



SOLAR ENERGY

Monitoring equipment

- **Meteorological station for PV application**
- **Field system for PV Performance Ratio application**

For an operating Photovoltaic Plant, the main exogenous limitation to optimal performance is represented by the environmental conditions and by soiling presence on the PV module surfaces. The main environmental parameters as solar radiation, the basic feedstock of the system, and temperatures, influence performances of the plant, and less-heralded factors such as wind speed, wind direction, rainfall, concur to generate the environmental conditions determining the potential expected plant yield against which actual plant performances are measured. For this reason monitoring of the environmental characteristics of the site and, on the other hand, of the PV module itself, can give parameters to calculate the efficiency of the power plant. The key variables to be monitored are: global irradiance, air temperature and module temperature, diffuse irradiance. Also wind speed, wind direction, rain and storm distance are key factors in the field of risk prevention during extreme events.

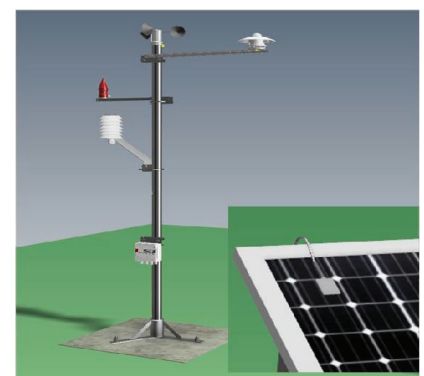
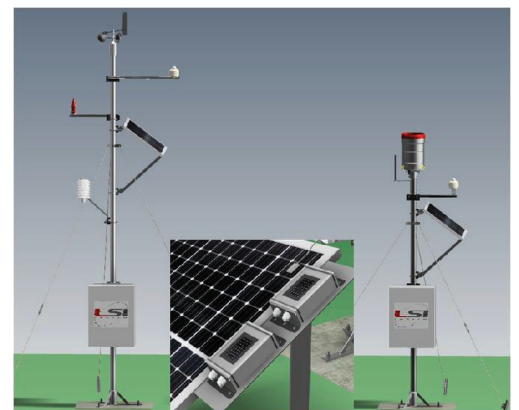


► Meteorological station for PV application

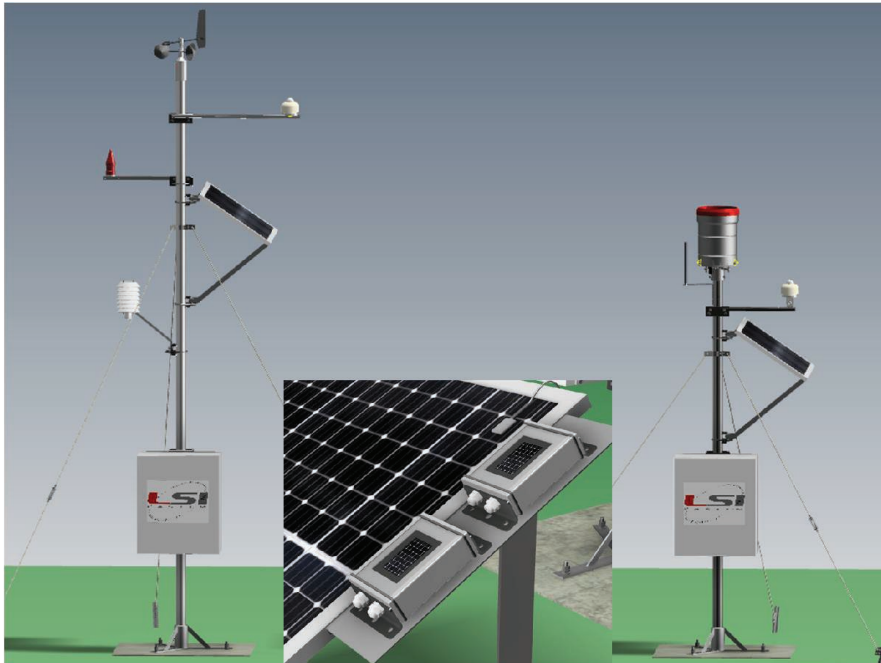
A meteorological station designed for environmental monitoring in PV plants. Sensors for Performance Ratio calculation (Pyranometer, Air Temperature, PV module Surface Temperature) are accompanied by a Diffuse Irradiance, Wind Speed and Wind Direction Sensor or a Storm Distance Sensor and a Rain gauge for rainfall. System for soiling monitor can be integrated.

