ALMIPL SOLAR

Powering The New Age (Energy)

SOLAR INSTRUMENTATION

Mohammed Mubarak
Solar Energy

ALMIPL SOLAR
Powering The New Age (Energy)

SOLAR INSTRUMENTS

ALMIPL SOLAR

ALMIPL SOLAR
Powering The New Age (Energy)

Utility of Instruments

- Instruments are essential devices of measurement for all aspects of Solar PV system development.
- Instrument are used to judge various Physical parameters at the time of:
  - Designing a system
  - Procuring things for the system
  - Construction of the system
  - Operation and maintenance of the system

ALMIPL SOLAR

ALMIPL SOLAR
Powering The New Age (Energy)

Compass

ALMIPL SOLAR
Powering The New Age (Energy)

Compass

- A **compass** is an instrument used for navigation and orientation that shows direction relative to the geographic *cardinal directions*, or "points". Usually, a diagram called a compass rose, shows the directions north, south, east, and west as abbreviated initials marked on the compass.

ALMIPL SOLAR

Irradiance Meter

ALMIPL SOLAR
Powering The New Age (Energy)

Irradiance Meter

- The versatile Seaward Solar Survey 100 uses a precision PV cell sensor for the highly accurate irradiance measurement, displaying results in either Wm-2 or BTU/h/ft2 and making it ideal for both solar PV and solar thermal site installations.
- Uniquely, the new multi function unit also incorporates a digital compass, a digital tilt meter and a dual channel precision thermometer.

ALMIPL SOLAR

ALMIPL SOLAR
Powering The New Age (Energy)

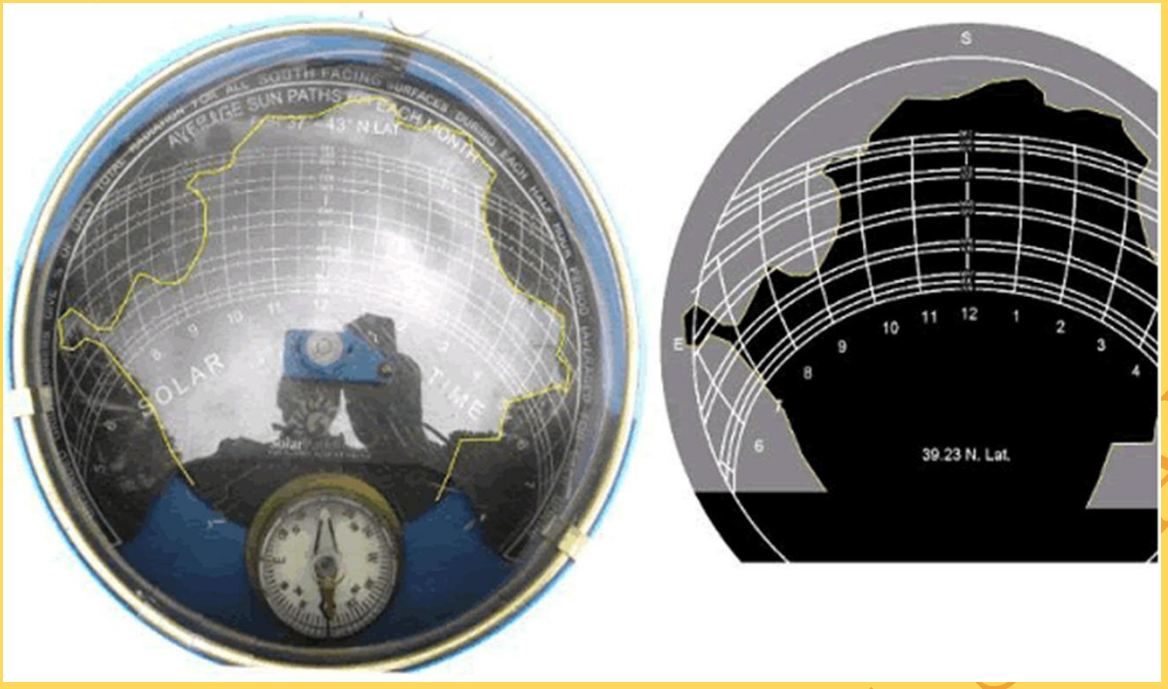
Irradiance Measurement

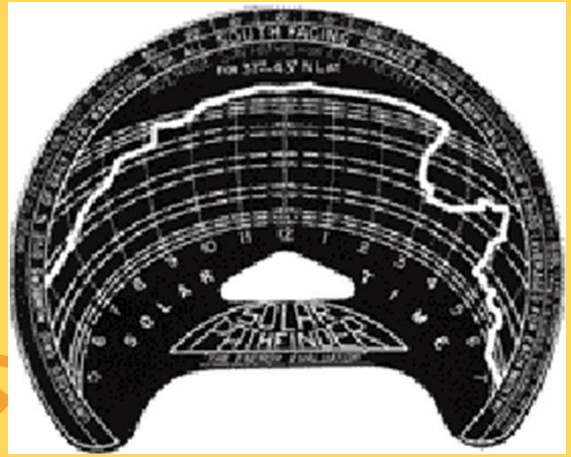
- **Irradiance** is a **measurement** of solar power and is defined as the rate at which solar energy falls onto a surface. The unit of power is the Watt (abbreviated W). In the case of solar **irradiance,** we usually **measure** the power per unit area, so **irradiance** is typically quoted as W/m² - that is Watts per square meter.

