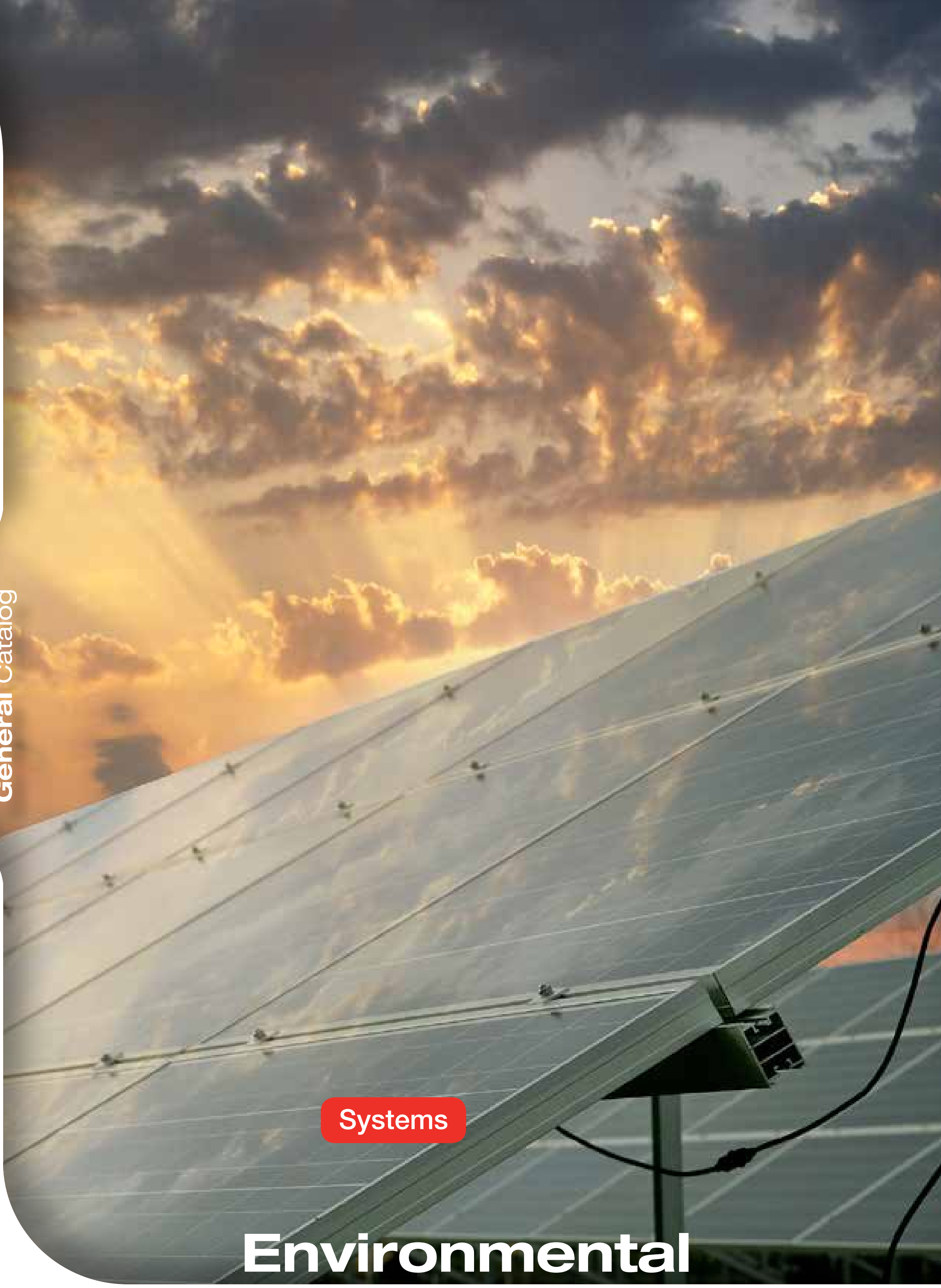


outdoor

General Catalog

Systems

Environmental monitoring systems for solar energy applications

LSI LASTEM

Milano
ITALY

> Environmental monitoring

Environmental monitoring systems for solar energy applications

Sensors, components and systems for the monitoring of environmental conditions in solar energy power plants performance evaluation.

For solar energy plants managers and investors, precise monitoring of system performance parameters is an absolute priority, both at brief and long term. In the brief term, to monitor conversion efficiency or possible faults and malfunctioning. In the long term, to guarantee investments and its return.

For an operating plant, the main exogenous limitation to optimal performance is represented by the **environmental conditions**. Both solar radiation, the basic feedstock of the system, temperatures, influencing performances of its main components, and less-heralded factors such as wind speed and direction concur to generate the environmental conditions determining the potential plant yeld against which actual **plant performances** are measured.

Being able to monitor meteorological conditions affecting plant performances, and being able to do it with precision, it's the only way for the operator to keep investments under control.

In this document:

This guide shows LSI LASTEM weather systems suitable for the production of electrical energy obtained from solar power. Our products are an ideal complement to performance monitoring systems when good environmental data accuracy (solar radiation, air and FV module temperature, wind speed and direction) and reliable and easily integrated systems are requested.

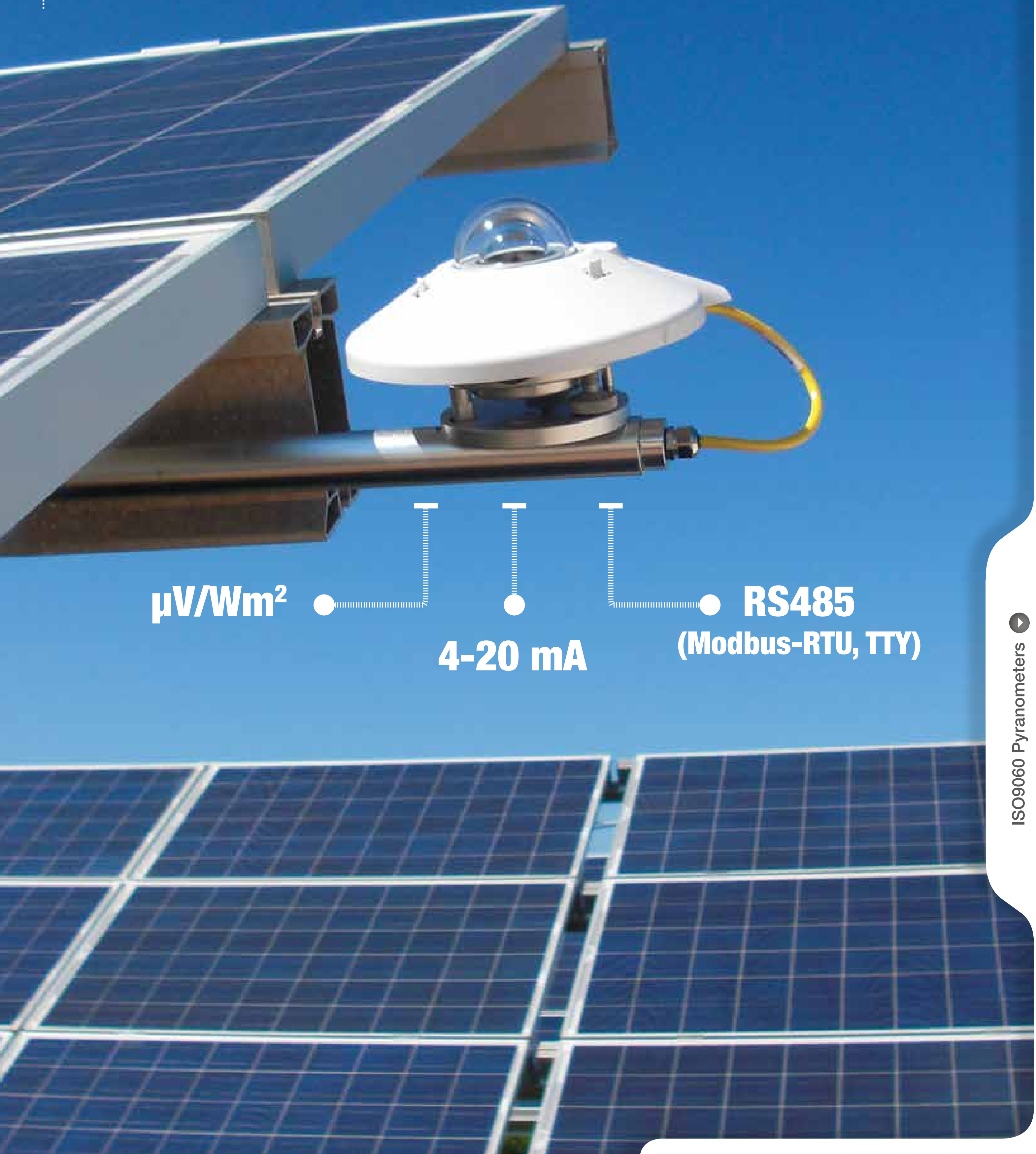
The instruments are designed both to be mounted in complete turn-key systems or to be integrated with third party systems following a policy of simplicity, flexibility and convenience.