► Field system for PV Performance Ratio application

Modbus Sensor Box module is the simplest and fastest way to connect environmental sensors to PLC/SCADA systems by Modbus RTU. The module can be easily interfaced to Global Irradiance sensors, each with its own sensitivity value, temperature sensors (Air and PV module surface), wind speed and storm front distance sensors.



Meteorological station for PV application



- ▶ Sensors for the calculation of PV plant
- ▶ Meteorological parameters monitoring with several available sensors
- ▶ Data storing for further analysis
- ▶ Risk protection during extreme events thanks to wind speed and direction sensors and storm distance sensor
- ▶ Modbus RTU or Modbus TCP for connection to PLC/SCADA system
- ▶ Connection by Modem to remote servers
- ▶ Configurable thresholds to generate alarms through SMS, E-mails or activation of local devices with electrical outputs

A meteorological station designed for environmental monitoring in PV plants. Sensors for Performance Ratio calculation (Pyranometer, Air Temperature, PV module Surface Temperature) are accompanied by a Diffuse Irradiance, Wind Speed and Wind Direction Sensor or a Storm Distance Sensor and a Rain gauge for rainfall. Global Irradiance is the most important climatic parameter for the evaluation of the photovoltaic plant performance and in this regard, LSI Lastem provides pyranometers with different classifications: Spectrally Flat Class A, B and C according to ISO9060:2018 standard (see the Table below and also MW9000-ENG-11 catalogue). State of the art ventilated and heated Spectrally Flat class A pyranometers are also available. System for soiling monitor can be integrated. This station is normally connected by Modbus RTU or Modbus TCP to the plant SCADA system, but at the same time it can store the measurements and send them to one or several remote servers, produce alarms by SMS, Email and trigger, using electrical output, local devices in case of particular events.

PN Models with direct output	DPA252	DPA154	DPA053
PN Models amplified 4÷20mA version	DPA952	DPA855	DPA863
PN Models with Modbus output	DPA953	DPA980	DPA983
ISO9060 Classification	Spectrally flat Class A	Spectrally flat Class B	Spectrally flat Class C
Daily total uncertainty	±2%	±5%	±10%
Spectral range	285÷3000 nm	285÷3000 nm	285÷3000 nm
Output (sensitivity)	7÷25 µV/W/m ²	10÷15 µV/W/m ²	10÷15 µV/W/m ²
Response time (95%)	4,5 s (3 s only DPA953)	20 s	16 s
Zero-offset due to temperature varia-	±2 W/m ²	±3 W/m ²	±4 W/m ²
Directional response	<±10 W/m ²	<±20 W/m ²	<±20 W/m ²
Non-linearity	<±0,2% (100÷1000 W/	<±1%(100÷1000 W/m ²)	<±1,2%(100÷1000 W/m ²)
Stability (% change/year)	<±0,5%	<±1%	<±1,5%
Temperature response	<±0,4% (-30÷50°C)	<±4% (-10÷40°C)	<±4% (-10÷40°C)



▶ **Contact Temperature sensor**

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 m cable. Sensors are easily connected to photovoltaic modules by means of a thermo conductive paste and supporting strip.



▶ **Air Temperature sensor**

Meteorological air temperature sensor protected by antiradiation screen from the direct radiation. The sensor's accuracy is 1/3 DIN (0,1°C) for temperature. It is equipped with 4-wires cable. Temperature and Relative Humidity (%) sensor is also available.



▶ **Wind Speed and Direction sensor**

Wind affects the natural cooling of the PV modules. Wind monitoring is also important because significant wind load can reduce the module stability mainly in case of solar concentrator or adjustable solar panel systems.



▶ **Storm Front Distance sensor**

Since PV plants are sensible to lightning activity, this sensor can help reducing the risk detecting the storm front distance within an area of in 5÷40 km range. Utilizing a sensitive RF receiver and integrated proprietary algorithm, detects the electrical emissions.



▶ **Rain gauge**

When it is raining there is clouds coverage reducing the system production. But rain washes away dirt and debris, essentially giving good cleaning to the panels. Rain can also effect the overall stability of the PV brackets when fixed directly on the soil.



