Technical Note:

Delta-T Booster II

PV Powered Motor Starter with Differential Temperature Control

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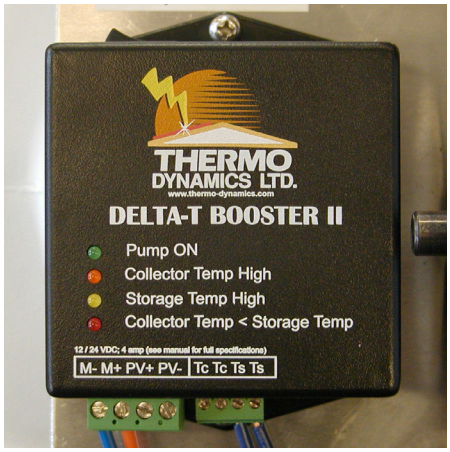


Overview:
The Delta-T Booster II (DTBII or "Booster") is a differential temperature controller with linear current boosting functionality. It has been designed specifically for solar thermal pumping applications that utilize a photovoltaic (PV) solar module as the power source.

Thermo Dynamics Ltd. (TDL) manufactures various solar-powered drivers for DC motors, or DC-DC transformers, under the trade names Booster™ and Jolter™. A Booster™ or Jolter™ is used to drive the TDL Solar Pump™, a solar-powered pump with a DC motor. The Booster™ maintains the voltage of the photovoltaic (PV) module at 15 VDC in a "12-V nominal" system, or 30 VDC in a "24-V nominal" system. If the motor voltage rises above 15 V, the Booster™ allows PV voltage to rise with motor voltage. The PV voltage should be 15 V, except in the early hours of the morning as the sun rises above the horizon, and in the late hours of the day as the sun sets. During such low sunlight conditions when the PV module does not produce sufficient power to drive the Solar Pump™ continuously, the Booster™ stores the electrical energy from the PV module, and then releases it in bursts of power to cause rotation of the pump. This feature also serves to start the pump earlier in the day, when it might remain at rest due to static friction after resting overnight.

The DTBII also has connections for two temperature sensors for differential temperature control. By comparing the two temperatures, the DTBII ensures that the circulator pump is only activated when there is energy to be gained (eg. when the collector sensor is hotter than the storage sensor). Complete with high and low temperature limits, as well as fail safe protection in the event of an open or short circuit, the DTBII provides all the control functionality necessary for a typical solar thermal system powered 100% by the sun.

Connections:

PV+	Positive terminal of PV module or battery
PV-	Negative terminal of PV module or battery
M+	Positive lead wire for the DC motor
M-	Negative lead wire for the DC motor
Tc	Collector temperature sensor
Tc	Collector temperature sensor
Ts	Storage temperature sensor
Ts	Storage temperature sensor

Operation:
The Delta-T Booster II will turn ON (eg. energize the M+ terminal) when the collector sensor measures 3°C (5ºF) higher than the storage sensor.

The Delta-T Booster II will turn OFF (eg. de-energize the M+ terminal) when:
• the collector sensor drops in temperature measuring 1ºC (2ºF) or less, above the storage temperature sensor.
• the "Storage Temp High" set-point is reached. This set-point is factory set to 70°C (158°F) and can be adjusted between 32 - 90ºC (90 – 194ºF) using the potentiometer located next to the power switch. Fully clockwise equals 90ºC (194ºF).
• the "Collector Temp High" set-point is reached at 112°C (234°F).
• the "Storage Temp Low" set-point is reached at -3°C (27°F).

Note: There is 3°C (5°F) of hysteresis for all set-points, meaning that once a set-point has been reached the corresponding temperature must fall (or rise) by 3°C before the controller will turn ON (or OFF) again.

LEDS:
The following describes the conditions required to illuminate each LED:
(Note: ΔT refers to the difference in temperature between the collector sensor and the storage sensor)
• RED: Low ΔT (eg. collector temp < storage temp); collector sensor open circuit.

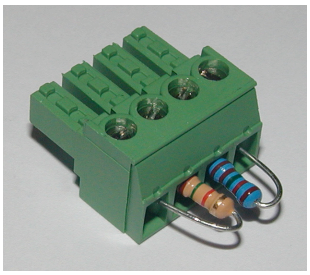
•YELLOW: Storage temperature HIGH; storage sensor short circuit.

•AMBER: Collector temperature HIGH; collector sensor short circuit.

•GREEN (ON): the collector temperature is sufficiently greater than the storage temperature and the system should be running. NOTE: if there is minimal sunlight, the LED may be "ON" but the pump will not be turning. If so, wait for more sunlight.

• No LEDs will be illuminated when:
- The power switch is in the OFF position,
- There is no power from the PV panel (eg. no sunlight),
- The storage sensor is open circuited,
- The storage sensor measures -3°C or less.

Service Plug:
The "Service Plug" provided is used to override the Delta-T Booster II's differential temperature controls. Use the service plug to force the Delta-T Booster II into a "Pump ON" state when power is available from the PV module. This is useful for commissioning and/or servicing.

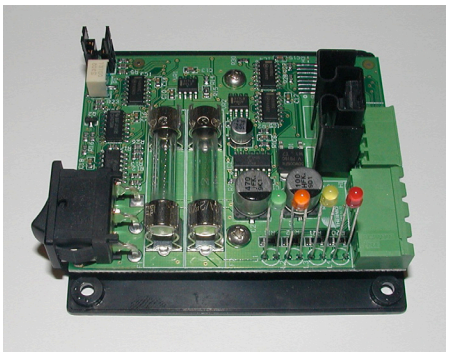


Fuses:
The Delta T Booster II has two internal fuses, F1 and F2. Both fuses are fast acting, size 3AG.

• F1 is rated at 4 A, 250 VDC and is used to protect the controller circuit.

• F2 is used to protect the motor from overheating.
- F2 is rated at 2 A, 250 VDC for Solar Boiler™ Systems (SB32-9PV, SB64-9PV)
- F2 is rated at 4 A, 250 VDC for any non-Solar Boiler™ Systems

IMPORTANT: Should any of these fuses need replacement, they must be replaced with an equivalent rated fuse.



Fuse F1 is shown on the left.
Fuse F2 is shown on the right.

Troubleshooting:
Problem: The green LED is ON when the sun is shining but the pump is not turning.

Diagnosis: Fuse F2 has blown.
Solution: Replace fuse F2 with equivalent rated fuse (see above for fuse ratings). If fuse F2 blows repeatedly, pump/motor may be seized.

Power Requirements:
Voltage (nominal): 12 VDC or 24 VDC*
Voltage (maximum): 22 VDC or 44 VDC
Voltage (typical): 15 VDC or 30 VDC
Current (maximum): 4 Amps
**shipped in 12 VDC configuration unless specified*