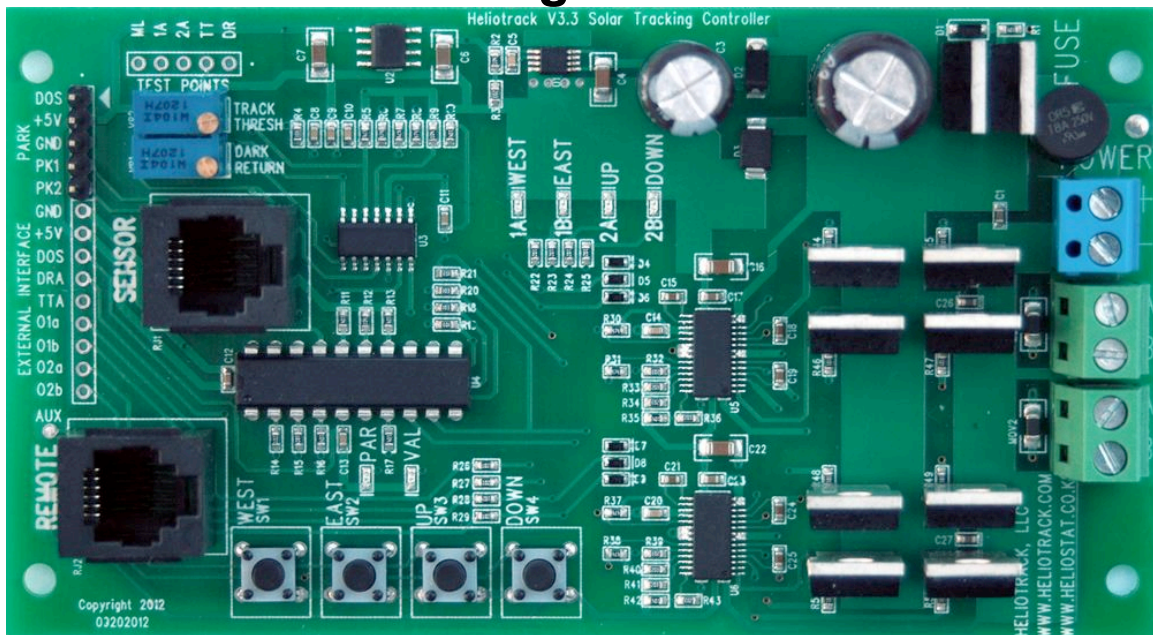


Heliotrack Programmable Dual Axis Solar Tracking Controller V3.3



Features:

- 9-48 VDC power supply
- Two Solid-State H-bridge drivers up to 8 amps.
- Variable Track-to-Track time delay extends actuator life
- Dead Reckoning Timer can advance tracker to follow sun when cloudy
- Programmable load sequencing to reduce power supply amperage requirements
- Programmable Load Sequencing frequency and duty cycle
- Dark return direction selectable for each axis
- Park1 direction selectable for each axis (Includes release timer)
- Park2 direction selectable for each axis (Includes release timer)
- Drive-Off-Sun (DOS) direction selectable for each axis (Includes release timer)
- Programmable Drive-Off-Sun (DOS) timer
- On-Board control buttons for manual control of tracker and programming of controller
- Remote control plug for manual control of tracker and programming of controller
- Screw terminals for easy connection to power supply and motors
- Fuse protection
- Short circuit protection for each axis
- External interface points for expanding capabilities of the controller.
- Output drivers can be bridged for higher current single axis operation
- RJ12 sockets for convenient Sun Sensor and Remote Control connection
- On-board LED indicators for Motor Direction, Duty Cycle, and Duty Frequency
- Power Supply reverse connection protection

Primary Applications:

Single-Axis, Twin Single-Axis, and Dual-Axis solar tracking.

Controller can also be adapted for...

Pump control

Thermostat control

Servo control

Motor controls based on voltage comparisons

Specifications:

Specification	Value
Power supply	9 – 48 Volts DC
Idle current drain	14 milliamps
Sun Sensor and Logic power supply	5.0 Volts DC (50 milliamps)
Motor Output voltage	Equal to power supply minus
Continuous output Power	100 Watts per axis
Continuous output current	12VDC = 8 Amps (100% duty cycle)
Continuous output current	24VDC = 6 Amps (100% duty cycle)
Continuous output current	36VDC = 4 Amps (100% duty cycle)
Continuous output current	48VDC = 3 Amps (100% duty cycle)

Controller circuit description:

Although this controller was designed primarily for dual axis solar tracking it can also be used for control of other loads requiring DC current up to 8 amps. Possible applications include, but are not limited to, circulation pumps, relays, solenoids, fans, motion control, and system monitoring. The controller is capable of driving up to two loads at once.

The dual axis solar tracking controller features three inputs and two solid state H-bridge driver outputs. Inputs 1A & 2A are voltage comparators that control bi-directional DC outputs, input ML is a window comparator whose input is compared to the Tracking Threshold and Dark Return Threshold.

- Power: +12-48 VDC positive terminal of power supply
- Ground: Negative terminal of power supply
- Motor wire 1A (W) WEST: Usually wired to the East-West actuator - Positive when moving West (Reversed in Southern Hemisphere)
- Motor wire 1B (E) EAST: Usually wired to the East-West actuator - Positive when moving East (Reversed in Southern Hemisphere)
- Motor wire 2A (U) UP: Usually wired to the Up-Down actuator - Positive when moving Up
- Motor wire 2B (D) DOWN: Usually wired to the Up-Down actuator - Positive when moving Down
- Fuse: 8 amp slow-blow fuse for actuator motors
- Tracking Threshold: Turn clockwise to decrease Sun Sensor sensitivity and increase the amount of sunlight required to activate tracking. Turn counterclockwise to increase Sun Sensor sensitivity and activate tracking with less sunlight.
- 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 before nightfall.

