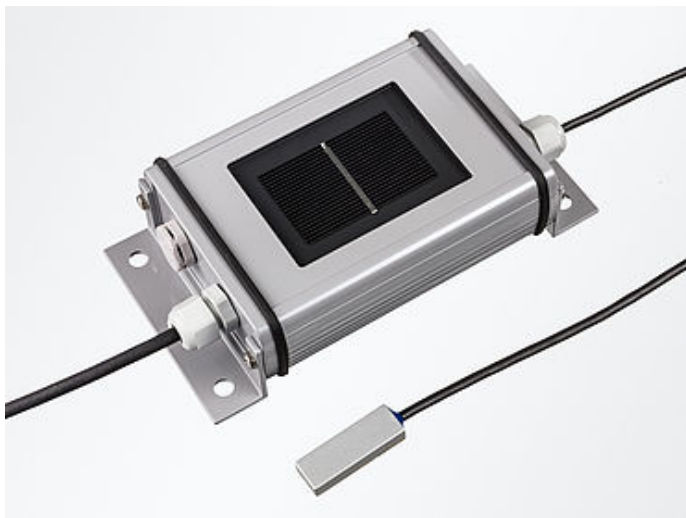


Silicon Irradiance Sensor

Instruction for Use



7.1419.21.x81



7.1419.20.x81

Dok. No. 022040/02/23

THE WORLD OF WEATHER DATA

Safety Instructions

- Before operating with or at the device/product, read through the operating instructions. This manual contains instructions which should be followed on mounting, start-up, and operation. A non-observance might cause:
 - failure of important functions
 - endangerment of persons by electrical or mechanical effect
 - damage to objects
- Mounting, electrical connection and wiring of the device/product must be carried out only by a qualified technician who is familiar with and observes the engineering regulations, provisions and standards applicable in each case.
- Repairs and maintenance may only be carried out by trained staff or **Adolf Thies GmbH & Co. KG**. Only components and spare parts supplied and/or recommended by **Adolf Thies GmbH & Co. KG** should be used for repairs.
- Electrical devices/products must be mounted and wired only in a voltage-free state.
- **Adolf Thies GmbH & Co KG** guarantees proper functioning of the device/products provided that no modifications have been made to the mechanics, electronics or software, and that the following points are observed:
 - All information, warnings and instructions for use included in these operating instructions must be taken into account and observed as this is essential to ensure trouble-free operation and a safe condition of the measuring system / device / product.
 - The device / product is designed for a specific application as described in these operating instructions.
 - The device / product should be operated with the accessories and consumables supplied and/or recommended by **Adolf Thies GmbH & Co KG** .
 - Recommendation: As it is possible that each measuring system / device / product may, under certain conditions, and in rare cases, may also output erroneous measuring values, it is recommended using redundant systems with plausibility checks for **security-relevant applications**.

Environment

- As a longstanding manufacturer of sensors Adolf Thies GmbH & Co KG is committed to the objectives of environmental protection and is therefore willing to take back all supplied products governed by the provisions of "*ElektroG*" (German Electrical and Electronic Equipment Act) and to perform environmentally compatible disposal and recycling. We are prepared to take back all Thies products concerned free of charge if returned to Thies by our customers carriage-paid.
- Make sure you retain packaging for storage or transport of products. Should packaging however no longer be required, please arrange for recycling as the packaging materials are designed to be recycled.



Documentation

- © Copyright **Adolf Thies GmbH & Co KG**, Göttingen / Germany
- Although these operating instructions have been drawn up with due care, **Adolf Thies GmbH & Co KG** can accept no liability whatsoever for any technical and Typeographical errors or omissions in this document that might remain.
- We can accept no liability whatsoever for any losses arising from the information contained in this document.
- Subject to modification in terms of content.
- The device / product should not be passed on without the/these operating instructions.

