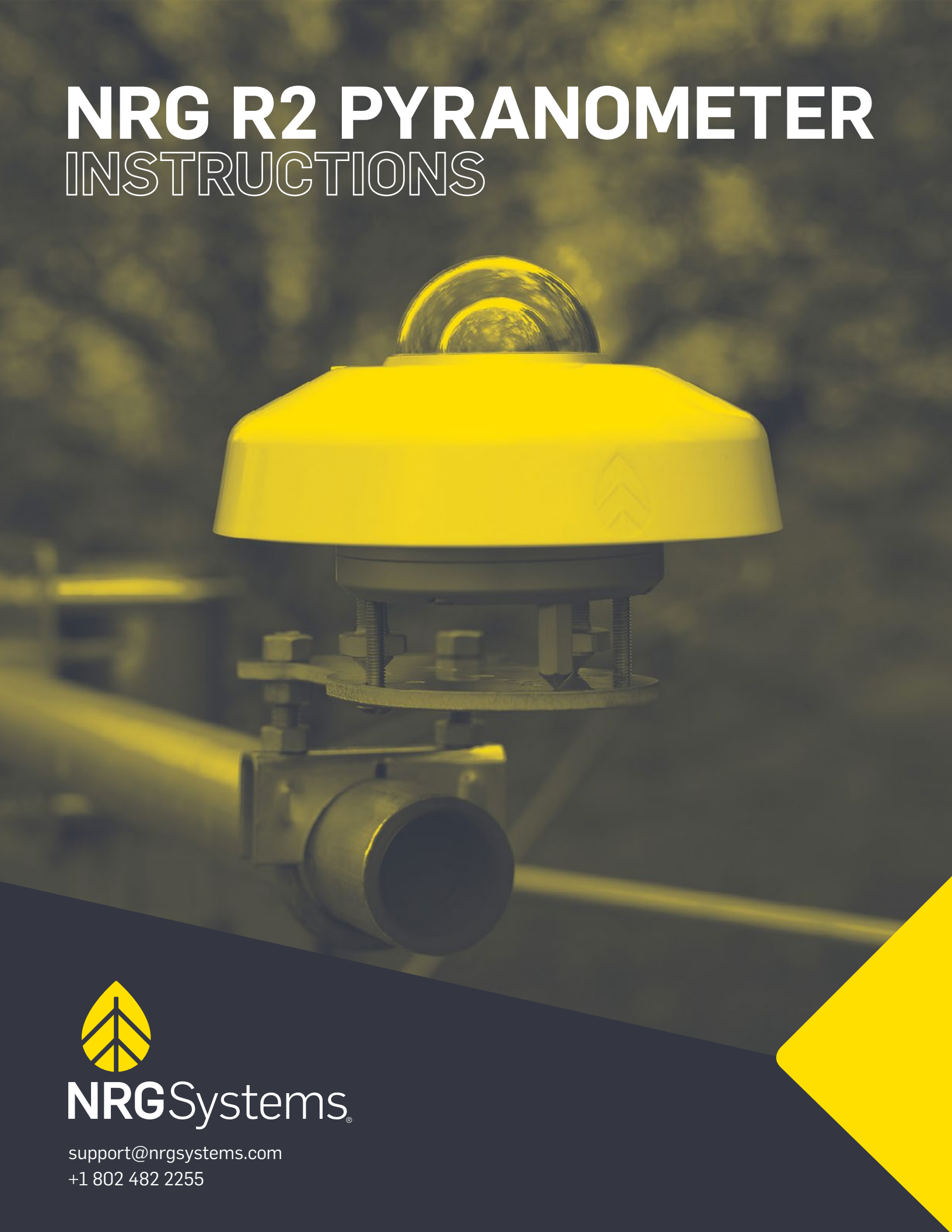
NRG R2 PYRANOMETER
INSTRUCTIONS



NRG Systems®

support@nrgsystems.com
+1 802 482 2255

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1 INTRODUCTION

The NRG R2 Series Pyranometers are a high-performing family of sensors for utility grade solar resource assessment (pre-solar farm construction) and solar performance monitoring (post-solar farm construction). These spectrally flat thermopile pyranometers meet Class A (Secondary Standard) per ISO 9060:2018 and meet the requirements of the WMO “Guide to Instruments and Methods of Observation”.

The NRG R2 pyranometer measures the global irradiance on a flat surface (W/m2), sum of direct solar irradiance and diffuse irradiance. The NRG R2 series falls within the Spectrally Flat Class A pyranometers according to the ISO 9060:2018 standard and meets the requirements of the WMO “Guide to Instruments and Methods of Observation”.

The newly available internal temperature, relative humidity and pressure diagnostic sensors allow continuous observation of the pyranometer’s operating conditions and early detection of environmental impacts to ensure performance optimization, reliable measurements, and maintenance planning.