▶ **Soiling monitoring**

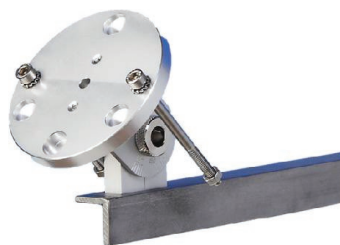
To monitor the soiling on the PV module, two reference cells are placed besides the module. One of them is kept clean, while the second is left in the natural condition, the difference between the modules performance is an index of the soiling of the module.



▶ **Diffuse Radiation**

Obtained through 4 different ways:

- PRRDA3960 sensor for diffuse radiation
- Pyranometer and shadow band
- Pyrhelimeter on a sun tracker with the shading ball
- Calculated by Alpha Log data logger knowing the global and direct radiation and the sun elevation



▶ **Pyranometer inclination**

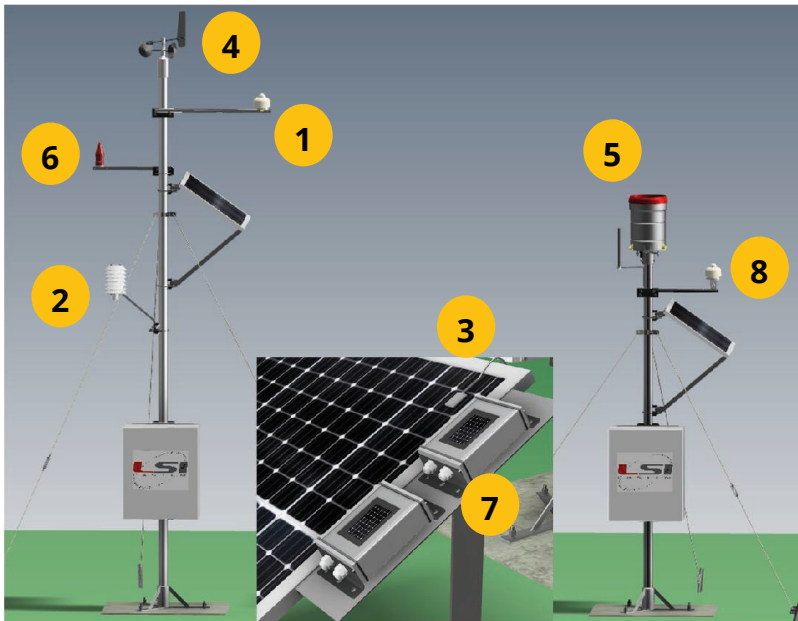
Pyranometers can be mounted on a horizontal arm to measure the Global Horizontal Irradiance (GHI) or on a tilted arm to measured the Tilted Global Irradiance (POA). Tilting arms are available also for two pyranometers in the same location (redundancy).



▶ **ALL-IN-ONE**

If a compact solution is needed, All-In_one sensors are extremely compact and allow to monitor several environmental parameters at the same time: temperature, humidity, pressure, wind direction and wind speed (optional models with optic rain sensor or global radiometer).

► Meteorological Station Kit



The meteorological modular station for PV plants can be designed with two boxes and two poles. The first pole supports the datalogger and some sensors (Pyranometer, Temperature sensor, storm distance sensor), while on the second pole, the ALIEM module is connected to a rain gauge, a diffuse radiation sensor, a surface temperature sensor and to the reference cells for soiling monitoring. Other meteorological sensors are available and can be added. If a compact solution is needed, the ALL-IN-ONE sensor can be the choice.

NOTES	
A	Cable length is function of poles distance
B	If a remote data management is needed

