



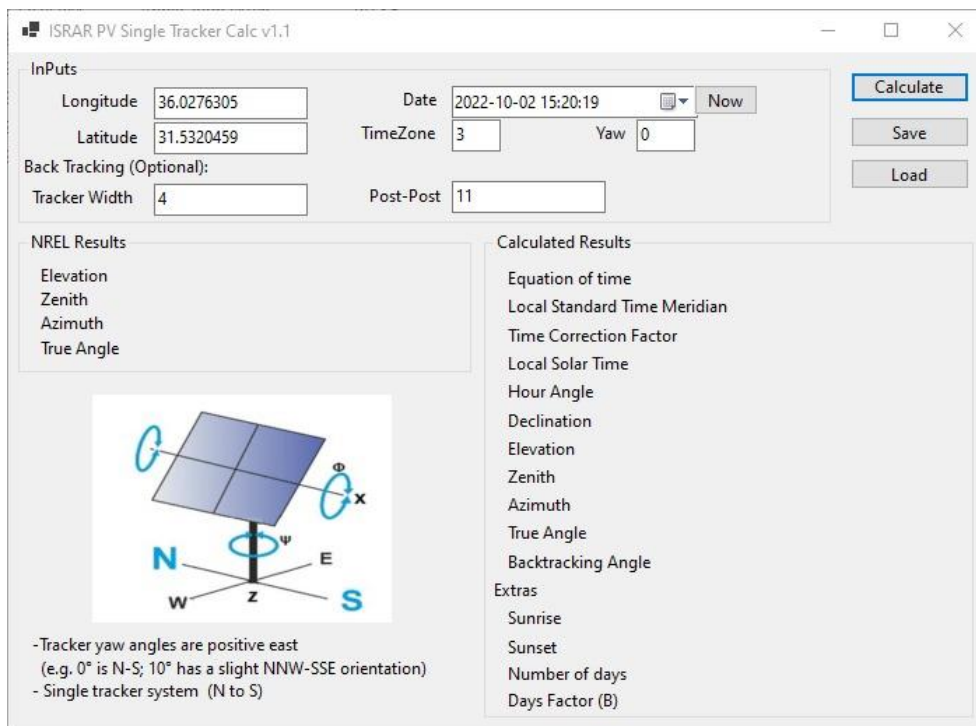
Power Meter Monitor

Business and Mission-

Critical Solutions Provider

ISRAR SUN CALCULATIONS

User Manual



Document: User Manual

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This restriction is subject to protect the operational process of the system in the business environment, which will produce, use, and transmit radiofrequency energy. Harmful interference to radio communication could result if instructions to the correct installation and usage were not applied. The interference prevention cannot be guaranteed even with proper installation according to the manual. If the device causes a bad effect on the radio / TV signal. The user could preclude that by turning the device on/off.

When this device produces some harmful interference, the user can use the following measure to solve the interference problem:

1-Setting the receiving antenna's direction or location to increase the distance between this device and receiver.

2-Plug in the device's power connector into different circuits of the power outlet with the receiver.

3-If any technical support is needed, the dealer or experienced radio/TV technical personnel must be informed.

TECHNICAL SUPPORT AND SERVICE

Visit Pmm-usa.us to browse FAQs and get further details.

User should collect the following information before submitting technical support and service requests:

- Product name, model and serial number.
- Installed software (operating system, OS version, installed applications and so on).
- Full description of the problem
- Detailed information about every error.

SAFETY INSTRUCTIONS

- Only trained and qualified personnel can install, operate, or maintain the device.
- Before starting the installation, all safety precautions must be read, and warning labels affixed to the device must be observed. Doing so protects the device from damage and ensures your safety.
- Safety precautions provided in this document may not cover all safety aspects, note to always remain mindful of safety.
- PMM is not liable for any consequence that results from violation of regulations pertaining to safe operations or safety codes pertaining to design, production, and equipment usage.
- DO NOT use liquids or decontamination spray to clean the device surface and assure that it is totally disconnected while cleaning.
- Take all measures to prevent device drop before or during installation.
- Prior to connecting the device to power source, ensure the source and device voltage and power are 100% matched.
- Keep the cables in a suitable covered place.
- If the device is not used for a long time, shut off the power to avoid the damages by transient overvoltage.
- DO NOT allow any liquid flow into the device; to avoid fire or short circuit.
- The recommended storage temperature range should NOT be less than 30°C OR higher than 85°C.



Warning:

- Read the power source and device inlet carefully.
- Handle device with both hands.
- Clean and maintain the device using recommended, safe and suitable methods.



Caution:

If any unauthorized changes of settings or repairs are done without PMM approval; then user's rights of controlling this device will be canceled.

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1. INTRODUCTION

This Document is a fully descriptive operational manual for ISRAR Sun Calculation application. Providing the operator with the needed information in terms of instructions and screen layout allowing for easy use.

1.1 DESCRIPTION

Tracker-mounted photovoltaic and solar thermal installations' efficiency and profitability greatly depend on how precisely the receiving units are directed at the sun; as a result, tracking control intelligence is essential to maximizing energy and profit return.

ISRAR Sun Calculations calculates the sun's position throughout the day, as the azimuth angle and the elevation angle at solar noon are the two key angles which are used to orient photovoltaic modules. Both the elevation angle and the azimuth angle must be calculated throughout the day.

2. USER INTERFACE

- Insert the input of the photovoltaic plant:
 1. Geographic coordination: longitude and latitude.
 2. The date (by default it shows the current time) or the user can choose a specific time.
 3. Time zone.
 4. Yaw.
- The back tracking (optional): which aims to minimize PV panel-on-panel shading, thus avoiding production losses. When a tracker, or a linked tracker row, is used near another, it shades the adjacent tracker during early morning and late afternoon hours.
 1. Set the tracker width.
 2. Set post-post.

ISRAR PV Single Tracker Calc v1.1

InPuts

Longitude: 36.0276305 Date: 2022-10-02 15:20:19 Now

Latitude: 31.5320459 TimeZone: 3 Yaw: 0

Back Tracking (Optional):

Tracker Width: 4 Post-Post: 11

Calculate **Save** **Load**

NREL Results

Elevation
Zenith
Azimuth
True Angle

Calculated Results

Equation of time
Local Standard Time Meridian
Time Correction Factor
Local Solar Time
Hour Angle
Declination
Elevation
Zenith
Azimuth
True Angle
Backtracking Angle
Extras
Sunrise
Sunset
Number of days
Days Factor (B)

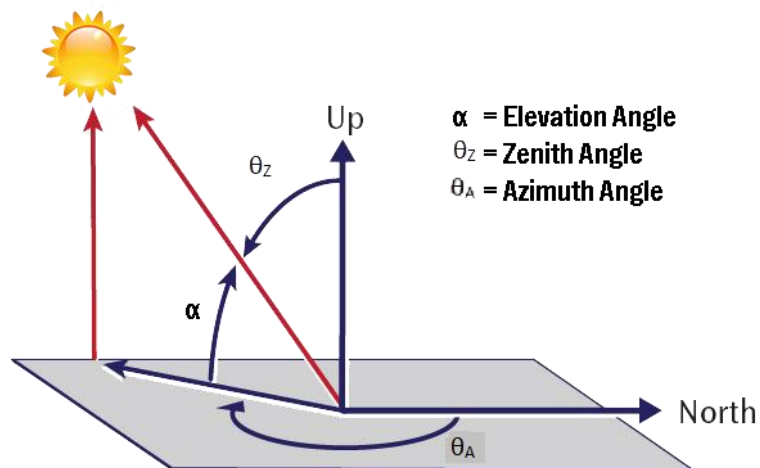
Diagram: A 3D diagram of a solar panel tilted on a vertical axis. The panel is blue and divided into four quadrants. The vertical axis is labeled 'Z'. The horizontal axis is labeled 'X'. The panel's tilt angle is labeled 'ψ'. The panel's orientation is labeled 'φ'. The cardinal directions N, E, S, and W are indicated.

- Tracker yaw angles are positive east
(e.g. 0° is N-S; 10° has a slight NNW-SSE orientation)
- Single tracker system (N to S)

- Click on “Calculate”.
- The calculated results will be displayed in the “NREL Results” and “Calculated Results” section as shown below.

The calculated results:

Parameter	Definition
Elevation Angle	is the angular height of the sun in the sky measured from the horizontal. The elevation is 0° at sunrise and 90° when the sun is directly overhead.
Zenith Angle	The zenith angle is the angle between the sun and the vertical. The zenith angle is similar to the elevation angle but it is measured from the vertical rather than from the horizontal, thus making the zenith angle = 90° - elevation.
Azimuth Angle	The azimuth angle is the compass direction from which the sunlight is coming. At solar noon, the sun is always directly south in the northern hemisphere and directly north in the southern hemisphere.



Parameter	Definition	Equation
Equation of Time	The equation of time (EoT) (in minutes) is an empirical equation that corrects for the eccentricity of the Earth's orbit and the Earth's axial tilt.	$EoT = 9.87 \sin(2B) - 7.53 \cos(B) - 1.5 \sin(B)$ Where: $B = \frac{360}{365}(d-81)$ d: is the number of days since the start of the year
Local Standard Time Meridian	The Local Standard Time Meridian (LSTM) is a reference meridian used for a particular time zone and is similar to the Prime Meridian, which is used for Greenwich Mean Time.	$LSTM = 15^\circ \cdot \Delta T_{GMT}$
Time Correction Factor	The net Time Correction Factor (in minutes) accounts for the variation of the Local Solar Time (LST) within a given time zone due to the longitude variations within the time zone and also incorporates the EoT above.	$TC = 4(\text{longitude} - LSTM) + EoT$
Local Solar Time	The Local Solar Time (LST) can be found by using the previous two corrections to adjust the local time (LT).	$LST = LT + \frac{TC}{60}$
Hour Angle	The Hour Angle converts the local solar time (LST) into the number of degrees which the sun moves across the sky. By definition, the Hour Angle is 0° at solar noon. Since the Earth rotates 15° per hour, each hour away from solar noon corresponds to an angular motion of the sun in the sky of 15°. In the morning the hour angle is negative, in the afternoon the hour angle is positive.	$HRA = 15^\circ (LST - 12)$
Declination	-	$\delta = 23.45^\circ \sin\left(\frac{360}{365}(d-81)\right)$
Elevation	-	$\alpha = \sin^{-1}(\sin\delta \sin\phi + \cos\delta \cos\phi \cos(HRA))$
Azimuth	-	$\text{Azimuth} = \cos^{-1}\left(\frac{\sin\delta \sin\phi + \cos\delta \cos\phi \cos(HRA)}{\cos\alpha}\right)$
Sunrise	The time of sunrise according to the plant location.	
Sunset	The time of sunset according to the plant location.	
Number of days	The number of the day in the year.	
Days Factor (B)	-	$B = \frac{360}{365}(d-81)$