- Sun Sensor: There are up to two "Sun Sensor" sockets that are interchangeable. This is where you plug in the Sun Sensor.
 - Pin 1 : Sun Sensor Detect
 - Pin 2 : Ground
 - Pin 3: 5.0 VDC
 - Pin 4: Dark Return Input
 - Pin 5: East-West Tracking Input
 - Pin 6: Up-Down Tracking Input
- Remote: There is one Remote plug for connecting an external Remote Control. Connecting remote control pins will move the tracker as follows assuming the tracker is located in the Northern Hemisphere facing South
 - 1 & 2 WEST (W) Positive / (E) Negative (Opposite for southern hemisphere)
 - 1 & 3 EAST (W) Negative / (E) Positive (Opposite for southern hemisphere)
 - 1 & 4 UP (U) Positive / (D) Negative
 - 1 & 5 DOWN (U) Negative / (D) Positive

*** Never apply power to the motor terminals. This will destroy the driver transistors and incur a \$75 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 supply. If you do happen to 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 one week and ship it back to you USPS Priority.

LED indicators:

WEST (RED) Motor Wire 1A (W) is positive.

EAST (RED) Motor Wire 1B (E) is positive.

UP (RED) Motor Wire 2A (U) is positive

DOWN (RED) Motor Wire 2B (D) is positive

PAR (GREEN) Parameter indicator (Also power, data read, active motor and Park mode indicator)

VAL (YELLOW) Parameter Value indicator (Also data write, active motor, and Park mode indicator)

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.

2) Connect the motor wires from your actuators to the motor terminals on the circuit board.

- Motor terminals W and E should control the WEST-EAST or AZIMUTH actuator.
 - Motor terminals U and D should control the UP-DOWN or ALTITUDE actuator.
 - In the Northern Hemisphere Motor wire W will be positive when the tracker needs to move WEST.
 - Motor wire E will be positive when the tracker needs to tilt UP.
- Reverse the polarity of the motor wires if an actuator is moving in the wrong.
- In the southern hemisphere the polarity of the EAST-WEST motor wires should be reversed.

3) The sun sensor should be mounted to the tracking plane (solar panels or concentrator) with the cable leading in the Tilt-Down direction, or South when the tracker is at the Noon position in the Northern Hemisphere. The sensor comes with floating spring mounts for convenient calibration. 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, then replace the 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 turning the wing nuts in the appropriate direction.

4) WITHOUT THE POWER ON... connect your 9 - 48 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 GREEN LED should flash quickly 15 times while the controller loads the user saved parameters from memory.

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 cable is seated in the notch on the controller box. Do not over tighten the screws when replacing the enclosure lid, it may cause the lid to warp enough to break the rubber seal around the edge and water to penetrate into the box.

Load Sequencing (Duty Cycle):

Load sequencing alternates power to the motors, this reduces the maximum current draw of the controller to the current draw of the highest amperage motor.

Load sequencing can also reduce the on-time of each actuator to prevent overheating of the driver transistors when using actuators drawing greater than 4 amps. Using Load Sequencing in this way also requires replacing the stock filament fuses with polyfuses that can permit greater amperage spikes without tripping.

Tracking Delay:

The Tracking Delay setting controls the time the controller waits between tracking corrections. Concentrator applications usually 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 precise accuracy so we recommend a Time Delay of more than 30 seconds. Time delay can also be used to mitigate "back tracking" or "back-lashing" caused by the tracker traveling past the sun and then tracking in the opposite direction during the next tracking correction. Greater Tracking Delays mean the motors turn on and off fewer times per day generally increasing actuator life.

Relay Controller Option:

If your actuators draw more than 8 amps then relays can be used to supply power to the actuators. See the “Schematic” link on our website for details.

Limit Switches:

Limit Switches are required for each direction for every actuator when using Heliotrack solar tracking products! Many actuators on the market include internal limit switches but the user must verify this before connecting actuator motors to the tracking controller. It is also necessary to verify that the limit switches are set to stop the motors before any damage is done to tracking mechanism due to over-traveling. If your actuators do not include limit switches then please see the “Schematics” link on our website for details.

The External Interface points O1A, O1B, O2A, O2B can be used for logic level limit switching. Limit switches using these test points do not have to carry high amperage as they work at logic level and only need to carry 10 milliamps. See the External Interface portion of this manual for details.

Disclaimer:

Heliotrack,LLC assumes no liability or responsibility for damages caused by the use or misuse of our products. Although this controller is low voltage it is capable of supplying very high amperages. Some components, particularly the driver transistors and reverse connection protection diode, can reach temperatures of up to 150 degrees centigrade during operation and much higher if they fail for some reason. We strongly recommend that anyone working with electronics with exposed components wear eye protection, it is not uncommon for a failing electronic component to explode expelling bits of hot shrapnel.

Don't mean to scare you... just please use caution.

Never have combustibles near electronic circuitry or motors.

STARTUP BUTTON FUNCTIONS

Available while the controller is starting up by pressing indicated buttons while connecting power to the controller.

Pressing WEST & EAST buttons simultaneously while powering up the controller restores the factory presets.

Pressing UP & DOWN buttons simultaneously while powering up the controller allows access to hidden Parameters 11 (Time Delay Override) and 12 (Bridge Mode) in the programming mode Bank 1.

OPERATION BUTTON FUNCTIONS

Available after startup is complete.

Remote Control

Pressing WEST button will turn on motor wire1A (W)

Pressing EAST button will turn on motor wire1B (E)

Pressing UP button will turn on motor wire (Up)

Pressing DOWN button will turn on motor wire (Down)

Pressing WEST & EAST buttons simultaneously will toggle between Tracking Enable and Tracking Disable. Entering or exiting this mode is indicated by three short blinks. When tracking is disabled the green and yellow lights will continue to blink three short blinks.

Pressing UP & DOWN button simultaneously enters the programming mode Bank 1.

Pressing Up & Down button simultaneously enters the programming mode Bank 2.

PROGRAMMING MODE (V3.3 controller with V3.1 Firmware)

1) Entering programming mode:

Pressing UP and DOWN buttons simultaneously for a second will enter the programming mode For Bank 1.

Pressing EAST and UP buttons simultaneously for a second will enter the programming mode For Bank 2.

PAR (Green) indicates which PARAMETER is selected.

VAL (Yellow) indicates the VALUE of the current parameter.

WEST button:

Advance to the next parameter.

If the Parameter is the one in that bank then it will wrap back around to Parameter1

EAST button:

Display current parameter and increase the value of the current parameter by one.

When the value is at maximum it will wrap back around to a value of 1

UP button:

Display the current parameter without changing value.

