

- Determine PV performance losses due to soiling
- Calculation of the Soiling Loss Index (SLI) and Soiling Ratio (SR)
- Measurement of short circuit current and module surface temperature



Soiling significantly affects the energy production of PV power plants. Effects of soiling on PV modules should be assessed site-specific due to variations in soil type, location and weather patterns. Implementing an Ammonit soiling measurement kit helps you to:

- Analyse soiling losses in the PV module performance
- Quantify site-specific impacts of soiling on PV energy production
- Optimize cleaning routines for best return-on-investment
- Determine typical soiling rates for forecasting models

Soiling is the accumulation of dust, dirt and other contaminants on the surfaces of PV modules. The amount of dust is extremely dependent on the location of the PV power plant, e.g., desert valley with sand storms. In absence of significant rain events or regular cleaning, production losses due to soiling effects increase. Measuring soiling effects provides important details about the PV power plant production, e.g., how much dust can be on the modules before any problem occurs and how does the dust affect transparency and efficiency of the modules.

Plane of Array (POA) irradiance, Soiling Ratio (SR) and Soiling Loss Index (SLI)

The temperature-corrected short-circuit current of a clean PV module is proportional to the irradiance. After measuring short-circuit current and temperature of the PV module, the **POA irradiance** can be determined using the following equation:

$$G = \frac{G_0 \cdot I_{SC} \cdot (1 - TK_{I_{SC}} \cdot (T - T_0))}{I_{SC0}}$$

- G: POA irradiance reaching the solar cells
- G₀: Irradiance at reference conditions
- I_{SC}: Measured short circuit current of the PV module
- I_{SC,0}: Short circuit current of the reference PV module
- T: Surface temperature of the PV module
- T₀: Surface temperature of the reference PV module
- TK_{I_{SC}}: Temperature coefficient of short circuit current

The **Soiling Ratio SR_{I_{SC}}** index is a metric for the loss in the irradiance reaching the PV modules due to soil accumulation, reducing the transmission of the PV glass (SR_{I_{SC}} = 1 when clean). It compares the actual measured value of the soiled PV module with the expected output.

$$SR_{I_{SC}} = \frac{I_{SC}^{Soiled}}{I_{SC0} \cdot (1 + TK_{I_{SC}} \cdot (T^{Soiled} - T_0)) \cdot \left(\frac{G}{G_0}\right)}$$

- G: POA irradiance of the clean PV module
- I_{SC}^{Soiled}: Measured short circuit current of the soiled PV module
- T^{Soiled}: Measured temperature of the soiled PV module

The **Soiling Loss Index SLI** is a metric for the loss in the irradiance, based as well on the measurement of PV module short-circuit current and surface-temperature, expressed as a percentage (SLI = 0% when clean). The SLI is calculated from the irradiance of a clean and a soiled modules as follows:

$$SLI = \left(1 - \frac{G_{Clean}}{G_{Soiled}}\right) \times 100$$

- G_{Clean}: POA irradiance of the clean PV module
- G_{Soiled}: POA irradiance of the reference PV module

