

# SEMS-2000/3000

## SOLAR ENERGY MEASUREMENT SYSTEM AND COMPLETE METEOROLOGICAL STATION WITH REALLY UNIQUE FEATURES



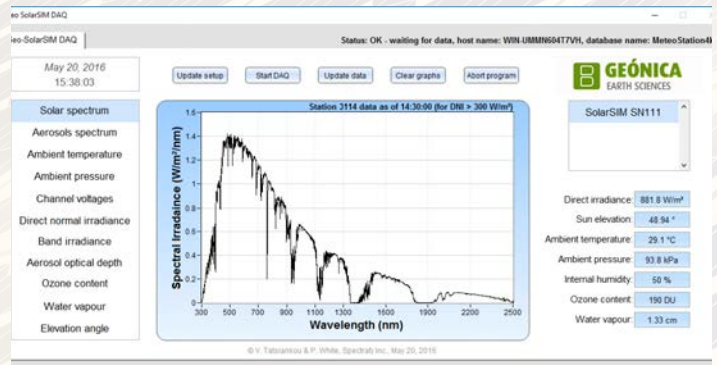
**TRUE AND PRECISE MEASUREMENT WITH DATA TRANSMISSION IN NEAR REAL-TIME OF SOLAR IRRADIANCE AND SOLAR SPECTRAL IRRADIANCE IN THE RANGE OF 280 – 4000 nm WITH 1 nm RESOLUTION, PLUS AEROSOLS, OZONE AND WATER VAPOUR CONTENT IN THE ATMOSPHERE**

### **SOLAR IRRADIANCE COMPONENTS MEASURED AUTOMATICALLY BY SEMS-2000/3000 SYSTEM**

- Direct Normal Irradiance (DNI) by Pyrheliometer
- Global Horizontal Irradiance (GHI) by Pyranometer
- Global Tilted Irradiance (GTI) by Pyranometer
- Diffuse Horizontal Irradiance (DHI) by shaded Pyranometer

## SOLAR IRRADIANCE SPECTRAL COMPONENTS MEASURED AUTOMATICALLY BY SEMS-2000/3000 SYSTEM USING OPTIONAL GEO-Solar Spectral Irradiance Sensors

- Direct Normal Spectral Irradiance (DNSI)
- Global Horizontal Spectral Irradiance (GHSI)
- Global Tilted Spectral Irradiance (GTSI)
- Aerosol Optical Depth (AOD)
- Total Column Ozone Content (TCOC)
- Total Column Water Vapour Content (TCWVC)



### AREAS OF APPLICATION OF SEMS-2000/3000 SYSTEM # SOLAR ENERGY RESOURCE ASSESSMENT & SOLAR MAPS # PHOTOVOLTAIC (PV), CONCENTRATED PHOTOVOLTAIC (CPV) AND CONCENTRATED (CSP) SOLAR POWER PLANTS

#### WITH THE OBJECTIVE OF:

- Correction of atmospheric components (AOD, Water Vapour and Ozone) from satellite and in clear sky models.
- Decrease uncertainty in the long-term estimation of Direct Normal Irradiance (DNI).
- Precise identification of clear sky conditions analyzing spectral bands attenuated by clouds. Especially important in areas of high turbidity as Middle East, India, etc. since it is not possible to identify clear sky conditions based on pyranometric data and current algorithms.
- In Solar Power Tower plants, characterization of the attenuation of solar radiation in the path from heliostats to solar receiver.
- Precise solar radiation predictions using on-site atmospheric components to correct modeled AOD, WV, Ozone and rest of components.
- Selection of best photovoltaic technologies for specific locations based on their spectral response.
- Accurate predictions from sky imagers combined with spectral radiation and Radiative Transfer Model (RTM).
- Accurate modelling and prediction of Concentrated Photovoltaic (CPV) output through its spectral response.



Typical field installation of SEMS-3000 System with solar sensors mounted on the sun tracker, plus meteorological mast, datalogger and power supply for autonomous unattended operation of the whole system

## SEMS-2000/3000 SYSTEM BASIC PACK CONFIGURATION (See Diagram 9785.0135)

### DATALOGGER

**METEODATA** is a Remote Automatic Data Acquisition and Transmission Unit, teleprogrammable, designed as a total compact mount in a heavy duty weatherproof Polypropylene or Metallic housing (Protection IP-67/ IP66 respectively, and dimensions 41x33x20cm).