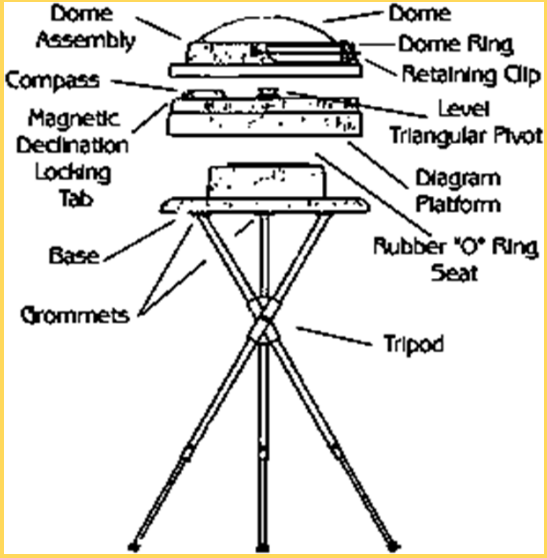
ALMIPL SOLAR

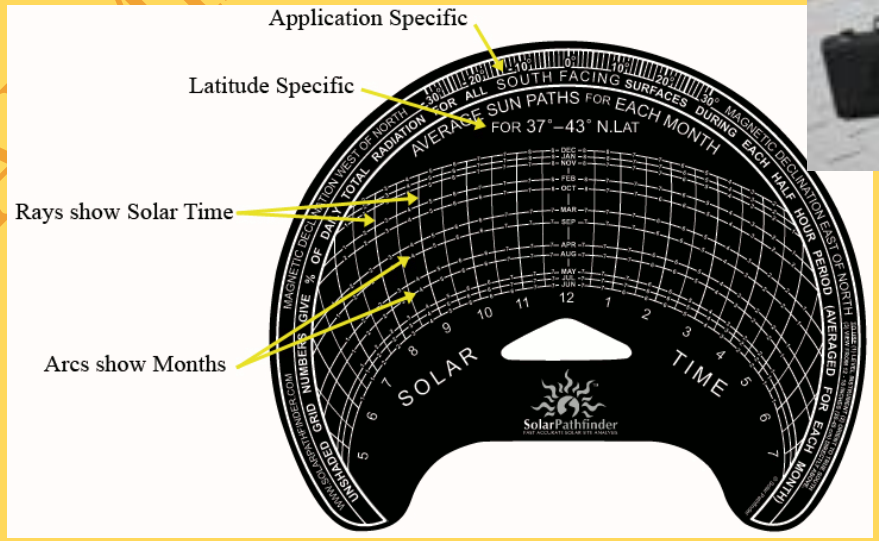
ALMIPL SOLAR
Powering The New Age (Energy)