LSI LASTEM is an historical Italian brand of meteorological equipment. We design and produce nearly all the parts of our catalogue in our factory in Milan; among them, our line of pyranometers and sensors for the measurement of the different solar radiation aspects: global, diffuse, direct, albedo, net and UV.

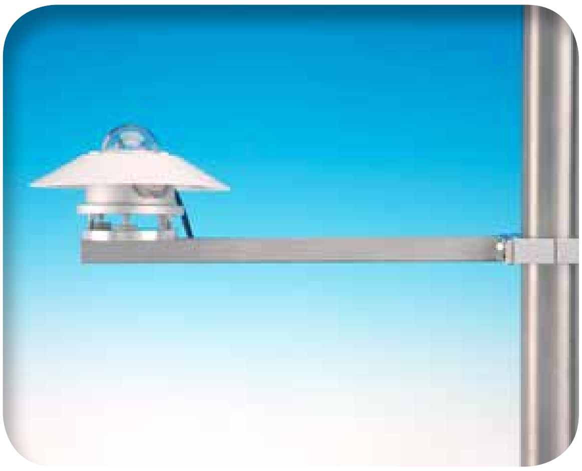
In the last years, we have provided more than 1000 systems for applications linked to solar energy: weather stations including multi megawatt installations as well as sensors and components in smaller power plants. Thanks to our experience and competence in meteorology, we have become the preferred choice of plant owners as well as EPC contractors and inverter producers.

LSI LASTEM

Incident solar radiation is the most important parameter for performance evaluation of solar power power plants



ISO9060 Pyranometers
The world standard for measuring solar irradiance



Highlights

- Secondary Standard, First Class, Second Class pyranometers according to ISO9060
- Sensors complying with the World Meteorological Organization (WMO) specifications and with the international standards, such as IEC 61724 regulation for outdoor monitoring of photovoltaic systems
- Compliance with international standards to obtain bankable data
- Flat spectral response, independent from PV modules technology
- Very low working temperature dependence
- Low directional error, suited for horizontal or inclined plane (plane-of-array) mounting
- Low total uncertainty

Pyranometers have been representing the recognized standard for the measurement of solar radiation for over 80 years now and comply with the specifications and the classification defined by the World Meteorological Organization (**WMO**) and the International Standards Organization (ISO). Additionally, several standards for outdoor measurements in photovoltaic applications have adopted pyranometers as reference measurements, such as IEC 61724 (Photovoltaic system performance monitoring - Guidelines for measurement, data exchange and analysis). Pyranometers are an ideal solution when target is to monitor the performance of the plant or to carry out measurement campaigns or tests on materials with due account for internationally accepted standards. The measurements carried out with pyranometers are additionally comparable with “solar atlases” and with data from other locations. Our range of pyranometers covers all ISO9060 categories, respecting or exceeding the performance specifications. LSI LASTEM provides as well solutions for the mounting of sensors on the plant structures or on meteorological masts. In addition to pyranometers, LSI LASTEM provides reference photovoltaic cells, available with different technologies.

P/N Models with direct output	**DPA252**	**DPA154**	**DPA053**
P/N Models amplified 4-20mA version	**DPA952**	**DPA855**	**DPA863**
P/N Models with Modbus output	**DPA952**	**DPA870**	**DPA873**
ISO 9060 Classification	Secondary Standard	First Class	Second Class
Daily total uncertainty	2%	5%	10%
Spectral range	285-3000 nm	305-2800 nm	305-2800 nm
Irradiance range	<4000 W/m²	<2000 W/m²	<2000 W/m²
Output (sensitivity)	7-25 µV/W/m²	10-15 µV/W/m²	10-15 µV/W/m²
Response time (95%)	3 sec (T95%)	23 sec (T95%)	16 sec (T90%)
Zero off-set due to temperature variations (5°C/hr)	<± 2 W/m²	<± 4 W/m2	< 4 W/m²
Directional error (80°, 800 W/m²)	<± 10 W/m²	<± 20 W/m²	<± 20 W/m²
Non-linearity (0 to 1000 W/m²)	<± 0,2 W/m²	<± 1 W/m²	<± 1,2 W/m²
Non-stability (per year)	± 0.5%	±1,5%	± 1,5%
Sensitivity temperature dependence	<± 1%	<± 4%	<± 4%

For more technical information, see also MW9001 catalogue (Meteorological Sensors)

Main features

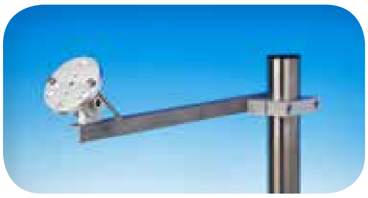
Pyranometers
Incident radiation is the most important climatic parameter for the evaluation of the photovoltaic plant performance. LSI LASTEM provides pyranometers with different classifications:
Secondary Standard, First and Second Class Standard according to ISO9060. The Secondary Standard is the solution featuring the greatest accuracy and is the best choice for evaluations when high measurement precision is requested.
First Class pyranometer is the most widely employed standard for this application. Second Class pyranometer is usually employed in smaller power plants or as peripheral measurement in big installations.

Direct Output Pyranometers
Sensors suitable for connecting to systems capable of reading the sensor sensitivity (µV) and converting it in W/m², as LSI LASTEM acquisition systems.

Analog Output Pyranometers
LSI LASTEM offers a range of pyranometers with integrated analog output (4-20mA) and 9-30 Vdc/ac power supply.

Modbus Output Pyranometers
Models with RS485 (Modbus-RTU) output measure, besides radiation, the sensor body temperature. Class 1 and Class 2 models have also additional input for connecting an external probe (DLE125) for the measurement of the contact temperature of photovoltaic modules.

Cables and accessories
All models (excluding DPA053) have a connector allowing connection to DWA4xx cables (class 1 and class 2 sensors) and DWA2xx cables (Secondary Standard sensors). This is a convenient solution during installation and/or sensor replacement.
LSI LASTEM provides supports for fixing pyranometers to masts or to panel structures. Horizontal plane and tilting mounting brackets are available.



Temperature-based correction
Secondary Standard pyranometers with 4-20 mA and RS485 output have an internal temperature probe and correct the radiation output value based on the temperature measurement.

Diffuse radiation measurement
Shadow band DPA245. This is a simple solution for diffuse radiation measurements, since the band continuously shades the pyranometer's dome from direct radiation. It is made in aluminum and can house any pyranometer belonging to LSI LASTEM range.
The band shades also portion of the sky, that's why a correction factor is provided to be applied to the measurements.

Photovoltaic cells

In addition to pyranometers, LSI LASTEM offers high-quality reference photovoltaic cells.

The table below shows some hints helping in evaluating the use of this technology. Even if they are not suitable for the monitoring of the photovoltaic plant performance, the reference cells can help in evaluating the behavior and conversion efficiency downstream of modules.
The use of both data (cells and pyranometers) can help in better evaluating the efficiency of the modules and their performance reduction over time.

LSI LASTEM cells are available in several technologies (monocrystalline, polycrystalline, amorphous), thus the user can select the most suitable cell to the photovoltaic module technology being adopted. Additionally, the calibration of each sensor is carried out in W/m² with a reference (class A) identical sensor certified by an accredited laboratory. Each sensor is accompanied by a certificate similar to DIN EN 17025.