The integrated bubble level and the adjustable feet allow precise alignment and simplified installation while the internal tilt sensor continuously monitors the proper alignment after installation.

NRG R2 Pyranometer

2 SENSOR IDENTIFICATION

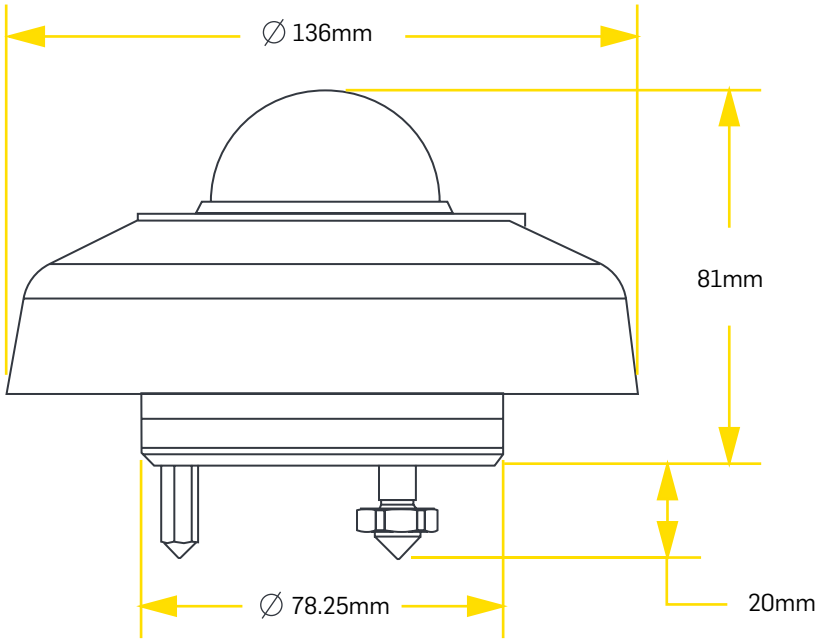
The NRG R2-A (item 9461) is a passive irradiance sensor with mV signal output. The sensor can be identified by the body label, which contains the “R2-A” model name and serial number (9461NNNNNN).

The NRG R2-D (item 9462) is a digital sensor with modbus RTU signal output including irradiance and body temperature. The sensor can be identified by the body label, which contains the “R2-D” model name and serial number (9462NNNNNN).

3 TECHNICAL SPECIFICATIONS

3.1 R2 Pyranometer Technical Specifications According to ISO 9060:2018

Classification	Spectrally Flat Class A
Response time	(95%) < 2 s
Zero offset **a) response to a 200 W/m2 thermal radiation** **b) response to a 5 K/h change in ambient temperature** **c) total zero offset including the effects a), b) and other sources**	 < +/- 7 W/m2 < +/- 2 W/m2 < +/- 10 W/m2
Long-term instability (1 year)	< +/- 0.5 %
Non-linearity	< +/- 0.2 %
Directional response **(up to 80° with 1000 W/m2 beam)**	< +/- 10 W/m2
Spectral error	< +/- 0.2%
Temperature response	< +/- 0.5%
Tilt response	< +/- 0.2%



3.2 R2-Analog Pyranometer Specifications

Sensor	Thermopile
Measuring range	-200 to 4000 W/m2
Resolution	0.1 W/m2
Viewing angle	2π sr
Spectral range (50%)	283 to 2800 nm
Output	Passive in mV
Power supply	NA - Passive Sensor
Consumption	Passive sensor
Connection	5-pole M12
Weight	620 g approx.
Operating conditions	-40 to +80 °C / 0 to 100 %RH / Max. altitude 6000 m
Bubble level accuracy (See specifications below for Tilt sensor accuracy)	< 0.2°
Protection degree	IP 67
Materials	Housing: anodized aluminum Screen: ASA Dome: optical glass

3.3 R2-Digital Pyranometer and Diagnostic Sensors Specifications

Sensor	Thermopile
Measuring range	-200 to 4000 W/m2 The irradiance range for the analog output is configurable (default 0 to 2000 W/m2)
Resolution	0.1 W/m2
Viewing angle	2π sr
Spectral range (50%)	283 to 2800 nm
Output	RS485 Modbus-RTU (isolated)
Power supply	7 to 30 Vdc
Consumption	15 mA @ 24 Vdc / 21 mA @ 12 Vdc
Connection	5-pole M12
Weight	620 g approx.
Operating conditions	-40 to +80 °C / 0 to 100 %RH / Max. altitude 6000 m
Bubble level accuracy **(See specifications below for Tilt sensor accuracy)**	< 0.2°
Protection degree	IP 67
Materials	Housing: anodized aluminum Screen: ASA Dome: optical glass
INTERNAL TEMPERATURE	
Measuring range	-40 to +80 °C
Resolution	0.1 °C
Accuracy	±0.5 °C (0...60 °C)
INTERNAL RELATIVE HUMIDITY	
Measuring range	0 to 100%
Resolution	0.1%
Accuracy	±3% @ T=25 °C & RH=20...80%
INTERNAL PRESSURE	
Measuring range	300 to 1100 hPa
Resolution	0.1 hPa
Accuracy	±1 hPa (0 to 60 °C)
TILT SENSOR	
Measuring range	0 to 180°
Resolution	0.1°
Accuracy	< 0.5°

4 MEASURING PRINCIPLE

NRG R2 pyranometer is based on a thermopile sensor. The thermopile sensitive surface is coated with a black matte paint, which allows the pyranometer not to be selective at different wavelengths.

