* Don't Forget To Plug In Internal Battery Pack (See Diagram P 6)

WATTSUN™
SOLAR TRACKERS

WATTSUN TRACKER OPERATION - HOW IT WORKS

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The Wattsun Solar Tracker utilizes a patented, closed loop optical system to track the sun. It tracks based on the equalization of light falling on opposing sensors for each axis. The controller circuitry automatically adjusts the tracker sensitivity depending upon the amount of direct component of light and also on the absolute amount of light input received by the sensors. As the direct component of light diminishes so does the sensitivity. As the absolute light level (direct and diffuse) decreases, the sensitivity of the tracker decreases further. This eliminates undue hunting during cloudy or overcast sky conditions. On a completely overcast day the tracker will park in an approximate noon position, the optimum position for the existing weather conditions. If the sun breaks out of the clouds, the tracker will move to the appropriate position. Upon sensing a very low light level at sunset, the controller will disable the elevation axis (dual axis versions) and return the array to the east.

The controller circuitry exploits solid state technology throughout, eliminating relays and other components which are prone to failure. The sensors are hermetically sealed for long life and reliability. The control circuitry is housed in a powder coated, water-tight, die cast aluminum chassis.

HOW IT MOVES AND HOW THE LIMIT SWITCHES FUNCTION:
The tracking control head sends a signal of the appropriate polarity to the DC motors of the linear actuators which move the array to create a tracker update event. The array will track towards the sun until the light input falling on the opposing sensors for a given axis is equalized, at which time the controller will electrically brake the actuator motor to keep it on target. The tracker will continue to move in this fashion throughout the day until it engages a pre-set mechanical limit switch integral to the linear actuators. The limit switches are gear driven from the motor end of the linear actuator. The limit switches are factory set but should be checked for proper operation during installation (see the pre-operation checklist in the instruction booklet). These limit switches are field adjustable. When set correctly, the limit switches disengage the power from the actuator motor prior to the tracker frame binding. If set incorrectly, the frame will bind, causing the actuator motor to stall and fuses to blow or the LED to glow red. The position of the clamp mounted along the tube of the actuator sets the retracted length of the actuator. The limit switch in the motor end of the actuator sets the stroke range, the distance that the actuator will travel. The extended length is the sum of the retracted length and the stroke range.

TO RE-SET THE ACTUATOR LIMIT SWITCHES:

Set the retracted length first:
A) For actuators without the rubber bellows between the telescoping tubes (6 module and smaller trackers):

1) Remove the 1/2" bolt connecting the end of the actuator to the tracker frame.
2) Cover the appropriate sensor: the tracker will move towards the illuminated sensor. Cover the opposite sensor of the direction you want it to move with black electrical tape to make the actuator retract. Allow the actuator to retract until it stops: this engages the retracted limit switch.
3) Screw the inner tube of the actuator in until it binds internally. Then back out the tube two full turns.
4) Re-attach the actuator to the frame of the tracker with the 1/2" bolt.
5) Loosen the tube mounted clamp of the actuator and rotate the array towards the actuator until the frame binds.
6) Then rotate the frame back in the reverse direction so that there is 1/4" to 1/2" clearance between the binding frame parts.
7) Tighten the bolts of the tube mounted clamp to lock it in position. The retracted length has now been set.

For ball screw actuators with the rubber bellows between the telescoping tubes follow steps 5 through 7 only.

Setting the stroke range and extended length:
1) Remove the tape that you placed on the sensor to set the retracted length and cover the opposite sensor to make the actuator extend.
2) While the actuator is extending, watch to see if the frame is going to bind as it nears the end of its stroke. If the frame looks like it is going to bind, un-plug the rubber connector on the elevation tube which feeds the actuator as soon as there is 1/4" to 1/2" of clearance between the mechanical limitations of the frame.
3) Remove the back cover of the actuator and set the limit switch so that it engages at this position. There will be either an adjustable rod or cam in the back of the actuator for this purpose. You will see and hear the limit switch click when it is engaged. Refer to the manufacturer's instruction sheet enclosed in the actuator shipping box for more detail on this procedure if necessary. The extended limit is now set.

As a check, manipulate the tracker by placing black electrical tape on the sensors so that it moves to all extremes. The tracker should move freely within the limit switch settings without the frame binding or being obstructed from wiring service loops that are too short or caught inside the pivot points.