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1 Models

Article No.	Description	Interface / Data output	Supply	Connection type
7.1419.20.081	Solar irradiance incl. cell temperature sensor	RS 485 / Modbus RTU	10 ... 28V DC	3m calbe
7.1419.20.781	Solar irradiance incl. cell temperature sensor	RS 485 / Modbus RTU	10 ... 28V DC	Plug
7.1419.21.081	Solar irradiance incl. cell temperature and module temperature sensor	RS 485 / Modbus RTU	10 ... 28V DC	3m cable
7.1419.21.781	Solar irradiance incl. cell temperature and module temperature sensor	RS 485 / Modbus RTU	10 ... 28V DC	Plug

Scope of supply:

1 x Silicon Irradiance Sensor

1 x Instruction for Use

1 x Cable socket (mating connector) is included in the scope of delivery, if no cable is sold.

The instructions for use are available for download under the following link:

https://www.thiesclima.com/db/dnl/7.1419.2x.xxx_Silicon_Irradiance_Sensor_en.pdf

2 Application

Silicon irradiance sensors (Si sensor) show a but rugged and reliable solution for the measurement of solar irradiance, especially for the monitoring of Photovoltaic (PV) systems. Based on the construction of the sensor element corresponding to a PV module they are ideal as reference for the monitoring of PV systems. Especially the spectral response comparable to PV modules as well as the similar inclination error (incident angle modifier) allow an exact analysis of PV energy yields using Si sensor data.

3 Setup and Mode of Operation

A silicon solar cell can be used as an irradiance sensor, because the short-circuit current is proportional to the irradiance. Our sensors are built out of a monocrystalline Si solar cell connected to a shunt. Due to the low resistance of the shunt the cell operates next to short-circuit. To minimize influences of temperature to the measuring signal all of our sensors have an active temperature compensation via a temperature sensor laminated to the back surface of the solar cell.

All sensors are calibrated in artificial sunlight against a reference cell calibrated at the Physikalisch-Technische Bundesanstalt (PTB, National Metrology Institute of Germany).

3.1 Mechanical design

The solar cell is embedded in Ethylen-Vinyl-Acetat (EVA) between glass and Tedlar. The laminated cell is integrated into a case of powder-coated aluminium. Therefore the sensor construction is comparable to that of a standard PV module. The electrical connection is realized by a 3m cable or a water proof (IP67) connector.

3.2 Optional temperature measurement

Additionally to the irradiance measurement our silicon sensors are able to measure the temperature of the solar cell using a temperature sensor laminated to the back of the cell. This solar cell temperature can approximately be used as module temperature.

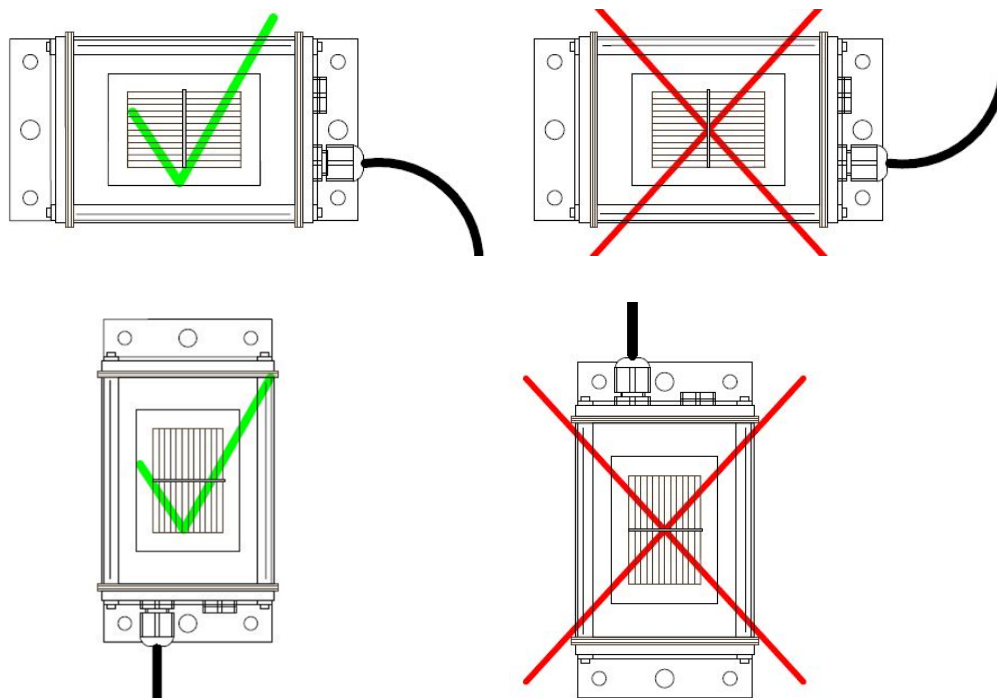
4 Recommendation Side Selection / Standard Installation