Radiant energy is absorbed by the thermopile black surface, thus creating a difference of temperature between the center of the thermopile (hot junction) and the pyranometer body (cold junction). Due to the Seebeck effect, the difference of temperature between hot and cold junction is converted into a difference of potential. The pyranometer spectral range is determined by the transmission of the two concentric glass domes, with 50 and 30 mm outer diameters, which provides thermal insulation to the thermopile.

The special material used to manufacture the domes allows the spectral range to be extended to short wavelengths starting from 283 nm. Considering a standard solar spectrum, the portion of solar irradiation detected by the pyranometer is greater than 99.8%. Figure 3.1 shows the relative spectral sensitivity of the NRG R2 pyranometer (blue line) and the standard solar spectrum (red line).

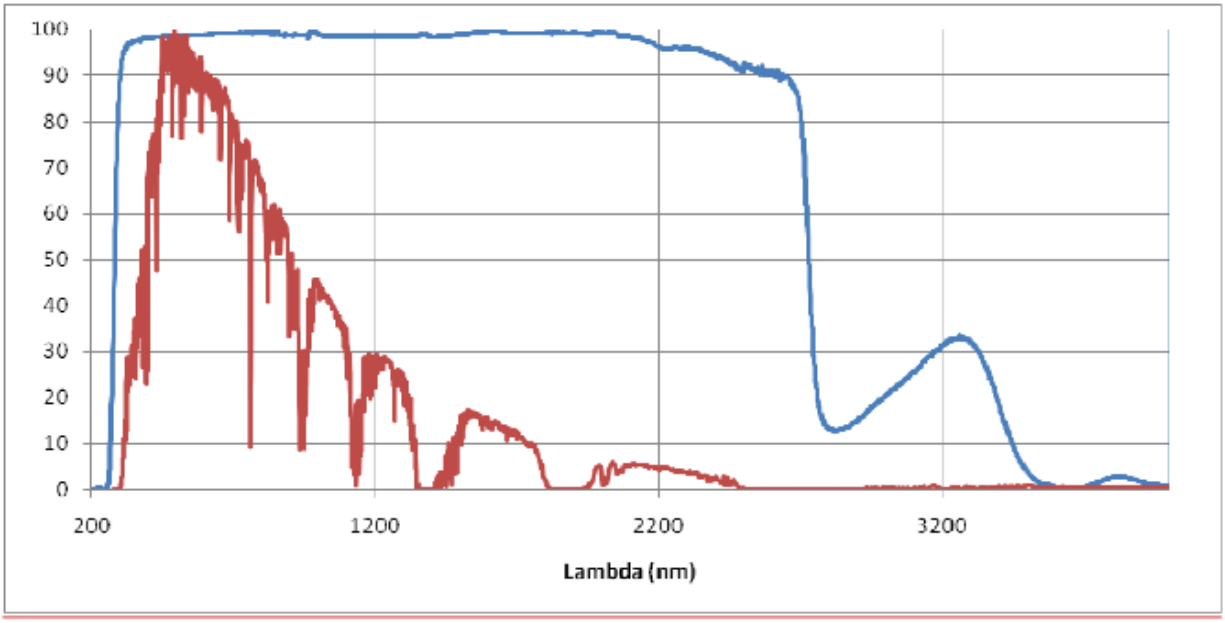


Fig. 3.1: NRG R2 relative spectral sensitivity and standard solar spectrum

An internal compensation circuit minimizes the change of sensitivity with temperature.

To prevent condensation from forming on the internal side of the dome under certain climatic conditions, silica-gel is inserted inside the pyranometer to absorb moisture.