### SunTracker-2000 or SunTracker-3000

One of the important advantages of our SEMS solution is that the **Sun Tracker-2000/3000** does not require any local PC , as it is fully controlled by our datalogger, the same used for measuring and recording all the parameters.

#### Local and remote control functions

The following Control Functions of **SunTracker-2000/3000** are done locally or remotely from the Data Receiving Center :

- Automatic Axis Calibration at any time
- Change of geographical coordinates
- Fine-Tune of azimuth and elevation axis alignment
- Activate / Deactivate solar radiation measurements during start-up and maintenance operations
- Date and time synchronization
- Diagnostic Alarm Threshold setting

## OPTIONS FOR BASIC PACK OF SEMS-2000/3000 SYSTEM

- **SDK-2000/3000** Shadow Disk Kit for true automatic measurement of DHI with shadowed pyranometer.
- **GEO-SUN SENSOR** for active tracking of the **SunTracker-2000/3000**.

## DATA COMMUNICATIONS OPTIONS OF SEMS-2000/3000 SYSTEM

The datalogger of **SEMS-2000/3000** System records and stores all the measurements, including Global, Diffuse and Direct Irradiance, the raw spectral data, as well as all additional meteorological parameters required for each project.

Data is transmitted to a Central Receiving Station and a complete SQL database is generated for subsequent analysis and final data process. Communications with a local SCADA are also possible.

The information available in the database of the Central Server can be transferred to a WEB Server by means of our **WEBTRANS Ubiquitas** Internet Platform as described in a separate Doc No 9780 0030. This Application offers graphical and numerical information via Internet to authorized users.

So it is possible to access from your office to the WEB Server via Internet and to visualize in near real-time the curves of all parameters as well as to download data.

Therefore our **WEBTRANS Ubiquitas** Internet Platform is also a very efficient tool for remote status surveillance, diagnostic and maintenance of **SEMS System**.

The **Sun Tracker-2000/3000** can be programmed locally by a PC via the datalogger, or remotely by 3G/GPRS connection using our **TELETRANS-W4K** Application.



## DATA COMMUNICATIONS OPTIONS OF SEMS-2000/3000 SYSTEM cont.

- Option “VipService-4K” Geonica’s Virtual IP Service that enables communication between Data Receiving Center and Remote Station regardless the operator’s SIM/RUIM features (public, private, static or dynamic IP address, etc.), allowing full featured communications with all mobile operators supplying Internet access SIM/RUIM cards over the world. Note that the VipService-4K requires the option GPRS-IP already included in the basic pack.
- Option INMARSAT BGAN M2M Satellite Terminal, including antenna and connecting cables. Bidirectional communications. Broadband Global Area Network.
- Option ETHERNET for Direct connection to Ethernet networks, SCADAs, INMARSAT Terminal, etc. Includes RJ45 connector.
- Option MODBUS Protocols, “Modbus Slave” communications module integrated in the own remote Station program, allowing a Master device (i.e. PC, PLC, RTU, etc.) connected to the Station to access variables map in order to:
  - Read instantaneous values of every channel in the Station
  - Read statistical values regarding the last calculation period of every channel in the Station
  - Master and Station date and time synchronization

Depending on the physical link type and the Master Station protocol, the following alternatives can be chosen (to be defined with the order):

- MODBUS-RTU Option, Serial port RS232/RS485 link, or
- MODBUS-RTU over TCP-IP Option, or
- MODBUS-TCP Option.

## RECOMMENDED MOUNTING ACCESSORIES



- Model TM-180-03.  
Tower, 3 m height (6 and 9 meters optional) plus 1,5 m adjustable mast. Triangular section 180 mm.
- Model SP-360.  
Sun Tracker support, consisting on a tubular metallic structure (1.5 m height) in triangle pattern, ended by a flat plate.

## AUTONOMOUS OPERATION

The **SunTracker-2000** and the **SunTracker-3000** consume 2 Watts and 3 Watts respectively, so they can be powered by the internal batteries of the datalogger and a solar panel of about only 70W, depending on the irradiance conditions of each location. This feature makes the difference between our design and that of other manufacturers, as in fact other designs have to count on AC supply at the remote site; but this is not the case of our solution.

As indicated before, the whole **SEMS system** consists on: Datalogger, Sun Tracker, Sensors and Communication, and it is powered by the internal battery pack of only 2x9 Ah mounted inside the logger cabinet that also includes a suitable charge/regulator circuit which allows the connection to a solar panel or the mains.