DOWN button:

Exit programming mode and write any changes to memory.

The controller only accepts input from the buttons after the parameter and value have been completely displayed.

Programmable Parameters Bank 1

PARAMETER NAME	Parameter Selected	PARAMETER VALUE
GREEN LED BLINKS		YELLOW LED BLINKS
1	Tracking Delay Count	1 – 8 Blinks
2	Dark Return Direction	1 – 9 Blinks
3	Park1 Direction	1 – 9 Blinks
4	Park2 Direction	1 – 9 Blinks
5	Drive Off Sun Direction	1 – 9 Blinks
6	Drive Off Sun Count	1 – 8 Blinks
7	Park1 Latch Timer	1 – 8 Blinks
8	Park2 Latch Timer	1 – 8 Blinks
9	DOS Latch Timer	1 – 8 Blinks
10	Tracking Delay Multiplier	1 – 9 Blinks
*11	Tracking Delay Override	1 – 2 Blinks
*12	Bridge Mode	1 – 2 Blinks

***SPECIAL ACCESS PARAMETERS:** Press UP and DOWN Buttons during startup to enable access to these parameters in Programming Mode.

Tracking Delay Override: Disabling the **Tracking Delay** may cause damage to the motor driver transistors. Overriding the Tracking Delay enables high frequency output and should not to be used with the stock H-Bridge driver in this controller.

Bridge Mode: Proper bridge wiring must be observed when Bridge Mode is enabled or the fuses will blow and the driver transistors may be damaged.

Bank 1 Parameter 1: Tracking Delay Count

GREEN LED: 1 Blink

YELLOW LED 2: 1 – 8 Blinks

Default Value = 4

YELLOW LED Blinks	Tracking Delay count: Rest time between tracking corrections. Actual time depends on Tracking Delay Multiplier. Tracking Delay is applied to Dark return, Tracking Threshold, and On-Sun signals.	
	Tracking Delay Count	* Tracking Delay Time
1	1	1.8 seconds
2	3	6 seconds
3	7	14 seconds
4	15 (Factory Default)	31 seconds (Factory Default)
5	31	64 seconds
6	63	133 seconds
7	127	266 seconds
8	255	532 seconds

* Tracking Delay Times in this table are only valid when the Tracking Delay Multiplier (Bank 2 Parameter 10) value is set to the factory default of 4.

The Tracking Delay Count sets the amount of time the controller waits between tracking corrections.

The sun traverses the sky at a rate of 1 degree every four minutes; so a Tracking Delay Time of four minutes would limit the tracking accuracy to 1 degree. The default Tracking Delay Time of 31 seconds represents an accuracy of about 1/8 degree. Change the Tracking Delay Multiplier (Parameter 11) to achieve Tracking Delays that are greater or less than the Tracking Delays available in this table.

Bank 1 Parameter 2: Dark Return Direction

GREEN LED: 2 Blinks

YELLOW LED: 1 – 9 Blinks

Default Value = 1

YELLOW LED Blinks	Dark Return Direction: Activated when the sun sensor's Mass Light output (Pin: ML) is less than the Dark Return Threshold (Pin: DRT) which is set by the Dark Return Threshold potentiometer (R35)
1	Motor 1 off / Motor 2 off (Factory default)
2	Motor 1 East / Motor 2 off
3	Motor 1 West / Motor 2 off
4	Motor 1 off / Motor 2 Down
5	Motor 1 East / Motor 2 Down
6	Motor 1 West / Motor 2 Down
7	Motor 1 off / Motor 2 Up
8	Motor 1 East / Motor 2 Up
9	Motor 1 West / Motor 2 Up

NOTE: East and West directions are reversed in the Southern Hemisphere when the Tracker is facing North.

The Dark Return Direction is the direction the tracker will move when the Mass Light output voltage of the Sun Sensor (Test Point **ML**) is less than the voltage set by the Dark Return Threshold potentiometer (Test Point **DRT**). The Dark Return output will be on the entire night so limit switches are required on the actuators to stop the tracker in the sunrise position (East Limit).

The most common value for the Dark Return Direction parameter in the Northern Hemisphere is 2; in the Southern Hemisphere it is 3.

Bank 1 Parameter 3: Park 1 Direction

GREEN LED: 3 Blinks

YELLOW LED: 1 – 9 Blinks

Default Value = 1

YELLOW LED Blinks	Park 1 Direction: Activated when the Park 1 (Pin: PK1) is connected to Ground. Park 1 supersedes Park 2, Drive Off Sun, and Dark Return. Most likely used for stowing the tracker at the horizontal (tilt up) limit for high wind or the vertical (tilt down) limit for Hail.
1	Motor 1 off / Motor 2 off (Factory default)
2	Motor 1 East / Motor 2 off
3	Motor 1 West / Motor 2 off
4	Motor 1 off / Motor 2 Down
5	Motor 1 East / Motor 2 Down
6	Motor 1 West / Motor 2 Down
7	Motor 1 off / Motor 2 Up
8	Motor 1 East / Motor 2 Up
9	Motor 1 West / Motor 2 Up

NOTE: East and West directions are reversed in the Southern Hemisphere (Tracker facing North).

The tracker will turn on the motor(s) in the Park 1 direction whenever the Park 1 pin (PK1) is connected to ground. This function can be used to park the tracker during adverse weather conditions like high wind or hail. The motor wires will be the entire time the Park 1 pin is connected to ground requiring limit switches to keep the actuators from over-traveling.

Park 1 has priority over Park 2, Drive Off Sun, and Dark Return.

Bank 1 Parameter 4: Park 2 Direction

GREEN LED: 4 Blinks

YELLOW LED: 1 – 9 Blinks

Default Value = 1

YELLOW LED Blinks	Park 2 Direction: Activated when the Park 2 (Pin: PK2) is switched to Ground. Park 2 supersedes Drive Off Sun, and Dark Return. Parking for weather or a system fault.
1	Motor 1 off / Motor 2 off (Factory default)
2	Motor 1 East / Motor 2 off
3	Motor 1 West / Motor 2 off
4	Motor 1 off / Motor 2 Down
5	Motor 1 East / Motor 2 Down
6	Motor 1 West / Motor 2 Down
7	Motor 1 off / Motor 2 Up
8	Motor 1 East / Motor 2 Up
9	Motor 1 West / Motor 2 Up

NOTE: East and West directions are reversed in the Southern Hemisphere (Tracker facing North)

The tracker will turn on the motor(s) in the Park 2 direction whenever the Park 2 pin (PK2) is connected to ground. This function can be used to park the tracker during adverse weather conditions like high wind or hail. The motor wires will be the entire time the Park 2 pin is connected to ground requiring limit switches to keep the actuators from over-traveling.