Si sensors that are used for monitoring PV installations must be installed with the same alignment and inclination as the PV generator. The mounting location should be free of shading as far as possible. To facilitate maintenance and cleaning of the Si sensor, the Si sensor should be mounted in an easily accessible place.

The mounting location at a PV generator must be selected such that snow cannot jeopardise the Si sensor as it slides off. For this reason do not mount along the drip edge on the PV generator.

5 Installation

5.1 Mechanical Mounting



5.2 Electrical Connection

The sensors are designed for safety extra-low voltage (SELV) operation. The maximum power of the voltage supply is 50 VA.

Reversing the polarity or mixing up the connections on the Si sensor may cause irreversible damage to the sensor. The cable shield is to be connected to PE during installation.

5.2.1 Cable

Core count / Cross-section / Type
Cable 4 x 0,25mm ² LIYCY - BLACK, UV-resistant

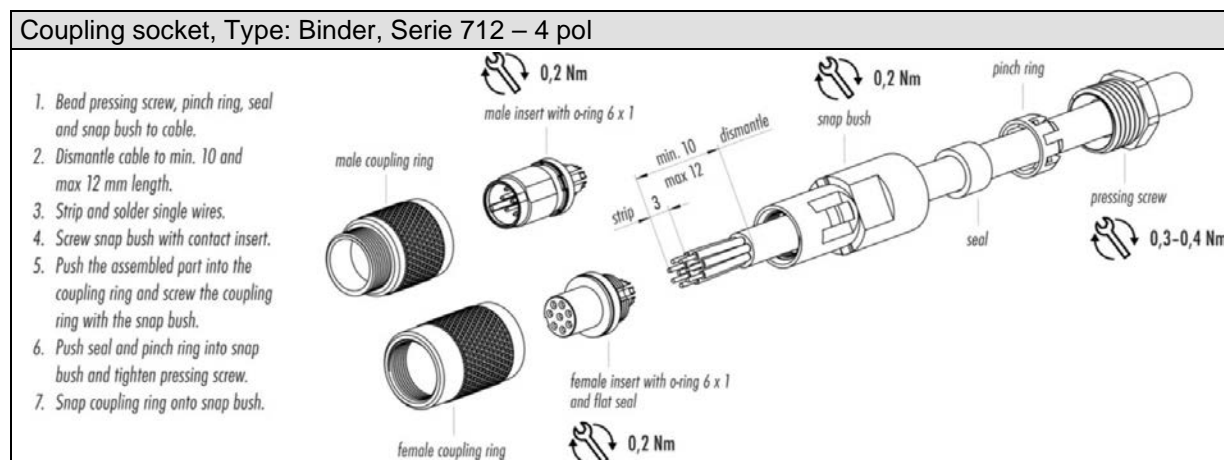
5.2.2 Connection recommendation for the cable shield

The connecting cable should always be laid separated from, e.g. main DC cables or AC cables. The connecting cable is to be laid so it is fixed. The minimum bending radius of 15 x cable diameter (\varnothing approx. 5mm) is to be observed. The voltage drop at the cable has to be considered when calculating the maximum cable length.