Pyranometer versus Photovoltaic cell
Which is the best technology for your application? Some hints.
(RC=Reference Cell, P=Pyranometer)

Performance monitoring
RC: measures the radiation available for a cell made of the same material and with the same covering.
P: measures the total radiation available, this is the data necessary to calculate the real "performance ratio".

Measurement campaigns
RC: measurements carried out in different sites are not comparable without a spectral correction.
P: measurements are comparable between different sites and with solar atlases.

Outdoor measurements
RC: originally intended for indoor use, they need corrections for Air Mass, temperature, cell technology and local meteorology (spectral correction).
P: it has been the meteorological standard for over 80 years and can be employed in any condition and without corrections.

Decrease
RC: if the cell stability is not known, it is not suitable for evaluating the performance decrease over time.
P: stability defined by ISO9060, can be calibrated with standard ISO9847.

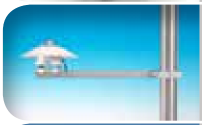
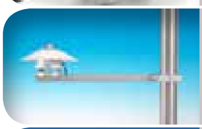
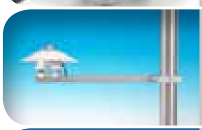
Directional error
RC: the flat covering reflects part of the incident radiation, leading to substantial measurement underestimates.
P: the spherical enclosure allows incident radiation to be transmitted from all directions. Suitable also for installations at different inclination angles.

Costs
The costs of Class 2 pyranometers can be compared to the costs of high-quality reference cells.

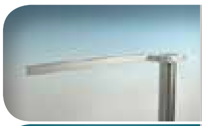
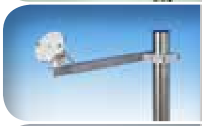
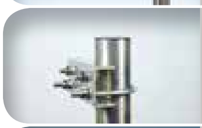
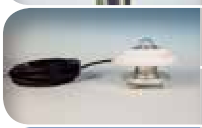
KIT 1.0
Direct Output Pyranometer
µV direct Output Pyranometer and accessories for mast fixing

KIT 1.1
4-20 mA Output Pyranometer
4-20 mA Output Pyranometer and accessories for mast fixing

KIT 1.2
Modbus Output Pyranometer
Pyranometer + air temperature with RS485 Modbus RTU output including contact temperature probe and accessories for mast fixing

	Code	Description	1.0	1.1	1.2
		Pyranometers (direct output signal)		Note 1	
	DPA252	Secondary Standard Pyranometer (ISO9060) L = 10 m cable included	●		
	DPA154	First Class Pyranometer (ISO9060) L = 10 m cable included	●		
	DPA053	Second Class Pyranometer (ISO9060) L = 5 m cable included	●		
		Pyranometers with amplified analog output		Note 1	
	DPA852	Secondary Standard Pyranometer (ISO9060) 4-20 mA output, 5-30 Vdc power supply		●	
	DPA855	First Class Pyranometer (ISO9060) 4-20 mA integrated output, 10-30 Vdc power supply		●	
	DPA863	Second Class Pyranometer (ISO9060) 4-20 mA integrated output, 10-30Vdc power supply		●	
		RS485 Modbus Output Pyranometers		Note 1	
	DPA952	Secondary Standard Pyranometer (ISO9060) RS485 (Modbus) output, 10-30 Vdc power supply			●
	DPA870	First Class Pyranometer (ISO9060) RS485 (Modbus) output, 10-30 Vdc power supply Input available for contact temperature probe DLE125			●
	DPA873	Second Class Pyranometer (ISO9060) RS485 (Modbus) output, 10-30 Vdc power supply Input available for contact temperature probe DLE125			●

continued

	Code	Description	1.0	1.1	1.2
		Cables for pyranometers		Note 2	
	DWA205	L = 5 m cable for pyranometers DPA852-952			
	DWA210	L = 10 m cable for pyranometers DPA852-952			
	DWA225	L = 25 m cable for pyranometers DPA852-952			
	DWA410	L = 10 m cable for pyranometers DPA863-873-855-870-873			
	DWA425	L = 25 m cable for pyranometers DPA863-873-855-870-873			
	DWA426	L = 50 m cable for pyranometers DPA863-873-855-870-873			
	DWA427	L = 100m cable for pyranometers DPA863-873-855-870-873			
		Supports and accessories for pyranometers		Note 2	
	DYA032	Arm for DPA053	Note 3		
	DYA034	Arm for DPA252-154.852-855-863-952-870-873	Note 3	Note 3	Note 3
	DYA035	Tilting arm for DPA252-154.852-855-863-952-870-873 (DPA053 with DYA048)	Note 3	Note 3	Note 3
	DYA049	Collar for DYA032, DYA034 and DYA035 to masts Ø 45÷65 mm	Note 4	Note 4	Note 4
	DYA048	Fixing plate for DPA053 pyranometer to DYA035 arm	Note 5		
	DYA120	Anti-radiation screen for DPA053 Pyranometer	Note 6		
	DLE125	Contact temperature L = 20 m sensor cable with connector for DPA870-873			Note 7

Note 1 Select the model according to requested class.

Note 2 Class 2 (DPA053), Class 1 (DPA152) and Secondary Standard (DPA252) pyranometers include L = 10 m cable. For Secondary Standard pyranometers (DPA852-952) select cable DWA2xx according to the requested length; for Class 2 (DPA863-873) and Class 1 (DPA855-870) pyranometers select cables DWA4xx.

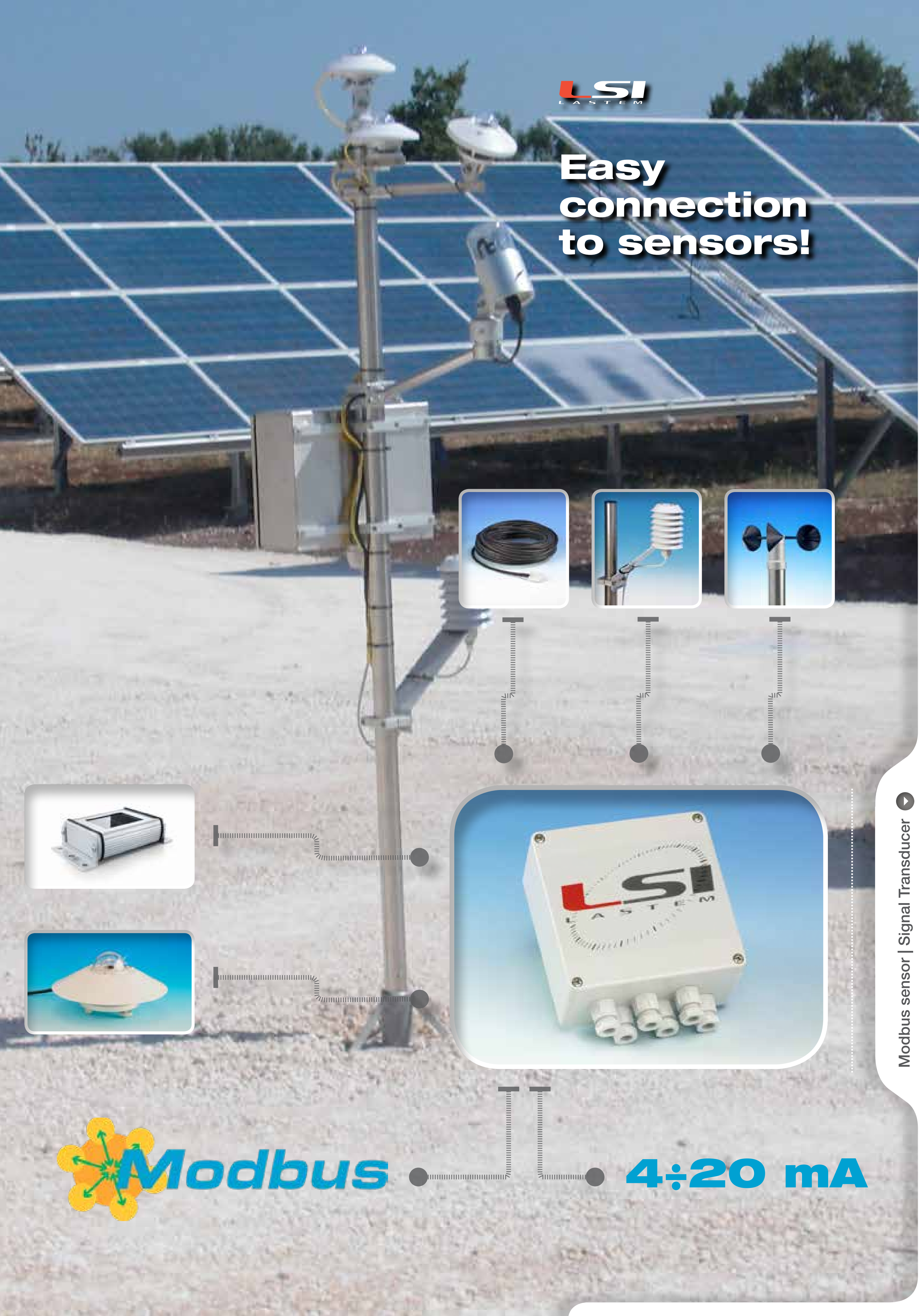
Note 3 Select the support according to the pyranometer model. The tilting arm DYA035 is necessary for the sensor installation with the same tilt angle as photovoltaic modules in order to measure the incident radiation on the module plane.

