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REA: 1009921 **Reg.Imprese:** 04407090150

First & second class Pyranometers

User manual

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1 Notes about this manual

Document: INSTUM_01388_en - Update on 28 March 2014.

2 Technical features

The LSI LASTEM pyranometer is an instrument to measure the solar irradiance (direct and diffuse) which reaches the terrestrial surface.

With this instrument it is possible to measure not only the global radiation (see WMO n°8 7th ed.), but also the reflected sun radiation (*albedometer*) and the diffuse radiation by means of the occultation band.

The pyranometer measures radiation values within 300 and 3000 nm, with a visibility of 2π steradians. The element used to for the measurement is a thermopile whose external surface has been darkened with matt black paint bearing a reflecting power < than 2% (e>0.98) in the spectral area of the sensor.

The following table compares the specifications required for the pyranometers in "first class" or "second class" (ISO 9060) or in "good quality" (WMO n°8, 7th ed.) and the Lsi Lastem pyranometers.

ISO 9060	Secondary standard	First class	Lsi Lastem 1st class	Second class	Lsi Lastem 2nd class
Response time (95 % response)	< 15 s	< 30 s	26 s	< 60 s	28 s
Zero offset: (a) Response to 200 Wm^{-2} net thermal radiation (ventilated) (b) Response to 5 Kh-1 change in ambient temperature	7 Wm^{-2} 2 Wm^{-2}	15 Wm^{-2} 4 Wm^{-2}	12 Wm^{-2} 2 Wm^{-2}	30 Wm^{-2} 8 Wm^{-2}	14 Wm^{-2} 3 Wm^{-2}
Stability (change per year, percentage of full scale)	0,8 %	1,5 %	< 1 %	3 %	<1,5 %
Non-linearity (percentage deviation from the responsivity at 500 Wm^{-2} due to any change of irradiance within the range 100 to 1000 Wm^{-2})	0,5 %	1 %	0,75 %	3 %	1,5 %
Directional response for beam radiation (the range of errors caused by assuming that the normal incidence responsivity is valid for all directions when measuring, from any direction, a beam radiation whose normal incidence irradiance is 1000 Wm^{-2})	10 Wm^{-2}	20 Wm^{-2}	20 Wm^{-2}	30 Wm^{-2}	30 Wm^{-2}
Spectral sensitivity (percentage deviation of the product of spectral absorptance and spectral transmittance from the corresponding mean within the range 200 to 3000 nm)	2 %	5 %	< 2 %	10 %	< 2 %
Temperature response (percentage maximum error due to any change of ambient temperature within an interval of 50 K)	2 %	4 %	< 4 %	8 %	< 7 %

ISO 9060	Secondary standard	First class	Lsi Lastem 1st class	Second class	Lsi Lastem 2nd class
Tilt response (percentage deviation from the responsivity at 0° tilt (horizontal) due to change in tilt from 0° to 90° at 1000 Wm^{-2})	0,5 %	2 %	-	5 %	-
WMO n°8 7th ed. Pyranometer table 7.5					
Achievable uncertainty (95 % confidence level): - Hourly totals - Daily totals	 3 % 2 %	 8 % 5 %	 < 8 % < 5 %	 20 % 10 %	 < 20 % < 10 %