Park 2 has priority over Drive Off Sun, and Dark Return.

Bank 1 Parameter 5: Drive Off Sun Direction

GREEN LED: 5 Blinks

YELLOW LED: 1 – 9 Blinks

Default Value = 1

YELLOW LED Blinks	Drive Off Sun Direction: Activated when the Drive Off Sun (Pin: DOS) is grounded (GROUND or Pin: GND)
1	Motor 1 off / Motor 2 off (Factory default)
2	Motor 1 East / Motor 2 off
3	Motor 1 West / Motor 2 off
4	Motor 1 off / Motor 2 Down
5	Motor 1 East / Motor 2 Down
6	Motor 1 West / Motor 2 Down
7	Motor 1 off / Motor 2 Up
8	Motor 1 East / Motor 2 Up
9	Motor 1 West / Motor 2 Up

NOTE: East and West directions are reversed in the Southern Hemisphere (Tracker facing North)

When the Drive Off Sun pin (DOS) is connected to ground the tracker will move in the Drive Off Sun Direction for the time specified by the Drive Off Sun Count and then stop. When the DOS pin is released from ground the DOS counter will reset.

This function is designed to move the tracker off sun when the solar collector is overheating. This is important in Concentrated Solar Power (CSP) applications where the collector may be damaged if recirculation of the working fluid is interrupted, or when overheating can cause the working fluid to boil causing critical buildup of system pressure.

Bank 1 Parameter 6: Drive Off Sun Count

GREEN LED: 6 Blinks

YELLOW LED: 1 – 8 Blinks

Default Value = 4

YELLOW LED Blinks	Drive Off Sun Count: Time that the tracker moves in the Drive Off Sun direction while the DOS pin is grounded. When the count expires the tracker will rest until The DOS pin is released from ground. Park 1 and Park 2 will override the DOS function. Actual time depends on Tracking Delay Multiplier.
1	0.5 Seconds
2	1.7 Seconds
3	3.5 Seconds
4	8 Seconds (Factory default)
5	16 Seconds
6	32 Seconds
7	64 Seconds
8	128 Seconds

Drive Off Sun Count is the amount of time that the tracker will move in the Drive Off Sun Direction when the DOS pin is connected to ground. The Drive Off Sun Count is reset whenever the DOS pin is released from ground.

Bank 1 Parameter 7: Park 1 Latch Timer

GREEN LED: 7 Blinks

YELLOW LED: 1 – 8 Blinks

Default Value = 1

YELLOW LED Blinks	Park 1 Latch Timer: This is the time that the controller will wait to resume Tracking, Dead Reckoning, or Dark Returning after Park 1 has been released.
1	OFF (Factory default)
2	30 Seconds
3	60 Seconds
4	120 Seconds
5	240 Seconds
6	480 Seconds
7	960 Seconds
8	1920 Seconds

Park Latch Timers are used to delay the resumption of tracking operations after the respective park pin has been released. For example, if Park 1 is being triggered by a high wind alarm then the Park 1 Latch Timer will allow the user to set how long the wind needs to be below a certain speed before tracking will resume. The Park 1 Latch Timer will be cleared if either Park 2 or DOS are activated.

Bank 1 Parameter 8: Park 2 Latch Timer

GREEN LED: 8 Blinks

YELLOW LED: 1 – 8 Blinks

Default Value = 1

YELLOW LED Blinks	Park 2 Latch Timer: This is the time that the controller will wait to resume Tracking, dead reckoning, or Dark Returning after Park 2 has been released.
1	OFF (Factory default)
2	30 Seconds
3	60 Seconds
4	120 Seconds
5	240 Seconds
6	480 Seconds
7	960 Seconds
8	1920 Seconds

Park Latch Timers are used to delay the resumption of tracking operations after the respective park pin has been released. For example, if Park 2 is being triggered by a hail alarm then the Park 2 Latch Timer will allow the user to set how long the hail storm needs to have passed before tracking will resume. The Park 2 Latch Timer will be cleared if either Park 1 or DOS are activated.

Bank 1 Parameter 9: DOS Latch Timer

GREEN LED: 6 Blinks

YELLOW LED: 1 – 8 Blinks

Default Value = 4

YELLOW LED Blinks	DOS 1 Latch Timer: This is the time that the controller will wait to resume Tracking, dead reckoning, or Dark Returning after DOS has been released.
1	OFF (Factory default)
2	30 Seconds
3	60 Seconds
4	120 Seconds
5	240 Seconds
6	480 Seconds
7	960 Seconds
8	1920 Seconds

Park Latch Timers are used to delay the resumption of tracking operations after the respective park pin has been released. For example, if DOS is being triggered by a collector overheat alarm then the DOS Latch Timer will allow the user to set how long the overheat condition needs to be corrected before tracking will resume. The DOS Latch Timer will be cleared if either Park 1 or Park 2 are activated.

Bank 1 Parameter 10: Tracking Delay Multiplier

GREEN LED: 10 Blinks

YELLOW LED: 1 – 9 Blinks

Default Value = 4

YELLOW LED Blinks	Drive Off Sun Direction
1	X 1
2	X 2
3	X 3
4	X 4 (Factory default)
5	X 5
6	X 6
7	X 7
8	X 8
9	X 9

Tracking Delay Multiplier is used to extend or reduce the factory default Tracking Delay Times. The minimum Tracking Delay Time is approximately .25 seconds when using a multiplier of 1. This setting is used for extremely precise tracking.

The maximum Tracking Delay Time is about 20 minutes when using a multiplier of 9. This setting is good for PV tracking where having fewer tracking movements per day may be preferable to high accuracy.

See the Tracking Delay Time Table to determine possible Tracking Delay Time possibilities.

