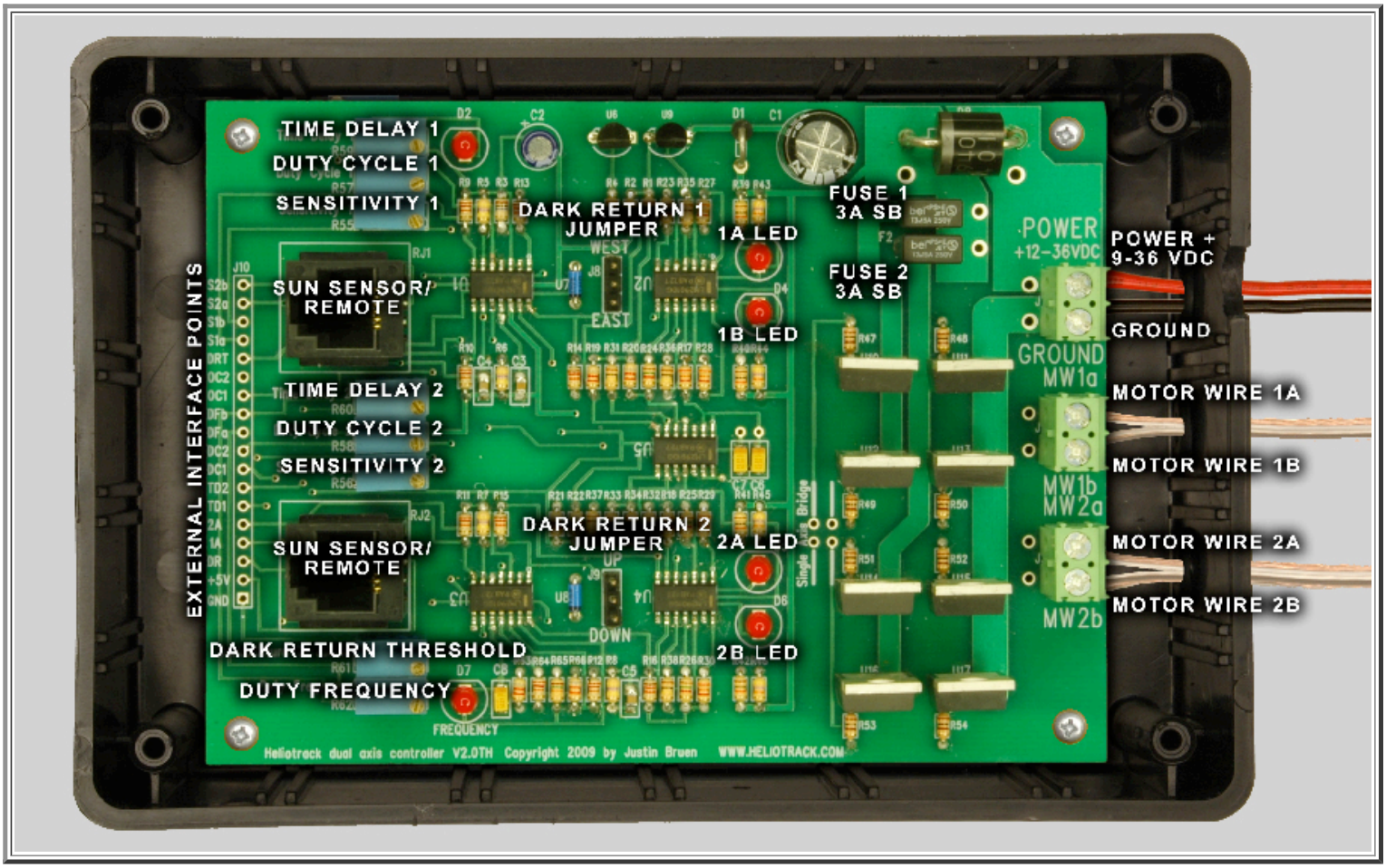
Heliotrack Dual Axis Tracking Controller



Features:

- 12-36 VDC power supply
- Solid state H-bridge driver with shoot-through protection
- Variable Track-to-Track time delay extends actuator life
- Variable output duty cycle (0 – 100%)
- Variable duty frequency (1 cycle per minute - 4 cycles per second)
- Dark return direction selectable for each axis
- Remote control interface for manual or automated controls
- Screw terminals for easy connection of power supply and motors
- Fuse protection on each axis
- External interface points for expanding capabilities beyond basic dual axis closed loop solar tracking.
- External interface points for manual control of Duty Cycle, Duty Frequency, Time Delay, and Sensitivity
- Output drivers can be bridged for higher current single axis operation
- RJ12 Socket for convenient Sun Sensor and Remote Contol connection.
- On Board LED indicators for Motor Direction, Duty Cycle, and Duty Frequency
- Power Supply reverse connection protection