Solar Path Finder

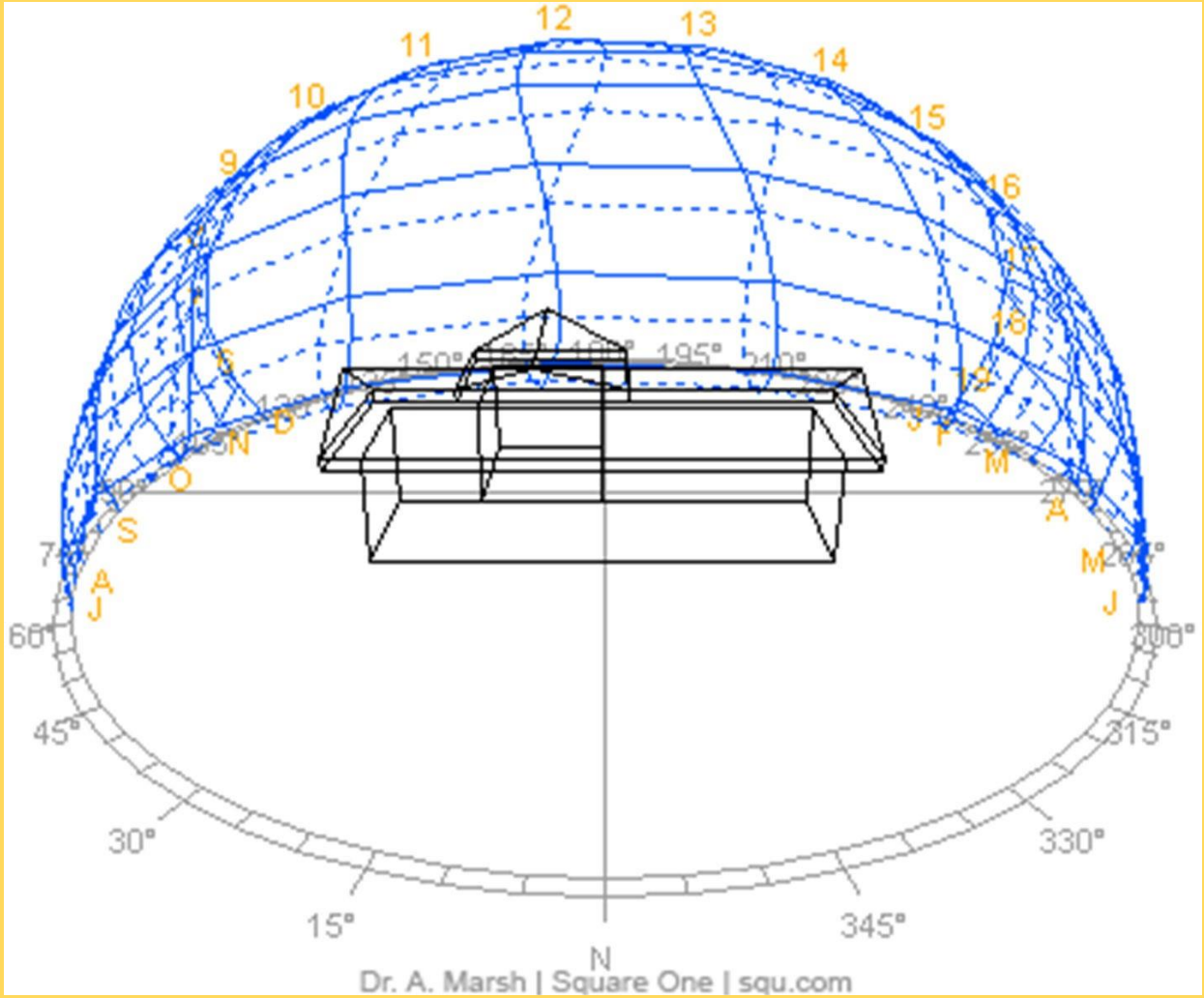

AVERAGE SUN PATHS FOR EACH MONTH
SOLAR
TIME
S
E
39.23 N. Lat.