CONTROLLER POWER SUPPLY CONSIDERATIONS:

The controller will consume approximately 1/2 watt of power during tracking hours. This can be supplied from the PV array, main battery bank, or from a small PV module dedicated to power the tracker. The controller is equipped with a low voltage disconnect/disable circuit which monitors the charge on the internal battery pack. The clear LED on the bottom of the control box will turn red when the controller is in the disable mode and will cease to track. In the disable mode, all available input energy will be used to re-charge the internal ni-cad battery pack. Once a sufficient charge is reached, the tracker will resume operation. This should only occur after long periods of overcast conditions, typically a couple of times per year. If this occurs very frequently, refer to the troubleshooting guide to diagnose the problem. The low voltage disable circuit may be reset when the controller is connected to the PV array or other power source by un-plugging the battery connector and plugging it back in.

NOTE: During installation, initial connection of the battery pack to the circuit board will cause the LED to glow red.
After connecting the controller to a PV module or other power source for a short time, the LED will go out and the tracker will begin to function.

CONTROLLER POWER SUPPLY OPTIONS:

Method #1 - Connecting the controller to the P.V. array:
The controller input voltage can range from 12 to 32 volts dc. This requires that the controller be connected to a nominal 12 volt leg of the array. A failsafe approach is to connect the positive and negative input leads of the controller to the output of the same module. This will insure that the input voltage requirement is not exceeded, regardless of the array wiring configuration. Do not connect the controller to the output of a 24 volt or 2 module series string. The open circuit voltage of 2 modules in series will exceed 32 volts and may damage the controller circuitry. The controller should not be powered from the main PV array if the array is wired above a nominal 24 volts or two modules in series as in may water pumping applications - use the optional P.V. module or alternate power source. The controller should not be powered from the array if there is a shunt type charge controller installed in the system. For these systems, if the array power is not being consumed, the regulator will short out the PV array and will not be able to supply power to the controller resulting in excessive disable or "red light" conditions. A series regulator should be used when powering the controller directly from the PV array. When powered from the main P.V. array, the controller will use the energy from the array during daylight hours to power the linear actuators and charge the internal ni-cad battery pack. Energy consumption will

average 1/2 watt during tracking hours on 12 volt arrays and 1 watt on 24 volt array configurations. At sunset the controller will use energy supplied from the internal ni-cad battery pack to return the tracker to the east position.

Method #2 - Powering the tracker with a dedicated small PV panel: A small PV panel must be used if the array voltage is above a nominal 24 volt configuration. An ancillary benefit of using a small PV module as an independent power source for the tracker is the electrical isolation of the tracker from the rest of the PV system. This autonomy insures that the PV system output will not affect the tracker performance. Using an optional dedicated P.V. module is advisable for battery based systems installed in locations where the main battery bank may get abused by continual excessive discharging. When the main battery bank holds the array voltage below 12 volts, the controller cannot charge the internal battery pack and will result in excessive disable conditions. See the controller diagram for the alternate input connections when operating from a small PV module. It is recommended that the factory install and mount the module in order to insure proper connection and a good seal on the control box. When powered by the small PV module the modules will charge the internal ni-cad battery pack which will supply all power to the tracker.

SIZING THE APPROPRIATE INDEPENDENT PV PANEL FOR TRACKER POWER:

Choose a Solarex SA-1 module for locations where the average solar insolation value on an optimally tilted fixed surface for the worst month of the year is above 4 KWH/M^2/day.

Choose a Solarex SA-2 (12v) module for locations where the average solar insolation value on an optimally tilted fixed surface for the worst month of the year is between 2 and 4 KWH/M^2/day.

If the average insolation value described above is below 2 KWH/M^2/day for the worst month of the year it is advisable that the tracker be powered from the main battery bank.

Method #3 - Connecting the controller to the main battery bank: This method will require that an extra positive feed wire capable of handling five amps of current be brought back to the tracker from the main battery bank. The negative input wire to the controller may be connected to the negative output of the array. The controller will accept the input voltage of either a 12 volt or 24 volt battery bank. Remember, the input voltage may range from 12 to 32 vdc. The feed wire should be fused close to the battery bank with a 5 amp fuse. The internal battery pack supplied with the controller should be removed as it will no longer be necessary. If the average solar insolation value on an optimally tilted, fixed surface for the worst month of the year

is below 2 KWH/M^2/day power the controller from the main battery bank. In these extremely cold climates, the internal ni-cad battery pack may freeze. Using power from the main battery bank allows for the removal of the battery pack and will insure that sufficient power is always available to the tracker. This arrangement will also eliminate the need for future battery pack replacement.