5 INSTALLATION

For maximum performance, adhere to the following installation guidelines:

- Place the pyranometer in an easy-to-reach location to facilitate cleaning the dome regularly and carry out maintenance. Avoid buildings, constructions, trees, or obstructions that exceed the horizontal plane where the pyranometer is mounted. If this is not possible, select a site where obstructions in the path of the sun from sunrise to sunset do not exceed 5 degrees of elevation. ***Note: The presence of obstructions on the horizon line significantly affects the measurement of direct irradiance.***
- Locate the pyranometer far from any kind of obstruction, which might reflect sunlight (or sun shadow) onto the pyranometer itself.
- The mast height should not exceed the pyranometer plane to avoid measurement errors caused by any reflection or shadow of the mast itself.
- In compliance with ISO TR9901 standard and WMO recommendations, if the pyranometer is used without the solar radiation protection screen, it must be positioned so that the connector points to the North Pole, if the instrument is used in the Northern Hemisphere, and to the South Pole, if used in the Southern Hemisphere. It is best to follow this recommendation even when the screen is installed.
- For mounting the pyranometer, use the two M5 holes with inserts on the base of the pyranometer. For accurate leveling of the sensor, adjust the height of the two lower feet with knurled ring, referencing the bubble level integrated in the pyranometer.

  Note: For horizontal positioning it is preferable to use the bubble level in addition to the tilt sensor as it is more accurate. Use the tilt sensor for positioning monitoring after installation and for installation only if the pyranometer must be positioned tilted with respect to the horizontal plane.
- It is preferable to thermally insulate the pyranometer from its mounting bracket by securing it not with the base directly in contact with the support plate, but by leaving a layer of air in between (for this purpose, always use the feet even if the installation is not horizontal), while at the same time ensuring that there is good electrical contact to ground.