Measuring soiling effects

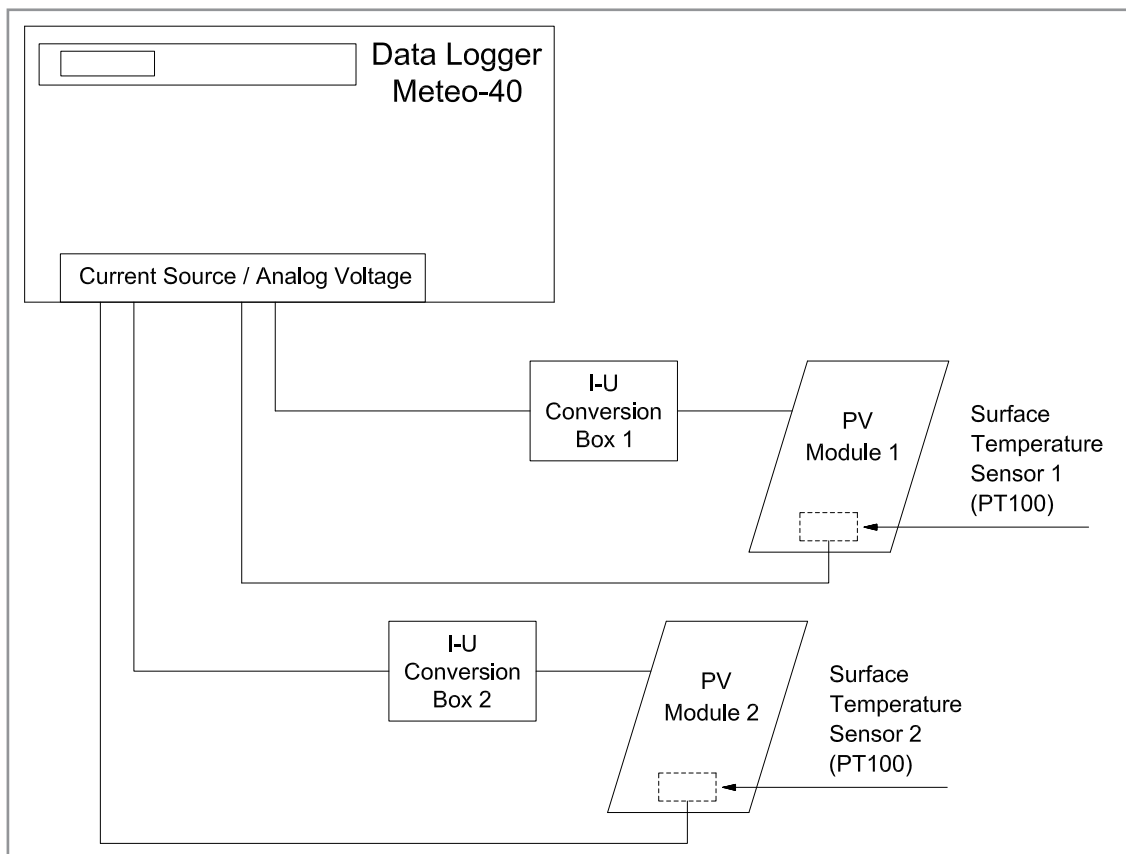
The Ammonit soiling measurement kit compares power output and surface temperature of a naturally-soiled PV module with the data of a clean reference PV module. The measurement station determines local solar irradiation for power output parameter evaluation as well as the module surface temperature from the backside of each PV module.

The Ammonit soiling measurement kit includes the following components:

Amount	Component	Order No.
2	Ammonit I-U Conversion Box	CM8281
2	Surface Temperature Sensor	S68920
2	PV Module (30 W)	M51030

Furthermore, we recommend measuring type and amount of precipitation as well as environmental factors such as pollution. The tilt angle of the PV modules should also be considered in the calculations, as well as existing cleaning plans.

Scheme of Ammonit Soiling Measurement Solution



Specifications
**I-U Conversion Box
Order No. CM 8281**

Characteristic	Description
Continuous current*	15 A
Peak current	40 A
Shunt resistance	50 mΩ**
Shunt tolerance	1 %
Shunt temperature coefficient	< 50 ppm/K (20 ... 60 °C)
Max. input voltage ***	48 V
Max. operating temperature @ 16 A	60 °C (if ventilated)
Dimensions	160 x 100 x 80 mm

- * Corresponding to max. short circuit current of a solar module
 ** Other values are possible according to technical requirements
 *** Corresponding to the max. open circuit voltage of a solar module

**Surface Temperature Sensor
Order No. S68920**

Characteristic	Description
Sensor type	Pt 100 class B
Sensor capture	Silicon rubber patch
Temperature range	-50 ... 150 °C
Dimensions	40 x 13 x 5 mm

**Solar Module (30 W / 12 V)
Order No. M51030**

Characteristic	Description
Module type	Monocrystalline
Standard Test Conditions (STCs) Solar irradiance Cell temperature	1000 W/m ² 25 °C
Peak Power (Pmax)	30 W
Short circuit current (I _{sc})	1.91 A
Temperature coefficient of I _{sc} (TK I _{sc})	0.06 %/°C
Dimensions / Weight	633 x 427 x 34 mm / approx. 4 kg (without cable)