Note 4 DYA049 collar is required for fixing DYA032-034-035 supports to Ø 45÷65 mm masts.

Note 5 Class 2 pyranometer (DPA053) can be fixed to DYA048 plate for attachment to DYA035 arm.

Note 6 Class 2 pyranometers (DPA053) can be equipped with anti-radiation screen.

Note 7 Pyranometers with Modbus output (DPA870-873) are provided with connection input to DLE125 probe for measuring the contact temperature of photovoltaic modules.


LSI LASTEM
Easy connection to sensors!
Modbus
4÷20 mA

MSB - Modbus Sensor Box
STB – Signal Transducer Box

Highlights

- RS485 (MSB) and 0/4-20 mA (STB) outputs.
- N.4 inputs
- Internal PT100 temperature sensor (can be removed if an external air temperature sensor is used)
- Terminal block for input signals
- Statistical values (min/avg/max, stdev) output from each input with programmable time base
- 9-30 Vdc/ac power supply
- IP65 Protection
- RS232 port: for setup using a terminal (HyperTerminal)
- RS485 port: Modbus RTU® protocol data output with galvanic protection (MSB only)
- Configurable alternative protocols on RS232 port: TTY or CISS (LSI LASTEM proprietary protocol)

MSB and STB modules are the simplest and fastest way to connect environmental sensors to PLC/ SCADA systems, as in solar plants applications, where it is required to interface radiation sensors, each with its own calibration factor, temperature sensors and anemometers to the supervision and monitoring systems of power plants.
MSB module guarantees the benefits of a standard communication protocol well-proven by years of field testing: Modbus RTU®. STB module instead is provided with n.4 0/4-20 mA outputs, typical of industrial standards.
MSB and STB modules can be connected to LSI LASTEM sensors, but the input feature allows the use of practically all types of environmental sensors on the market.
In particular, any pyranometer can be used, since you can set the typical sensitivity value of its thermopile.

Type	Models	N°Input µV, mV, 4÷20 mA	Pt100 (3 threads) Temperature Input Nr	Thermocouple T Temperature Input Nr	Wind speed Frequency Input Nr	Output
MSB	DEA485	1	2	-	1	RS485 Modbus RTU
STB	DEA420.1	1	2	-	1	4 x 0/4÷20 mA
STB	DEA420.2	1	1	1	1	4 x 0/4÷20 mA

Main features

18-bit input for radiation sensors (µV, mV) or 4÷20 mA
High resolution programmable sensor (-300÷1200 mV, ±78 mV, ±39 mV) for pyranometers, photovoltaic cells, sensors with 4÷20 mA output (with 50 Ω resistance drop) or voltage output.

Input for Thermocouple (STB only: DE420.2) sensors
Input for Thermocouple T sensor for temperature measurement. LSI LASTEM does not provide Thermocouple sensors, but this technology is usually less expensive than sensors Pt100.

Frequency input
For connection with anemometers, this parameter help to evaluate any heat dispersion from the photovoltaic module due to the wind as well as any reasons of system safety.

Internal temperature sensor
If an external temperature sensor is not available, MSB and STB modules are equipped with a Pt100 1/3 DIN sensor mounted on its terminal block. This element can be easily removed in case of external sensor. This solution is used for measuring the temperature inside the box, which could be close to air temperature if the box is positioned in a shaded place and thermally isolated with respect to its support.

Statistical values
MSB and STB modules sample the connected sensors and give, as output, calculate statistical values on a custom-defined time basis (1÷3600 sec).

Contact temperature sensors
Pt100 sensors are available for the measurement of contact temperature of photovoltaic modules with 1/3 DIN (0,1°C) accuracy. They are provided with 4-wires L.20 cable. DLE124 models are suitable for connection to MSB and STB modules. DLE125 model is suitable for connection to pyranometers with Modbus output (see chapter Standard ISO9060 Pyranometers). Sensors are easily connected to photovoltaic modules by means of a thermo conductive paste and supporting strip.

Modbus RTU® interface on RS485 line with Galvanic isolation (MSB only)
RS485 interface allows long wiring runs between MSB and PLC/SCADA. RS485 line allows to operate in half-duplex mode and connect several devices on the same line. MSB is provided with EMC certification for industrial environments.

Air temperature sensors

The meteorological sensor DMA033, closed in its anti-radiation screen DYA230, can be connected to MSB and STB modules. The sensor's accuracy is 1/3 DIN (0,1°C) and is equipped with L.10 m cable.

A less expensive alternative is represented by DLE120 sensor;

It needs to be positioned in a shaded location, typically under the photovoltaic panel, since it is not equipped with an anti-radiation screen.

Inputs Pt100 (3 wires)
Resistive inputs for connecting thermo resistances Pt100 sensors.

Terminal Configuration
MSB and STB modules are completely programmable from any remote terminal – no software needs to be installed and it is possible to operate from any platform. They are provided with a RS232 port for configuration and diagnostic tasks.

Screw terminal block for inputs
For easy wiring, MSB and STB modules are equipped with a convenient screw terminal block for each input.

Wind speed sensor

MSB and STB modules can be connected to the meteorological cup sensor DNA202 for wind speed measurement. This sensor is mounted on top of on ø 5 mm poles.