Bank 1 Parameter 11: Tracking Delay Override (*SPECIAL ACCESS PARAMETER)

GREEN LED: 11 Blinks

YELLOW LED: 1 – 2 Blinks

Default Value = 1

YELLOW LED Blinks	Time Delay Override: Disables Time Delay between tracking corrections. Caution!! this may cause high frequency oscillations that can destroy the transistors if the controller has the stock H-Bridge output.
1	Tracking Delay Enabled (Factory default)
2	Tracking Delay Disabled

Tracking Delay Override disables the Tracking Delay Timer causing the controller motor outputs to react instantaneously to signals from the sun sensor. This parameter should be never be enabled when using the stock controller driver transistors because the high speed switching frequencies can damage the transistors.

This parameter enables high speed control of an external driver circuit and requires that the controller PCB be modified as a logic controller; this is done by removing the four N-MOSFET driver transistors or all of the driver transistors depending on the application.

Please contact us for more information if you plan on enabling this parameter or the warranty may be void.

Bank 1 Parameter 12: Motor Bridging Mode (*SPECIAL ACCESS PARAMETER)

GREEN LED: 12 Blinks

YELLOW LED: 1 – 2 Blinks

Default Value = 1

YELLOW LED Blinks	Motor Bridging Mode: Both motor outputs are driven by the selected axis. Caution!! Proper wiring must be observed or the output transistors may be damaged.
1	Bridging off (Factory default)
2	Bridge Axis 1 (East / West) to all motor terminals
3	Bridge Axis2 (Up / Down) to all motor terminals

Motor Bridging Mode is used to bridge the motor output terminals for higher amperage single-axis operation. Pulsed currents of up to 8 amps are possible in Motor Bridging Mode. Continuous currents of up to 8 amps are possible if the reverse connection protection diode is bypassed. The controller may be severely damaged if the power supply is connected in reverse while the reverse connection protection diode is bypassed.

Motor Wire 1a and Motor Wire 2a should be connected together and Motor Wire 1b and Motor Wire 2b should be connected together Motor Bridging Mode is enabled. The fuses will blow or the controller may be severely damaged If the motor terminals are wired for Motor Bridging Mode and the Motor Bridging Mode parameter is not enabled; for this reason the Motor Bridging Mode is hidden. Please contact us if you have any doubts about the correct implementation of this parameter.

Tracking Delay Time Table

		Tracking Delay (Parameter 1)							
		1	2	3	4	5	6	7	8
Tracking Delay Multiplier (Parameter 11)	1	.1 - .5	1.5	3.5	7	15	32	66	133
	2	.8	3	7	15	32	66	133	266
	3	1.3	4.5	10	22	47	98	200	400
	4	1.8	6	14	31	64	133	266	532
	5	2.4	7.5	18	38	81	166	332	665
	6	3	9	22	46	98	200	400	800
	7	3.5	10.5	25	53	114	233	464	933
	8	4	12	29	61	133	266	533	1066
	9	4.5	13.5	33	68	145	300	600	1200

Tracking Delay table results are in seconds.

The default value of the Tracking Delay and Tracking Delay Multiplier parameter is 4 making the tracking delay time 31 seconds. The minimum Tracking Delay Time possible is about .25 seconds, the maximum Tracking Delay Time is about 20 minutes.

Programmable Parameters Bank 2

PARAMETER NAME GREEN LED BLINKS	Parameter Selected	PARAMETER VALUES YELLOW LED BLINKS
1	Dead Reckoning Enable	1 – 4 Blinks
2	Dead Reckoning Lock	1 – 2 Blinks
3	Load Sequencing Mode	1 – 2 Blinks
4	Load Sequencing 1 Count	1 – 8 Blinks
5	Load Sequencing 2 Count	1 – 8 Blinks
6	Load Sequencing Rest Count	1 – 8 Blinks
7	Load Sequencing Speedup	1 – 8 Blinks
8	Remote Follows Load Sequencing	1 – 3 Blinks

Bank 2 Parameter 1: Dead Reckoning

GREEN LED: 1 Blink

YELLOW LED: 1 – 4 Blinks

Default Value = 1

YELLOW LED Blinks	Dead Reckoning: Operates motors at timed intervals during the day when cloudy to approximate path of sun.
1	Dead Reckoning Disabled (Factory default)
2	Dead Reckoning Enabled Axis 1 (East – West)
3	Dead Reckoning Enabled Axis 2 (Up – Down)
4	Dead Reckoning Enabled Axis 1 & Axis 2

The Dead Reckoning feature times how long the motors run while tracking. When it is cloudy the tracker will run the motors at the same frequency to approximate the path of the sun. This keeps the tracker aligned approximately with the sun when it is cloudy.

Dead Reckoning will not work with trackers that backtrack due to backlash in the mechanics. After power is connected to the controller the Dead Reckoning timer requires three subsequent corrections in the same direction before it will begin working.

Bank 2 Parameter 2: Dead Reckoning Lock

GREEN LED: 2 Blinks

YELLOW LED: 1 – 2 Blinks

Default Value = 1

YELLOW LED Blinks	Dead Reckoning Lock: Locks the current Dead Reckoning times in memory and prevents future updates.
1	Dead Reckoning Lock Disabled (Factory default)
2	Dead Reckoning Lock Enabled

When the Dead Reckoning Timer has values that are satisfactory then these values can be locked into memory by enabling the Dead Reckoning Lock. The values will be saved even when power is disconnected and will be restored at next startup.

When the Dead Reckoning Lock is disabled then the Dead Reckoning times are reset to Zero and will be constantly updated during tracking.

Bank 2 Parameter 3: Load Sequencing

GREEN LED: 3 Blinks

YELLOW LED: 1 – 2 Blinks

Default Value = 2

YELLOW LED Blinks	Load Sequencing Mode
1	Load Sequencing Off
2	Load Sequencing On (Factory default)

Load Sequencing is used to alternate power to the actuators, this limits the maximum current that the controller draws at any time to the current drawn by the largest actuator. The controller's reverse connection protection diode is limited to 5 amps, so it is necessary to enable Load Sequencing if the current draw of both actuators running simultaneously is greater than 5 amps.

The Load Sequencing cycle follows this order...