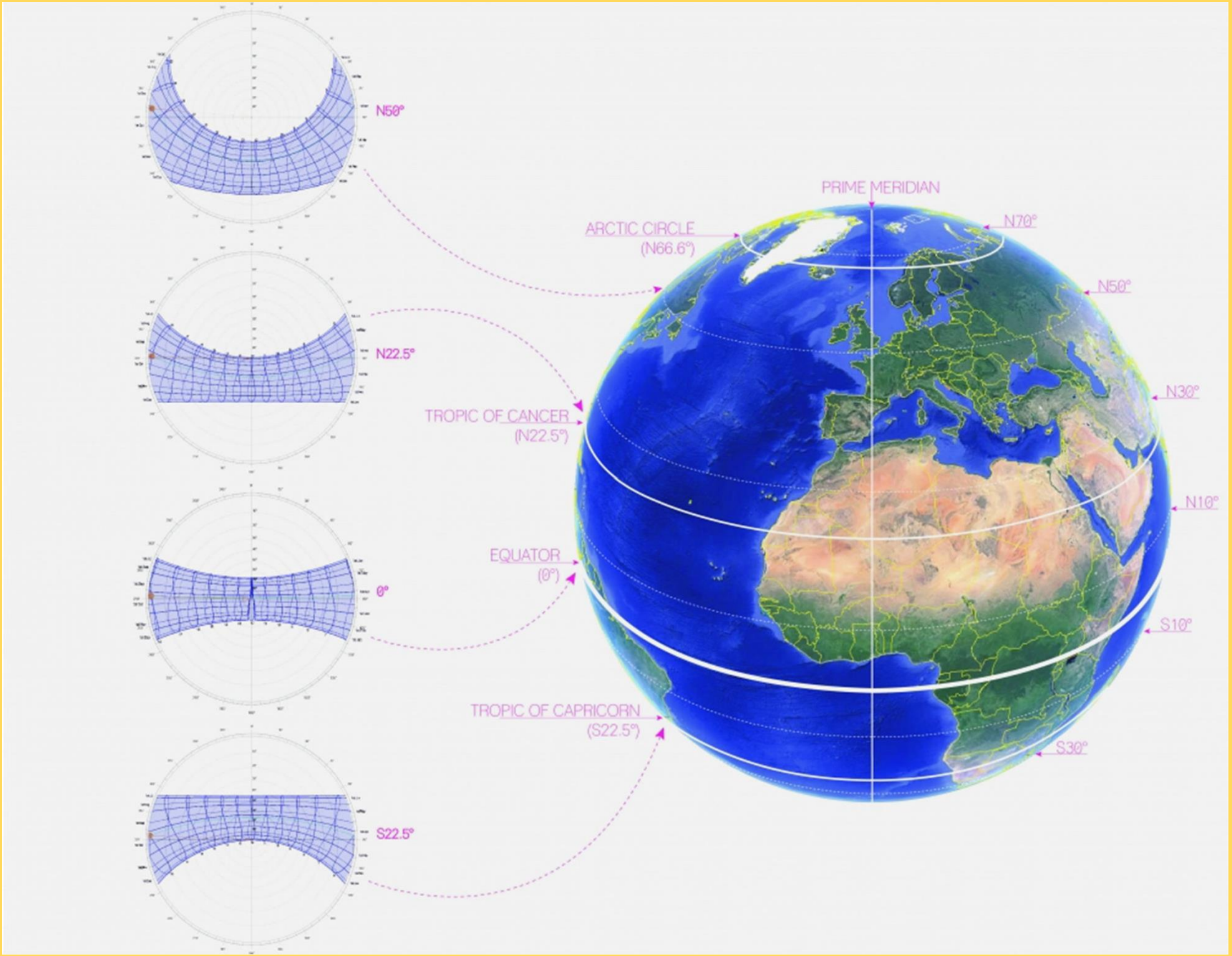


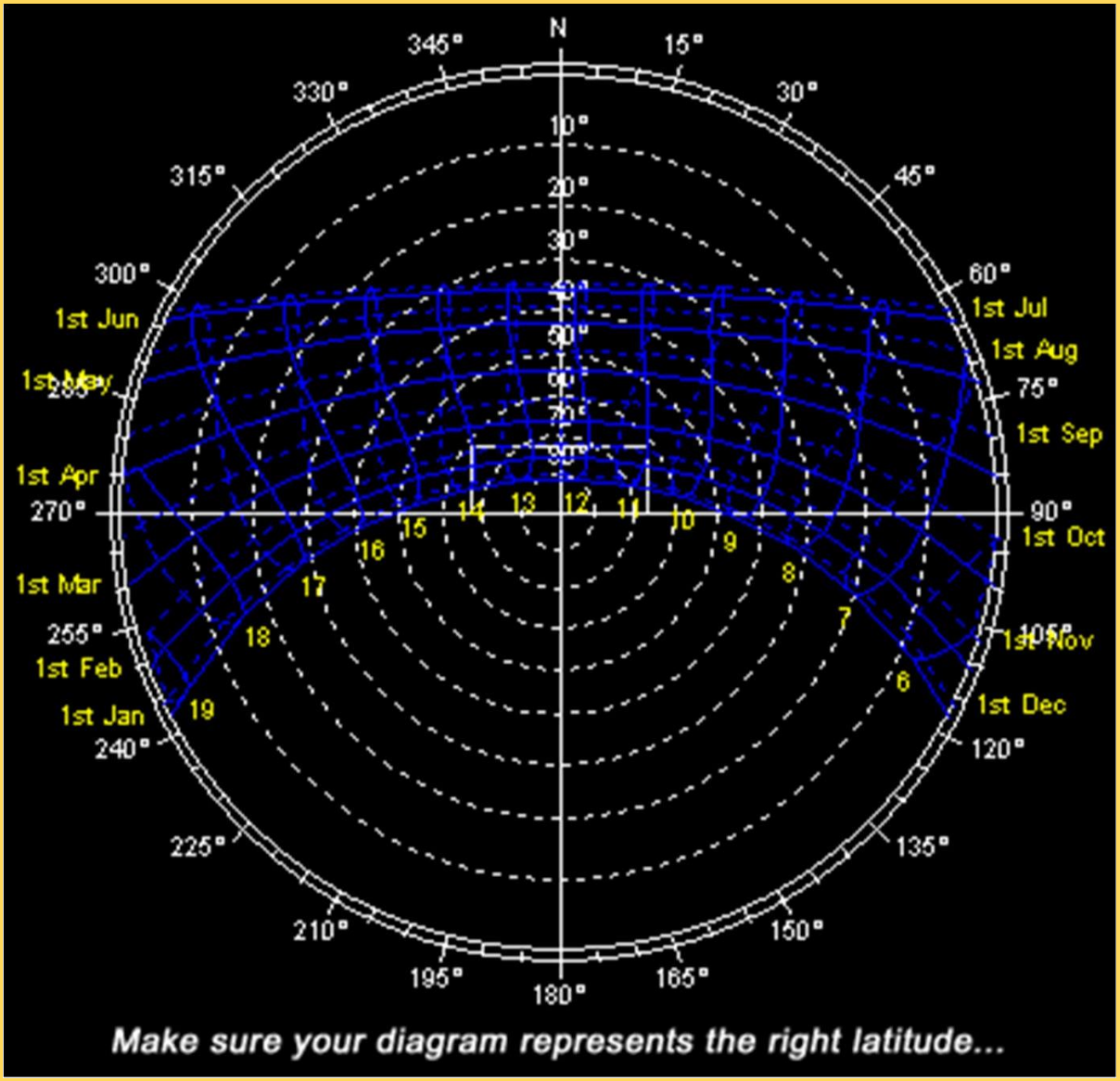

Dome Assembly
Dome
Dome Ring
Retaining Clip
Compass
Level
Magnetic Declination
Triangular Pivot
Locking Tab
Diagram Platform
Rubber "O" Ring Seat
Base
Grommets
Tripod


Application Specific
Latitude Specific
Rays show Solar Time
Arcs show Months
AVERAGE SUN PATHS FOR EACH MONTH
FOR 37°–43° N.LAT
SOLAR
TIME
SolarPathfinder

ALMIPL SOLAR
Powering The New Age (Energy)




N50°
N22.5°
0°
S22.5°
PRIME MERIDIAN
ARCTIC CIRCLE
(N66.6°)
N70°
N50°
N30°
TROPIC OF CANCER
(N22.5°)
N10°
EQUATOR
(0°)
S10°
TROPIC OF CAPRICORN
(S22.5°)
S30°


N
345°
15°
330°
30°
10°
315°
20°
45°
30°
300°
60°
1st Jun
1st Jul
1st Aug
1st May
75°
1st Sep
1st Apr
270°
90°
1st Oct
1st Mar
255°
1st Nov
1st Feb
1st Jan
1st Dec
240°
120°
225°
135°
210°
150°
195°
165°
180°
Make sure your diagram represents the right latitude...

ALMIPL SOLAR
Powering The New Age (Energy)

Path Finder

- The Solar Pathfinder™ is non-electronic. **Simple and straight-forward in its engineering, it requires no special skills or technical know-how.** One simple tracing does the job and becomes the permanent record for the solar data. When properly cared for, the unit will give the user years of accurate site analysis.

- The Solar Pathfinder™ uses a highly polished, transparent, convex plastic dome to give a panoramic view of the entire site. All the trees, buildings or other obstacles to the sun are plainly visible as reflections on the surface of the dome. The sunpath diagram can be seen through the transparent dome at the same time.

ALMIPL SOLAR

Shading

Source: Solmetric SunEye, Solar Pathfinder

ALMIPL SOLAR
Powering The New Age (Energy)

Shading Measurement Tool

ALMIPL SOLAR
Powering The New Age (Energy)

Shading Measurement Tool

- The award-winning SunEye incorporates a calibrated fisheye camera, electronic compass, tilt sensor, and optional GPS to give immediate measurements in the field. The one-handed operation, rugged enclosure, outdoor readable display