Sales Kit
Modbus Sensor Box | Signal Transducer Box

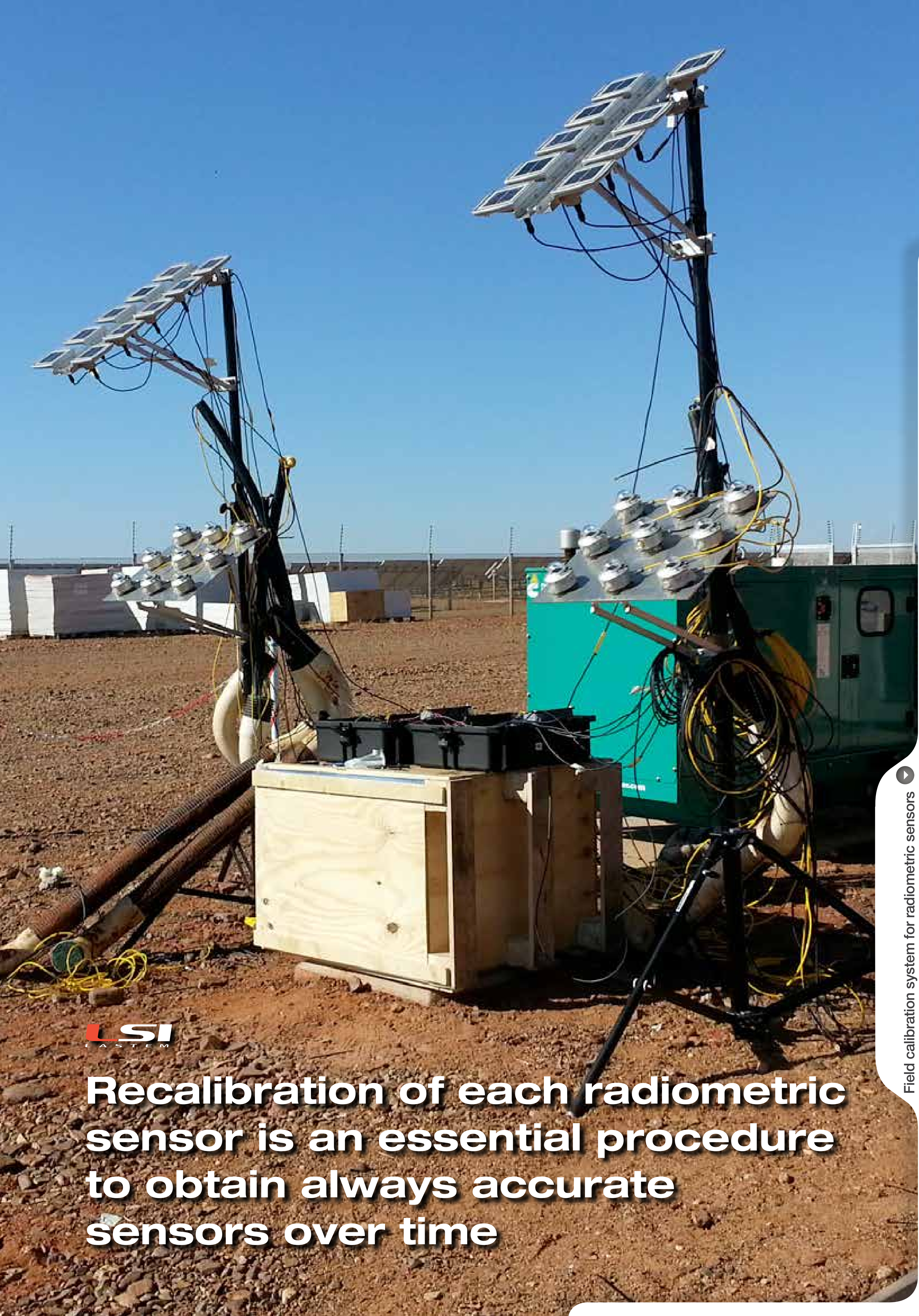
KIT 2.0
Modbus sensor box (alternatives: Signal Transducer box), temperature and wind sensors

- Select pyranometers from kits 1.0 in chapter Standard ISO9060 Pyranometers
- Air temperature sensor (with anti-radiation screen)
- Module surface temperature sensor
- Anemometer

	Code	Description	2.0
		MSB - Modbus sensor box	
	DEA485	RS485 converter with data output Modbus protocol 4 inputs: 2 Pt100 N.1 µV (mV, 4-20 mA) N.1 Hz	●
		STB–Signal transducer box	
	DEA420.1	0/4-20 mA converter. 4 inputs: 2 Pt100, 1 µV (mV, 4-20 mA), 1 Hz	Note 1
	DEA420.2	0/4-20 mA converter. 4 inputs: 1 Pt100, 1 Thermocouple T, 1 µV (mV, 4-20 mA), N.1 Hz	Note 1
		Pyranometer	
	DPAxxx	Select pyranometers from kit 1.0 of “Standard ISO9060 Pyranometers” chapter	
		Pole mount	
	DYA090	Mount bracket DEA485-420.1-420.2 to Ø 50 mm masts	Optional
		Air temperature sensor with anti-radiation screen	
	DMA033	Air temperature sensor Pt100 1/3 DIN. L = 10 m cable free wires	Note 2
	DYA230	Anti-radiation screen for DMA033	●
	DYA049	Collar for fixing DYA230 to Ø 45-65mm mast	Optional
		Temperature sensor without anti-radiation screen	
	DLE120	Pt100 1/3 DIN finned sensor for air temperature measurements L = 10m cable, free wires	Alternative Note 2
		Module surface temperature sensor	
	DLE124	Plate sensor for surface temperature measurements. Free wires. L = 20 m cable	●
		Wind speed sensor	
	DNA202	Wind speed sensor (Hz output)	●
	MN1071	Cable for sensor DNA202 (per meter)	●

Note 1 Select the requested model (MSB or TSB) according to the desired output. For TSB models, select the model according to the surface temperature probe used (Pt100 or Thermocouple). LSI LASTEM doesn’t provide Thermocouple sensors.

Note 2 Alternatives. Select the temperature sensor with or without anti-radiation screen. Models with anti-radiation screen carry out meteorological-quality measurements. Models without anti-radiation screen must be mounted in a location protected against direct sun rays.



Recalibration of each radiometric sensor is an essential procedure to obtain always accurate sensors over time

Field calibration system for radiometric sensors

Highlights

- Full compliance with ISO9847 regulation "Field calibration of pyranometers for comparison to reference pyranometer"
- Portable, autonomous and easy-to-use system
- Allows simultaneous calibration of n.2 to n.12 sensors
- Direct reading of the sensitivity value (calibration factor) obtained
- Can be used also for the calibration of photovoltaic cells
- Template of the calibration report according to ISO9847

Recalibration of each radiometric sensor is an essential procedure to obtain always accurate sensors over time.
The thermopile actually provides a stable value, but after 2-3 years this value may degrade, for this reason a new value needs to be obtained.
LSI LASTEM propose a kit for field calibration of radiation sensors (pyranometers). Field calibration is carried out under direct sun light. The kit includes a reference sensor (Secondary Standard), air temperature probe and data acquisition device (M-Log or E-Log) selected according to the number of sensors to be calibrated (3-6 or 8-16). Additionally, the kit includes a series of accessories for fixing the different parts and for their transportation. The data logger is set to directly calculate the calibration factor for each sensor under calibration: this value is reported in the supplied calibration report template.

Main features

Reference Sensor

The reference sensor consists in a "Secondary Standard" pyranometer, supplied with calibration certificate. It is also suited for the calibration of pyranometers with the same class. The sensor must be yearly recalibrated by an accredited certification body (ISO17025); LSI-LASTEM supplies this kind of service.

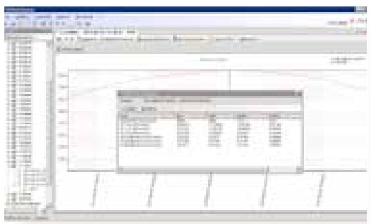
Calibrated Sensors

The calibration kit is used for obtaining the calibration value typical of each thermopile. This factor must be applied to the sensor electrical output in order to obtain an accurate measurement. This factor, usually obtained from the sensor's original certificate, is typically stable over time, but will have to be recalculated every 2-3 years or before if required.

Thermopile-based sensors (class 2, 1 and secondary standard pyranometers) can be calibrated following the ISO9847 procedure LSI LASTEM kit refers to. The same kit can be used for the calibration of photovoltaic cells.
If a data logger M-Log is used, up to n.4 sensors (n.8 with single-ended connection) can be simultaneously calibrated, whereas up to n.8 sensors can be calibrated with a data logger E-Log (n.16 with single-ended connection).

Obtained values

The data logger M-Log (or E-Log) is programmed so as to provide the following parameters:
- Irradiance value of the reference pyranometer (W/m^2)
- mV value generated by the sensor under calibration
- Calibration factor value (mV/W/m^2) of the sensor under calibration.



Thanks to the supplied software, it is possible to select the representative measurement periods and calculate the mean value of the calibration factor.

Report Template
A calibration report template is supplied where the obtained values can be reported. It will be the sensor's new certificate. The new calibration factor value shall be placed to engineering the electric value at the output of the pyranometer.

Procedure
The recommended calibration kit complies with the procedure described in ISO9847 standard "Field calibration of pyranometers for comparison to the reference pyranometer". It required at least three hours with solar irradiation not lower than 600 W/m2 during the central hours of the day and air temperature with gradient not exceeding 10° C during the test. The "tilt" of the reference sensor and of the one under calibration is the same and settable.

Accessories
The calibration kit provides a support plate housing 2 sensors. This plate is fixed to a portable tripod, anchored to the ground with pickets and tie rods. The data logger is mounted into an IP65 portable box, containing also the power supply system and the battery.