Applications:

Single or dual axis solar tracking
Pump control
Thermostat control
Servo control
Applications requiring switching outputs based on voltage comparisons

Specifications:

Specification	**Value**	**Units**
Power supply	12 – 36	Volts DC
Idle current drain	.008	Amps
Sun sensor and logic power supply	0 – 5.15	Volts DC
Output voltage	*Power supply minus .5volts	Volts DC
Continuous output current	3.15 Amps @ 100% duty cycle	Amps
Pulsed output current (.5hz)	**5 Amps a@ 20% duty cycle	Amps
Pulsed output current (.5hz)	**10 Amps @ 5% duty cycle	Amps
Time delay (variable for each axis)	.1 – 60	Seconds
Duty cycle (variable for each axis)	0 – 100	Percent
Duty frequency (variable)	4 cycles per second – 1 cycles per minute	Cycles
Duty cycle control voltage	2.2 – 4.5	Volts DC

* Equal to power supply if reverse connection protection diode is being bypassed increased amperage output.
** Must increase fuse value to equal maximum amperage draw. Polyfuses need to be replaced by standard fuses only if current draw is greater than 7 amps.

Controller circuit description:

The dual axis solar tracking controller features three inputs and two solid state H-bridge driver outputs. Inputs 1 & 2 are window comparators for bi-directional control of direct current loads, input 3 is a single ended comparator whose output can be linked to the output of either direction of either window comparator, or to an input external unit for auxiliary control.
Although this controller is ideal for dual axis solar tracking it is also well suited for other control loads requiring DC current up to 3 amps. Possible applications include, but are not limited to, re circulation pumps, relays, solenoids, fans, motion control, and system monitoring.

*** Caution***
Duty Frequency of greater than 1 cycle per second can potentially damage the driver transistors when larger motors are being used The fuse may not protect against this. High frequency duty cycles should only be used with loads of less than .5 amps.

- Power: 12-36 VDC (volts direct current)
- Ground: Negative terminal of power supply

• Motor wire 1A: Usually wired to the East-West actuator - Positive when moving West
• Motor wire 1B: Usually wired to the East-West actuator - Positive when moving East
• Motor wire 2A: Usually wired to the Up-Down actuator - Positive when moving Up
• Motor wire 2B: Usually wired to the Up-Down actuator - Positive when moving Down

• Fuse 1: 3.15 amp slow-blow fuse for East-West actuator motor
• Fuse 2: 3.15 amp slow-blow fuse for UP-Down actuator motor

• Time Delay 1: Turn clockwise to increase delay between EAST-WEST tracking Corrections
• Time Delay 2: Turn clockwise to increase delay between Up-Down tracking Corrections

• Duty cycle 1: Turn clockwise to increase duty cycle of East-West axis
• Duty cycle 2: Turn clockwise to increase duty cycle of Up-Down axis
• Duty Frequency: Turn Clockwise to INCREASE cycle time (Lower the frequency)

• Sensitivity 1: Turn counterclockwise to increase immunity of East-West axis if wandering is a problem
• Sensitivity 2: Turn counterclockwise to increase immunity of Up-Down axis if wandering is a problem.
***Note: When the sun is obscured, optical solar trackers can be susceptible to wandering toward the brightest source of light, this could be a reflection from a window or the silver lining of a cloud. This circuit features a sensitivity adjustment that can compensate if wandering becomes a problem. The sensitivity can also be increased for applications requiring low-light tracking or greater degrees of accuracy. Turning the adjustment screw clockwise will increase tracking sensitivity.

• Dark return threshold: Turn clockwise if ambient light is keeping the tracker from returning at night. Turn counterclockwise if the tracker is returning in heavy cloud conditions when it is not yet night.

• Dark Return 1 Jumper:
-- Place shorting jumper across Center and East pins to return EAST if the tracker is facing South (Northern Hemisphere)
-- Place shorting jumper across Center and West pins to return EAST if the tracker facing North (Southern Hemisphere)
-- Remove jumper to disable Dark Return function.

• Dark Return 2 Jumper:
-- Place shorting jumper across Center and UP pins to tilt UP at night
-- Place shorting jumper across Center and DOWN pins to tilt UP at night
-- Remove jumper to disable return function.