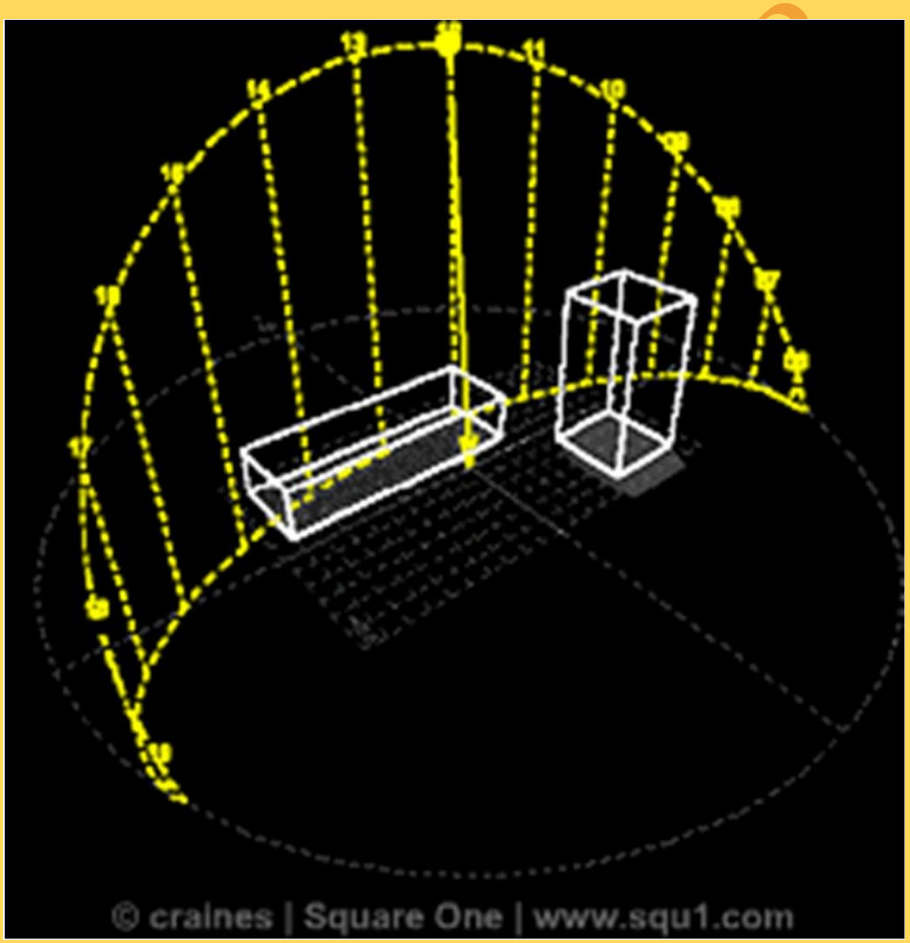
ALMIPL SOLAR

ALMIPL SOLAR
Powering The New Age (Energy)

ALMIPL SOLAR
Powering The New Age (Energy)

Shading Tool

ALMIPL SOLAR
Powering The New Age (Energy)



ALMIPL SOLAR
Powering The New Age (Energy)

Pyranometer

ALMIPL SOLAR
Powering The New Age (Energy)

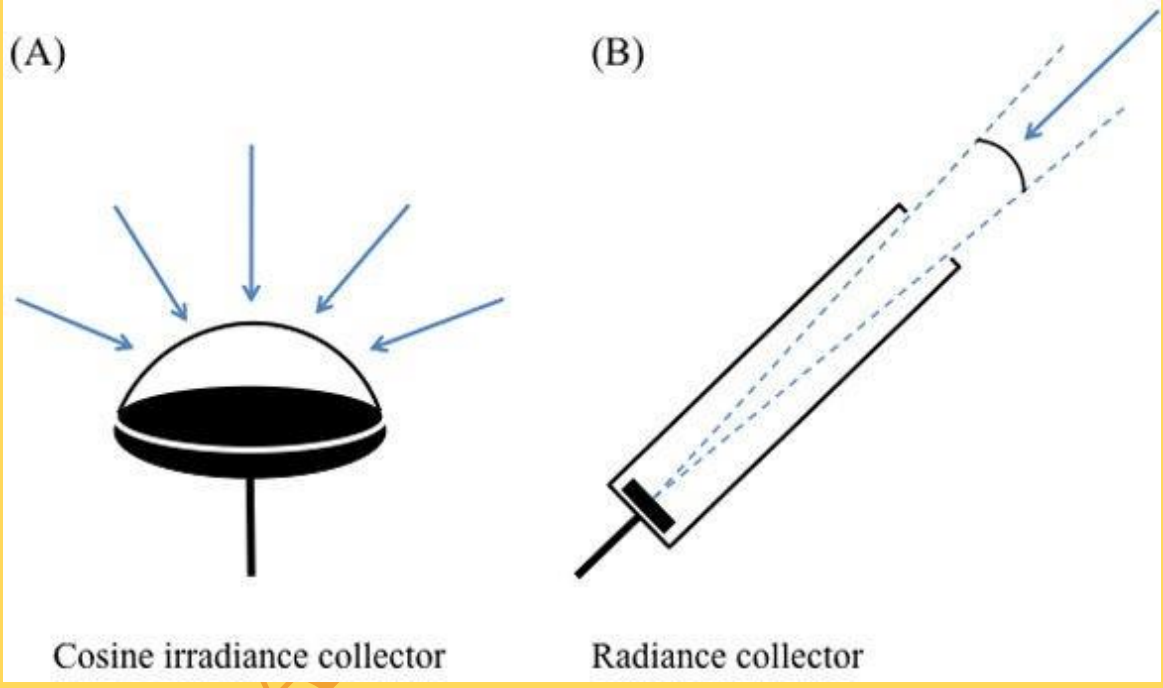
Pyranometer

- A **pyranometer** is a type of actinometer used to measure broadband solar irradiance on a planar surface and is a sensor that is designed to measure the solar radiation flux density (W/m^2) from a field of view of 180 degrees.
- A shade ring is used to shield a pyranometer from direct solar radiation, a correction to the measured diffuse radiation is necessary to account for diffuse radiation intercepted by the ring. A general analysis is developed to relate shade-ring corrections to the radiance distribution of diffuse radiation. The corrections are split into two components: a geometric component based on an isotropic sky and varying with shade-ring dimensions; and an anisotropy component, relatively independent of ring dimensions. Shade-ring corrections are calculated using mean distributions of the radiance of cloudless skies.