Sales Kit

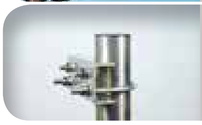
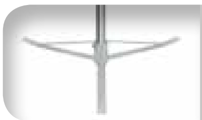
Field calibration system for radiometric sensors

KIT 3.0

Calibration kit for pyranometer

Including:
- Reference Sensor (Secondary Standard Pyranometer ISO9060) with calibration certificate
- Air temperature sensor with anti-radiation screen
- Data Logger/calculator with display and software
- IP65 data logger case including battery and battery charger
- Tiltable support for reference radiometric sensor and sensor under calibration
- Tripod for sensor mounting, anchored to the ground with pickets and tie rods

	Code	Description	3.0
		Data Logger	
	ELO008	M-Log, 5 inputs, 12 Vdc power supply, terminal block for input signals, display, 2 MB memory, 2 RS232 ports. Simultaneous calibration of max n.4 sensors (n.8 with single-ended connection)	●
	ELO305	E-Log, 12 inputs, 12 Vdc power supply, terminal block for input signals, display, 8 MB memory, 2 RS232 ports. Simultaneous calibration of max n.8 sensors (n.16 with single-ended connection)	Optional
		Portable IP65 case for data logger housing	
	ELF432	Portable IP65 case with 15 Ah battery and 220Vca/12Vdc battery power supply charger	●
		Reference Sensor (Secondary Standard Pyranometer ISO9060)	
	DPA252	Secondary Standard Pyranometer (ISO9060) L = 10 m cable including calibration certificate	●
	DYA030	Tilting arm for n.2 sensors: DPA252 and calibrated sensor	●
	DYA049	Collar for DYA030 to BVA308 mast	●

	Code	Description	3.0
		Air temperature sensor with anti-radiation screen	
	DMA033 #CS4	Air temperature sensor Pt100 1/3 DIN. L10 m cable, free wires. ACCREDIA ISO17025 calibration certificate included	●
	DYA230	Anti-radiation screen for DMA033 sensor	●
	DYA049	Collar for DYA030 to BVA308 mast	●
		Portable tripod	
	DYA005	Pole H.1 m	●
	DYA021	Portable tripod	●
	DYA023	Set of n.3 pickets for DYA021	●
		Software	
	BSZ311	GIDAS program for data management, report (tables and charts) of performed measurements	●
		Transport case	
	BWA314	Carrying case	●
	BWA048	Bag for tripod and accessories	●

Direct Normal Irradiance monitoring systems for concentrated solar energy applications

An efficient DNI monitoring system is critical for concentrated solar energy applications both for solar prospecting and for plant operation

Direct solar radiation and sunshine duration sensors

Highlights

- Complete solution for concentrating photovoltaic power plants
- Solutions for direct radiation measurement (DNI – Direct Normal Irradiance) with First Class Pyrheliometer (ISO9060) and high-accuracy automatic solar trackers
- Global Horizontal Irradiance (GHI) and Global Diffuse Irradiance
- Sunshine duration sensors

Concentrating photovoltaic technology uses an advanced optical system to focus a large quantity of sunlight onto part of the photovoltaic cells. The concentrated radiation is converted into heat that operates a thermal motor generating electrical power.
Diffuse radiation, which occurs in cloudy weather conditions, cannot be concentrated; therefore these installations need to be located in areas receiving maximum direct sunlight. For this reason direct normal irradiance (DNI) is a critical data.
An efficient monitoring of DNI radiation is crucial in concentrating systems, both for the site predictive analysis and for the subsequent plant operation. Since this kind of power plants involve significant investments, predictive campaigns are normally required before installation. DNI radiation is measured with a radiometer called pyreliometer, which is a particular thermopile radiometer with a field of vision of 5°. Consequently, the sensor must be constantly centered on the sun's disk for measuring purposes and needs to be mounted on an automatic sun tracker.
LSI-LASTEM catalogue includes a complete range of radiation monitoring solutions for concentrating solar power applications.

For more technical information, see MW9001 catalogue (Meteorological Sensors).

Main features

Class 1 Pyreliometers (ISO9060)

Pyireliometers are offered at affordable prices as well as with a quality complying with 'First Class' classification (ISO9060). A heated window eliminates moisture formation on the sensor, for more accurate measurements in the event of condensation presence.
DPA259 model provides high speed response, making this model the best choice for these applications.

Solutions for the measurement of Global Horizontal Irradiance (GHI) and Diffuse Horizontal Irradiance (DHI).

Our solar trackers can integrate pyranometers and shade systems to complete DNI monitoring with the global and diffuse horizontal irradiance for a complete evaluation of the solar resource. As simpler solution, diffuse radiation can be also obtained using pyranometer with DPA251 shadow band (see ***ISO9060 Standard Pyranometers***)

Automatic solar trackers

A solar tracker is a mobile platform used for pointing the pyreliometer to the sun according to its movement.
This device is completely automatic and doesn't require any computer or software for installation. The integrated GPS receiver allows the system's position and time to be set automatically. Two models are available. The first one (DPA271) houses only the pyreliometer sensor for direct radiation measurement. The second one (DPA271.1) can house, besides the pyreliometer, one (with DPA271.3 arm) or two (with DPA271.4 arm) pyranometers for the measurement of the global or diffuse radiation. In case of diffuse radiation measurement, it must be equipped with a shade ball (DPA271.2).

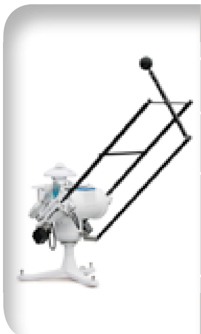
Heliophanometer

Based on non-tracking technology, this sensor measures the sunshine duration, defined by the World Meteorological Organization (WMO, 1981) as the time, usually expressed in hours, during which the direct solar radiation exceeds the level of 120 W/m²
The sensor is placed on a small rotating disc intercepting the global solar radiation. If the radiation sensor measures a difference between the two measurement moments, which exceeds 120 W/m², it means that the direct radiation exceeds 120 W/m2. The sensor provides two measurements: direct radiation (4-20 mA output) and on/off signal of the sunshine status. It represents a simpler low-cost alternative for the measurement of direct solar radiation.

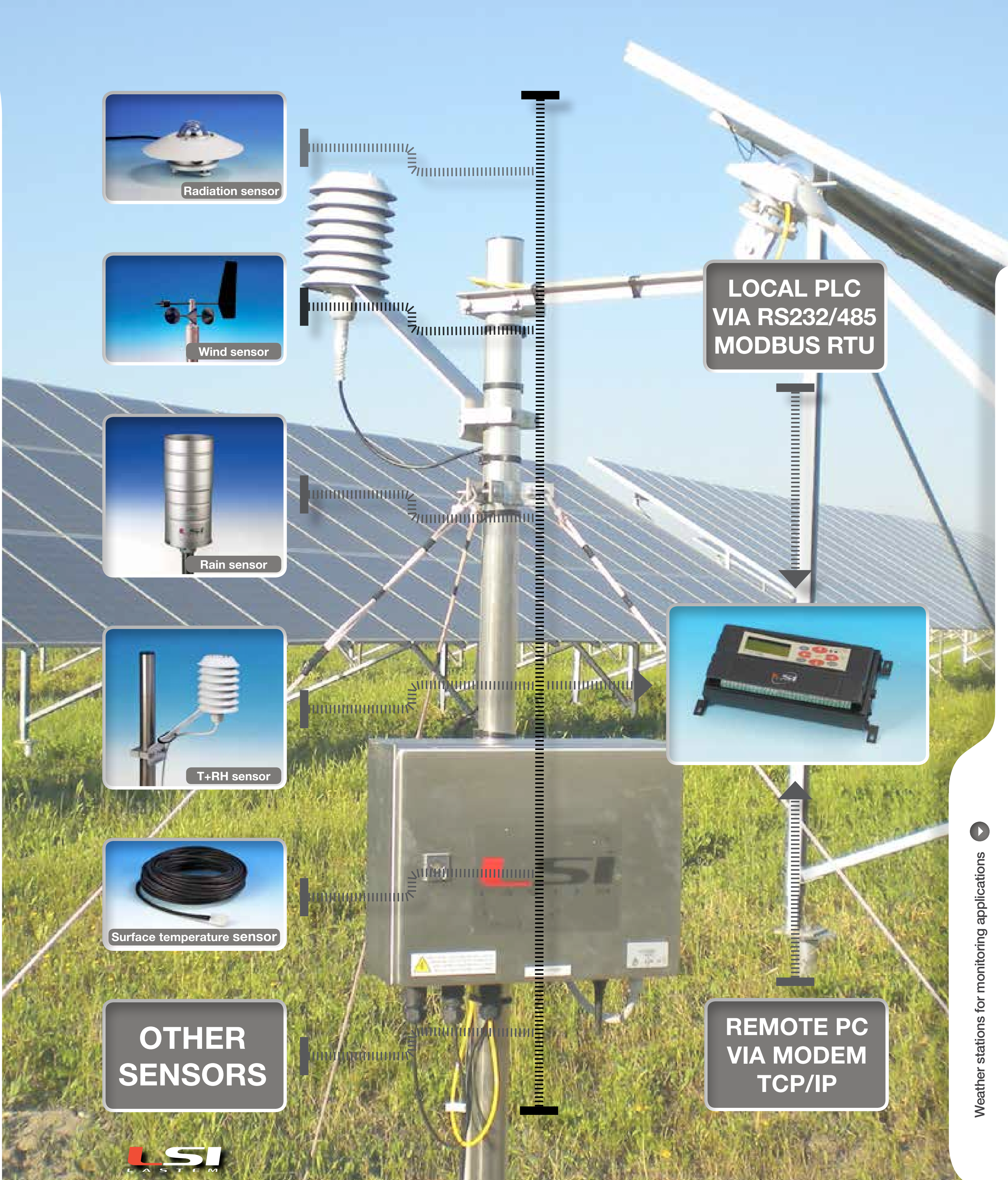
KIT 4.0
Basic Kit for the measurement of DNI radiation
- First Class Pyrheliometer
- Automatic Sun Tracker

