Home CSP Inc. Trackers and electronics for home solar energy

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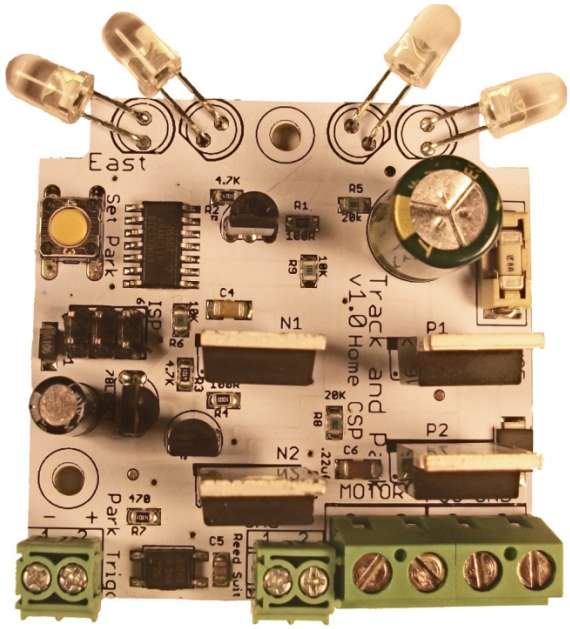


Track'n Park

Single-Axis Controller
With Custom Park Position
& Remote Trigger

Home CSP, Inc.
www.homecsp.com

Track'n Park – single axis controller version 1.1 F

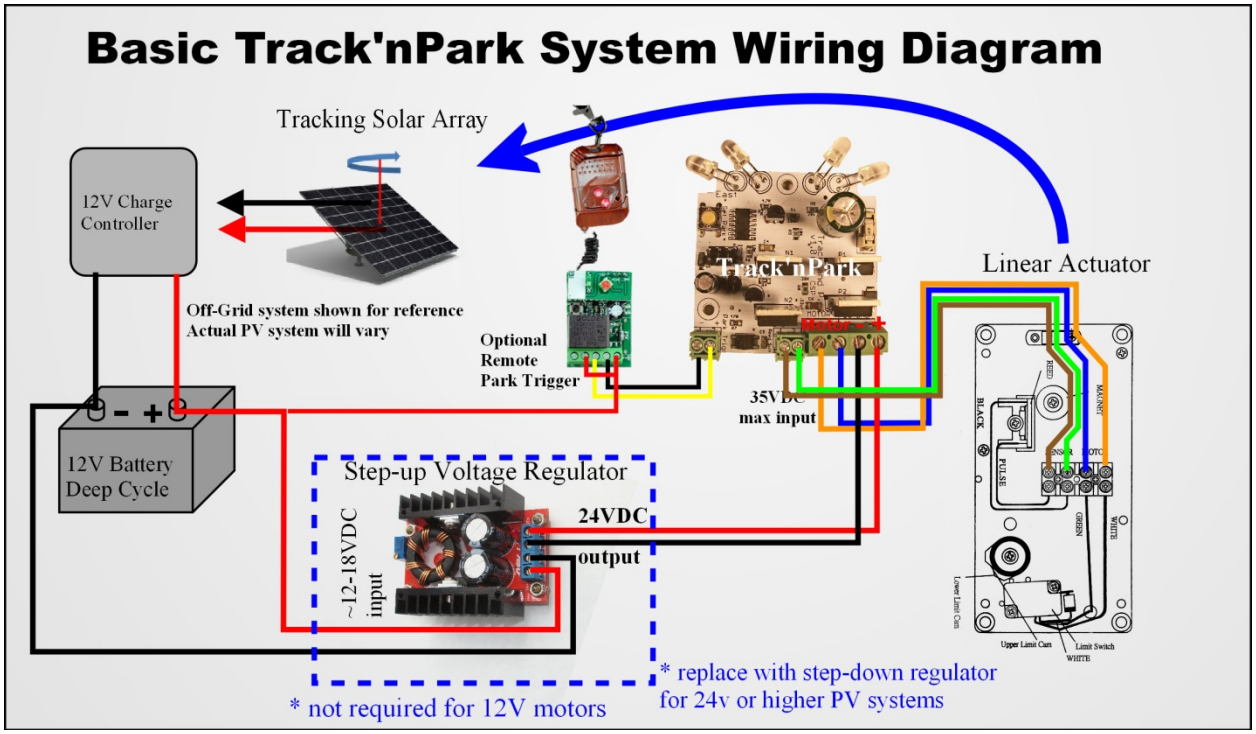
Thanks for purchasing your **Track'n Park** controller from Home CSP Inc. The **Track'n Park** provides the most advanced yet simple and effective solution for single-axis solar tracking with common satellite linear actuators and other various small DC motors.