- 1) Load Sequencing 1 Count (Motor 1 – East/West)
- 2) Load Sequencing 2 Count (Motor 2 – Up/Down)
- 3) Load Sequencing Rest Count (Motors disabled)

If the *Remote Respects Load Sequencing* parameter is disabled then the load sequencing order will automatically advance when the position of the operating actuator is On-Sun.

If the *Remote Respects Load Sequencing* parameter is enabled then the load sequencing order will not automatically advance when the position of the operating actuator is On-Sun.

Bank 2 Parameter 4: Load Sequencing 1 Count

GREEN LED: 4 Blinks

YELLOW LED: 1 – 8 Blinks

Default Value = 3

YELLOW LED Blinks	Load Sequencing 1 Count: Time that Motor 1 will be on during the Load Sequencing routine.
1	0.5 Seconds
2	1.7 Seconds
3	3.5 Seconds (Factory default)
4	8 Seconds
5	16 Seconds
6	32 Seconds
7	64 Seconds
8	128 Seconds

Load Sequencing 1 Count is the maximum time that Motor 1 (East/West) will be on during each Load Sequencing cycle.

Bank 2 Parameter 5: Load Sequencing 2 Count

GREEN LED: 2 Blinks

YELLOW LED: 1 – 8 Blinks

Default Value = 3

YELLOW LED Blinks	Load Sequencing 2 Count: Time that Motor 2 will be on during the Load Sequencing routine.
1	0.5 Seconds
2	1.7 Seconds
3	3.5 Seconds (Factory default)
4	8 Seconds
5	16 Seconds
6	32 Seconds
7	64 Seconds
8	128 Seconds

Load Sequencing 2 Count is the time that Motor 2 (Up/Down) will be enabled during each Load Sequencing cycle.

Bank 2 Parameter 6: Load Sequencing Rest Count

GREEN LED: 6 Blinks

YELLOW LED: 1 – 8 Blinks

Default Value = 1

YELLOW LED Blinks	Load Sequencing Rest Count: Time that both motors are off during the Load Sequencing routine. Only enabled when Remote Respects Load Sequencing is enabled as well.
1	0.5 Seconds (Factory default)
2	1.7 Seconds
3	3.5 Seconds
4	8 Seconds
5	16 Seconds
6	32 Seconds
7	64 Seconds
8	128 Seconds

Load Sequencing Rest Count is the amount of time that both motors will be disabled during each Load Sequencing cycle. Remote Respects Duty must be set to 1 for the Load Sequencing Rest Count to be enabled. This is because the Load Sequencing Rest Count is primarily used to slow down actuators that move too fast or to limit the amperage supplied to motors that draw more amperage than the controller can supply continuously. It is usually desirable that the remote control also respect load sequencing if it is being used in either of these ways.

Bank 2 Parameter 7: Load Sequencing Speedup

GREEN LED: 7 Blinks

YELLOW LED: 1 – 2 Blinks

Default Value = 1

YELLOW LED Blinks	Load Sequencing Speedup
1	Load Sequencing Normal Speed (Factory default)
2	Load Sequencing 2X normal speed
3	Load Sequencing 4X normal speed
4	Load Sequencing 8X normal speed
5	Load Sequencing 16X normal speed
6	Load Sequencing 32X normal speed
7	Load Sequencing 64X normal speed
8	Load Sequencing 128X normal speed

Load Sequencing Speedup divides the Load Sequencing Timer. This can be used when smaller increments of load sequencing time are needed for shorter pulses to the motors.

Use high speed sequencing with caution as faster switching of the driver transistors can cause them to heat up. Longer Load Sequencing Rest Counts are recommended when enabling this parameter.

The warranty does not cover transistors that are damaged resulting from load sequencing speedup. It is a good idea to monitor the temperature of the driver transistors to make sure they are not heating up when using the Load Sequencing Speedup parameter value is greater than 3.

Bank 2 Parameter 8: Remote Respects Load Sequencing

GREEN LED: 8 Blinks

YELLOW LED: 1 – 2 Blinks

Default Value = 1

YELLOW LED Blinks	Load Sequencing Mode: Whenever the remote control buttons are used to move the tracker the motors will start and stop according to the load sequencing order. Used to limit the duty cycle when driving motors that exceed 4 amps continuous current draw.
1	Tracking Respects Load Sequencing (Factory default)
2	Tracking and Park Functions Respect Load Sequencing
3	Tracking, Park Functions, and Remote Control Respect Load Sequencing

Remote Respects Load Sequencing should be enabled when Load Sequencing is being used to limit the time that the motors are on to prevent the driver transistors from heating up or to slow down motors that move too fast. This insures that the load sequencing order is followed when using the remote buttons to operate the motors. Enabling Load Sequencing mode 2 or 3 also enables Load Sequencing Rest Count.

User Interface Pin Descriptions:

*****Caution must be used to insure that no static discharge is introduced any of the interface pins or the controller may be damaged and require factory repair.**

CALIBRATION TEST POINTS:

Set multimeter on volts. Negative lead goes to ground. Positive lead goes to test point.

DRT - Dark Return Threshold: Sets Dark Return activation voltage threshold.

Default = .7 volts

Increase voltage to set the threshold lighter.

Increase voltage by turning adjustment screw clockwise.

TT - Tracking Threshold: Sets Tracking Threshold activation voltage threshold.

Default = 2.6 volts

Increase voltage to increase sun intensity needed to track.

Increase voltage by turning adjustment screw clockwise.

SUN SENSOR TEST POINTS

1A - Axis 1 Sun Sensor Output

2A - Axis 2 Sun Sensor Output

ML - Mass Light Sun Sensor Output: Voltage represents sun intensity
(Dark = .1V – 1.5V | Cloudy = 1.5V – 2.2V | Sunny = 2.2V – 4.9V)

PARK & DRIVE OFF SUN ACTIVATE:

DOS - Drive Off Sun: Pull pin to Ground to activate DOS function.

+5V - +5 Volts DC (50ma)

GND - Ground

PK1 - Park 1 Activate: Connect to Ground to activate Park 1 Function.

PK2 - Park 2 Activate: Connect to Ground to activate Park 2 Function.

EXTERNAL INTERFACE:

GND - Ground

+5V - +5 Volts DC (50ma)

DOS - Drive Off Sun: Pull pin to Ground to activate DOS function.