KIT 4.1
System for the measurement of Direct, Diffuse and Global Radiations
- First Class Pyrheliometer
- 2 First Class Pyranometers
- Automatic Solar Tracker with shade system

KIT 4.2
Sensor for the measurement of sunshine duration
Sensor and accessories

	Code	Description	4.0	4.1	4.2
		Global Radiation (Pyranometer)	Note 1	Note 1	
	DPAxxx	Select pyranometers from kit 1.0 in chapter "Standard ISO9060 Pyranometers"			
		Incident Normal Radiation (Pyreliometer)			
	DPA257	First class ISO9060 Pyreliometer L = 10 m cable	Note 2	Note 2	
	DPA259	First class ISO9060 Pyreliometer, fast response L = 10 m cable	Note 2	Note 2	
		Solar tracker			
	DPA271	Solar tracker with Pyreliometer connection Pre-set for the installation of pyranometers	●		
	DPA271.1	Solar tracker with Pyreliometer connection Pre-set for the installation of pyranometers		●	
	DPA271.2	Shade system for the measurement of diffuse radiation It must be associated to DPA271.3 or DPA271.4		● Note 3	
	DPA271.3	Narrow arm for 1 Pyranometer (diffuse or global radiation) Compatible with DPA271.1 To be associated to DPA271.2 for diffuse radiation measurement		● Note 4	
	DPA271.4	Large arm for 2 pyranometer (diffuse or global radiation)		● Note 5	
		Sunshine duration sensor			
	DPD504	Sunshine duration sensor 0÷300 mV ouput 12 Vdc power supply			●
	DYA041	Mounting arm DPD504			●
	DYA049	Clamping collar for DYA041 to Ø 45÷65 mm masts			●
	DWA510	L = 10 m cable			●

Note 1 Select the model according to the requested accuracy. The number of pyranometers depends on the measurement requirements: 1 pyranometer in case of diffuse radiation only. 2 pyranometers if diffuse+global radiation measurement is needed.
Note 2 Alternatives. For CPV applications, high-speed response DPA259 (1 sec) is highly recommended. For all other applications, DPA257 is sufficient.
Note 3 The shade system is necessary for the diffuse radiation measurement in association with a pyranometer.
Note 4 When only diffuse or only global radiation measurement is required, only one pyranometer and DPA271.1 shade system are required.
Note 5 When diffuse and global radiations are required. In this case, two pyranometers are selected and DPA251.4 is required, besides the DPA271.1 shade system.



Weather stations for site's meteorological assessment or for performance analysis of the operating plant

Weather stations for monitoring applications in solar and photovoltaic power plants

Highlights

- Data loggers with Modbus RTU output for easy interface with the plant supervisory system.
- Complete range of meteorological sensors
- GSM/GPRS modem connection to remote supervisor for data storage and analysis.
- Inputs for pyranometers, air and module surface temperature sensors. Possibility to connect other sensors for complete climate monitoring: anemometer, rain gauge, thermo-hygrometer, barometer, etc.
- Acquisition rate from 1 sec to 12 h
- Processing data base from 1 sec to 12 h
- Connection to a PC via RS232/radio/modem PSTN/GSM/GPRS/Ethernet
- Local display and keyboard
- Compatibility with CommNET, GIDAS and LSI LASTEM XPanel software
- Real-time data publication and report on WEB pages

LSI LASTEM experience is historically based on meteorological measurement instrumentation. For this reason, our products are not limited to sensors and components for solar power applications, but to all those components which, as a whole, create complete weather stations for professional use, allowing extended data logging capabilities.
This section describes weather stations designed for the site's meteorological assessment or for performance analysis of the operating plant. Our acquisition systems can be connected to a series of meteorological sensors, measurements are processed, stored and made available for two simultaneous uses: 1) connect to a local or remote PC (by means of communication devices) for analyzing and managing historical series of measured data, 2) send the instant readings to the plant control system through Modbus RTU protocol via RS485.

For more technical information, see also MW9005 (Data Loggers), MW9000 (Meteorological sensors), MW9006 (Software) and MW9007 (poles and towers) catalogues.

Main features

Inputs
Models with 4/8 analog inputs (voltage, current and resistance), 1/4 inputs (programmable as frequency or on/off signals).

Data storage
8MB circular memory for storing statistical values on a programmable basis from 1 sec to 12 hours:
- instant values
- statistical values: mean, maximum, minimum, standard deviation
- total and integral values
- Wind elaborations: prevailing/resultant wind direction/ standard deviation (sigmatheta), calm wind percentage.

Memory has a circular structure.

Direct connection with local PC
Connection through the following interfaces:
- USB, with adapter
- RS485 for distances up to 1 km, (DEA504-504.1 converters)
- Ethernet (DEA550 unit)

Connection to remote PC
Connection through the following interfaces:
- GSM Modem
- GPRS Modem
- UHF Radio for long distances

CommNetEG program allows the management of automatic calls from local or remote PC at programmed hours.

Installation

The data logger is normally mounted into IP65 protection boxes (ELF series) against atmospheric agents. The box houses as well a power supply system, communication systems and, if any, back-up batteries and barometric sensor.

Outputs activated with programmable events
Digital outputs to on/off external devices or alarm systems. The outputs are activated with user-programmable logic.

Batteries
Batteries (2-15-40 Ah) are normally included in the ELF boxes. They are charged by the electric power system or by a solar panel.

Output data protocols
COM1 port:
- LSI LASTEM native (CISS)

COM2 port:
- LSI LASTEM native reduced (CISS)
- TTY: instant values (spontaneous output or on external request);
- Modbus RTU: instant, static values, and diagnostic information

Data transmission in ASCII format with GPRS and TCP/IP protocol
The data logger can spontaneously transmit the data in ASCII format with programmable timing through GPRS modem and FTP protocol or through a TCP/IP converter (on LAN or WAN) to a FTP area

Sales Kit

Weather stations for monitoring applications in solar and photovoltaic power plants

KIT 5.0
Basic weather station for photovoltaic applications
Complete station with data logger mounted into IP65 box, 220 Vca power supply, connection to PLC/SCADA (Modbus RTU via RS485) and/or with remote PC by GPRS connection. - Includes the following sensors:
- Inclined or horizontal pyranometer
- Air temperature sensor
- PV module surface temperature sensor
- Wind speed sensor (option)

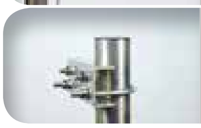
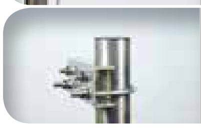
Includes H2 m mast for mounting sensors and data logger.