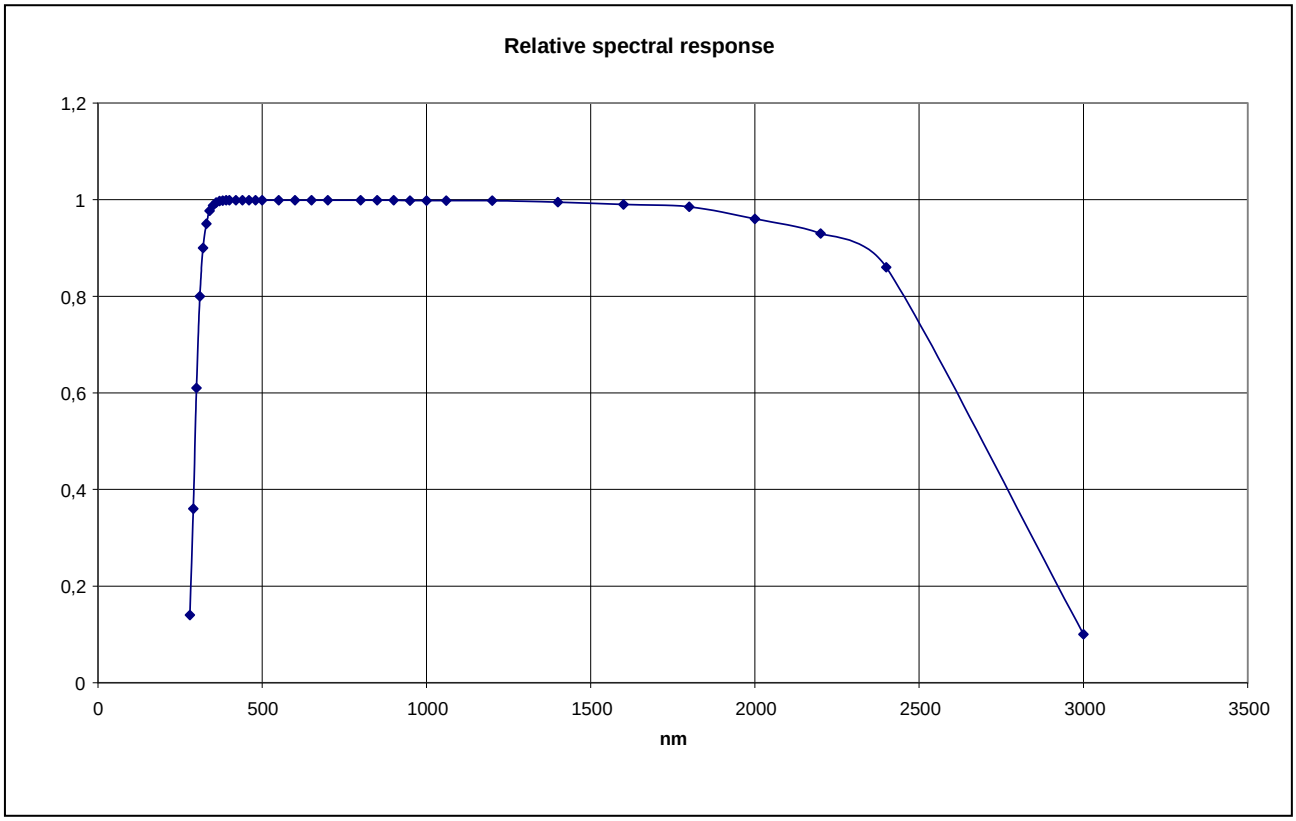
Pyranometer First Class (direct output)		
	DPA/ESR 153	DPA/ESR-154
Measures	Solar irradiance	
Principle	Thermopile	
Spectral range [nm]	285-2800	
Range of measure [W/m2]	0-2000	
Uncertainty [/%/daily]	< 5	
Linearity [% of meas. range]	0,75	
Sensitivity [µV/W/m^2]	7-14	
Temperature term drift [%/Δ 50 °C]	< 4	
Long term drift [%/yr]	< 1	

Pyranometer Second Class (direct output)	
	DPA/ESR 053
Measures	Solar irradiance
Principle	Thermopile
Spectral range [nm]	285-2800
Range [W/m2]	0-2000
Uncertainty [/%/daily]	< 10
Linearity [% of meas. range]	1,5
Sensitivity [µV/W/m2]	7-14
Temperature term drift [%/Δ 50 °C]	< 4
Long term drift [%/yr]	< 1,5

Pyranometer First Class (analogical output)				
	DPA 851	DPA 853	DPA 854	DPA 855
Electrical features				
Signal outputs [mA]	0/4 ÷ 20		0/4 ÷ 20	4 ÷20
Range of measure [W/m2]	0 ÷ 4000	0 ÷ 1500	0 ÷ 1500	
Power supply [Vdc/Vac]	10 ÷ 30			
Power consumption [W]	0,5			
Sensor features				
Measures	Solar irradiance			
Principle	Thermopile			
Spectral range [nm]	285 ÷ 2800			
Uncertainty [/%/daily]	< 5			
Linearity [% of meas. range]	0,75			
Temperature term drift [%/Δ 50 °C]	< 4			
Long term drift [%/yr]	< 1			
Operative condition				
Temperature range [°C]	-40 ÷ +80			
Umidity range [% RH]	0 ÷ 98			
Storage condition				
Temperature range [°C]	-40 ÷ +80			
Umidity range [% RH]	0 ÷ 98			
Protection [IP]	65			

Pyranometer Second Class (analogical output)		
	DPA/ESR 860	DPA 863
Electrical features		
Signal outputs [mA]	0/4 ÷ 20	4 ÷ 20
Range of measure [W/m2]	0 ÷ 1500	
Power supply [Vdc/Vac]	10 ÷ 30	
Power consumption [W]	0,5	
Sensor features		
Measures	Solar irradiance	
Principle	Thermopile	
Spectral range [nm]	285 ÷ 2800	
Uncertainty [/%/daily]	< 10	
Linearity [% of meas. range]	1,5	
Temperature term drift [%/Δ 50 °C]	< 4	
Long term drift [%/yr]	< 1,5	
Operative condition		
Temperature range [°C]	-40 ÷ +80	
Umidity range [% RH]	0 ÷ 98	
Storage condition		
Temperature range [°C]	-40 ÷ +80	
Umidity range [% RH]	0 ÷ 98	
Protection [IP]	65	

Total (sensor + glass dome) relative spectral response of LSI LASTEM pyranometers.