INTERNAL NI-CAD BATTERY PACK SPECIFICATIONS:

The internal ni-cad battery pack supplied with the controller is a 9.6 volt 600 MAH dry cell pack. It consists of 8 AA ni-cad batteries connected in series. The ni-cad pack should last approximately 5 to 7 years in operation. When the ni-cad pack has expired the red led will start to come on consistently during east return. It may also come on more frequently in cloudy weather. A replacement pack may be purchased from Array Technologies or an electronic supply store.

PORTABLE MANUAL JOYSTICK CONTROL:

Designed primarily as an installation tool, the manual controller is offered as an option and is very handy during installation and array wiring. It allows for the positioning of the array by depressing momentary switches for each axis. The manual controller can be powered from either the PV array, a 12 volt battery or may be plugged into an automobile cigarette lighter socket. It connects to the tracker via all the wiring harness connectors. Spare fuses for the control head are enclosed in a rear compartment of the joystick controller. Use of this controller is highly recommended as a time saver during installations.

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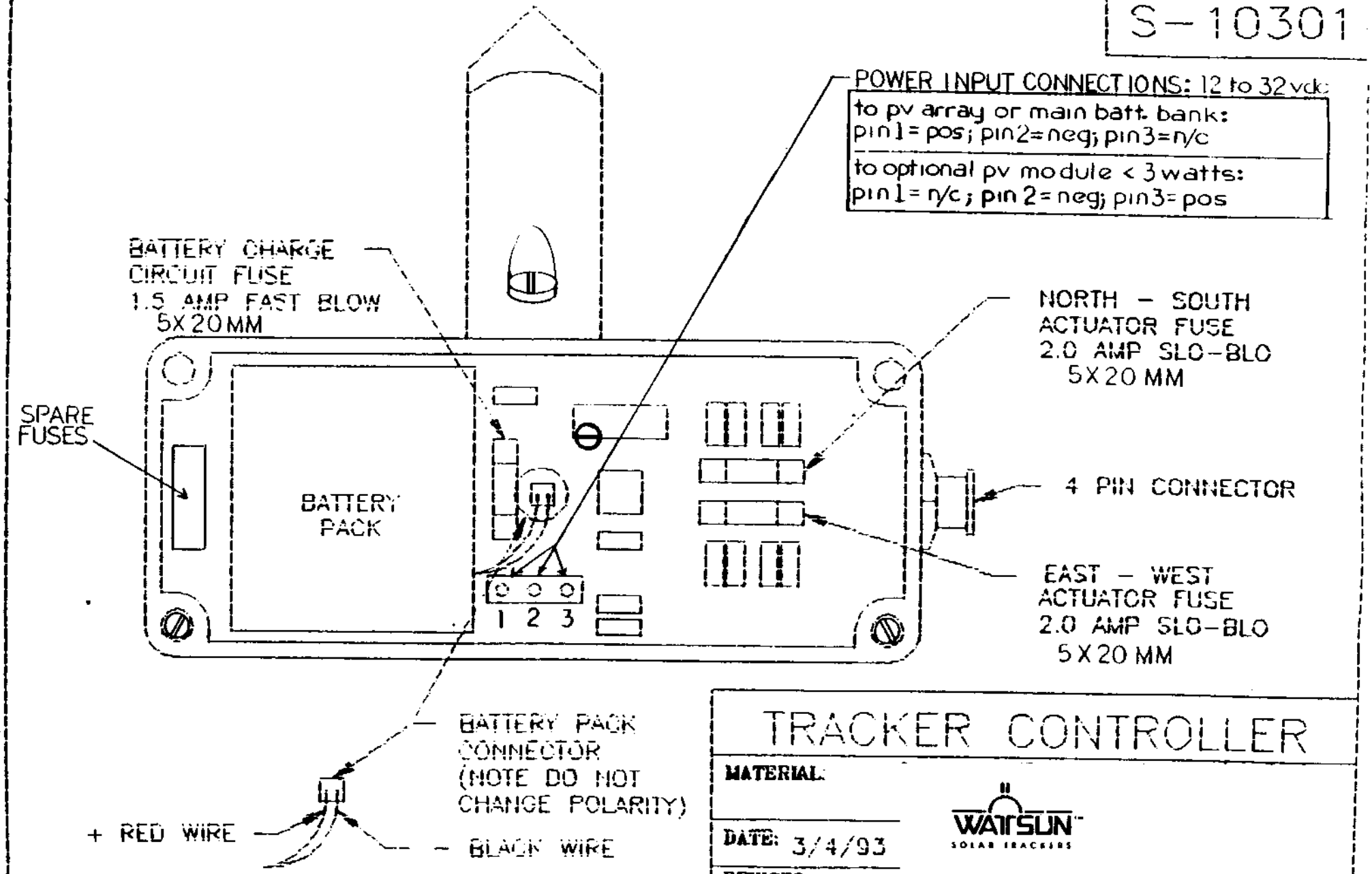

NOTE: Disconnect battery connector and input power before changing fuses.