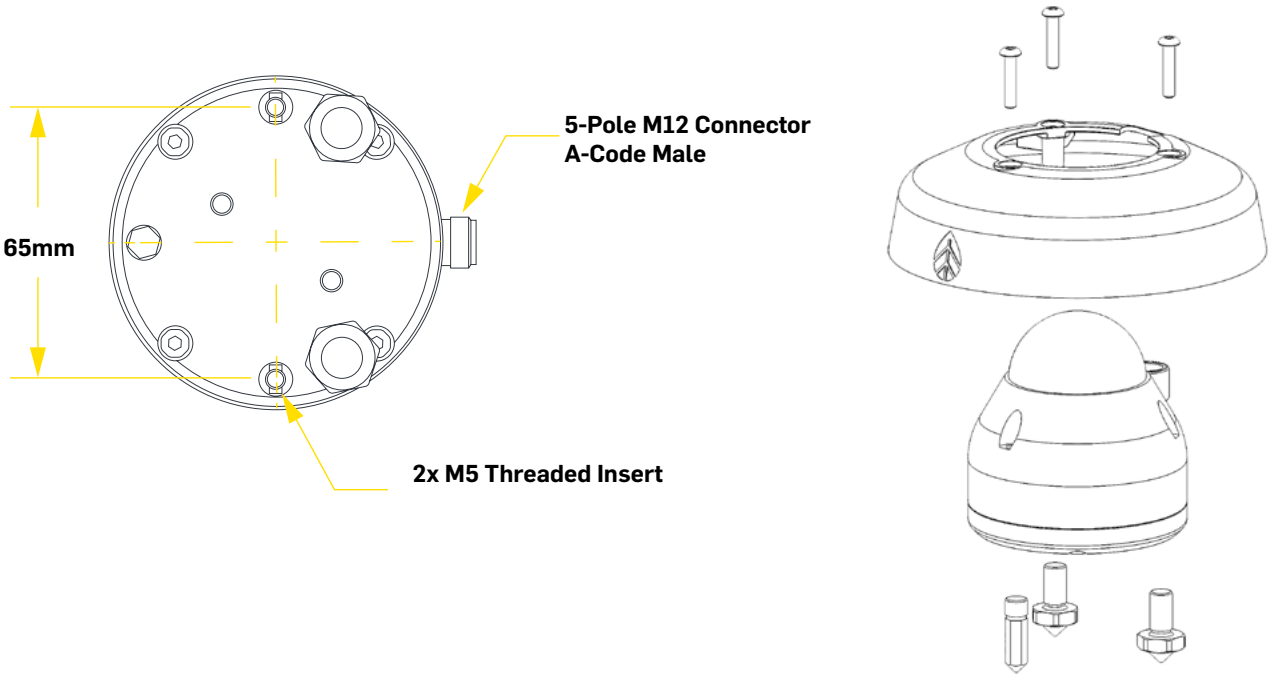


Fig. 4.1: position of fixing holes and bubble level

5.1 OPTIONAL MOUNTING SUPPORTS

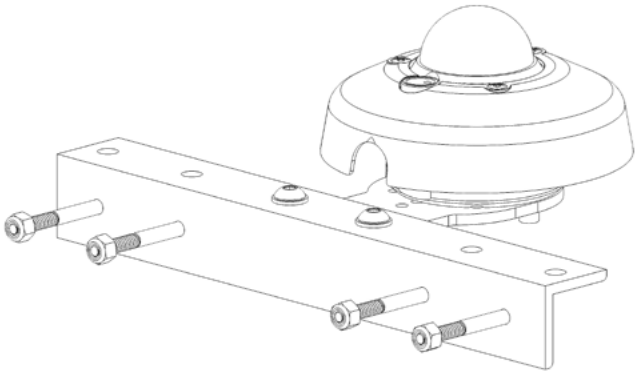
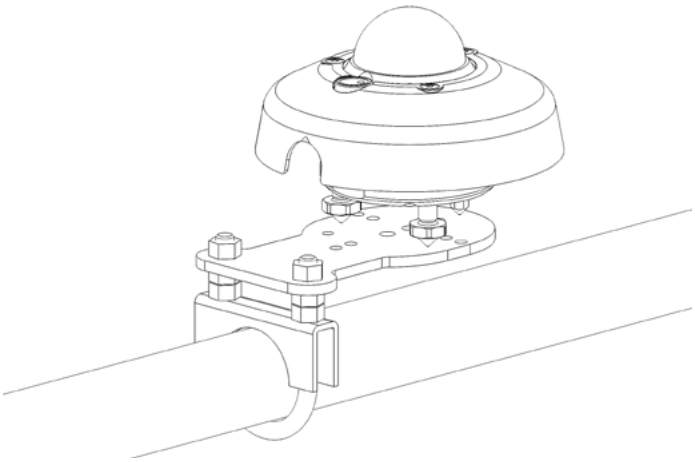


Fig. 4.2 R2 Bracket assembly 14983 permits mounting in the plant of a fixed PV array.

Fig. 4.3 Mounting bracket assembly 14357 allows mounting on SRA or SRM towers.



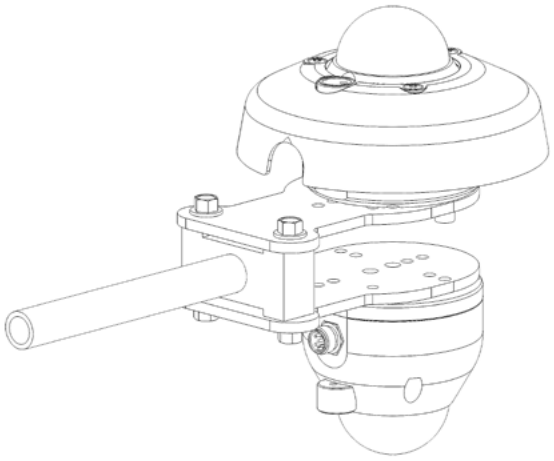


Fig. 4.4 title: “Bracket assembly 14369 permits two NRG R2 pyranometers to measure albedo.

6 ELECTRICAL CONNECTIONS

It is suggested to ground the metallic housing of the pyranometer locally. In this case, do not connect the wire of the cable corresponding to the housing to prevent ground loops.

If it is not possible to ground the metallic housing of the pyranometer locally, connect the wire of the cable corresponding to the housing to ground.

There are surge protection devices internally connected to the housing. Grounding the housing allows the correct protection functionality of the devices.

7 CONFIGURATION | LOGR-S AND LOGR | SOLAR

It is best practice to update your logger firmware before performing logger configuration and/or data processing tasks. The latest versions of software, firmware and documentation can be downloaded from this page: https://www.nrgsystems.com/support/product-support/.

Navigate to the Sensors > Serial Sensors web page and select the NRG R2 from the drop-down list. Click save. Note, if you do not see the R2 in the “Load From Defaults” drop-down menu, please update your software from the “Services and Support” section of our website (https://www.nrgsystems.com/support/product-support/).

7.1 R2-Analog Configuration

The NRG R2-A pyranometer defaults are available in LOGR-S and LOGR | Solar with firmware scheduled for release in Version 1.09.333 or later.

Navigate to the Sensors > Analog Sensors web page and select the NRG R2-A form the drop-down list. Note, if you do not see the R2-A in the “Load From Defaults” drop-down menu, please update your software from the “Services and Support” section of our website (https://www.nrgsystems.com/support/product-support/)

Default Scale Factors

The LOGR-S and LOGR | Solar contains default scaling information for the R2-A Pyranometer sensor to achieve the units W/m^2.

- Slope: Sensor specific scale factor from label/calibration

* Refer to the sensor’s calibration report for the calibrated sensitivity and convert to a scale factor.

Slope = 1000000 / Sensitivity

- Offset: 0

Example: Pyranometer sensitivity is 9.11 uV/W/m^2, the slope for the LOGRS / LOGR | Solar Analog irradiance channel is calculated as 1000000/9.11 = 109769.484.

Logger slope is in the units W/m^2/Volt, and recorded data is in the units W/m^2.

Sensor Outputs

Active

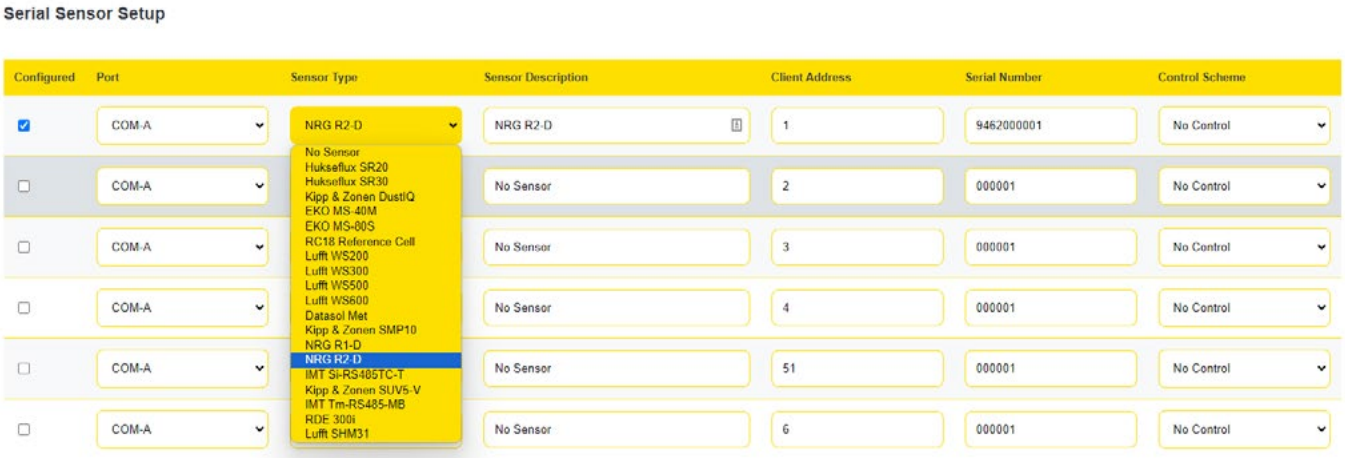
Channel Number	Type	Description	Data
1	Analog	PSM c-Si Isc Soil	0.01 A
2	Analog	PSM c-Si Voc Soil	0.27 V
4	Analog	NRG T60 (pre 3/2023)	-40.87 deg_C
102	Serial	Hukseflux SR30-Heater Current	0.00 mA
103	Serial	Lufft WS51200-Temperature	0.00 deg_C

7.2 R2-Digital Configuration

The NRG R2-D pyranometer defaults are available in LOGR-S / LOGR Solar with firmware scheduled for release in November 2023 or later.

NOTE: It is best practice to update your logger firmware before performing logger configuration and/or data processing tasks. The latest versions of software, firmware and documentation can be downloaded from this page: https://www.nrgsystems.com/support/product-support/.

Navigate to the Sensors > Serial Sensors web page and select the NRG R2-D from the drop-down list. Click save. Note, if you do not see the R2-D in the "Load From Defaults" drop-down menu, please update your software from the "Services and Support" section of our website (https://www.nrgsystems.com).



8 WIRING AND CONFIGURATION | LOGR-S AND LOGR | SOLAR

8.1 NRG R2-Analog Wiring

Wire the NRG R2-Analog to the LOGR-S and Solar according to the table below.

TERMINAL BLOCKS A1 TO A7		
R2-A CONNECTION	**COLOR**	**NRG LOGR-S / LOGR | SOLAR**
mV output (+)	Brown	Connect “SIG” terminal
mV output (-)	White	Connect “SIG-” terminal
No connection	Blue	No connection
No connection	Black	No connection
No connection	Gray	No connection
Housing	Yellow/Green	Connect to “SHD” terminal

8.2 NRG R2-Digital to NRG LOGR-S

Wire the NRG R2-Digital to the LOGR-S according to the table below.

TERMINAL BLOCKS COM A-1 TO COM B-1		
R2-D CONNECTION	**COLOR**	**NRG LOGR-S**
VCD+	Brown	Connect to Com A-1, Com A-2, Com B-1 EXC
Data +	White	Connect to Com A-1, Com A-2, Com A-3, or Com B-1 Data +
Data Ground	Blue	Connect to Com A-1, Com A-2, Com A-3, or Com B-1 GND
VDC-	Black	Connect to Com A-1, Com A-2, Com A-3, or Com B-1 GND
Data -	Gray	Connect to Com A-1, Com A-2, Com A-3, or Com B-1 Data -
Housing	Yellow/Green	Connect to “SHD” terminal

9 CONFIGURATION | SYMPHONIEPRO

The NRG R2 Pyranometer defaults are available in SymphoniePRO Desktop Application SPD v3.15 and later. There are no additional logger firmware requirements.

NOTE: It is best practice to update your desktop software and logger firmware before performing logger configuration and/or data processing tasks. The latest versions of software, firmware and documentation can be downloaded from this page: https://www.nrgsystems.com/support/product-support/.

Channel Configuration

Create the following configuration in the SymphoniePRO Desktop Application (Version SPD v3.15 or later). Note, if you do not see the R2-A or R2-D in the "Load From Defaults" drop-down menu, please update your software from the "Services and Support" section of our website (https://www.nrgsystems.com).

