Pyranometer

JW-TBQ-2L(LC17)

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1. Product Introduction

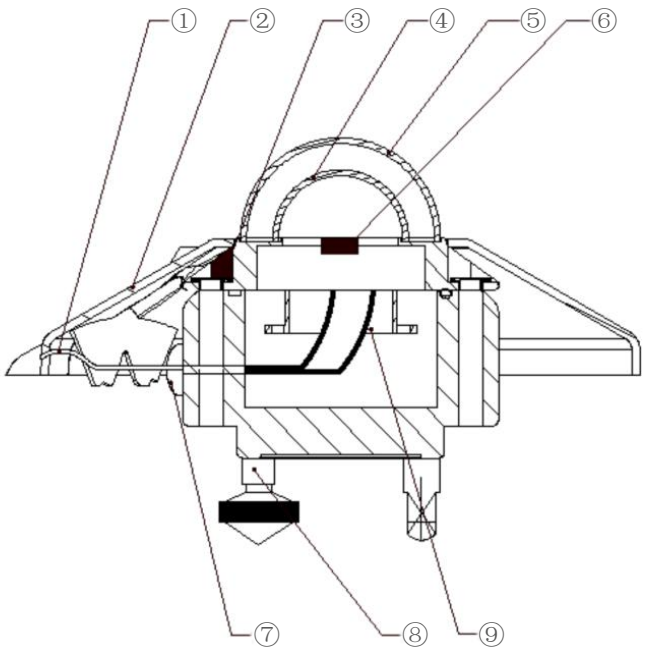
TBQ total radiation sensor is a short-wave total radiation sensor used for solar radiation observation. It is a first-class total radiation sensor that complies with the latest ISO9060 and WMO technical standards.

TBQ total radiation sensor is used to measure the solar radiation received by the horizontal plane from a solid angle of 2π steradians (hemispheric direction). The unit is W/m^2. The TBQ total radiation sensor operates completely passively, using a thermopile sensor to generate an output voltage proportional to the incident radiation flux. Due to the use of two spherical glass covers, measurement errors, especially thermal offset, are reduced, so the sensor has high measurement accuracy.

The use of the TBQ total radiation sensor is very simple. You only need a high-precision voltmeter to read the measurement data. When calculating incident irradiance, the output voltage is divided by the sensitivity. Each sensor will provide corresponding sensitivity data when it leaves the factory. The TBQ total radiation sensor can be connected to most commonly used data acquisition systems. The TB total radiation sensor can be used for meteorological observations, building physics, climate and solar light collection experiments. A common application is as part of a weather station to measure outdoor solar radiation.

2. Working Principle

TBQ total radiation sensor uses the black coating on the sensor to absorb solar radiation. The radiation is converted into heat energy and enters the interior of the sensor, forming a temperature difference at both ends of the thermopile, thereby generating a voltage output signal proportional to the incident solar radiation. The structure diagram of TBQ total radiation sensor is shown in Figure 1:



(1) Cable (standard length 5 meters)

(2)Protective cover

(3)Level bubble

(4) Quartz glass inner cover

(5)Quartz glass cover

(6) Thermopile sensor with black coating

(7) Cable waterproof head

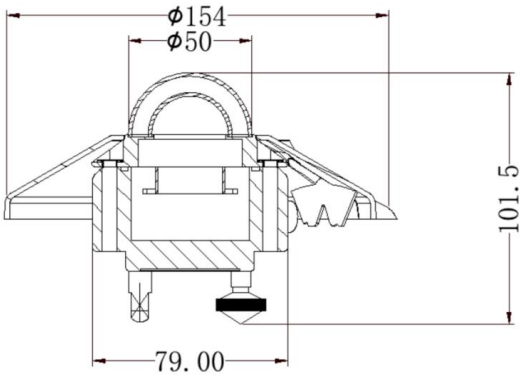
(8)Level adjustment feet

3. Technical Parameters

The TBQ series total radiation sensor is used to measure the solar radiation received by the horizontal plane from a solid angle of 2π steradians (hemispheric direction), in W/m^2. The TBQ total radiation sensor adopts a completely passive working mode, using the black coating on the sensor surface to absorb incident solar radiation and convert it into heat energy, creating a temperature difference at both ends of the sensing device, thereby generating a radiation that is proportional to the amount of incident radiation. the output voltage. The main technical indicators of the TBQ total radiation sensor are as shown in Table 1:

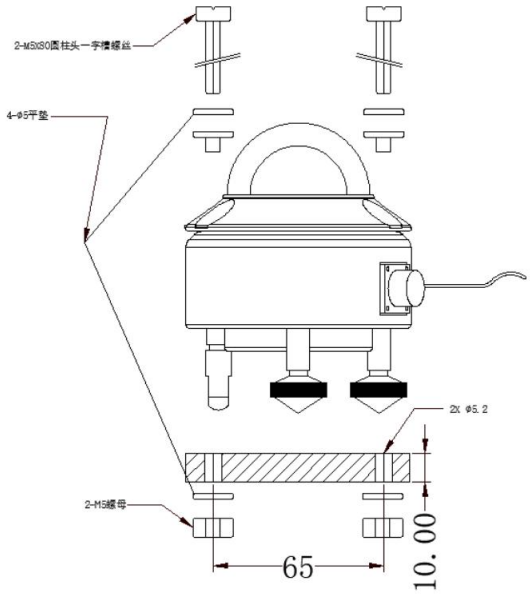
ISO/WMO technical indicators	JW-TBQ-2H(LC25)	JW-TBQ-2L(LC17)
Classified according to ISO 9060/WMO standards	Class A/Good quality	Class B/Good quality
Response time (95% response)	<5s	<10s
Internal resistance	<30Ω	<50Ω
Daily radiation exposure uncertainty	±1%	±2%
Zero offset: (a) Corresponds to 200W/m^2 net thermal radiation (ventilation)	<15W/m^2	
Zero offset: (b) Response corresponding to a 5K/h change in ambient temperature	<4W/m^2	
Stability (change/year, % of full scale)	±1.5%	
Nonlinear	±1%(100~1000 W/m^2)	
Directional response	±20W/m^2	
Temperature response	<4%(−10~40℃)	
Tilt response	<2%	
Sensitivity range	7−14μV/(W/m^2)	
Operating temperature	−40～+80℃	
Measuring range	0~2000W/m^2	
Power consumption	<0.6W(RS485);<0.96W(4−20mA)	
Cable replacement	Users can remove and install cables	
Spectral range	280~3000 nm (50% transmission point)	
Reading request	One differential voltage channel or one single-ended voltage channel	
Horizontal calibration	Includes level bubble and adjustment feet	
Calibration traceability	Traceability WRR, procedures are in accordance with ISO9847	
Recommended calibration period	once every two years	
Standard cable length	3m(default), other length on request	
Weight (excluding cables)	0.8kg	
Power Supply	DC12~24V	
Output Signal	RS485, 4~20mA(DC12~24V) 0~20mV raw output(need not power supply)	

4. Product Dimension



Unit:mm

5. Installation Instruction



Unit:mm

[1] The goods should include the following items:

Pyranometer (including cable)	1 unit
Fixing screws	1 set

Lens cleaning cloth	1 piece
User manual	1 copy(PDF)

[2] After checking that the appearance of the sensor is intact, do a simple test on its performance. The testing instrument can be carried out with a handheld multimeter:
Detect the sensor impedance between the red (+) wire and the black (-) wire. The resistance value scale of the multimeter should be within the 200Ω range. First take a polarity value, exchange the polarity and measure again, and take the average value as the measured value. The typical resistance value of the wire is 0.1Ω/m. Typical impedance measurements should be less than 200 ohms. Infinite impedance indicates an open circuit; zero impedance indicates a short circuit.
Check whether the sensor responds to light: Set the multimeter to the most sensitive setting for DC voltage measurement, usually 100mV or less. Expose the sensor to a strong light source, such as a 10cm distance from a 100-watt light bulb, and a voltage signal of several millivolts can be detected. Cover the sensor with an opaque cloth or turn off the lights, and the instrument's voltage output will drop and approach zero millivolts within a minute.

[3]Sensor installation:
The TBQ series total radiation sensor is usually installed horizontally, but it can also be installed tilted or upside down. Regardless of the installation method, the sensor measures the amount of radiation incident on a plane parallel to the surface of the sensor's sensing surface.
The installation position of the total radiation sensor should have a wide view, especially during the year, there should be no obstruction greater than 5° at the sunrise and sunset directions. It can be installed on the ground or on a rooftop platform, and a dedicated column or platform should be set up. A metal plate slightly larger than the base of the total radiation sensor is fixed on the upper part of the platform, and the contact surface with the instrument is well insulated. The column platform is about 1.5m away from the ground and must be strong. Even if it is subject to severe shock and vibration (such as strong wind, etc.), the horizontal state of the instrument will not be changed. For more accurate measurements, we recommend users use a heated vent hood.
The direction of the terminal of the instrument is facing north. Use screws to initially fix the instrument on the mounting plate. Then use the level bubble attached to the instrument to adjust the adjusting feet on the base so that the sensing surface of the total radiation sensor is in a horizontal state, and then fix the mounting screws. TBQ fixed installation precautions are shown in Table 2

Table 2 Precautions for fixed installation of TBQ series total radiation sensors	
mechanical fixation	Use the screws in the accessory to fix the total radiation sensor to the mounting base plate.
Installation location	Avoid placing objects between the path of sunlight and the instrument to prevent shadows on the instrument.
Horizontal calibration	If it is fixed horizontally, using the level bubble on the instrument requires patiently adjusting the leveling feet several times.
Installation	The terminal faces north.

direction	
Installation height	If installed upside down, WMO recommends installing it at a height of no less than 1.5 meters from the ground.
Tilt	Usually mounted horizontally, but in some applications it can be mounted tilted or upside down. In each case it measures the solar radiation flux incident on the surface of an area parallel to the sensor surface.

6. Wiring Definition

For RS485 output, cable is a 4-core wire, and the wire sequence definition:

Red	Black	Yellow	Green
Power+(DC12~24V)	GND	RS485_A	RS485_B

For 0~20mV raw output, cable is a 3-core wire, and the wire sequence definition:

Red	Black	Yellow
Voltage+	Voltage-	Internal Resistance

Note: when 0~20mV raw output, just connect red and black wire, no connection required for yellow wire.

For 4-20mA raw output, cable is a 3-core wire, and the wire sequence definition:

Red	Blue	Yellow
Voltage+	GND	4-20mA input

Note: when 0~20mV raw output, just connect red and black wire, no connection required for yellow wire.

7. Modbus Protocol Communication

7.1 Data Format

The default data format for Modbus communication is:

Slave Address (Default)	Baud Rate	Data Bit	Stop Bit	Parity
0x01	9600	8	1	None

Note: Default slave address is 0x01 and baud rate is 9600 and can be modified as request.

7.2 Function Code

The sensor supports 2 function codes in standard Modbus: 0x03, 0x10

Function Code	Description
0x03	Read register
0x10	Write register

7.3 Register Address

Register Address(HEX)	Name	Read & Write	Data type	Data Length	Remarks
0x0000	Radiation	R	UINT16	2 Bytes	Unit:W/m²
0x0501	Device Address	R/W	UINT16	2 Bytes	1~255, default is 1
0x0503	Baud Rate	R/W	UNIT16	2 Bytes	0x01: 4800 0x02: 9600(Default) 0x03: 19200 0x04: 38400 0x05: 57600 0x06: 115200

7.4 Communication Example

Here is an example of how to access system registers using the Modbus RTU command:

7.4.1 Read one or multiple registers(Function code: 0x03)

[1] Read radiation value

Host Command:

Device Address	Function Code	Register Address (H)	Register Address (L)	Register Quantity (H)	Register Quantity (L)	CRC16 (L)	CRC16 (H)
0x01	0x03	0x00	0x00	0x00	0x01	0x84	0x0A