• Sun Sensor / Remote: There are two "Sun Sensor / Remote" sockets, they are interchangeable. This is where you plug in the Sun Sensor or the Remote Control.
-- Pin 1 : No Connection
-- Pin 2 : Ground
-- Pin 3: 5.15 VDC
-- Pin 4: Dark Return Input
-- Pin 5: East-West Tracking Input
-- Pin 6: Up-Down Tracking Input

• Connecting remote control pins will move the tracker as follows assuming the tracker is in the northern hemisphere facing South
-- 2 & 5 East (MW1a Negative / MW1b Positive) (Opposite for southern hemisphere)
-- 3 & 5 West (MW1a Positive / MW1b Negative) (Opposite for southern hemisphere)
-- 2 & 6 Down (MW2a Negative / MW2b Positive)
-- 3 & 6 Up (MW2a Positive / MW2b Negative)

We suggest using a 1K resistor when bridging pins for remote control, this prevents accidental shorting of the power pins (Pin 2 and Pin 3)

*** Never apply power directly to the motor leads when they are connected to the controller circuit. This will destroy the driver transistors and incur a $40 fix it fee. YOU MUST disconnect the motor wires from the tracking controller If you want to test your motors by connecting them directly to the power source.

If you do damage the boards from mishandling then remove the controller board from the plastic enclosure and send it back to us in a padded mailer. We will fix the board within two days and ship it back to you USPS Priority. We will request a $25 + shipping payment via PayPal for the repair.

LED indicators:

LED designator	Indicates	Comments
D2	Power Available	This LED will change intensity with controller current draw
D3	Motor Wire 1a Positive	This LED turns on when MW1a is positive
D4	Motor Wire 1b Positive	This LED turns on when MW1b is positive
D5	Motor Wire 2a Positive	This LED turns on when MW2a is positive
D6	Motor Wire 2b Positive	This LED turns on when MW2b is positive
D7	Duty Frequency	Flashes at same rate as Duty Frequency Oscillator

Installation instructions:

1) Mount the tracking controller box in an accessible location. Be sure to mount the box with the wire holes leading down, this will prevent water from running into the box. If you wish to drill mounting holes in the controller box – remove the 4 screws from cover, there is space above and below the circuit board for mounting hardware to penetrate the plastic enclosure.

2) Connect the motor wires from your actuators to the motor terminals on the circuit board.
•Motor terminals 1a and 1b should control the EAST-WEST or AZIMUTH actuator.
•Motor terminals 2a and 2b should control the UP-DOWN or ALTITUDE actuator.
•In the Northern Hemisphere Motor wire 1a will be positive when the tracker needs to move West.
•Motor wire 2a will be positive when the tracker needs to tilt UP. If an actuator is moving in the wrong direction try reversing the polarity of the motor wires.
•In the southern hemisphere the polarity of the EAST-WEST motor terminals / wires are reversed.

3) The sun sensor should be mounted to the tracking plane with the cable leading in the Tilt down direction, this would be South if the tracker is at the Noon position. The sensor comes with floating spring mounts for convenient aiming. Remove the wing nuts and one washer from each mounting bolt (this leaves one washer and the spring on each bolt). Pass the three bolts through pre-drilled holes on your sensor bracket. Replace washer and then the wing nut on each bolt. This provides a spring-loaded tripod mount for your sensor. Fine-tune the alignment of the sensor by simply turning the wing nuts in the appropriate direction.

4) WITHOUT THE POWER ON... connect your 12 - 36 VDC power supply wires to the power terminals on the tracking circuit. Be sure to verify polarity, especially when bypassing the reverse protection diode for high amperage operation. Verify connections and turn on the power. The controller takes a while to charge up but should should start tracking the sun in less than two minutes. The time it takes the controller to start tracking is roughly equal to the Track-to-Track time delay.

5) If an actuator is tracking in the wrong direction, disconnect the power, reverse the polarity of the motor wires for that actuator, and reconnect the power.

6) Replace the cover on the control box when you are satisfied that everything is working properly. Make sure that the stress grommet on the sun sensor wire is seated in the notch on the controller box. For permanent outdoor installations it is a good idea to put a bead of caulking around the lid before replacing it to prevent moisture from getting in.

***Maintenance note: Once a year place a coat of clear fingernail polish on the surface of the sun sensor and around the base of the six photocells.

Duty Cycle:

Duty Cycle is how long the motor is on compared to how long it is off during the Duty Period. If the duty period is 2 seconds (.5 Hertz) and the motor is on for one second and off for one second then the Duty Cycle is 50%. The Heliotrack tracking controller features a Duty Cycle control for each axis. The Duty Frequency will be the same for both axis but the duty cycle can be adjusted for each axis individually by adjusting the Duty Cycle 1 or Duty Cycle 2 potentiometers. Duty cycle is useful in two situations...

1) Compensating for tracker overshoot: If a solar tracker has actuators that move too fast the inertia of the tracking plane will move it past alignment with the sun even after the controller turns off the motor. This overshoot may cause the tracker to move back and forth (back tracking) and cause focal point misalignment in concentrator applcations. Using a duty cycle of about 25% and a duty period of about 2 seconds will send short .5 second pulses to the motor reducing momentum of the tracker and mitigating overshoot problems.

2) Operating at higher amperages: You can also use duty cycle to power motors that draw more current than the controller rating. Decrease the duty cycle to send short .5 to .25 second pulses to the actuator motors. It is necessary to increase the fuse value when using the controller in this manner, particulary if your controller has fillament fuses installed. It is also necessaty to monitor the temperature of the transistors when operating at higher amperages to make sure that they are not overheating. Controllers equipped with polyfuses can run intermitent loads up to 7 amps, higher amperages than that will require installation higher amperage fuses.

Time Delay:

The Time Delay adjustment controls the amount of time the controller waits between tracking corrections. Concentrator applications require higher accuracy and need to make tracking corrections more frequently so a Time Delay of less than 30 seconds is recommended. PV tracking applications do not require such precice accuracy so we recommend a Time Delay of mor than 30 seconds. Time delay can also be used to mitigate "back tracking" on tracker that move too fast or have excessive mechanical backlash. The greater the time delay the less often the actuators run increasing actuator life.

Customizations:

There are a few customizations available upon request when you place your order.

• Higher Amperage Motor Drivers: (This configuration bypasses the reverse connection protection diode. If you order these options we are not responsible for controllers damaged from reverse connection
1) ($20 USD) 5 amps continuous for each channel
2) ($40 USD) 8 amps continuous for each channel

• Relay Controller Outputs:
1) (No charge) Controller output terminals wired specifically for relays
2) ($150 USD) Controller output terminals wired specifically for relays and includes relays and harness

• Polyfuses instead of Fillament Fuses:
1) (No charge) Replace slo-blow fuses with resettable poly fuses. You reset polyfuses by disconnecting the power for about 1 minute.

• Single Axis Bridging:
*** INCORRECT BRIDGING WILL BLOW FUSES AND POSSIBLY RUIN THE DRIVER TRANSISTORS!
Please contact us if you want to use the controller setup in this mode as it requires some additional instructions.
A pair of jumper wires connect these bridging points together to make a Single Axis Controller with twice the amperage output.

Calibration and On Board Adjustments:

Several of the external interface points are used to calibrate the Controller as well. Each calibration measures the voltage between two test points, set your multimeter to measure voltage and place the leads between the test points referenced.

Calibration	Interface / Test Points	Voltage	Component Label	POT Designator
Axis 1 Duty Cycle	GND - DC1	4.7	Duty Cycle 1	R57
Axis 2 Duty Cycle	GND - DC2	4.7	Duty Cycle 2	R58
Axis 1 Sensitivity	S1a - S1b	1.2	Sensitivity 1	R55
Axis 2 Sensitivity	S2a - S2b	1.2	Sensitivity 2	R56
Time Delay 1*	TD1	N/A	Time Delay 1	R59
Time Delay 2 *	TD2	N/A	Time Delay 2	R60
Dark Return Threshold	GND - DRT	0.8	Dark Return Threshold	R61
Duty Frequency**	DFa - DFb	N/A	Duty Frequency	R62

* Time Delay is set at the factory to approximately 30 second. This calibration is done by observation.
** Duty Frequency is set at the factory to approximately .25 cycles per second by observing the frequency LED. This represents a duty period of about 4 seconds.

Advanced Features:

There are several external interface points for manual control of Duty Cycle, Duty Frequency, Time Delay, and Sensitivity. These interface points can be used with external circiutry for automated tracker controls like hail or high wind parking or dirving the tracker off sun if the collector is overheating. Here is a listing of the external interface points and what they can do.

• GND: Ground - Several calibrations use GND for reference

• +5V: 5.15 VDC Logic Supply - Can be used to power small microprocessors or other accesories to the controller. Also used as a voltage source for several external functions.

• DR: (Input / Output) Sun Sensor Dark Return Signal - Voltage that represents how much ambient light is hitting the Sun Sensor. This signal can be used to control systems that need to know if the sun is out or not, or if the tracker is on target. Connect this pin to +5V with a 1K resistor to disable the Dark Return function. Connect this pin to GND with a 1K resistor to activate the Dark Return function (dark return jumpers must be set for this to do anything).

• 1A: (Input / Output) Sun Sensor Output Axis 1 EAST-WEST - Voltage that represents which direction the Sun Sensor needs to move to be pointing directly at the sun. If this voltage is greater than 2.5 volts then the Sun Sensor needs to move West to point at the sun. If this voltage is less than 2.5 volts then the Sun Sensor needs to move East to point at the sun. Connect this pin to +5V with a 1K resistor to manually move the tracker West. Connect this pin to GND with a 1K resistor to manually move the tracker Eest.

• 2A: (Input / Output) Sun Sensor Output Axis 2 UP-DOWN - Voltage that represents which direction the Sun Sensor needs to move to be pointing directly at the sun. If this voltage is greater than 2.5 volts then the Sun Sensor needs to move UP to point at the sun. If this voltage is less than 2.5 volts then the Sun Sensor needs to move DOWN to point at the sun. Connect 2A to +5V with a 1K resistor to manually move the tracker UP. Connect 2A to GND with a 1K resistor to manually move the tracker DOWN.

• TD1: (Input) Time Delay 1- Connect variable of fixed resistor betweeen TD1 and +5V to decrease the time delay between tracking corrections for axis 1 (EAST-WEST). Decreasing the resistance decreases the Time Delay. Shorting TD1 to +5V will result in the minimum time delay of approximately one tenth of a second. The time delay can only be decreased from the time delay set by the on board Time Delay 1 potentiometer.

• TD2: (Input) Time Delay 2- Connect variable of fixed resistor betweeen TD2 and +5V to decrease the time delay between tracking corrections for axis 2 (UP-DOWN). Decreasing the resistance decreases the Time Delay. Shorting TD2 to +5V will result in the minimum time delay of approximately one tenth of a second. The time delay can only be decreased from the current time delay set by the on board Time Delay 2 potentiometer. This external interface is usually used to override the time delay during manual control.

• DC1: (Input / Test Point) Duty Cycle 1 - Voltage that controls the duty cycle of Axis 1. You can change the voltage of DC1 with external resistors connected to +5V or GND. A 100K potentiometer voltage divider is a convenient voltage source. You should always connect any external voltage to DC1 through a 1K resistor to prevent damage to the Duty Cycle 1 potentiometer.

• DC2: (Input / Test Point) Duty Cycle 2 - Voltage that controls the duty cycle of Axis 2. You can change the voltage of DC2 with external resistors connected to +5V or GND. A 100K potentiometer voltage divider is a convenient voltage source. You should always connect any external voltage to DC2 through a 1K resistor to prevent damage to the Duty Cycle 2 potentiometer.

• DFa: (Input) Duty Frequency Control - Connect a fixed or variable resistor between this point and DFb to control Duty frequency. Frequency can only be increased from the frequency set by the Duty Frequency adjustment potentiometer.

• DFb: (Input) Duty Frequency Control - See DFa above.

• OC1: (Output) Duty Oscillator 1 Output: Duty Cycle 1 square waveform that goes from 0 - 5.15 volts.

• OC2: (Output) Duty Oscillator 2 Output: Duty Cycle 2 square waveform that goes from 0 - 5.15 volts.

• DRT: (Input / Test Point) Dark Return Threshold - Voltage reference that controls the how little light there must be to turn on the Dark Return function.

• S1a: (Input / Test Point) Sensitivity 1a - Voltage threshold for tracking WEST. If the voltage at 1A is greater than S1a then motor wire 1a will go positive.

• S1b: (Input / Test Point) Sensitivity 1b - Voltage threshold for tracking EAST. If the voltage at 1A is less than S1b then motor wire 1b will go positive.

• S2a: (Input / Test Point) Sensitivity 2a - Voltage threshold for tracking UP. If the voltage at 2A is greater than S2a then motor wire 2a will go positive.

• S2b: (Input / Test Point) Sensitivity 2b - Voltage threshold for tracking DOWN. If the voltage at 2A is less than S2b then motor wire 2b will go positive.