9.1 R2-Analog Configuration | Passive

Default Scale Factors

The SymphoniePRO Desktop Application contains default scaling information for the R2-A Pyranometer sensor to achieve the units W/m^2.

- Slope: Sensor specific scale factor from label/calibration

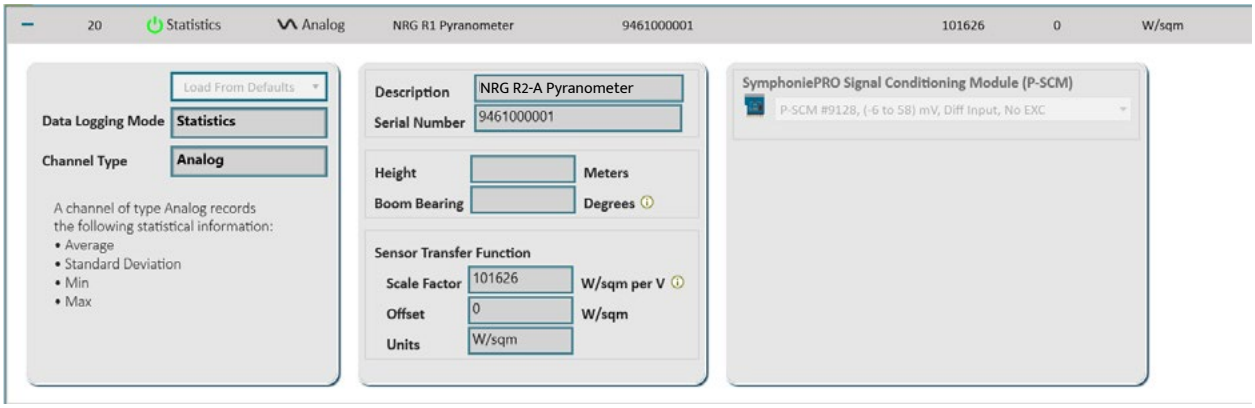
Refer to the sensor's calibration report for the calibrated sensitivity and convert to a scale factor.
Slope = 1000000 / Sensitivity

- Offset: 0

Example: Pyranometer sensitivity is 9.11 uV/W/m^2, the slope for the SymPRO Analog irradiance channel will be 1000000/9.11 = 109769.484.

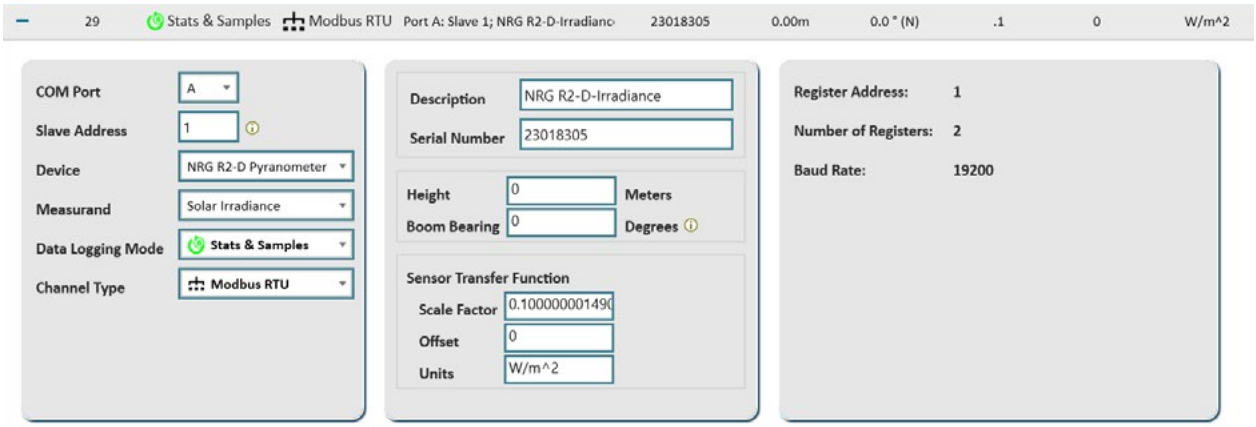
Logger slope is in the units W/m^2/Volt, and recorded data is in the units W/m^2.

The R2-A can be used on channels 20 through 26 when the logger is equipped with NRG Part Number 9128 (P-SCM [-6 to 58mV Input no EXC]). Choose "NRG R2-A" from the "Load From Defaults" drop down menu.



9.2 R2-Digital Configuration | RS485

The R2-D can be used on the COM-A and COM-B terminals. Configure the connected serial channels for Client ID and Measurand.



10 WIRING AND CONFIGURATION | SYMPHONIEDPRO

10.1 R2-Analog Wiring

Wiring the R2-Analog to the SymphoniePRO is straightforward and familiar. Please follow the table below.