ALMIPL SOLAR

ALMIPL SOLAR
Powering The New Age (Energy)

ALMI


(A)
(B)
Cosine irradiance collector
Radiance collector

ALMIPL SOLAR
Powering The New Age (Energy)

Anemometer

ALMIPL SOLAR
Powering The New Age (Energy)

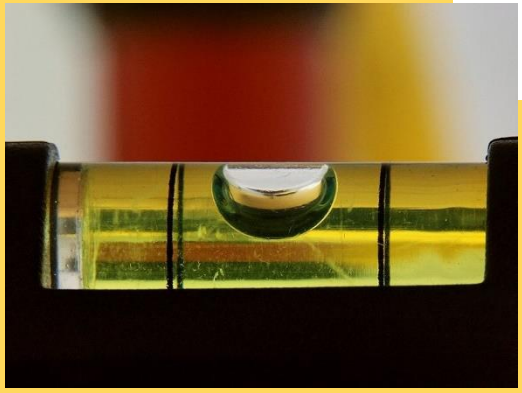
Anemometer

- An **anemometer** is a device used for measuring wind speed, and is a common weather station instrument. The term is derived from the Greek word anemos, which means wind, and is used to describe any wind speed measurement instrument used in meteorology

ALMIPL SOLAR

ALMIPL SOLAR
Powering The New Age (Energy)

Spirit Level



ALMIPL SOLAR
Powering The New Age (Energy)

Spirit Level

- A **spirit level**, **bubble level** or simply a **level** is an instrument designed to indicate whether a surface is horizontal (level) or vertical (plumb). Different types of spirit levels may be used by carpenters, stonemasons, bricklayers, other building trades workers, surveyors, Solar Technicians and other metalworkers, and in some photographic or videographic work.
- Alcohols such as ethanol are often used rather than water. Alcohols have low viscosity and surface tension, which allows the bubble to travel the tube quickly and settle accurately with minimal interference with the glass surface.

ALMIPL SOLAR

ALMIPL SOLAR
Powering The New Age (Energy)

Tilt Measurement

SOLAR

ALMIPL SOLAR
Powering The New Age (Energy)

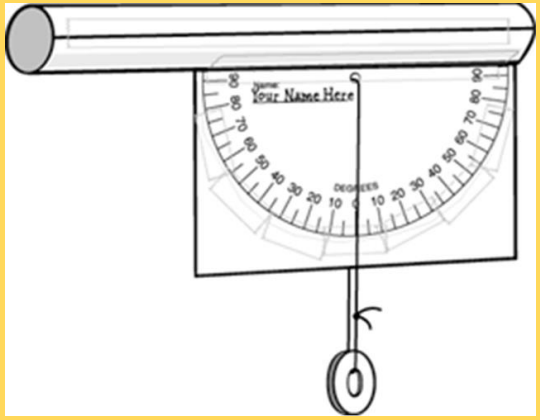
Inclinometer

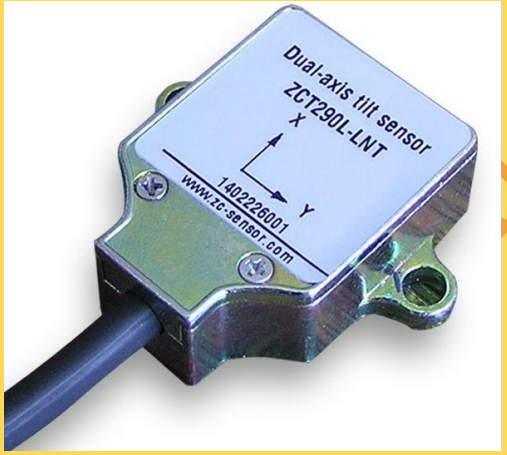
- An **inclinometer** or **clinometer** is an instrument for measuring angles of slope (or tilt), elevation or depression of an object with respect to gravity. It is also known as a *tilt meter*, *tilt indicator*, *slope alert*, *slope gauge*, *gradient meter*, *gradiometer*, *level gauge*, *level meter*, *declinometer*, and *pitch & roll indicator*.

ALMIPL SOLAR

ALMIPL SOLAR
Powering The New Age (Energy)

Inclinometer



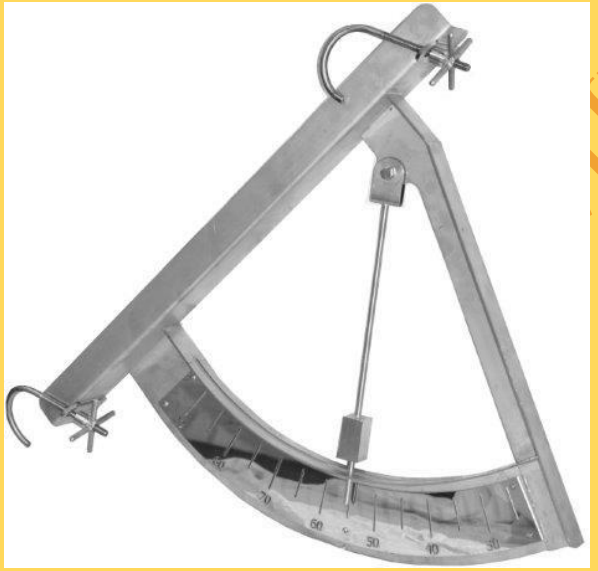


ALMIPL SO

ALMIPL SOLAR
Powering The New Age (Energy)

