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KIPP & ZONEN PYRANOMETER INTERFACE OPTIONS

Kipp & Zonen manufactures two ranges of thermopile-type pyranometers: the 'Classic' CMP series and the 'Smart' SMP series. All CMP and SMP pyranometers, and AMPBOX, have a 5-year factory warranty.

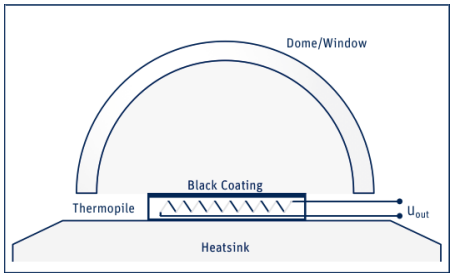
Kipp & Zonen pyranometer classifications according to ISO 9060

ISO 9060:2018	Class C	Spectrally Flat Class C	Spectrally Flat Class B	Spectrally Flat Class A
ISO 9060:1990	Not allowed	Second Class	First Class	Secondary Standard
Performance	Lower	→	→	Higher
Passive pyranometers	SP Lite2 (Fast Response)	CM4 CMP3	CMP6	CMP10 CMP11 CMP21 CMP22
Smart pyranometers	RT1	SMP3	SMP6	SMP10 SMP11 SMP21 SMP22

CMP Pyranometers

These models have no active electronics inside them and do not require any power to operate, connecting power to them will damage the instrument. The thermopile detector generates a small continuous voltage in proportion to the radiation received by the black absorbing surface.

Each pyranometer has a unique sensitivity, defined during the calibration process (usually at around +20°C), which is used in a field data logger mV input configuration to convert the pyranometer output signal into irradiance in W/m^2.



The sensitivity changes with temperature and the response has a third-order polynomial function. CMP10, 11, 21 and 22 have an internal compensation circuit, CMP3 and CMP6 do not.

The thermopile output signal is in the order of 10 µV (microvolts) per W/m^2 of solar irradiance, so on a sunny day of 1000 W/m^2 the output will be around 10 mV (millivolts). This means that in order to see changes of 1 W/m^2 the data logger input must be able to accurately measure 10 µV, this generally means a 'scientific' type of logger.

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Up to 100 m of good quality instrument cable can be used without affecting the measured values, provided that the input impedance of the following amplifier or data acquisition device is >1 MΩ.

CMP models are ideal where power is limited and/or where lightning is likely. Because there are no active electronics inside, they are quite difficult to damage. When recalibrated the new sensitivity must be entered into the data logger configuration.

CMP Pyranometers and AMPBOX

For installations where cables longer than 100m are required and/or the data logger does not have sufficient resolution/accuracy CMP pyranometers can be bought in combination with our AMPBOX 4-20 mA signal amplifier. For example: p/n 0379900-802 CMP10 Pyranometer • AMPBOX • 10 m cable.

The pyranometer connects to the AMPBOX through a cable gland and screw terminals, the 10m pyranometer cable can be shortened if desired (it does not affect the readings). The AMPBOX is programmed with the sensitivity of that pyranometer such that 0-1600 W/m^2 of irradiance is represented by 4-20 mA. The resolution is 0.1 W/m^2.

This means that a pyranometer and AMPBOX are a pair and the AMPBOX label states the model, serial number and sensitivity of the matching pyranometer; and they need to be recalibrated as a pair. When this is done there is no need to change the data logger settings.

AMPBOX requires 7.2 VDC across its 4-20 mA connection terminals to operate and it is powered by the current flowing in the loop. There are only 2 wires back to the data logger, where 12 or 24 VDC is supplied to power the loop. AMPBOX is 'current sink', it controls the flow of current in the loop. The input from the pyranometer is isolated and therefore it is unlikely to be damaged by surges on the 4-20 mA cable.

It is also possible to produce a voltage signal by placing a precision 'shunt' resistor with a low temperature coefficient in the current loop at a suitable data logger voltage input. For example, 4-20 mA through a 50 Ω resistor produces 0.2 V to 1 V and a 500 Ω resistor produces a 2 V to 10 V range.

Up to 1000 m of good quality shielded twisted pair control cable can be used, depending upon the resistive load and the supply voltage.

Advantages of the CMP + AMPBOX combination are that no power supply is needed at the installed location, only at the data logger, and that a voltage can be produced at the logger using long cables without signal loss.