TRACKER CONTROLLER

MATERIAL:

DATE: 3/4/93

REVISED:

SCALE: 1:1

DRAWN BY:

WATTSUN SOLAR TRACKERS

ARRAY TECHNOLOGIES, INC.

P.O. Box 751 Albuquerque, NM 87103
614 2nd St. SW Albuquerque, NM 87102 505-242-8024

EARLY TRACKERS
USING A CONTROLLER WITH
INTERNAL BATTERY PACK.

TROUBLESHOOTING GUIDE

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Please read the "Tracker Operation" section in the tracker installation manual prior to attempting to use this guide. Familiarizing yourself with the proper operation of the tracker will aid in troubleshooting. Please follow this guide before calling dealer or manufacturer.

PROBLEM	CHECK & REMEDY
TRACKER WILL NOT OPERATE LED CLEAR	* Make sure power leads are properly connected * Make sure internal battery pack is plugged into circuit board * Check 4 pin connector at control box * Check rubber connectors to linear actuators * Check all fuses inside control box
TRACKER WILL NOT OPERATE LED ALWAYS RED	* Check battery charge fuse (see diagram) * Check battery connection to circuit board - Reset * Make sure that voltage input to controller is between 12 and 32 volts * Make sure that the frame is not mechanically binding * Expired battery pack
FUSE BLOWS OR LED TURNS RED CONSISTENTLY WHEN IN THE EXTREME WEST OR EAST POSITION	* Make sure tracker frame is not binding on base of azimuth pivot brackets - Check azimuth actuator eylet bracket for correct orientation on cross support tube - Check azimuth actuator settings (see installation manual) * Make sure wiring is not caught in pivot joints and that output service wiring is long enough

PROBLEM	CHECK & REMEDY
FUSE BLOWS OR LED TURNS RED CONSISTENTLY WHEN IN THE EXTREME NORTH OR SOUTH POSITION (DUAL AXIS MODELS ONLY)	* Make sure tracker frame is not binding near the elevation pivot on the masthead clamp/pivot bar assembly * Check that the tracker is not streching the array output service wiring * Check the elevation actuator tube mounted clamp position and limit switch settings (see installation manual)
ERRATIC OPERATION STOPS FREQUENTLY IN VARIOUS POSITIONS LED RED WHEN STOPPED	<u>If powered by independent Small P.V. Module</u>: * Module size insufficient or connected to incorrect input terminals (see controller diagram) <u>If powered by Main P.V. Array</u>: * Input voltage from array under 12 volts - main battery bank continually over-discharged <u>If powered from Battery Bank</u>: * Check battery charge fuse <u>General checks</u>: * Check internal battery pack connection * Expired internal battery pack
TRACKER MOVES EAST TO WEST - ELEVATION DOES NOT FUNCTION (DUAL AXIS MODELS)	* Elevation fuse blown * Check rubber actuator connector
LED FLASHES	* Internal battery pack not plugged into circuit board
TRACKER FUNCTIONS PROPERLY BUT DOES NOT RETURN EAST SUNSET - LED CLEAR	* Internal battery pack not plugged into circuit board * External light source illuminating sensors at sunset

Get More PV Power With a Solar Tracker; Get The Most With The Wattsun™ Tracker From Array Technologies

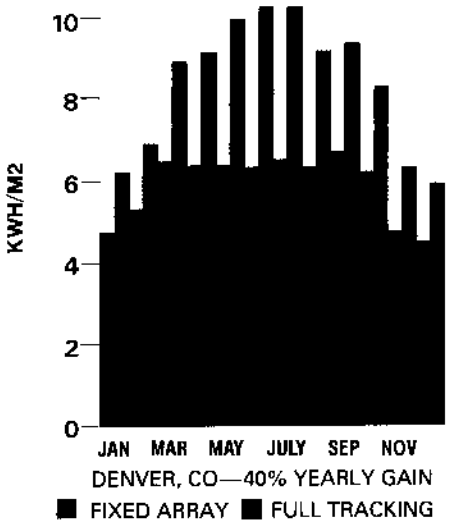
Many photovoltaic (PV) arrays aren't equipped with solar trackers, even though tracking can greatly increase power output. The problem has been that passive trackers, which typically use the expansion of harmful freon gas to provide collector movement, have serious limitations: they do not fix the panels on the early morning sun, they are often overpowered by wind, their pointing accuracy is not precise, they require seasonal adjustments (because they are single axis), and they do not work well at low temperature and lose the sun during cloudy conditions.

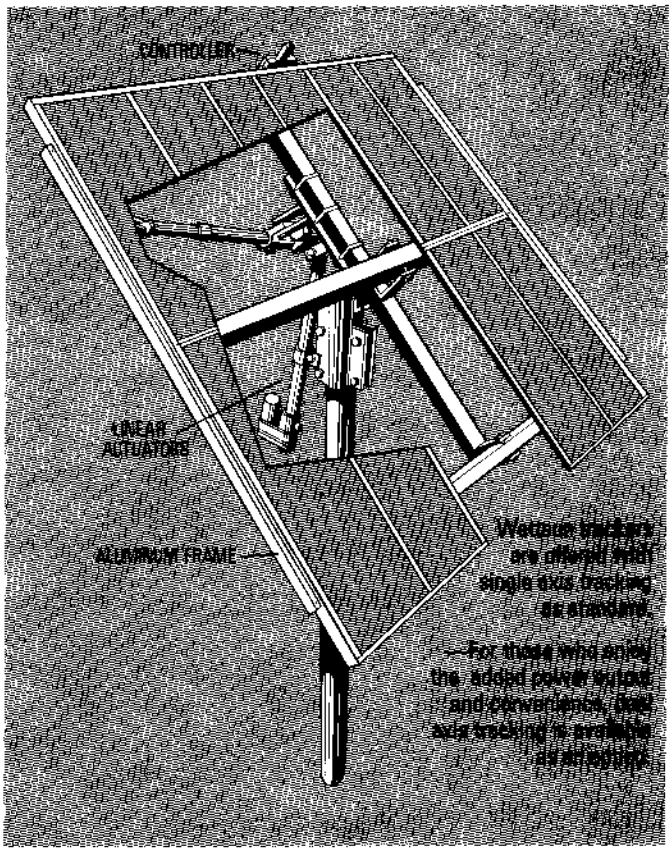
The Wattsun Solar Tracker is different. Its revolutionary solid-state sensor finds the maximum sun available in the sky, from sunup to sundown. Using dependable worm-drive linear actuators it keeps the panel array pointed accurately at the sun at all times. For a Wattsun-powered array, it's high noon every hour the sun shines. It pays to aim the PV modules at the source. Wattsun Trackers maximize power production without the shortcomings characteristic of freon trackers. They outperform freon trackers in every aspect. And although Wattsun Trackers offer all these advantages over the competition, they are reasonably priced and often less expensive once shipping costs are included. Low price, high performance and reliability combine to make the Wattsun the most economical tracker on the market.

It makes sense to equip every array with a Wattsun Tracker. It will pay for itself in a short period of time, and its simplicity and durability will provide long-term, low-maintenance performance with thousands of extra watts during the lifetime of the array.

When you track—and it always pays to—do it with the state of the art in solar trackers. That's the Wattsun Active Solar Tracker from Array Technologies.

The Wattsun Solar Tracker Output Advantage





The Wattsun Tracker comes pre-wired complete with all of the hardware needed to mount it on the pole of a collector array.

SPECIFICATIONS

Pointing Accuracy: ± 0.1° in either axis
Azimuth range: 120°
Elevation range: 75°
Tracking mechanism: Worm-drive linear actuators
Frames: Anodized aluminum, pre-drilled to fit each major manufacturer's panels—disassembled for ease in shipping and installation.
Power supply: Uses ½ watt during daylight hours powered by the PV array or by an optional 1 watt solar module.
Reset feature: Fail-safe reset even if batteries have expired.
Wind loading: In excess of 100 mph

STANDARD FRAME SIZES

The easy-to-install Wattsun Solar Tracker features rugged anodized aircraft-quality aluminum frames that come in standard array sizes ranging from 2 panels to 24 panels.

Larger sizes are available on special order. Most trackers can be shipped UPS for added savings.

ARRAY TECHNOLOGIES, INC.

P.O. Box 751 Albuquerque, N.M. 87103 614 2nd St., SW Albuquerque, N.M. 87102
505-242-8024 FAX 505-242-2863

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