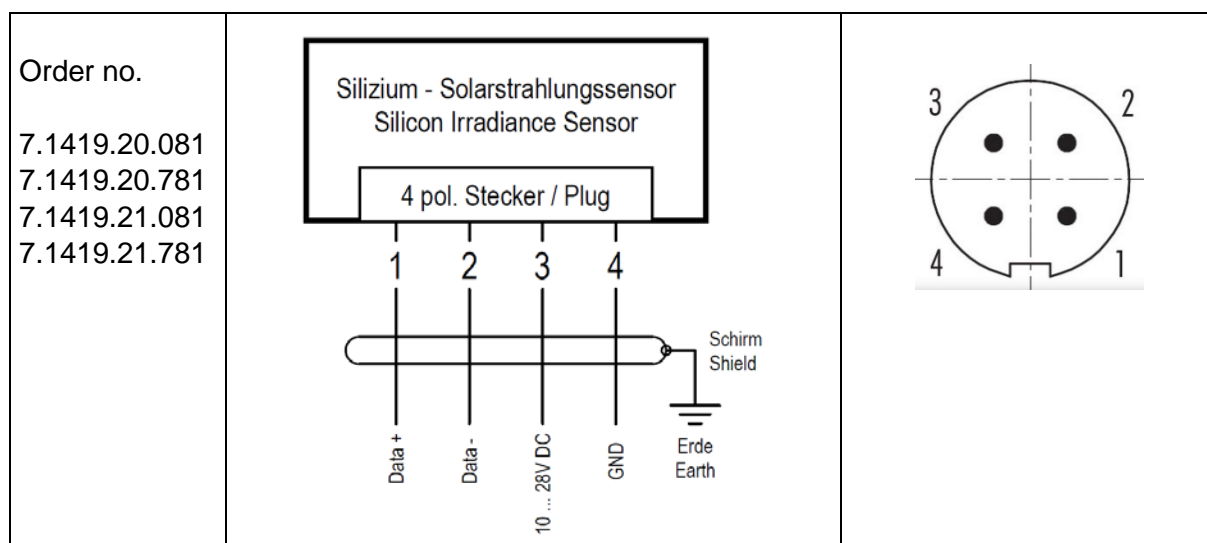
The pressure equalisation element must not be damaged. The cable gland is not allowed to be undone or tightened by the user. The housing for the Si sensors is not allowed to be opened, because as a consequence, the housing will no longer be sealed after it is closed. If the housing is nevertheless opened, no liability for the sealing can be accepted.

The surge protection concept must be adapted to the specific local situation. This means, for instance, that the measuring cables must be equipped with a separate surge arrester at the entry to a building. The sensor must be integrated into the lightning protection concept.

5.2.3 Plug and Cable Mounting



5.3 Connection Diagram



PIN	Wire color	Name	Function
1	White	Data+	RS485 Data +
2	Brown	Data-	RS485 Data -
3	Green	VCC	Power supply +10 ... 28V DC
4	Yellow	GND	Ground

6 Maintenance

Scope of the regularly check (at least every 2 years): Cleaning of solar cell, external damage, mechanical fastening, cable laying and any damage to the cable.

In the report IEA-PVPS T13-03: 2014 "Analytical Monitoring of Grid-connected Photovoltaic Systems" an interval of 1 to 2 weeks is recommended.

Should damage be found that degrades the function or safety, the sensor is to be replaced. A recalibration is recommended at least every 3 years.

7 Interface

The interface consists of an RS485 connection with the following settings:

- 9600 Baud (the Baud rate can be set).
- 8 Data bits.
- No parity.
- 1 Stop bit.
- Data in binary format (command interpreter: MODBUS RTU).

