory default). Most DSLR cameras use 8V and the DigiFire can power your camera when used with a compatible DSLR Battery Adapter (a dummy battery with a cord sticking out). Kendrick offers these for popular Canon and Nikon camera models. **For owners of older DigiFire 8 & 12 models who already have the DSLR Battery Adapter, you will need to acquire a new connector cable as the DigiFire FX models now use a 2.5mm barrel connector on the programmable DC Accessory Port. Battery Door needs to be CLOSED! Look for “notch” where the cord exits the battery compartment.**

To Program the output voltage:

- With Power OFF, press and hold BOTH the MODE and ADJUST buttons
- Continue to hold the buttons while you apply power to the unit.
- Continue to press BOTH buttons for 5 seconds

Temperature Sensing Information

Sensors are used to measure temperature of ambient air as well as the temperature of your optical tube (or mirror). The identical sensor is used for both ambient air and optics. The sensor is a tiny circuit board and uses an “audio” cable to connect to the DigiFire Controller. An aluminum “rivet” conducts heat (or cold) to the sensor itself. The only difference between the ambient air sensor and the optic sensor is where they are plugged into the DigiFire. The ambient sensor plug is on the left side just below the power plug. If you want to use temperature regulation for a second telescope, you will need 3 sensors (2 are included with the DigiFire), of which 1 is the ambient sensor.

On a refractor or SCT, the sensor is placed under the Dew Heater. So, attach your dew heater and then slide the sensor underneath so the aluminum rivet is touching the optical tube.

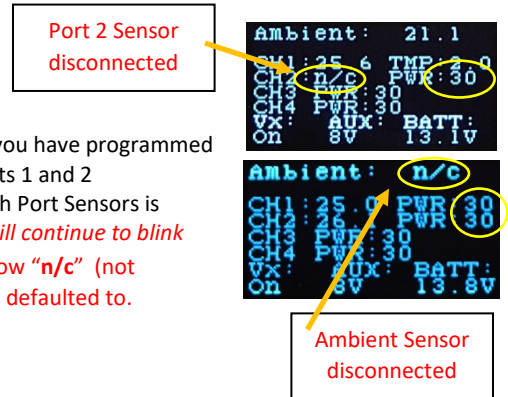
Heater Ports 1 and 2 (the bottom ports) are capable of using either Duty-Cycle OR Temperature Sensing to control heater output. The Temperature Sensing feature works by knowing the current temperature of the ambient (outside) air AND the current temperature of your telescope OTA. Then you simply “program” the unit to maintain the temperature “offset” of your optics to be xx°C (0.5 – 10.0) above ambient air temperature. If outside air temperature falls, the DigiFire will allow the optics temperature to fall, but will always maintain the temperature “offset”. The objective is to keep the optics to 2°C above ambient. It doesn’t matter how warm/cold it is outdoors, what counts is keeping the optics warmer than the outside air.

On most telescopes, the sensor cannot measure the actual temperature of the mirror/lens directly. The goal is to allow the heater to turn ON when the mirror/lens is within a few degrees of outside air temperature to prevent water vapor from condensing onto cold glass. For most telescope owners, the dew heater attaches to the Optical Tube as close as possible to where the lens or mirror is located. Heat seeks the easiest path (the coldest point) and will transfer into the glass optics. The DigiFire FX-Pro Controller can be set to maintain OTA temperature at a constant temperature above ambient air temperature (between 0-10°C above ambient).

Are Port Lights 1 and/or 2 Blinking? If port lights are blinking, it means:

- Unit is programmed to use Temperature Regulation.
- 1 or more sensors are NOT present or malfunctioning.

The unit needs an Ambient AND Optic Temperature Sensor to function. The lights blink to tell you that you have programmed it to maintain a temperature, but it can’t do that unless both sensors are available. If you have both Ports 1 and 2 programmed to use temperature regulation, the light will blink if the Ambient Sensor and/or either/both Port Sensors is missing. *When a required sensor is missing, the unit will revert to Duty-Cycle regulation, but the lights will continue to blink until a sensor is plugged in OR temperature regulation is turned OFF (set to 0.0).* The display will also show “n/c” (not connected) when 1 or more sensors is absent and the display will also show the duty-cycle setting it has defaulted to.



TIPS for temperature settings:

Every telescope is unique and finding the ideal temperature setting for your telescope will require some simple testing.