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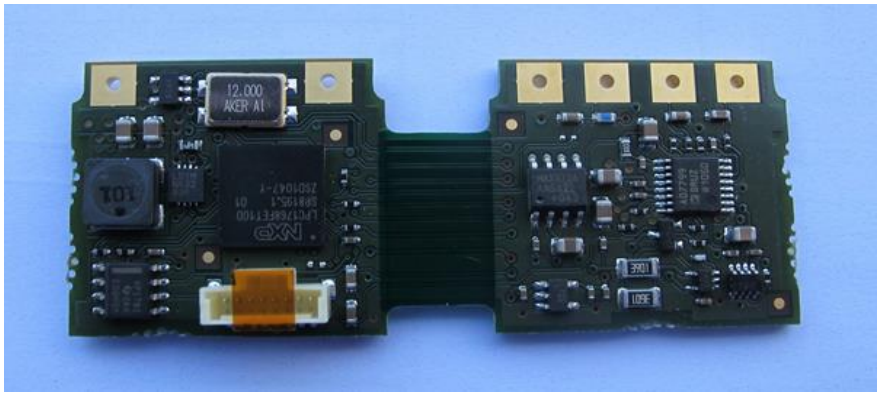
SMP Pyranometers

Our range of Smart pyranometers have the same detectors as the equivalent CMP models but with built-in digital signal processing, therefore they require external power to operate. This can be in the range from 5 V to 30 V DC, usually the site power available is 12 V or 24 V DC. The firmware has a feed-forward algorithm to speed up the response time and an internal temperature sensor provides data for the digital third-order polynomial temperature correction.



SMP pyranometers have 2-wire RS-485 serial communication using Modbus® RTU protocol (binary encoding) and are addressable for connection into a network of compatible devices. RS-485 cable lengths can be up to 1000m (depending on baud rate, number of devices connected and the bus topography). Use good quality RS-485 compatible shielded twisted pair (STP) cable with a third 'common' wire that is not connected to the cable shield. Normal RS-485 requirements regarding termination resistors and pull-up/pull-down resistors apply.

The calibration date and sensitivity are programmed into the instrument memory, it holds up to 10 sets of calibration information. Firmware uses the most recent stored sensitivity to convert the detector output into irradiance values in W/m^2 for a data acquisition system to read from the appropriate register, which is updated once per second. The internal temperature and the power supply voltage are also available.

There is also an analog output that is derived from the serial irradiance value through a digital-to-analog converter and an amplifier. Both serial and analog outputs can have a resolution of 0.1 W/m^2.

SMPXX-V models have RS-485 Modbus® and 0-1 V analog (representing -200 to 2000 W/m^2).
100m of good quality shielded 2-core signal cable can be used without affecting the analog values.

SMPXX-A models have RS-485 Modbus® and 4-20 mA analog (representing 0 to 1600 W/m^2).
Because the SMP is powered locally it is pushing 4-20 mA into the current loop, 'current source'.
Up to 1000 m of good quality shielded twisted pair control cable can be used, depending upon the resistive load and the supply voltage.

As described above for the AMPBOX, SMPXX-A can be used with a shunt resistor at the data logger to produce a voltage signal over long cables.

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Because of the microprocessor and other sensitive electronics inside the SMP models, care needs to be taken with ESD protection (proper grounding) and the installation of external surge protection devices for power and data/signal connections is highly recommended.

Note: The RS-485 Modbus® and analog outputs should NOT be connected at the same time, except (with care) for test purposes. This can cause ground-loop and common-mode issues and make the electronics more susceptible to surge/ESD damage.

Measurement Differences Between CMP and SMP Models

We will take as an example the popular CMP10 and SMP10 models, which both have internal desiccant that will last up to 10 years. They look the same, except that CMP10 has 2 wires in the cable and 2 pins in the connector, whereas SMP10 has 8 wires and 8 pins. CMP10 does not require power, SMP10 does.

Both are ISO 9090:1990 Secondary Standard pyranometers and ISO 9060:2018 Spectrally Flat Class A pyranometers and both meet the requirements of IEC 61724-1 for Class A PV plant monitoring.

The thermopile detector is the same in both models and so is the calibration uncertainty, typically ±1.4% at the 95% confidence interval (k=2). In most cases there is no significant difference in the overall uncertainty of the measurements made in the field, in non-extreme temperatures both CMP10 and SMP10 are capable of measuring the daily total of irradiance with an uncertainty of around ±2%

The differences lie in the digital signal processing of the SMP10; the change in sensitivity with temperature compared to the sensitivity at +20°C (temperature response) and the response time.

The 95% response time of CMP10 is 5 seconds, SMP10 is digitally accelerated to 2 seconds. However, typically in PV plant monitoring the output value is sampled every 1-3 seconds and the 1-minute average is recorded. It is unlikely that any difference will be seen in the 1-minute averages from the two models. Performance Ratio (PR) calculations are normally based on daily totals of plane of array (POA) irradiance and over this period the difference in response time has no effect.

The temperature response of the CMP10 is within 1% from -10°C to +40°C. ISO 9060:2018 requires that Class A pyranometers must be individually tested for temperature response over this range and the test report is supplied with each pyranometer, so the actual response can be seen. However, the passive temperature compensation circuit in CMP10 is not a perfect match for the third-order polynomial function and the deviations become larger outside this temperature range.

The SMP10 has a digitally implemented temperature correction that is more accurate than the CMP10 compensation circuit. It is within 1% from -20°C to +50°C and 2% from -40°C to +70°C. This means that the SMP10 will have lower overall measurement uncertainty than CMP10 at more extreme low and high temperatures.

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