7.1 Supported Settings

Baud Rate: 1200, 2400, 9600, 19200, 38400, 57600)
 Parity: None, Even, Odd
 Stop Bit: 1, 2 (only at no parity)
 Factory Default: 9600 Baud, 8N1, address: 1

The sensor offers the function code 0x46 of the Modbus protocol for setting the bus protocol parameters. Should you need any further information, please do not hesitate to contact us..

7.2 Modbus Specification

References:

- Modbus over Serial Line Specification and Implementation Guide V1.02
- Modbus Application Protocol Specification V1.1b

Transfer mode:

- Modbus RTU.

Die Sensoren starten den Modbus-Betrieb 4 Sekunden nach dem Einschalten.

Supported short codes:

- 0x03: Read holding register
- 0x04: Read input register

Register	Value	Gain	Offset	Phys. Range	Data Range	Data Type
0000	Cell Temperature in W/m ²	0,1	0	0...1500W/m ² ¹	0...1500 ¹	UINT16
0003	Wind Speed in m/s	0,1	0	0...80m/s	0...800	UINT16
0007 ²	Cell Temperature in °C	0,1	0	-40...+90 °C	-400...+900	INT16
0008 ²	External Temperature no. 1 in °C	0,1	0	-40...+90 °C	-400...+900	INT16
0009 ³	External Temperature no. 2 in °C	0,1	0	-40...+90 °C	-400...+900	INT16

¹) Up to Firmware Version 1.52 is range 0...1400 W/m²

²) Only available from Firmware Version 1.53

³) Only available from Firmware Version 2.01

Note:

The Register 0003, 0008 and 0009 are optional for some sensor types. If your sensor does not support this register, it will return the value 0 for this register

0x08: Diagnostics

- Sub function 0x00: Return Query Data
- Sub function 0x01: Restart Communications Option
- Sub function 0x04: Force Listen Only Mode
- Sub function 0x0A: Clear Counters
- Sub function 0x0B: Return Bus Message Count
- Sub function 0x0C: Return Bus Communication Error Count - Sub function 0x0D: Return Slave Exception Error Count
- Sub function 0x0E: Return Slave Message Count
- Sub function 0x0F: Return Slave No Response Count
- Sub function 0x10: Return Slave NAK Count
- Sub function 0x11: Return Slave Busy Count
- Sub function 0x12: Return Bus Character Overrun Count

0x46: Communication Parameter

Info:

These settings will take effect after restart of the sensor by power on reset or restart communication command (function 0x08, Sub function 01).

Sub function 04: Write Module Address

Request:

00	Address	1 Byte	1 to 247
01	Function Code	1 Byte	0X46
02	Sub Function Code	1 Byte	0x04
03	New Address	1 Byte	1 to 247

Response:

00	Address	1 Byte	1 to 247
01	Function Code	1 Byte	0X46
02	Sub Function Code	1 Byte	0x04
03	New Address	1 Byte	1 to 247

- Sub function 05: Read Communication Parameter

Request:

00	Address	1 Byte	1 to 247
01	Function Code	1 Byte	0X46
02	Sub Function Code	1 Byte	0x05

Response:

00	Address	1 Byte	1 to 247
01	Function Code	1 Byte	0X46
02	Sub Function Code	1 Byte	0x05
03	Baud rate	1 Byte	0 to 4, see table below
04	Parity / Stop Bit	1 Byte	0 to 3, see table below

- Sub function 06: Write Communication Parameter

Request:

00	Address	1 Byte	1 to 247
01	Function Code	1 Byte	0X46
02	Sub Function Code	1 Byte	0x05
03	Baud rate	1 Byte	0 to 4, see table below
04	Parity / Stop Bit	1 Byte	0 to 3, see table below

Response:

00	Address	1 Byte	1 to 247
01	Function Code	1 Byte	0X46
02	Sub Function Code	1 Byte	0x05
03	Baud rate	1 Byte	0 to 4, see table below
04	Parity / Stop Bit	1 Byte	0 to 3, see table below

Communication Parameter Setting Sub Function 05 and 06

Baud Rate	Value
1200	0
2400	1
9600	2
19200	3
38400	4

Parity / Stop Bit	Value
8N1 (10 Bit)	0
8N2 (11 Bit)	1
8E1 (11 Bit)	2
8O1 (11 Bit)	3

Sub function 07: Hardware and Firmware Version

Request:

00	Address	1 Byte	1 to 247
01	Function Code	1 Byte	0x46
02	Sub Function Code	1 Byte	0x07

Response:

00	Address	1 Byte	1 to 247
01	Function Code	1 Byte	0x46
02	Sub Function Code	1 Byte	0x07
03	Hardware Version	2 Byte	0 to 65535
04	Firmware Version	2 Byte	0 to 65535

Sub function 08: Read Serial Number (from Firmware Version 1.54)

Request:

00	Address	1 Byte	1 to 247
01	Function Code	1 Byte	0x46
02	Sub Function Code	1 Byte	0x08

Response:

00	Address	1 Byte	1 to 247
01	Function Code	1 Byte	0x46
02	Sub Function Code	1 Byte	0x08
03 ¹	Serial Number	30 Byte	Char

- 1) In firmware versions 1.54 and 1.55, the length of the serial number is fixed at 20 bytes. If the serial number is shorter than 20 characters, the output is padded with "blank" (0x20).

The response for the "Read serial number" function consists of 30 characters and is structured as follows:

- Any "-" characters printed on the sensor label will be omitted.
- For serial numbers less than 30 characters, the output is padded with null bytes "\0" (0x00).

Example:

Serial number printed on the sensor label:

485-12003-17-20311234

Output of Read Serial Number Function:

485120031720311234\0\0\0\0\0\0\0\0\0\0\0\0

Output of Read Serial Number Function in hex:

3438 3531 3230 3033 3137 3230 3331 3132 3334 0000 0000 0000 0000 0000 0000

Identification of the sensor type based on the serial number:

Serial number beginning with	Sensor Type	Active Register
485-1	Si-RS485TC-T-MB	0000, 0007
485-2	Si-RS485TC-2T-MB	0000, 0007, 0008
485-3	Si-RS485TC-2T-v-MB	0000, 0003, 0007, 0008
485-4	Si-RS485TC-T-Tm-MB	0000, 0007, 0008

Code exceptions:

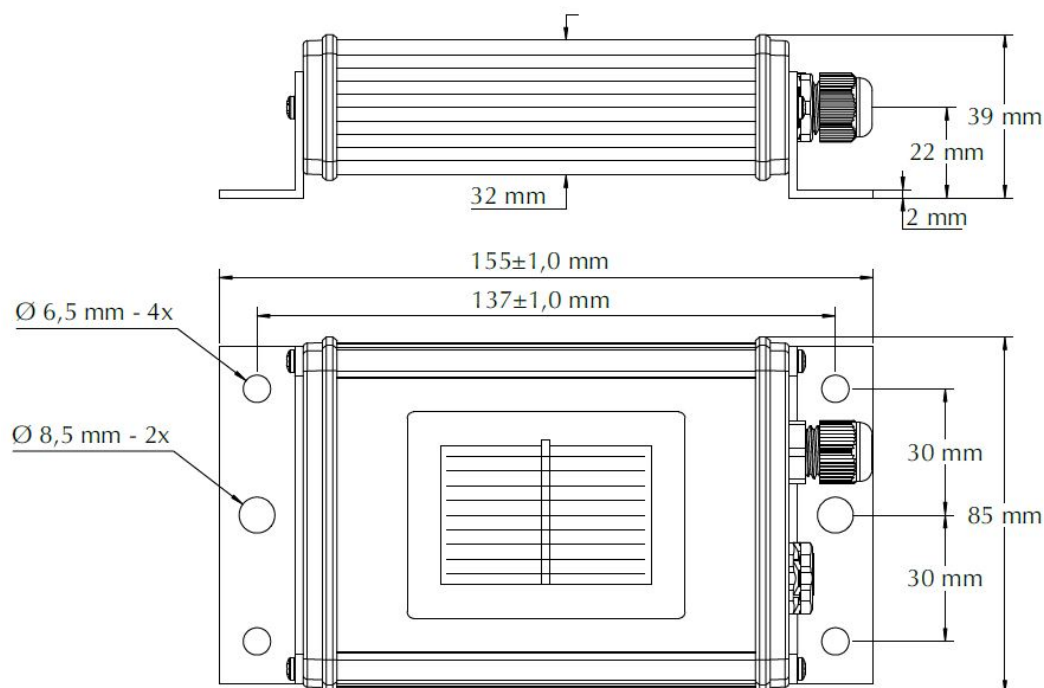
- 01: Illegal Function
- 02: Illegal Data Access
- 03: Illegal Data Value
- 04: Slave Device Failure