When first turned on, the controller will momentarily run the connected motor west, then east. Reverse motor leads if necessary to obtain proper behavior. The unit will pause for 10 seconds before first time park configuration.

<u>Important:</u> Adjust actuator limit switches prior to connecting the Track'n Park!

Specifications

Voltage:	35v dc max, 12-30 recommended
Tracking Period:	3 minutes
Motor Stall Period:	2 seconds
Sample Frequency:	1 hz
Max Motor Run:	3 minutes
Max Motor Wattage:	150W, <125 watts recommended
Park Delay:	30 minutes



Implementation

IMPORTANT: The **Track'n Park** does not require an actuator (or other motor) with pulse feedback. If feedback is not available, then the retracted, reset position will be used for parking. Pulse position signal capability such as standard reed-switch sensors are recommended for customized parking support (Hall effect sensors may also be used).

First-Time Start Up - until the unit has been configured, the Park position configuration will be automatically executed following the start-up self test. This may also be subsequently be triggered by holding down the Program button for 2 seconds.

Self Test – the unit will immediately run the actuator for one second forward, then one second in reverse (if your limit switch is engaged then you may only see movement one way). If the movement is backwards, then disconnect power, reverse the motor outputs, and re-connect power.

During this test the controller looks for pulse signals from the motor feedback. If none are detected then the unit will operate in basic photo-tracking mode, rather than with the enhanced parking capabilities.

Program Button – depressing the program button momentarily will cause the unit to move to the currently configured park position. Tracking will then resume after normal park delay period.

If no pulse feedback is present this should run the actuator to it's starting limit position and the Park Configuration will not apply.

Holding the program button down for about 2 seconds will cause the Park Configuration routine to be executed.

Park Configuration – after fully retracting the actuator, the **Track'n Park** will give a "wag" to indicate the start of the configuration sweep, and then engage the motor in a forward direction. At any point before the forward limit switch is engaged, pushing the Park button will cause the current position to become the future park position. If the Park button is not pushed, and the forward limit switch is reached, then the **Track'n Park** will calculate the middle position and store that as the park position.

The automatic park configuration steps are summarized as follows:

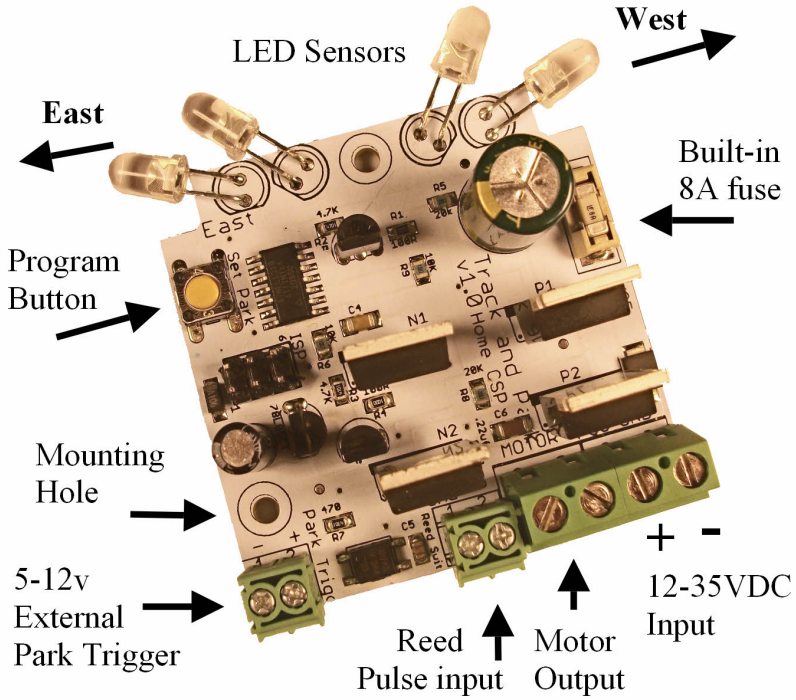
- Move to east limit switch
- Wag
- West sweep initiated
- West limit switch triggered
- Motor moves to default (middle) park position
- Two wags confirm park position
- After normal delay, regular tracking operation will begin/resume