Inclinometer

ALMIPL SOLAR



ALMIPL SOLAR
Powering The New Age (Energy)

Infra-Red Thermometer

ALMIPL SOLAR

ALMIPL SOLAR
Powering The New Age (Energy)

Multimeter

Multimeter

Voltage DC	Accuracy	±(0.05% + 1)
	Maximum resolution	10 µV
Voltage AC	**Maximum voltage**	1000 V
	Accuracy	±(0.7% + 2) True RMS
	AC bandwidth	20 kHz with low pass filter; 3 db @ 1 kHz
	Maximum resolution	0.1 mV
Current DC	**Maximum amps**	10 A (20 A for 30 seconds maximum)
	Amps accuracy	±(0.2% + 2)
	Maximum resolution	0.01 µA
Current AC	**Maximum amps**	10 A (20 A for 30 seconds maximum)
	Amps accuracy	±(1.0% + 2) True RMS
	Maximum resolution	0.1 µA

ALMIR SOLAR

Typical Multimeter Specifications

…Contd

Resistance	**Maximum resistance**	**50 MΩ**
	Accuracy	**±(0.2% + 1)**
	Maximum resolution	**0.1 Ω**
Capacitance	**Maximum capacitance**	**9,999 µF**
	accuracy	**±(1% + 2)**
	Maximum resolution	**0.01 nF**
Frequency	**Maximum frequency**	**200 kHz**
	Accuracy	**±(0.005% + 1)**
	Maximum resolution	**0.01 Hz**

Duty cycle	**Maximum duty cycle**	99.9%
	Accuracy	±(0.2% per khz + 0.1%)
	Maximum resolution	0.1%
Temperature measurement	–200.0°C – 1090°C –328.0°F – 1994.0°F excluding probe	
80 BK temperature probe	–40.0°C – 260°C –40.0°F – 500°F, 2.2°C or 2% whichever is greater	
Conductance	**Maximum conductance**	60.00 nS
	Accuracy	±(1.0% + 10)
	Maximum resolution	0.01 nS
Diode	**Range**	3 V

AMPLSOLAR

ALMIPL SOLAR
Powering The New Age (Energy)

Clamp Multimeter

ALMIPL SOLAR
Powering The New Age (Energy)

Clamp Meter

A **clamp meter** is an electrical tester that combines a basic digital multimeter with a current sensor. **Clamps** measure current. Probes measure voltage.

ALMIPL SOLAR

Fluke 376 True-rms AC/DC Clamp Meter with iFlex™

ALMIPL SOLAR
Powering The New Age (Energy)

- DC Current Range 999.9 A Resolution 0.1 A Accuracy 2% ± 5 digits
- AC Current via Jaw Range 999.9 A Resolution 0.1 A Accuracy 2% ± 5 digits (10-100 Hz)

  2.5% ± 5 digits (100-500 Hz)
- AC Voltage Range 1000 V Resolution 0.1 V (≤ 600.0 V) 1 V (≤ 1000 V) Accuracy 1.5% ± 5 digits (20 – 500 Hz)
- DC Voltage Range 1000 V Resolution 0.1 V (≤ 600.0 V) 1 V (.≤ 1000 V) Accuracy 1% ± 5 digits

ALMIPL SOLAR

ALMIPL SOLAR
Powering The New Age (Energy)

Specifications of Clamp Multimeter

- In electrical and electronic engineering, a **current clamp** or **current probe** is an electrical device having two jaws which open to allow clamping around an electrical conductor.
- Current clamps are usually used to read the magnitude of a sinusoidal current (as invariably used in alternating current (AC) power distribution systems), but in conjunction with more advanced instrumentation the phase and waveform are available. Very high alternating currents (1000 A and more) are easily read with an appropriate meter; direct currents, and very low AC currents (milliamperes) are more difficult to measure.

ALMIPL SOLAR

ALMIPL SOLAR
Powering The New Age (Energy)

Measuring Tape

ALMIPL SOLAR
Powering The New Age (Energy)

Field Measuring Tape

ALMIPL SOLAR
Powering The New Age (Energy)

Laser Distance Meter

ALMIPL SOLAR
Powering The New Age (Energy)

ALMIPL SOLAR