- On most telescopes, dew heaters are on the outside edges of your OTA and some heat will escape before reaching the center of your lens/mirror. That means the center will be cooler than what is measured by the sensor. Logic dictates that the OTA will be warmer than the center and the temperature “offset” will need to be raised to ensure the center of the optics will be 1-2 degrees above ambient.
- There are no published “recommended settings” because there are just too many variables:
 - o A Dew Shield will help the dew heater do its job using less heat
 - o Size of lens/mirror changes how far heat applied to the outside needs to travel before reaching the center.
 - o Generally, the larger the optics, the higher the temperature differential will need to be. Experimentation will reveal the ideal setting for your equipment. For example, start at a fairly high differential and then gradually reduce until you begin to show signs of dew formation. Allow at least 30-45 minutes for temperatures to equalize before attempting a new setting. Do this over several nights.
 - o Excess heat will degrade images, so it is worth the effort to experiment with finding “how low can you go”.
- Suggested starting points:
 - o Large SCT (11”-16”): 8°
 - o Small SCT (6”-8”): 6°
 - o Small/midsize refractor (60mm-110mm): 4°
 - o Large refractor (≥110mm and above): 6°
- Brand of heater makes a difference. For best results, use Kendrick Premier Brand which produce considerably more heat than any other brand (including our own FireFly Brand). Some heaters just can’t get hot enough to maintain desired temperature. Watts spec for heaters is directly related to how much heat they can produce, regardless of the amount of power applied.

The DigiFire FX-Pro supports Temperature Sensing on 2 telescopes at the same time. This means that there would be 3 sensors in use: 1 is for Ambient Air Temperature, 2 & 3 are for telescope optics. The Ambient and Optics temperature sensors are identical, and no calibration is required.

NOTE: Sensor Calibration is based on the “audio cables” supplied by Kendrick. Cables purchased elsewhere, or modified (lengthening/shortening), may alter sensor calibration.

Typical Temperature Differential Settings: Every telescope is different, so there is no “one-setting-fits-all”. The aperture of your optics will play a major role in determining what is best for your equipment. Using a Dew Shield will also help reduce the amount of heat that is needed to keep optics free of dew & frost. Excess heat will reveal “turbulence” and will also drain your battery faster, so we urge you experiment to find the ideal temperature differential for each of your telescopes.

- For small refractors, try starting with 4° differential and then lower by 0.5°-1° until you start to see signs of dew/frost.
- For SCT telescopes, try starting with a 8° differential and lower by 0.5°-1° until you start to see signs of dew/frost.

NOTE: 1 Ambient and 1 Optic Sensor was included with the purchase of your DigiFire FX-PRO Controller. If you wish to use Temperature Sensing on a 2nd telescope, you will need to purchase an additional temperature sensor (SKU: 2001-12-SCBL6).

Where to Place Temperature Sensors



Optics Sensors: The best place is directly under the heater band. The side with the aluminum rivet should be placed against the OTA.

Ambient Air Sensor: This sensor should be “free hanging” and NOT make contact with anything solid. To prevent heavy dew from entering the external cable plug, find a place that is protected from falling dew. Perhaps under the OTA, or suspended from the OTA saddle plate.



Low Voltage Cut-Off



This feature is designed to protect expensive batteries against permanent damage. Almost all astronomy devices are designed to run from a car battery. A 12V battery in good condition will typically measure 13.1V-13.8V when fully charged. A battery that measures only 12V is a dead battery and will become permanently damaged if drained too far. You can **disable** this feature if you wish.

Low Voltage Warning LED Light.

LED Light Behavior:

- When voltage is below 12.0V, but above 11.6V, this LED light will BLINK. The blinking light is a warning that the unit will shut down soon when voltage drops below 11.6V. The exception is when you have the Display Time-Out feature ON.

The light will NOT blink and will remain full ON. Pressing a button to wake-up the display will reveal actual voltage condition.

- When voltage is below 11.6 the LED Light will be solid ON (not blinking) the unit will turn OFF power to the heaters.
If you have turned OFF the Low Voltage Cut-Off Feature, the LED Warning Light will still illuminate. It will also still illuminate if you have the “Display Time-Out” feature active (ON).