The custom park configuration steps are summarized as follows:

- Move to east limit switch
- Wag
- West sweep initiated
- Push button when array reaches desired position
- Two wags confirm park position

- After normal delay, regular tracking operation will begin/resume

Park Trigger – any momentary signal from 5 to 12V may be used to trigger the **Track'n Park** to move to the park position. Once the Park Trigger has been detected, tracking operations will automatically be suspended for the next 30 minutes (regardless of light levels). This is designed to allow a possible wind storm to dissipate before moving from the park position (which ideally offers low wind resistance to common gusts).



Connections should be made as per the illustrations for your system. Note that an additional fuse and/or power switch may be desirable or required in many applications. Please consult a qualified professional for advice on your specific application when in doubt.

Supported Mount Types

There are many types of tracking mounts where the **Track'n Park** can be used here are just a few:

Azimuth – these are the most common type of pole tracker. Rotation is about the vertical axis, and the PV panel is usually set at a fixed angle. The circuit board should be positioned perpendicular to the PV panel.

Altitude-Azimuth – a second **Track'n Park** can be added to an Azimuth tracker to create a dual-axis tracker where the panel elevation angle is adjusted throughout the day as needed by the second controller.

Polar – the axis of rotation is tilted from horizontal to match your latitude and point at the celestial North Pole. This is ideal for a single axis configuration.

Equatorial – a declination axis is added to a polar mount for seasonal adjustment. This is theoretically the most efficient design for tracking and energy production.

Horizontal – this is a simplified version of the polar mount with a horizontal north-south axis. These are popular on flat rooftops and along north-south roof ridges. These work best at lower latitudes.

Theory

The **Track'n Park** provides single-axis solar tracking control with customizable park position functionality. Two LEDs at a 90 degree angle to each other form the core of the light sensor, while two additional LEDs provide a wider field of off-center light detection to help enable solar target acquisition. A microprocessor reads the voltage produced by light striking the opposing sensor LEDs, and then controls a MOSFET based H-Bridge motor driver circuit. This allows the microprocessor to control the direction of the current through the motor, as the controller attempts to achieve a position where the voltage produced by the East and West LEDs is equal, and the solar array is optimally oriented.

Unlike its cousin the **TinyTracker**, the **Track'n Park** has additional terminals which connect to any standard reed-switch based actuator sensor. The reed switch toggles as the actuator shaft rotates, providing a pulsed signal that the microprocessor uses to calculate the actuator position. Failure to detect pulses will be interpreted as a stall, and will disable motor operation to prevent possible damage.

Use of a microcontroller allows a minimum of electrical components and also enables the **Track;n Park** to be extremely energy efficient. The ATtiny84 chip draws less than 0.5 mA when the motor is not operating. By updating the motor position according to the Tracking Period, extraneous motor movements are avoided: reducing wear and also conserving energy.

Tracking operation may be affected by various environmental factors such as trees, clouds, ground color, reflections, and other extraneous light factors. The voltage from the LEDs and the 10bit resolution of the ADCs limit the theoretical resolution to slightly better than 0.5 degrees. The **Track'n Park** is primarily intended for PV tracking, and due to the factors mentioned, no minimum accuracy is appropriate.

Once light levels have fallen to "nighttime" levels, the **Track'n Park** will wait about 10 minutes (to make sure it's not a dark cloud, solar eclipse or something else transitory), and then move to the park position. When light levels again return above the daylight tracking threshold, the **Track'n Park** resumes normal tracking operation again.

Details

Fuse: Replacement fast acting 8A Littlefuse 154 series "Nano" fuses are available from HomeCSP. The fuse is intended to protect the unit from overcurrent damage likely caused by equipment malfunction, and is a "last resort" protection device. Use of a separate fuse or breaker for the power supply is strongly recommended.

Light Vane: Use of light vane is optional according to your requirements. A properly designed external light vane can increase tracking accuracy. A longer vane will cause more of a shadow to fall on the LEDs which will increase sensitivity. A simple and effective light vane can be created by placing a piece of electrical tape on the enclosure in the middle between the East and West LEDs.

LEDs: the two LEDs that are 180 degrees apart (East and West) are intended to help increase the effective field of vision. This can help the tracker re-orient itself in the morning if the east-return function did not work due to lack of power after sunset (if the tracker is powered by PV instead of batteries); however, in some circumstances this may not be desirable. For instance: with a dual-axis controller using the TinyTracker for elevation control (rather than Azimuth or Right Ascension angle), movement will be 90 degrees maximum. In this situation using a piece of tape to cover the outside LEDs will improve performance.

Supply Voltage: The TinyTracker is designed to handle a wide range of input voltage to allow operation from unregulated 12v PV panel output; however, unregulated 24v PV output may exceed the maximum rating (35vdc) for the LM78L05 voltage regulator used for the logic portion of the board. The actual voltage used will depend upon the requirements of your motor.

The **Track and Park** features a blocking diode to prevent damage from accidentally reversed DC polarity. A 24vdc output, 5-10A rated AC power supply is recommended when not using direct PV or battery.

Motor Amperage: The MOSFETs used to drive the motor are limited to about 6A continuous duty at 24VDC and 12A at 12VDC. More important than actual amps, are the watts used by your motor (Volts x Amps = Watts) as this will determine the actual heat dissipation factor for the electronics. The absolute maximum wattage recommended is 150. Remember we're trying to make more energy, not use it all up with the tracker! The linear actuators sold by HomeCSP draw slightly less than 0.4A at 24vdc (with no load), and the **Track'n Park** easily handle many times that load. Solar trackers should move slowly. Your motor should take at least a minute to go from one side to the other

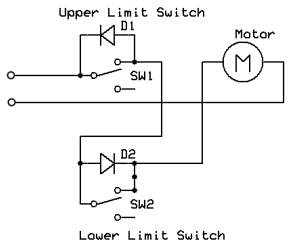
PWM versions of the **Track'n Park** firmware are available by request. Pulse Width Modulation is used to control motor speed and also reduces the average current level. PWM is typically set at 50% and 490Hz..

Enclosure: Painted or opaque enclosures with a clear window tend to function as small solar ovens and increase the temperature for the electronics, and are not recommended. The recommended enclosure for the **Track'n Park PCB** is a clear PET plastic jar or similar container. The PCB is easily fastened to the lid with a small stand-off, and this provides excellent weather protection and visibility for the tracker. The board is coated with a special acrylic conformal coating designed to protect from moisture and corrosion, but it is not waterproof! Make sure the enclosure is water tight: silicone sealant may be required. Waterproof conduit fittings are recommended, and a small desiccant package of silica gel may help prevent dew point condensation on the inside of the enclosure. For adjustment and alignment, rotate the enclosure as needed about the axis parallel to that which the **Track'n Park** will be controlling.

Location: For a south facing panel in the northern hemisphere, the north-east corner of the array is the generally preferred location to mount the **Track'n Park**. In the southern hemisphere, this becomes the south-east corner.

Limit Switches: Most linear actuators come with built in limit switches. These prevent the motor from destroying itself or the mechanical components by moving the actuator too far. Rocker switches are normally used and are configured in a Normally Closed manner. They are also used in conjunction in blocking diodes to allow the motor to reverse direction while the limit switch is open. If you are using a motor without built-in limit switches it is essential that you incorporate these into your design.

A basic limit switch schematic is shown below for reference purposes



Appendix

I.Software Updates

Software updates will be released from time to time by Home CSP Inc. These binary releases are available to registered **Track'n Park** owners for free upon request, and may be installed through the 6 pin ISP header. An AVR ISP programmer and AVRDude software is required to upload the new firmware. AVRDude is freely available, and is part of the Arduino development environment. AVR ISP programmers are commonly available on eBay and other from other sources such as www.adafruit.com. Firmware upload instructions are available on the HomeCSP.com website.
Currently available alternative tracking programs available upon request include:

- P**WM** – standard Tracker algorithm with PWM motor output (customizable PWM level)
- **East Inhibit** – only tracks west during sunlight
- **No East Return** – Standard Tracker algorithm with after-dark east-return function removed.
- **Elevation** – Perfect for second axis of dual-axis configuration: elevation axis

II. Circuit Schematic Diagram:

Track and Park