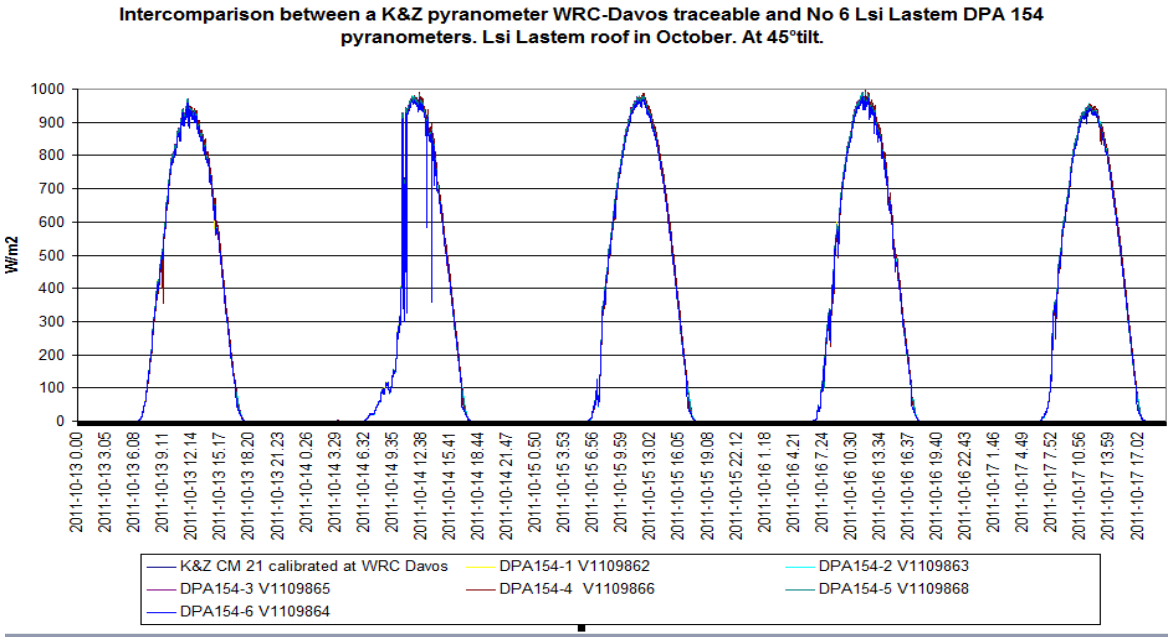
3 Calibration

Each pyranometer is supplied with a *Calibration Report* produced by comparison, under the sun or under a lamp (ISO 9847), with a pyranometer calibrated at the WRC-PMOD in Davos (WRC: World Radiation Center; PMOD: Phisikalisch Meteorologisches Observatorium Davos).
The *Calibration Report* contains the Calibration Factor whit its expanded uncertainty.

An overall accuracy value is not supplied; there are however many characteristics available according to the classes of the WMO n°8 and ISO 9060. Besides, the accuracy of this instrument is influenced by the quick temperature changes owing to the intervention of clouds and rain.

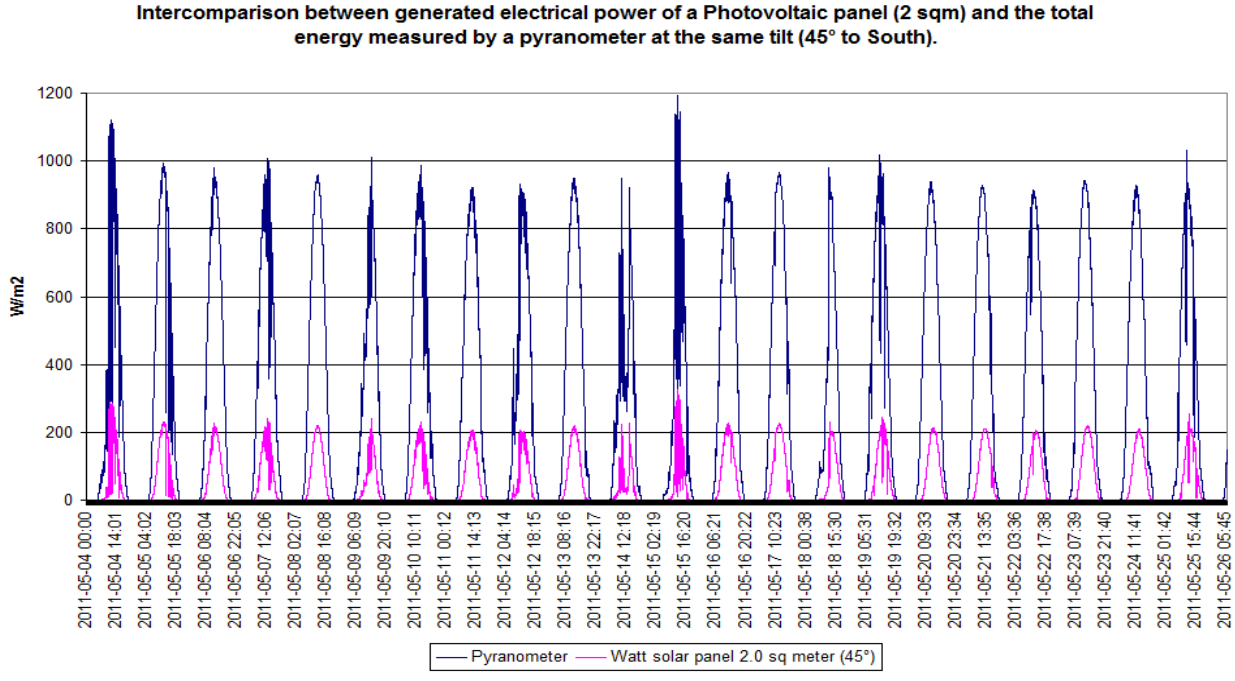
It is not necessary to re-calibrate the instrument frequently. It is advisable to re-calibrate the instrument every 2 to 3 years in order to keep calibration uncertainty variations in the range of 5%.