Important Notes:

Lights:

- Lights will automatically shut-off after 20 seconds. Press either the **Mode** or **Adjust** buttons to turn lights back on.
- Heater Ports: Only ports that have the duty-cycle set above 0% will illuminate. A 0% setting will shut off the heater port AND the LED light.
- “8V When Lit” (variable DC Accessory Port): When lit, the port is outputting 8V. If this light is NOT illuminated it means that it is set to output 12V.
- If Heater Port 1 or 2 LED lights are blinking, it means that device was programmed to use Temperature Sensing and the unit is unable to detect either/or: Ambient Sensor and/or Optics Sensor. Plug in the Sensor(s) to correct. If you do NOT wish to use Temperature Sensing, go into “Anytime Programming Mode” and Turn OFF that feature (MODE 6 and/or MODE 7) by adjusting the setting to 0 (zero). If you turn OFF temperature sensing and still want to plug a heater into Port 1 or 2, adjust the “Duty-Cycle” setting accordingly.

Heater “Duty-Cycle” Settings:

The “ideal” heater setting (duty-cycle) will vary for every telescope or weather conditions. Generally:

- Larger aperture optics (especially scopes with “corrector” lenses) will need a higher setting than smaller refractors as the heat needs to travel a further distance to reach the center of the lens.
- High humidity during warm day’s means more moisture will condense when the Sun sets and the temperature cools down.
- Experiment by trying different settings. 40%-60% is a good starting point. Starting with a higher setting and then gradually reduce the duty-cycle until you find your ideal setting.

NOTE: When using Temperature Sensing features, it is a good practice to also set an appropriate “Duty-Cycle” for heater ports 1 & 2. To use Duty-Cycle instead of temperature regulation, the temperature offset (delta) must first be turned OFF by setting temperature delta to 0.0.

Calibration/Accuracy – Voltage and Temperature Readouts

The Temperature and Voltage display is a nice convenience, but it is not a substitute for dedicated instruments. The onboard sensors are built into the onboard microchip and can be influenced by the amount of current being draw by heaters. The microchip uses an operating “frequency” that can also be influenced by your choice of 12V power supply, whether that be a battery or AC-DC Power Supply.

- **Voltage:** We have calibrated displayed voltage, using the supplied Power Cord, to report on the side of reading higher than actual to prevent premature shutdown when the Low Voltage Cut-Off feature is ON. You will likely find the voltage will display higher than actual when the unit is actively sending high-current to heaters. Again, we chose this compromise to avoid premature low-voltage shutdown from under-reporting voltage. For customers who choose to modify the power cord, all wires induce resistance which causes voltage to drop. Using a longer cord, or a smaller gauge wire will influence displayed voltage. If you plan on making your own power cord, the original cord is 18AWG. Cords longer than 70” (180cm) should use 14AWG or larger. **NOTE: industry wire gauge spec is reversed. For example, 14 gauge is a larger diameter than 18 gauge, etc.**
- **Temperature Sensors** are calibrated using the original sensor cable supplied by Kendrick. They are common 2.5mm “stereo audio cables”. Be aware that using your own cable will probably alter calibrated resistance and will affect accuracy. If you plan to use your own cables, it will be especially important that all sensor cables use the identical cable in both length and wire gauge.

Heater Brands – Some Are Better Than Others

ALL heater brands will produce considerably less heat that Kendrick Premier Heater brand. All Kendrick Dew Controllers will work with any brand of Dew Heater that we know of, but, except for our Premier brand, they do NOT produce as much heat. It does NOT mean that you are using more battery power, it just means that they simply don’t produce as much heat. This includes the Kendrick FireFly brand and all non-Kendrick heaters that are lower wattage

“budget” heaters. Some heaters are advertised as “energy efficient”, but watts = heat, so less watts simply means they produce less heat and thus, use less power.

Optional Power Cord Modification:

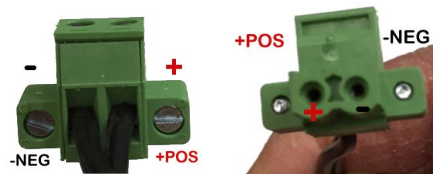
To get the full power capability (15 Amps) that the DigiFire offers, we invite you to modify the power cord to use a plug that can handle 15 Amps. We recommend Anderson Power Poles and offer a “kit” that provides a pair of pre-welded plugs with 30 Amp contacts. Kendrick SKU#: 208-IPP-ACKIT

There are several options:

- Use the original cord, cut-off the cigarette light plug, and attach your favorite high-amp plug.
- Make your own cord and attach the Device Plug using 16 AWG (gauge) wire. FYI, wire “gauge” is “backwards”. I.e: 14 gauge wire is substantially heavier than 18 gauge. The Device Plug has 2 screws that are covered by a rubber “divot” (shock hazard guard). The “divot” is friction fit and can be easily removed with a safety pin.
 - o Unscrew the 2 wire-clamp screws and pull out the cord.
 - o Strip ¼” of the wire insulation and “Pre-tin” with solder. For better results, use a “ferule” connector.
 - o Insert your cord, tighten the 2 wire-clamp screws and let set for 12-24 hours. Because solder is soft, tightening the screws will squash the solder and the cord might not be firmly attached yet. After 12-24 hours, retighten the cord-clamp screws and replace the rubber “divot”

WARNINGS:

- You must be certain of the polarity of your cord. A voltage meter is the best way to be sure.
- The power cord should be fused at the power supply end. If your cord gets snagged and breaks, you will have a serious shock hazard unless properly fused at the power supply side. For example, Kendrick LINX and Imaging Power Panels, as well as Kendrick Portable Power Packs have built-in circuit breakers.



Disclaimer: This product is designed with safeguards that reduce the risk of shock or damaging the device should the owner chose to make modifications. However, the customer assumes the responsibility for consequences that may result by making modifications to the device, which may include voiding the warranty.

Where is the best place to mount the Dew Controller?

ON TOP OF THE TELESCOPE! Most DigiFire owners use more than 1 dew heater and common sense dictates that a single power cord is easier to protect against snagging than 2,3,4 heater cords. So put that DigiFire up top and reduce the food supply of hungry mounts that like to eat cords.



8V DSLR Power Supply - Limitations

The DSLR power supply is designed for normal astrophotography applications.

Specifically, long exposures with momentary delay between exposures. It is NOT design for daytime “burst” exposures. For best results, follow these simple guidelines:

- 1) Normal Exposures: Use a 3 second delay between exposures
- 2) Flash: We can’t think of a reason why anyone would use flash for astrophotography, but if you need to use the camera built-in flash, allow a 6 second delay between exposures
- 3) Live-View: No restrictions

Troubleshooting

- **12V does NOT mean a measured voltage of 12V.** Almost all astronomy devices are designed to run from a car battery, which when fully charged, will have a measured voltage of 13.1-13.8V. A car battery that measures only 12V is a dead battery. Devices that produce heat (or CCD Camera Coolers) using electricity need quite a lot of power.
- **The most common (BY FAR!) cause of heater failure is POWER!!!!!!** Either voltage that is too low, or inadequate current (rate of flow). An adequate power source will be minimum 5 amps @ 13.8V. A big heater uses more power than a small heater. Heater output specs are WATTS of power, which is a combination of voltage and current. Even if you have the Low Voltage Cut-Off feature disabled, the heaters still won’t get enough power if voltage or current is under spec. The most common reason for power issues is due to your choice of power supply. Those “miracle” power packs that claim high capacity and are the size of a cigarette pack are common source of grief because they can’t deliver power fast enough.
- **Unit won’t power-up?** Check the glass fuse inside the cigarette lighter plug. The correct replacement fuse is 7 amps (or less!).
- **Broken Heater Cords.** Telescopes eat wires for a late night snack. The best way to prevent heater destruction is to mount the Dew Controller **ON THE TELESCOPE!** It is much easier to manage a single power cord that multiple heater cords.
- **When in doubt:** Plug the DigiFire into your car cigarette lighter socket and see if you get a different result.
- **Heater Port LED Lights Blinking?** The bottom 2 ports will have a blinking LED light IF: 1) Temperature Regulation is ON **AND** 2) A Temperature Sensor is not connected. Ambient Sensor **AND** the Optic Sensor needs to be connected. The graphic display will also show “n/c” if a sensor is NOT connected. Solution.... Connect the sensors OR turn Temperature Regulation OFF and revert to Duty-Cycle mode. The Ambient Sensor is used for both heater ports. To use Temperature Regulation, 2 sensors are required. For Temperature Regulation on BOTH Ports 1 and 2, 3 sensors are required.