DRA - Dark Return Activated (Goes from 5V to ground when Dark Returning)

TTA - Tracking Threshold Activated (Goes from 5V to ground when Tracking)

O1A - Override 1A WEST (Input / Output)

O1B - Override 1B EAST (Input / Output)

O2A - Override 2A UP (Input / Output)

O2B - Override 2B DOWN (Input / Output)

O1A, O1B, O2A, O2B: These interface points can be used to indicate motor direction and they can be used to override the controller program and force motors on or off. Connect 5 volts to an override point to turn a motor on in the respective direction. Connect an override point to GROUND to turn a motor off in the respective direction. These test points can be used to provide limit switching at logic levels so that the limit switches need not carry the high amperage of the motors. Logic level limit switches only need to carry 10 milliamps

Note: External interface pins can be used in conjunction with another microcontroller that uses the actuator “reed switch pulse encoders” for memory positioning functions.

REMOTE SOCKET:

Pin1: GND: Ground

Pin2: WEST: Move West: Connect to GND (Ground) to move tracker West

Pin3: EAST: Move East: Connect to GND (Ground) to move tracker East

Pin4: UP: Move Up: Connect to GND (Ground) to move tracker Up

Pin5: DOWN: Move Down: Connect to GND (Ground) to move tracker Down

Pin6: AUX: Open pin/conductor - User access is the AUX test point on the PCB.

Additional LED Signals:

- When power is first connected to the controller the Green LED will blink three times to indicate that this is V3 firmware.
- While the controller is starting up the Green LED will flash very quickly 22 times as the user parameters are recalled from memory.
- The Green and Yellow LED will alternate quickly if the sun sensor is not plugged in.
- When Load Sequencing is enabled the Green LED indicates that the sequence is in the Motor 1 Cycle. The Yellow LED indicates that the sequence is in the Motor 2 Cycle. They will both be off during the Rest Cycle.

- When Load Sequencing is disabled the Green LED will flash periodically to indicate that the controller is on.
- When Park 1 is enabled the Green LED will blink quickly continuously.
- When Park 2 is enabled the Yellow LED will blink quickly continuously.
- When DOS is enabled the Green & Yellow LED will blink twice quickly then repeat.
- When Tracking has been disabled by Remote Control the Green and Yellow LED will flash 3 times followed by a short pause and then repeat.

HINTS:

Disabling tracking to facilitate control of actuators with an external circuit:

1 - Program Park1 to have no direction. *Parameter 3(Green LED = 3 blinks)
Value = 1 (Yellow LED = 1 blink).*

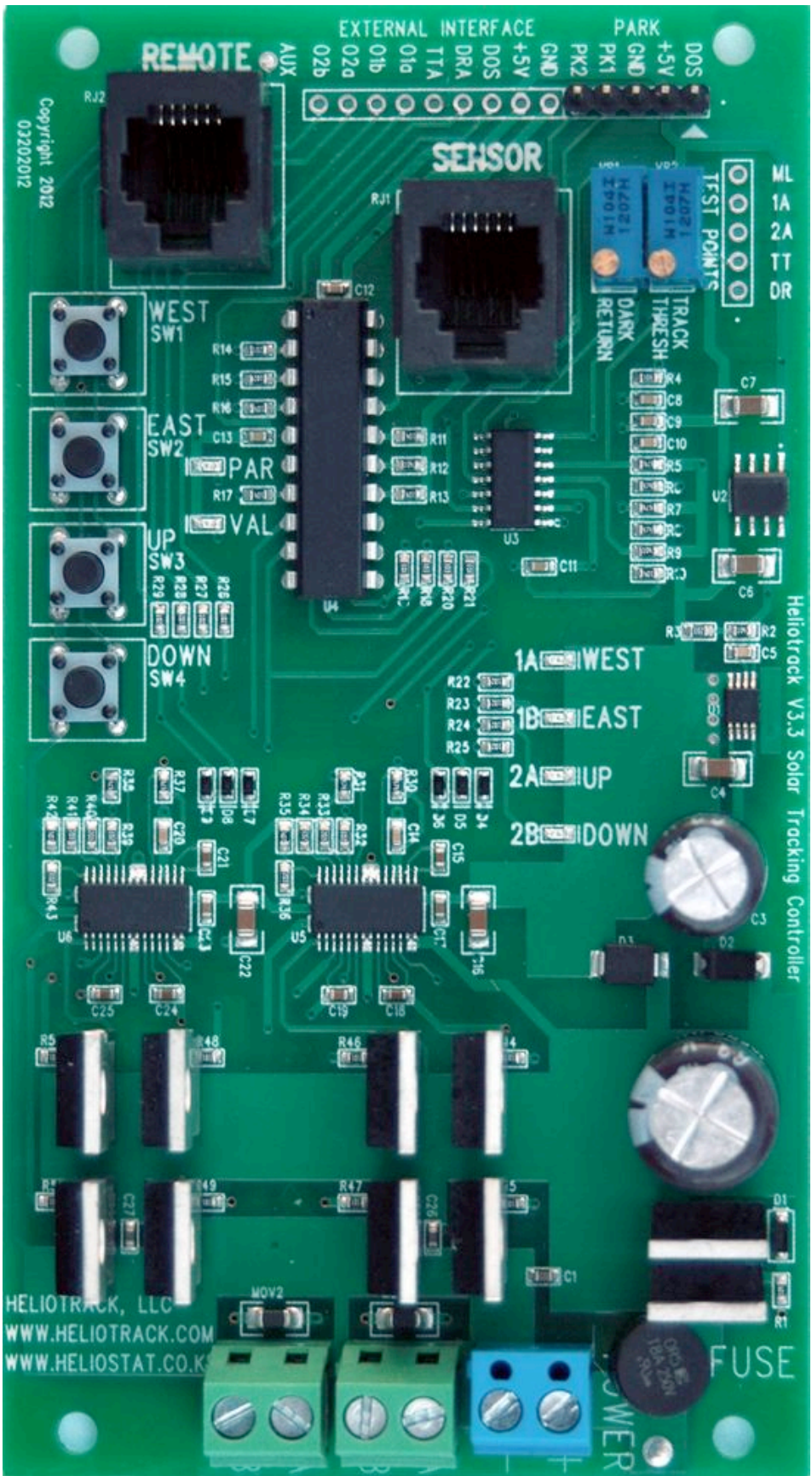
2 - Connect Park1 pin is to ground to disable Dark Return, Park2 and DOS and Tracking functions.