Drw. Ref.	PN	Description	Kit1	Ref. Notes
		A-Log data Logger		
	DLALA0100	Alpha-Log/400MB/n.2 RS232/n.1 RS485/n.2 USB/n.1 Ethernet	1	
	MDMMA1110	Alpha-Log/Inputs extension/N.8 Analog.+4 Digitals/RS232-Modbus	2	
		RS485 converter		
	DEA504	RS232->485 converter/DIN bar	1	
	MN1510	Cable/Lan 4X2Xawg24/I-S/Ftp-Cmx Cat5-Sch	1	A
		Modem	Optional	B
	DEA718.2	Modem/3G/Antenna+Cable/12V	1	
	DEA611	External antenna 2DB/5 m cable/support	1	
		Software		B
	BSZ309	SW PluviONE CommNET	1	
	BSZ311	SW Gidas-Viewer	1	
		IP66 enclosure		
	ELF340	Box IP66/50x40x16cm/230V->13,8V/50W/batt.2Ah	2	
	DYA074	Arm/ELFxxx/to D=45÷65mm.pole	2	
		Solar panel 60 W	Optional	
	DYA101	Solar pannel/60W/cable L=5m	2	
	DYA064	Arm/Solar panel/to D=45÷65mm pole	2	
1		Pyranometers (options Spectrally Flat Class A, B, C)		
		Spectrally Flat Class A		
	DPA252	Sensor/Pyranometer/Secondary Standard/μV	1	
	DWA205	Cable/L=5m/DPA252-952	1	
		Spectrally Flat Class B	Altern. to Class A	
	DPA154	Sensor/Pyranometer/First Class/μV/Cable L=10 m	1	
		Mounting Accessories for DPA154 and DPA252 Horizontal		
	DYA034	Arm/DPA154-855-870-863-873-252-952-817- 822/Horiz./to DYA049	1	
	DYA049	Collar/for sensor arm to D=45÷65mm pole	1	

Drw. Ref.	PN	Description	Kit1	Ref. Notes
		Mounting Accessories for DPA154 and DPA252 Tilt	Altern. To Horizontal Arm	
	DYA035	Arm/DPA154-855-870-863-873-252-952-817- 822/Tilt/to DYA049	1	
	DYA049	Collar/for sensor arm to D=45÷65mm pole	1	
		Spectrally Flat Class C	Altern. to Class A, B	
	DPA053	Sensor/Pyranometer/Second Class/μV/Cable L=5 m	1	
		Mounting accessories for DPA053 Horizontal		
	DYA032	Arm/DPA053-008, ESR003, DQA601, DMA131/ to DYA049	1	
	DYA049	Collar/for sensor arm to D=45÷65mm pole	1	
		Mounting accessories for DPA053 Tilt	Altern. To Horizontal Arm	
	DYA048	Arm/DPA053/to DYA035	1	
	DYA035	Arm/DPA154-855-870-863-873-252-952-817- 822/Tilt/to DYA049	1	
	DYA049	Collar/for sensor arm to D=45÷65mm pole	1	
2		Air temperature sensor		
	DMA033	Sensor/Air Temp/Pt100/Cable L.5 m	1	
	DYA230	Radiant screen/NV/DMA67x-033	1	
	DYA049	Collar/for sensor arm to D=45÷65mm pole	1	
3		Contact temperature sensor		
	DLE124	Sensor/Surface Temp/Pt100/Cable L.20 m	1	
		Wind speed sensor - Compact version (Hz output)	Optional	
	DNA202.1	Sensor/Cup-anem.-Compact/WS/Hz/7pin	1	
	DWA505	Cable/L=5m/sensors	1	
4		Wind speed&direction	Altern. To Wind Speed Sensor	
	DNA121	Sensor/cup&vane anem./WS+WD/Hz+0÷1V/ 10÷30V	1	
	DWA505	Cable/L=5m/sensors	1	
5		Rain gauge (Tipping bucket)	Optional	
	DQA230.1	Sensor/Rain gauge/324cmq/Siphone/Hz	1	
	DYA040.2	Arm/DQA230-231/to D=50mm.pole	1	
	DYA058	Lateral arm/D=50 mm.sensors/to D=45÷65mm. pole	1	
	DWA505	Cable/L=5m/sensors	1	
6		Storm Front distance sensor	Optional	
	DQA601.3	Sensor/Front distance/UART-TTL/5÷24V	1	
	DYA032	Arm/DPA053-008, ESR003, DQA601, DMA131/ to DYA049	1	
	DYA049	Collar/for sensor arm to D=45÷65mm pole	1	

Drw. Ref.	PN	Description	Kit1	Ref. Notes
7		Reference Cell	Optional	
	DPA048.1	Sensor/ISET radiom.cell/monicristalline/Cable L=3 m/Calib.	2	
	DPA048.2	Sensore/ISET radiom.cell/policristalline/Cable L=3 m/Calib.	Altern. To DPA048.1	
	DPA048.3	Sensor/ISET radiom.cell/amorfo/Cable L=3 m/Calib.	Altern. To DPA048.1	
8		Diffuse Radiation Sensor	Optional	
	PRRDA3960	Diffuse radiation sensor, analog output	1	
	MAARA1001	Horizontal arm for PRRDA3960 sensor fixing, l=1 m	1	
	CCDTA0101	RS232 extension cable for sensor PRRDA3960, length 10 m	1	
		Pole H.3 m		
	DYA010.1	Pole/H=3m/D=50mm	2	
	DYA020	Tripod/concrete installation/pole D= 50 mm	2	
	DYA020.1	Anchoring bolts for tripod/3 set	2	
	DYA028	Tie rods/H=2-3m	2	

Field system for PV Performance Ratio application



- ▶ Sensors kit for Performance Ratio calculation
- ▶ N.1 high-resolution input (18 bit) for Pyranometer (μV , mV) or 0÷1V. Configurable pyranometer sensitivity value
- ▶ N.2 Pt100 inputs (3-wire) with 0,5°C accuracy
- ▶ N.1 included internal Pt100 temperature sensor as alternative to external sensor. Thermistor input also available (DEA420.2 with 4÷20mA output)
- ▶ N.1 pulse/frequency input for LSI LASTEM wind speed sensors (DNA202-30x)
- ▶ N.1 RS232 input for Storm Distance Sensor (DQA601.1)
- ▶ RS485 (2-wire) Modbus RTU® port with galvanic insulation
- ▶ Model with 4÷20mA available (DEA420.1 with Pt100 input, DEA420.2 with thermistor input)

Modbus Sensor Box module is the simplest and fastest way to connect environmental sensors to PLC/SCADA systems by Modbus RTU. The module can be easily interfaced to Global Irradiance sensors, each with its own sensitivity value, temperature sensors (air and PV module surface), anemometers or a front distance sensor. Modbus Sensor Box module guarantees the benefits of a standard communication protocol well-proven by years of field testing: Modbus RTU®. MSB module 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.

DNA202.1—Wind Speed	
Type	Relay Reed
Range	0÷75 m/s
Accuracy	2,5%

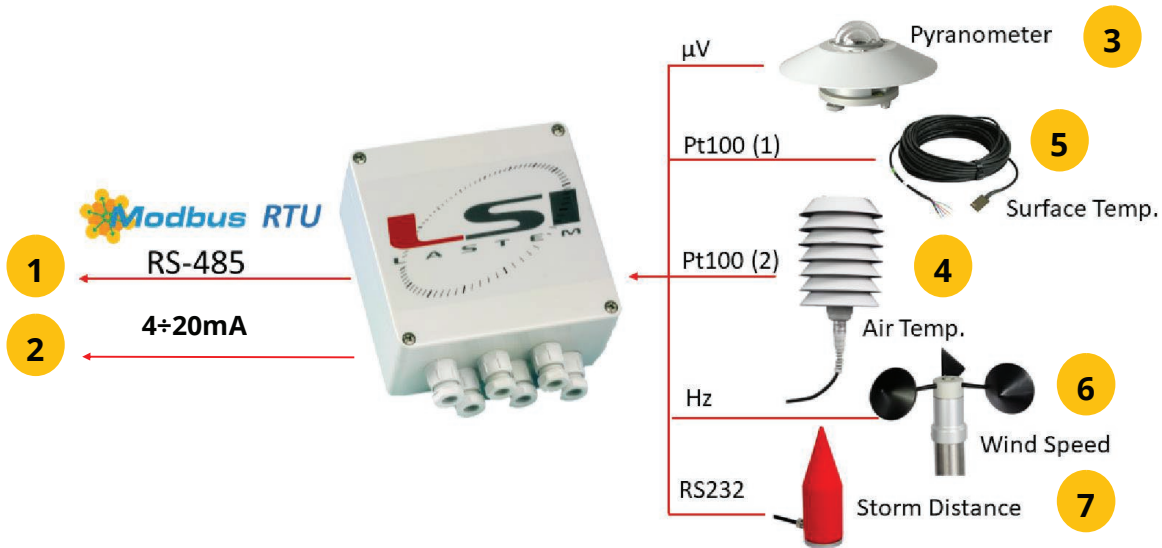
DQA601.3—Storm Distance	
Type	Sensitive RF receiver
Range	5÷40 km
Resolution	14 steps (5, 6, 8, 10, 12, 14, 17, 20, 24, 27, 31, 34, 37, 40 km)
Cable	L=5 m