8 Technical Data

Characteristic	Description
Solar cell	Monocrystalline silicon; 50mm x 33mm
Measuring range irradiance	0 ... 1500W/m ²
Measurement uncertainty ¹ irradiance	±1W/m ² ± 2,0 % v. MW Range 100 to 1,500W/m ² , perpendicular incidence of light, Spectrum AM1.5
Measuring range temperature	-40 ... +90 °C
Measurement uncertainty ¹ temperature	1,0K in range -35 ... 80°C
Ambient conditions	-35 ... +80 °C 0 ... 100% rel. Humidity, including condensation
Operating voltage	24VDC (10 ... 28VDC)
Power consumption	Typ. 25mA @ 24VDC
Connection type	4-pin connector for shielded cable (see connection diagram)
Sensor cable	Cable 4 x 0,25mm ² LIYCY, Black, UV- resistant
Max. cable length	1.000m
Galvanic isolation	Up to 1.000V between supply and RS485
Dimensions	Acc. dimensional drawing.
Weight	ca. 350 up to 470g
Type of protection	IP 65
Material Housing	Powder-coated aluminum

1) according GUM (Guide to the Expression of Uncertainty in Measurement), k = 2

9 Dimensional Drawing



10 EC-Declaration of Conformity

Manufacturer: Adolf Thies GmbH & Co. KG
Hauptstraße 76
37083 Göttingen, Germany
<http://www.thiesclima.com>

Product: Solar irradiance incl. cell temperature sensor

Doc. Nr. 2018-44970_CE

Article Overview:

7.1419.20.081 7.1419.20.781 7.1419.21.081 7.1419.21.781

The indicated products correspond to the essential requirement of the following European Directives and Regulations:

2014/30/EU	26.02.2014	DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility.
2017/2102/EU	15.11.2017	DIRECTIVE (EU) 2017/2102 of the European Parliament and of the Council of November 15, 2017 amending Directive 2011/65 / EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
2012/19/EU	13.08.2012	DIRECTIVE 2012/19/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4 July 2012 on waste electrical and electronic equipment (WEEE).

The indicated products comply with the regulations of the directives. This is proved by the compliance with the following standards:

Göttingen, 13.02.2023



General Manager - Dr. Christoph Peper



Development Manager - ppa. Jörg Petereit

This declaration of conformity is issued under the sole responsibility of the manufacturer.

This declaration certifies the compliance with the mentioned directives, however does not include any warranty of characteristics.

Please pay attention to the security advises of the provided instructions for use.

11 More Information / Documents as download

These document are available for download under the following links.

Instruction for use

https://www.thiesclima.com/db/dnl/7.1419.2x.xxx_Silicon_Irradiance_Sensor_en.pdf

**Please contact us for your system requirements.
We advise you gladly.**

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