3 - Now use the Remote Control inputs to control tracker motion.

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Troubleshooting tips:

- **Symptom** : The parameter LED flashes quick 15 times, then holds for a moment, then repeats but controller never properly powers up.
- **Cause** : One or both motor terminals may be shorted. When the motor terminals are energized the power supply will fold at which point the controller will power down and shut off current to the motor terminals, the power will come back up and the controller will begin the initialization sequence again only to repeat the process.



REMOTE

EXTERNAL INTERFACE

PARK

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SENSOR

ML
1A
2A
TT
DR

WEST
SW1

EAST
SW2

UP
SW3

DOWN
SW4

TFST POINTS
H4021
TP01M
TP01M
DARK
TRACK
THRESH
RETURN

1A WEST

1B EAST

2A UP

2B DOWN

Heliotrack V3.3 Solar Tracking Controller

HELIOTRACK, LLC
WWW.HELIOTRACK.COM
WWW.HELIOSTAT.CO.K

FUSE

POWER

Heliotrack Dual Axis Solar Tracking Controller V3.3

Operating Voltage: 9 - 48VDC
 Operating Temperature: -40°C - +125°C

Factory Potentiometer Calibration: Voltage between indicated test points
 Dark Return Threshold: (GND to DRT = 0.7)
 Tracking Threshold: (GND to TT = 2.6V)

Press UP and DOWN buttons simultaneously for Bank 1

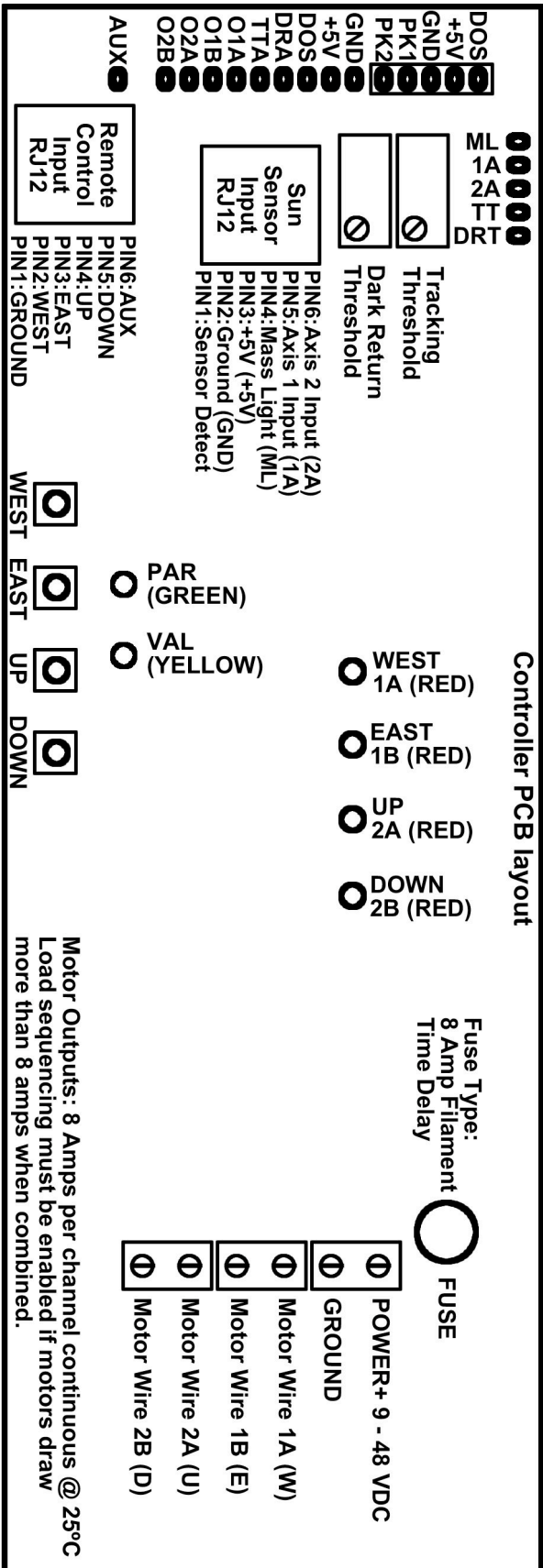
- Parameter 1: Tracking Delay Count (1 - 8)
- Parameter 2: Dark Return Direction (1 - 9)
- Parameter 3: Park1 Direction (1 - 9)
- Parameter 4: Park2 Direction (1 - 9)
- Parameter 5: Drive Off Sun Direction (1 - 9)
- Parameter 6: Drive Off Sun Count (1 - 8)
- Parameter 7: Park1 Latch Timer (1 - 8)
- Parameter 8: Park 2 Latch Timer (1 - 8)
- Parameter 9: Drive Off Sun Latch Timer (1 - 8)
- Parameter 10: Tracking Delay Multiplier (1 - 9)
- Parameter 11: Tracking Delay Override (1 - 2) (Hidden)
- Parameter 12: Bridge Mode (1 - 2) (Hidden)

Press EAST and UP buttons simultaneously for Bank 2

- Parameter 1: Dead Reckoning Enable (1 - 4)
- Parameter 2: Dead Reckoning Lock (1 - 2)
- Parameter 3: Load Sequencing Mode (1 - 2)
- Parameter 4: Load Sequencing 1 Count (1 - 8)
- Parameter 5: Load Sequencing 2 Count (1 - 8)
- Parameter 6: Load Sequencing Rest Count (1 - 8)
- Parameter 7: Load Sequencing Speedup (1 - 8)
- Parameter 8: Load Sequencing Mode (1 - 3)

Press WEST and EAST buttons simultaneously to disable tracking.
 Press WEST and EAST buttons simultaneously during startup to restore factory presets.
 Press UP and DOWN buttons simultaneously during startup to enable hidden parameters.
 Warning: Transistors can get HOT during operation. USE CAUTION!

Controller PCB layout



Motor Outputs: 8 Amps per channel continuous @ 25°C
 Load sequencing must be enabled if motors draw more than 8 amps when combined.

Notes: