Tap The Sun

The SolarTrak® Controller System

Pro-Active Sun Tracking and Peripheral System Control

Designed and Manufactured by

Enhancement Electronics, Inc.

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Summary of capabilities of the SolarTrak Controller Technology

The SolarTrak was originally developed at Sandia National Laboratories in Albuquerque, NM and is currently licensed to several companies including Enhancement Electronics, Inc. of Tijeras, NM. www.tapthesun.com

EEInc has aggressively implemented and tested the technology in a large variety of environments and has developed many new tracking control options in the process. The technology is inherently flexible although quite simple in design and has been proven to perform up to spec over long periods of time without maintenance.

There are currently over fifty units operating in nine countries plus the USA with over one hundred fifty consecutive unit-years without reported controller failures.

The SolarTrak has the following flexibilities and available options:

- Can control tracking of the Sun or Moon using any orthogonal two-axis geometry (Az/El, E-W or N-S Tilt/Roll, Polar/Decl) to +/- 0.025°.
- Runs either single- or dual-axis positioning systems.
- Can be configured for any power environment from twelve volts DC to two hundred forty volts AC single or three-phase.
- Can be operated standalone using power from batteries and PV charge panels, with charging control provided by the SolarTrak itself.
- Can be operated on a network for high-level field control and supervision as well as internet-based or telephone-based remote monitoring.
- Can be equipped with GPS support.
- Can fully control a two-axis hydraulic piston positioning system (two-piston commutation, pressure control and two-speed operation included)
- Can perform coordinated reflecting for central receiver applications including multiple targets, standby and emergency defocus.
- Uses anemometer for emergency wind stow.
- Operates or monitors ancillary equipment in concert with tracking functions (pressure, temperature or flow monitoring, blowers or valves On/Off)
- Offers several inputs for emergency tracking functions such as off-axis tracking (de-focus) and operation strategy such as focus avoidance (anti-focus) while parked.

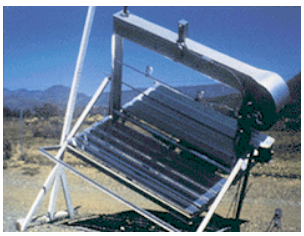
The following system configurations have been built and tested successfully or are still in operation. In most cases the mechanical positioners were designed and built by the customer and EEInc implemented the SolarTrak Controller on the system. The basic board is 4”x6”.

At the Heart of it ALL

- Standalone 9 kW heliostat reflector for central receiver residential thermal water heating – standalone PV/Battery power (Santa Fe). http://www.tapthesun.com/TTS Residential Thermal Systems.htm

- Amonix 20 kW CPV System – Grid connect – HV DC motors
- 30 kW CPV Hydraulic System Prototype – Operable in tropics and arctic with 360° 2-pistion commutation, oil pressure control, fail-safe deadman stow and high-wind stow. Demonstrated tracking at +/–0.025° precision. Grid/Inverter power connect.

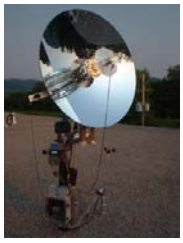
- DSET Accelerated weathering system with air-flow cooling and periodic water sprinkling with low air pressure lockout on tracking and anti-focus feature while parked. Standalone PV/Battery power.



- 2 kW Polar/Decl flat plate PV testbed unit for introduction in India by RPI/Solartech. Standalone PV/Battery power.

- PowerTracker™ by Shingleton Design, LLC. 115kW flatplate PV. Single axis with North-South orientation. 240 single and 3-phase grid-connect power. Prototype installed Fall of 1999. Eleven units installed in Fall of 2000. Six in Fall of 2001. Ten units installed Spring 2002. Nineteen units installed summer of 2003. No spontaneous failures of controller. http://www.tapthesun.com/TTS Industrial Grid Power Systems.htm

- ORNL Hybrid Daylighting System – Fiber Optic light transmission for interior lighting. Standalone PV/Battery power. http://www.tapthesun.com/TTS Hybrid Daylighting Concentrator Systems.htm



- University of Virginia – Daylighting unit – Fiber Optic light transmission – UVA entry in the Solar Decathlon October 2002 at the National Mall in Washington DC. Standalone PV/Battery power.

Description of Technology

- **Computer-Based Tracking Control** using electronic position feedback
- **Modular design – Distributed Tracking control** can be implemented in large and small groups or individually without control overhead imbalance.
- **Operates with or without Central Monitoring** and High-level Control.
- **Seamless integration of Multiple Positioner Types or Geometries** on or off network.
- **Low Operating Power** allows standalone battery power with photovoltaic charge control.
- **Environmental Stability** – Highly Resistant to nearby lightning strikes and grid voltage spikes or brownouts.
- **Broad ranging attention to safety issues** including high wind conditions, impending power loss for standalone systems and emergency defocusing. Will preclude accidental focusing even while parked.
- **Precision Timekeeping** with Optional GPS Support
- **Large Variety of Motion Control Interfaces** – DC, AC or Hydraulic.
- **High-precision Position information** – Absolute, Incremental or Combination up to 14-bit resolution (16384/Rev).

Background Information

Enhancement Electronics, Inc. is a designer, developer and OEM manufacturer of custom and production embedded microcontroller systems for high-precision motion control of sun tracking systems and low-cost solar collection data acquisition systems with network-based system monitoring capability.

The original SolarTrak® controller technology was designed and developed at Sandia National Laboratories in Albuquerque, NM over a period of seven years with a total government research investment of over ten million dollars. Many in-depth studies concerning reliability, longevity and mean-time-to-failure and repair were conducted by SNLA to ultimately arrive at a simple, strong architecture that can survive months or years in remote locations without significant risk of failure or imprecision.

A significant amount of effort on Sandia's part dealt with power consumption and time-keeping; the result being that the main control board consumes power at an average of only fifteen milliamps and keeps time to within fifteen seconds per year. It was the EEI/SNLA collaboration that produced the final level of time precision with the addition of an onboard thermometer for temperature compensation.

EEI joined Sandia in 1996 as a licensed partner in the SolarTrak® technology through their tech-transfer program. That collaboration has continued for six years as EEI's field experience has mounted and enhancements have been added to flesh out the full potential of this breakthrough high-precision tracking technology.

We enjoy a promising record of tracking precision and system longevity with units in place around the world in nine countries and the USA. Our controllers have been field-proven to provide continuous high-precision control to tolerances exceeding most angle-of-acceptance specifications. Stable control down to less than one-half milliradian has been achieved thus far with the limitation resting on the stiffness of the structural system.

EEI has continued on to develop ancillary control functions that serve to integrate solar collection operations such as flow control, cooling and over-temperature defocusing along with other more standard emergency detection and damage avoidance strategies.

The DAQuTrak® Data Acquisition System, developed primarily for remote solar collection stations incorporating PV panels, batteries, an inverter and a backup generator, records and reports eight channels of relevant data using a rather leisurely pace of four samples per second and can store a year's worth of data comprised of fifteen-second averages plus the maximum and minimum values at eight-bit resolution for all eight channels.

The system, loosely based on the SolarTrak® architecture, was developed on a separate contract for SNLA, tested by their data acquisition specialists against equipment costing ten times as much and found to be accurate across the full range of interest on all channels, in fact, the temperature acquisition method (though limited to –40 and +125C) exceeded the accuracy of the thermocouple system used by SNLA for comparison and showed a steady value at all times without noise.

All information generated or collected by either a SolarTrak® Controller or a DAQuTrak® Data Acquisition System can be made accessible on a simple, low-bandwidth network developed for the SolarTrak® by EEI.

The principal investigator and owner of EEI is Timothy M. Leonard. He has been in the computer industry for twenty-nine years with thirteen years at Sandia National Laboratories in Albuquerque, NM, nine of which were in the Vertical Axis Wind Turbine program. Further involvements included robotics and artificial intelligence development. His field experience in robust microcontroller hardware and programming development actually began in the gaming industry where electronics meet the real world in very unpredictable ways.

Since becoming involved in the solar industry with the environmental hazards inherent in surroundings of outdoor electronic systems he has personally installed and tested each new piece of hardware or software in such places such as the Arizona desert and Minnesota to verify that proper operation is upheld in the temperature extremes of our country as well as the dangers presented by well-meaning technicians and tourists. He has developed the SolarTrak Controller technology into a system that survives the harshest elements and does its job.