This standard power pack supplied with the basic system configuration allows under normal conditions up to 3-5 days autonomy of the whole system, but if a higher autonomy is required, a suitable external power pack can be calculated and quoted.

## AUTOMATIC DIAGNOSIS AND ALARMS (ADAS-3000 Software)



Pyrheliometer, Pyranometer and Solar Spectral Irradiance Sensor mounted on Suntracker-3000

The marriage of the Datalogger **METEODATA** and the **SunTracker-2000/3000** working together, is a unique and exclusive symbiosis solution, which allows to profit all the functionalities of the Automatic Diagnosis and Alarm Software (ADAS-3000) in real-time.

The **ADAS-3000** software installed at the datalogger is monitoring in real-time the measured values of the main three solar irradiance parameters (DNI, GHI and DHI), supervising also the results of the local running algorithms that are in charge of the SunTracker operation.

The monitored solar radiation parameters and the locally running algorithms of the **SEMS-2000/3000** System are :

- Global, Diffuse and Direct solar radiation sensors readings.
- Accurate GPS fixes.
- Astronomical sun tracking algorithm.
- Digital Signal Processing Functions.

The **ADAS-3000** determines automatically and in real-time the "coherence" between the three measured parameters: DNI, GHI and DHI values, entering these data into the following equation that links them together :

$$GHI = DNI \cdot \sin(\beta) + DHI$$

( $\beta$  = elevation angle of the sun)

If the **ADAS-3000** detects any inconsistency or lack of coherence because the measured values do not comply the above equation, then an alarm condition is automatically generated.

This calculation is carried out under certain site condition and considerations such as potential obstacles at the horizon and suitable irradiance level in order to avoid false conclusions.

The objective of the **ADAS-3000** Application is to alert the user about the existence of any anomalous operation of the measuring system (Sun Tracker, Pyranometers and Pyrheliometers), that might otherwise be totally unnoticed by any analyst, just in view of the data obtained for the three parameters (DNI, GHI and DHI) measured by the system.

This alarm can be generated by any of the following circumstances:

- Dirt deposition in the domes of Pyranometers or in the glass filters of Pyrheliometers
- Degradation of the solar sensors or incorrect calibration constant
- Wrong leveling of the Sun Tracker
- Misalignment of the Pyrheliometer mounted on the SunTracker
- Incorrect operation of the Astronomical algorithm
- Or due to any other potential and not identified reason

When **ADAS-3000** is installed in the **METEODATA** Datalogger that controls the Sun Tracker, measuring at the same time the three solar parameters, these alarms can be sent automatically by SMS up to 5 different users, or by TCP/IP to a Data Receiving Center, in order to warn the users about the fact that a non identified reason is originating low data quality being recorded at the site.

The alarm status is also recorded at the alarm channel of the Datalogger, alongside rest of historical data.

It is important to mention that minor and even large differences between the actual measurements of any of these three solar irradiance parameters and their real values (correct values), due to any of the reasons indicated before, will not be detected in any manner in real time without our unique automatic diagnosis carried out by the **ADAS-3000**.

Of course the inconsistency of the measured data can be detected when data is analyzed later in the office, but that may be irreversible, for example in the case of assessing the radiation conditions of a given location, but that will be too late because in this period the solar data will be invalid and the correct data would be irretrievable.



**WEBTRANS *Ubiquitas* Internet Platform**

**(WEB Posting Tool)**

- Data collected by Remote Stations accessible from Internet
- Restricted Webpage access using credentials
- Accessible from a wide variety of devices: PCs, Smartphones, tablets, etc.
- Customizable Website visual interface
- Easy installation and customization
- Graphical display of historic data
- Latest received data in the side panel values and compass rose
- Data downloading
- Display of images taken by **DIGICAM-3K** camera



The **SEMS-2000/3000 SYSTEM** collects and stores the data that then is transmitted via a communications system (3G, GPRS, Ethernet, Radio, etc.) to the database, where they are stored. Frequently, the database is located on a server, in a center called 'Data Reception Center (DRC)'.

The **WEBTRANS *Ubiquitas*** application accesses this database to display the measured data to the users as numeric data or as time series in graphs. It also allows the data to be downloaded in several formats (CSV, XML, zip) and display the images captured by the cameras installed on the remote station.