Measures example:



Typical mean values of Daily totals of energy (MJ/m2)of global radiation in three North Italy town during an year.

Locality	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
Turin	5.0	8.1	13.3	17.1	20.0	22.4	22.2	18.8	14.1	9.8	6.1	4.4
Aosta	3.6	6.2	11.8	16.0	19.4	21.8	21.5	18.2	13.6	9.4	5.4	3.6
Milan	5.2	8.1	13.6	17.3	20.4	22.6	22.7	19.3	14.3	9.6	5.9	4.3



4 Product installation

4.1 General safety rules

Please read the following general safety rules in order to avoid injuries to people and prevent damages to the product or to possible other products connected with it. In order to avoid any damages, use this product exclusively according to the instructions herein contained.

The installation and maintenance procedures must be carried-out only by authorized and skilled service personnel.

Power the instrument in a suitable manner. Pay attention and observe the power supplies like indicated for the model in your possession.

Carry-out all connections in a suitable manner. Pay strict attention to the connection diagrams supplied with the instrument.

Do not use the product in case of suspected malfunctions. In case of suspected malfunction, do not power the instrument and contact authorized technical support immediately.

Before you carry-out any operation on electrical connections, power supply system, sensors and communication apparatus:

- Disconnect the power supply.
- Discharge the accumulated electrostatic discharges touching an earthed conductor or apparatus.

4.2 Mechanical installation

The pyranometer must face equator and be exposed in a place with no shades throughout the day in every season; best installed at a height of 2 m on grassy ground. Do the Installation on pole using a DYA051 collar and DYA034 support. Follow these steps:

1. Remove the radiant protective screen from the pyranometer body.
2. Fix the DYA034 support the DYA051 collar and mount them on pole.
3. Turn the support until the sensor points to the terrestrial equator.
4. Mount the body of the sensor on the DYA034 support, having care to level the sensor horizontally using the two leveling feet and the bubble level.
5. Fix the pyranometer to the supporting disc using the two longest screws; use an Allen wrench n° 4 for this purpose.
6. Reassemble the protective screen on the pyranometer body.

4.3 Electrical connection

Connections must be performed following the drawing of the pyranometers or as descript in the following table:

DPA/ESR 053-153-154

Wire color	***Name***	***Meaning***
Brown	+ output	Thermopile output +
Blue	- output	Thermopile output -
Schield	Gnd	Ground

DPA 851-853-854

Wire color	***Name***	***Meaning***
Brown	Power In +	Power supply +
White	Power In -	Power supply -
Schield	Gnd	Ground
Black	Output -	- 0/4 ÷ 20 mA
Blue	Output +	+ 0/4 ÷ 20 mA

DPA855 - 863

Wire color	***Name***	***Meaning***
Red	Power In +	Power supply +
Blue	Power In -	Power supply -
Schield	Gnd	Ground
Green	Output -	- 4..20 mA
Brown	Output +	+ 4..20 mA

5 Maintenance

The pyranometer does not require special maintenance, anyway it is a precision measurement apparatus so, in order to maintain the specified measurement precision over the time, LSI LASTEM recommends to check and re-calibrate periodically the instrument .

It is also advisable to check the status of the external dome in the winter months, during which an icy layer may form on it as well as to check the status of the silica salt every 3-6 months depending on humidity of the site.

6 Spare parts

Spare parts available:

- MC4390 container with silica salt;
- MC1175 external white screen.