DMA033—Air Temperature	
Type (Temp.)	C-MOS (Silicon)
Range (Temp.)	-20÷80°C
Accuracy (Temp.)	0,1°C (@0°C)

Pyranometer	
See Table at pag.3 (only with μV output)	

DLE124—Surface Temperature	
Type	Pt100
Range	-50÷70°C
Accuracy	0,1°C (@0°C)
Response time (T90)	35 s
Cable	L=20 m - Ø 5 mm

► Performance Ratio Kit



Drw. Ref.	PN	Description	Kit1	Ref. Notes
		Modbus Sensor Box		
1	MDMMA1010.1	MSB/N2 Pt100+mV+Hz/RS485/10÷30V	1	
2	DEA420.1	STB/N2 Pt100+mV+Hz/4x4÷20mA/10÷30V	Optional	A
2	DEA420.2	STB/Pt100+mV+Hz+TC/4x4÷20mA/10÷30V	Optional	B
		Accessory	Optional	
	DYA090	Arm/MSB÷STB/to D=45÷65mm.pole	1	
3		Pyranometers (options Spectrally Flat Class A, B, C)		
		Spectrally Flat Class A		
	DPA252	Sensor/Pyranometer/Secondary Standard/µV	1	
	DWA205	Cable/L=5m/DPA252-952	1	
			Altern. To Class A	
		Spectrally Flat Class B		
	DPA154	Sensor/Pyranometer/First Class/µV/Cable L=10 m		
		Mounting Accessories for DPA154 and DPA252 Horizontal		
	DYA034	Arm/DPA154-855-870-863-873-252-952-817- 822/Horiz./to DYAO49	1	
	DYA049	Collar/for sensor arm to D=45÷65mm pole	1	
			Altern. To Horizontal Arm	
		Mounting Accessories for DPA154 and DPA252 Tilt		
	DYA035	Arm/DPA154-855-870-863-873-252-952-817- 822/Tilt/to DYAO49	1	
	DYA049	Collar/for sensor arm to D=45÷65mm pole	1	
			Altern. To Class A, B	
		Spectrally Flat Class C		
	DPA053	Sensor/Pyranometer/Second Class/µV/Cable L=5 m	1	
		Mounting accessories for DPA053 Horizontal		
	DYA032	Arm/DPA053-008, ESR003, DQA601, DMA131/ to DYAO49	1	
	DYA049	Collar/for sensor arm to D=45÷65mm pole	1	
			Altern. To Horizontal Arm	
		Mounting accessories for DPA053 Tilt		
	DYA048	Arm/DPA053/to DYAO35	1	
	DYA035	Arm/DPA154-855-870-863-873-252-952-817- 822/Tilt/to DYAO49	1	
	DYA049	Collar/for sensor arm to D=45÷65mm pole	1	

Drw. Ref.	PN	Description	Kit1	Ref. Notes
4		Air temperature sensor		
	DMA033	Sensor/Air Temp/Pt100/Cable L.5 m	1	
	DYA230	Radiant screen/NV/DMA67x-033	1	
	DYA049	Collar/for sensor arm to D=45÷65mm pole	1	
5		Contact temperature sensor		
	DLE124	Sensor/Surface Temp/Pt100/Cable L.20 m	1	
6		Wind speed sensor - Compact version (Hz output)		
	DNA202.1	Sensor/Cup-anem.-Compact/WS/Hz/7pin	1	
	DWA505	Cable/L=5m/sensors	1	
7		Front distance sensor	Optional	
	DQA601.3	Sensor/Front distance/UART-TTL/5÷24V	1	
	DYA032	Arm/DPA053-008, ESR003, DQA601, DMA131/ to DYA049	1	
	DYA049	Collar/for sensor arm to D=45÷65mm pole	1	
		Pole H.3 m		
	DYA010.1	Pole/H=3m/D=50mm	1	
	DYA020	Tripod/concrete installation/pole D= 50 mm	1	
	DYA020.1	Anchoring bolts for tripod/3 set	1	
	DYA028	Tie rods/H=2-3m	1	

NOTES

A	If option with 4÷20 mA is needed instead of RS485, input for Pt100
B	If option with 4÷20 mA is needed instead of RS485, input for thermistor



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