Slave Response:

Device Address	Function Code	Byte Quantity	Data (L)	Data (H)	CRC16 (L)	CRC16 (H)
0x01	0x03	0x02	0x00	0x6F	0xF8	0x68

Note: 0x006F means radiation value is 111W/m²

7.4.2 Write register (Function code: 0x06)

[1] Modify device address from 0x01 to 0x02

Host Command:

Device Address	Function Code	Register Add. (H)	Register Add. (L)	Register Quantity (H)	Register Quantity (L)	Byte Quantity	Data (H)	Data (L)	CRC16 (L)	CRC16 (H)
0x01	0x10	0x05	0x01	0x00	0x01	0x02	0x02	0x00	0xF3	0xE1

Slave Response:

Device	Function	Register	Register	Byte	Byte	CRC16	CRC16

Address	Code	Address (H)	Address (L)	Quantity (H)	Quantity(L)	(L)	(H)
0x01	0x10	0x05	0x01	0x00	0x01	0x50	0xC5

Note: modification value shall be in the high byte rather than low byte when sending host command.

[2] Modify baud rate from 9600 to 19200 (device address is 0x01)

Host Command:

Device Address	Function Code	Register Add. (H)	Register Add. (L)	Register Quantity (H)	Register Quantity (L)	Byte Quantity	Data (H)	Data (L)	CRC16 (L)	CRC16 (H)
0x01	0x10	0x05	0x03	0x00	0x01	0x02	0x03	0x00	0xF3	0x93

Slave Response:

Device Address	Function Code	Register Address (H)	Register Address (L)	Byte Quantity (H)	Byte Quantity (L)	CRC16 (L)	CRC16 (H)
0x01	0x10	0x05	0x03	0x00	0x01	0xF1	0x05

Note: modification value shall be in the high byte rather than low byte when sending host command.

8. Maintenance and Troubleshooting

8.1 Maintenance

(1) When the glass cover is contaminated, use a soft cloth moistened with water or alcohol to clean the glass cover; check the inside of the ball glass cover to see if there are condensed water droplets. If so, return it to the factory for repair;
(2) Check the horizontal status. When the horizontal status of the sensor changes, you need to loosen the fixing screw and readjust the level adjustment foot until the sensor is level and then tighten the fixing screw;
(3) Check whether the cable is damaged to prevent open circuit;
(4) Strictly check the data. Functional errors usually manifest as abnormal measurement values. Strictly checking the measurement data is the best daily maintenance;
(5) Calibrate again, it is recommended to calibrate once every two years.

8.2 Fault diagnosis

When the sensor does not work properly, perform fault diagnosis according to Table 3.

Table 3 Sensor fault diagnosis	
Sensor has no output signal	1. Measure the impedance of the wires at both ends of the sensor. This value should be less than 200 ohms. If the value is close to zero, it indicates a short circuit (check the wires), and if the value is infinite, it indicates an open circuit (check the wires). This check can also be performed when the sensor is covered; 2. Use a lit incandescent lamp to check the sensor's response. A 100-watt bulb held

	10 cm away from the sensor can produce a certain degree of response: 3. Check the data acquisition by applying a millivolt signal source to the sensor in the 1 millivolt range.
The sensor signal is abnormally high or low.	1. Check whether the correct sensitivity coefficient is entered in the algorithm. Each sensor has its own specific sensitivity coefficient: 2. Check whether the algorithm ϕ=U/E is correct and check the wiring status of the data collector; 3. Check whether the cable is broken; 4. Check the reading range of the data collector. The heat flow rate can be a negative value (which is beyond the reading range) or the amplitude can exceed the reading range; 5. Check the data collector by applying a millivolt signal source to the sensor within the millivolt reading range.
Sensor signal shows unexpected fluctuations	1. Check whether there is a strong electromagnetic radiation signal source (radar, radio, etc.) nearby; 2. Check the shielding situation; 3. Check the connection status of the sensor cable.