CHANNELS 20-26 (USE P-SCM #9128)		
R2-A CONNECTION	**COLOR**	**NRG SYMPHONIEPRO**
mV output (+)	Brown	Connect to 20-26 “SIG +” terminal
mV output (-)	White	Connect to 20-26 “SIG -” terminal
No connection	Blue	No connection
No connection	Black	No connection
No connection	Gray	No connection
Housing	Yellow/Green	Connect to 20-26 “SHD” terminal

10.2 R2-Digital Wiring

Wire the NRG R2-Digital to the SymphoniePRO according to the table below.

COM-A OR COM-B		
R2-D CONNECTION	**COLOR**	**NRG SYMPHONIEPRO**
VCD+	Brown	Connect to aux power supply +
Data +	White	Connect to RS-485 “Rx+/Tx+” terminal
Data Ground	Blue	Connect to RS-485 “GND” terminal
VDC-	Black	Connect to aux power supply -
Data -	Gray	Connect to RS-485 “Rx-/Tx-”
Housing	Yellow/Green	Connect to RS-485 “SHD” terminal

11 MODBUS-RTU PROTOCOL (R2-D ONLY)

By default, the pyranometer has Modbus address of the last two digits of the serial number and communication parameters 19200, 8E1.

The delay between the reception of a query from the master device and the start of the pyranometer reply is less than 10 ms.

Measurands available on LOGR-S and SYMPHONIEPRO:

MEASUREMENTS			
Modbus Register	Measurand	Description	Data Type
1	Solar Irradiance	Temperature compensated irradiance in W/m2 (x10) (it takes into account the change in sensor sensitivity as temperature changes)	32-bit Integer
3	Solar Irradiance (UC)	Nominal irradiance in W/m2 (x10) (calculated considering the sensor nominal sensitivity at the calibration temperature: ~23 °C)	32-bit Integer
6	Humidity	Internal relative humidity in % (x10)	16-bit Integer
7	Temperature	Internal temperature in the set unit of measurement (x10)	16-bit Integer
8	Pressure	Internal pressure in hPa (x10)	16-bit Integer
9	Raw Signal	Signal in mV generated by the thermopile (x1000)	32-bit Integer
11	Tilt	Tilt angle (x10)	16-bit Integer

12 USE OF THE DIAGNOSTIC SENSORS (R2-D ONLY)

The internal temperature, relative humidity, pressure, and tilt diagnostic sensors allow continuous observation of the digital pyranometer's operating conditions and early detection of environmental impacts to ensure performance optimization, reliable measurements, and maintenance planning.

Internal temperature

As a rule, the internal temperature of the pyranometer is on average 5 to 10 °C higher than the external ambient temperature. Temperatures that are excessively lower or higher than indicated may be a sign of malfunctions.

Monitoring the internal temperature helps determine if the irradiance measurement can be considered reliable.

Internal relative humidity

To minimize condensation and keep measurements accurate, desiccant silica-gel is provided inside the pyranometer base to absorb moisture. The silica-gel life is at least 10 years. The long-term monitoring of the internal relative humidity of the pyranometer allows the efficiency of the silica-gel to be checked. A progressive upward trend in relative humidity indicates the progressively decreasing ability of silica-gel to absorb moisture.

The internal relative humidity depends not only on the saturation level of the silica-gel but also on the temperature of the pyranometer; therefore, short-term humidity monitoring is not particularly significant in determining the condition of the silica-gel. Relative humidity monitoring can be annual.

It is advised to detect the relative humidity during the night, when the temperature is lower, and the relative humidity is higher.

Silica-gel can be considered close to saturation when the internal relative humidity is persistently above 50% at temperatures below 20 °C.

Internal pressure

Monitoring the internal pressure of the pyranometer allows the housing to be checked for tight seal (no leakage). The pressure/temperature ratio should remain approximately constant.

Tilt

Monitoring the inclination angle of the pyranometer allows for the detection of unwanted displacements that may occur in the long term or because of impacts during installation.

Take the measurement of the Tilt sensor immediately after installation and consider it as a reference for subsequent measurements.

MAINTENANCE

To collect highly accurate measurements, it is important to keep the outer glass dome clean. You can wash it using water and standard paper for lenses. If necessary, use pure ETHYL alcohol. After using alcohol, clean the dome again with water only.

To minimize condensation and keep measurements accurate, desiccant silica-gel is provided inside the pyranometer base to absorb moisture. The silica-gel life is at least 10 years, if replacement is needed or service on your pyranometer is needed, please contact our Technical Services team.

SAFETY INSTRUCTIONS

The pyranometer proper operation and operating safety can be ensured only in the climatic conditions specified in this manual and if all standard safety measures as well as the specific measures described in this manual are followed.

Do not use the instruments in places where there are:

- Corrosive or flammable gases.
- Direct vibrations or shocks to the instrument.
- High-intensity electromagnetic fields, static electricity.