KIT 5.1
Complete weather station for photovoltaic applications with double radiation measurement: horizontal and on the axis of PV modules
Complete weather station with data logger mounted into IP65 box, 220 Vca power supply, connection to PLC/SCADA (Modbus RTU via RS485) and/or with remote PC by GPRS connection. Includes the following sensors:
- N. 2 inclined and horizontal pyranometers
- Temperature and air relative humidity sensor
- PV module surface temperature sensor
- Wind speed and direction sensor
- Rain gauge
- Barometer (option)

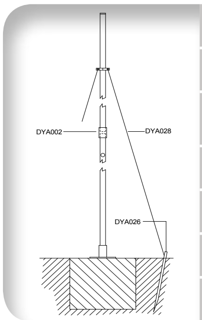
Includes H2 m mast for mounting sensors and data logger.

	Code	Description	5.0	5.1
		Data Logger		
	ELO305	E-Log, 12 inputs, 12 Vdc power supply, terminal block for input signals, display, 2 MB memory, 2 RS232 ports	●	●
	ELF340	Box 30x40 cm. Includes rechargeable battery (2 Ah), power supply device (220/24-12 Vac/Vdc, 50 W)	●	●
	DYA074	Mast mounting bracket to ELF222 box	●	●
		RS232-RS485 converter		
	DEA504	RS232-485 converter	●	●

continued

	Code	Description	5.0	5.1
		GSM/GPRS Modem		
	**DEA718.1**	"Dual band" GSM-GPRS/data modem with antenna	●	●
	ELA110.1	Cable connection to E-Log-DEA718	●	●
		Global Radiation (Pyranometer)	Note 1	
	**DPAxxx**	Select pyranometers from kit 1.0 in chapter “Standard ISO9060 Pyranometers”	●	●
		Air temperature sensor with anti-radiation screen		
	**DMA033**	Air temperature sensor Pt100 1/3 DIN L = 10 m cable, free wires	●	
	DYA230	Anti-radiation screen for DMA033 sensor	●	
	**DYA049**	Collar for DYA230 to Ø 45÷65 mm masts	●	
		Air temperature/RH% sensor with anti-radiation screen		
	**DMA672.1**	Thermohygrometric Sensor L = 3 m cable		●
	DYA230	Anti-radiation screen for DMA033 sensor		●
	**DYA049**	Collar for DYA230 to Ø 45÷65 mm masts		●
		Module surface temperature sensor		
	**DLE124**	Plate sensor for surface temperature measurements	●	●
		Wind speed sensor	Optional	
	**DNA202**	Wind speed sensor, Hz output		
	MN1071	Cable for DNA202 (per meter)		
	DYA345	Support for anemometer mounting on DYA340 mast		
		Wind direction and speed sensor		
	**DNA121#C**	Combined wind speed+direction sensor Includes rotor and vane and calibration certificate		●
	DWA505	L = 5 m cable		●

continued

	Code	Description	5.0	5.1
		Rain gauge		
	DQA130.1#C	Rain gauge Calibration certificate included		●
	DWA510	L = 10 m cable		●
	DYA040	Support for rain gauge on ø 50 mm pole		●
	DYA058	Lateral support for DYA040		●
		Barometer		Optional
	DQA240.1#C	Barometer 800÷1100 hPa Calibration Certificate included		
		Mast Ø 5 cm for sensor and data logger box fixing		
	DYA006.1	H = 2m Ø 50 mm mast	●	●
	DYA020	Mast base for cement plinth fixing	●	●
	DYA020.1	Set of n. 3 anchoring bolts Ø 12mm for fixing tripods DYA020 on cement plinths	●	●
	DYA028	Set of n. 3 tie rods and collar for meteo mast	●	●
	DYA026	Set of n. 3 pickets for DYA028	●	●
	DYA340	Portable telescopic tripod, H = 1.5÷4m		
	DYA043	Pickets for DYA340 tripod		
		Software	Note 2	Note 2
	BSZ311	GIDAS program for the management of data, report (tables and charts) of the performed measurements	●	●
	BSZ306.2	CommNET program for automatic calls to the station for data download	●	●
	BSZ411	X-Panel program for real-time display of the measured data on a configurable panel	●	●

Note 1 Tilting arm DYA035. Necessary for installation of the Pyranometer with the same inclination as the photovoltaic modules with the purpose of measuring the incident radiation on the module plane.

Note 2 The data logger is supplied with 3DOM program for its configuration and data download in ASCII format. Other packages are available for obtaining automatic communications (CommNET), managing downloaded data (GIDAS) or displaying instant values in dynamic format (see catalogue MW9006 Software).

Reference List

Some of the customers who choose our systems:

Institutional Customers
-**ENEL GREEN POWER SPA** – Rome, Italy
Complete system for PV parks
-**ENI SPA** – Rome, Italy
Solar tracking system
-**CESI SPA** – Milan, Italy
Portable monitoring systems
-**TERNA SPA** – Florence, Italy
Portable monitoring systems
-**RSE SPA** – Milan, Italy
P.A.C. testing systems

EPC Contractors
-**GDF SUEZ** – Paris, France
Complete system for PV parks
-**IBERDROLA S.A.** – Madrid, Spain
Complete system for PV parks
-**SIEMENS SPA** – Milan, Italy
Complete system for PV parks
-**ABB SPA** – Genova, Italy
Complete system for PV parks
-**ANSALDO T&D** – Genova, Italy
Meteorological sensors for PV monitoring system
-**CARLO GAVAZZI IMPIANTI SPA** – Milan, Italy
Meteorological sensors for PV monitoring system
-**SOLON SPA** – Vicenza, Italy
Meteorological sensors for PV monitoring system
-**GASCOM RENEW SPA** – Padova, Italy
Meteorological sensors for PV monitoring system
-**BUILDING ENERGY SPA** – Milan, Italy
Complete system for PV parks
-**SUN SYSTEM SPA** – Milan, Italy
Meteorological sensors for PV monitoring system
-**JUWI ENERGIE RINNOVABILI SRL** – Verona, Italy Meteorological sensors for photovoltaic applications
-**CONERGY ITALIA SPA** – Vicenza, Italy
Meteorological sensors for photovoltaic applications
-**RAVANO GREENPOWER SRL** – Genova, Italy
Portable monitoring systems
-**UNENDO ENERGIA SPA** – Milan, Italy
Complete system for PV parks
-**SAEM ENERGIE ALTERNATIVE SRL** – Altamura, Italy
Pyranometers for PV monitoring system
-**ESPE SRL** – Padova, Italy
Meteorological sensors for PV monitoring system
-**PLC SERVICE** – Napoli, Italy
Kit for outdoor pyranometer calibration (ISO9847)
-**LAPLACE SYSTEMS Co.**, Ltd., Japan
Modbus sensor box
-**AXIS ENGINEERING Co.**, Ltd, Japan
Modbus sensor box
-**ENERGY SOLUTIONS Inc**, Japan
Modbus sensor box

INVERTER'S MANUFACTURERS
-**ELETTRONICA SANTERNO SPA** – Imola, Italy
Complete system for PV park
-**SIEL SPA** – Milan, Italy
Complete system for PV parks
-**FIMER SPA** – Vimercate, Italy
Complete system for PV parks

B.O.S. AND TESTING EQUIPMENT

-**GREEN POWER MONITOR S.L** – Barcellona, Spain
Meteorological sensors for photovoltaic applications
-**BARLOVENTO RECURSO NATURALES** – Logroño, Spain
Meteorological sensors for photovoltaic applications
-**AMMONIT MEASUREMENT GmbH** – Berlin, Germany
Meteorological sensors for photovoltaic applications
-**ASITA SRL** – Milano, Italy
Meteorological sensors for photovoltaic applications
-**AVANSERVICE SRL** – Torino, Italy
Meteorological sensors for photovoltaic applications
-**AMRA SPA** – Milano, Italy
Portable monitoring system
-**FLYBY SRL** – Livorno, Italy
Meteorological sensors for photovoltaic applications
-**SAMARES SRL** – Milano, Italy
Meteorological sensors for photovoltaic applications
-**SAEM SRL** – Altamura, Italy
Meteorological sensors for photovoltaic applications

CONCENTRATED SOLAR ENERGY

-**ENEL RICERCA E INNOVAZIONE SRL**
Rome, Italy
Solar tracking systems
-**AEST Srl** – Gorizia, Italy
DNI Monitoring equipment
-**DELTA GROUP** – Ravenna, Italy
DNI Monitoring equipment

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