Solarcheck string monitoring

User manual

User manual

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2013-06-14

Designation: UM EN Solarcheck String Monitoring

Revision: 00

This user manual is valid for:

Designation	Order No.
SCK-C-MODBUS	2901674
SCK-M-I-8S-20A	2903241
SCK-M-I-4S-20A	2903242
SCK-M-U-1500V	2903591

Please observe the following notes

User group of this manual

The use of products described in this manual is oriented exclusively to:

– Qualified electricians or persons instructed by them, who are familiar with applicable standards and other regulations regarding electrical engineering and, in particular, the relevant safety concepts.

– Qualified application programmers and software engineers, who are familiar with the safety concepts of automation technology and applicable standards.

Explanation of symbols used and signal words

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety measures that follow this symbol to avoid possible injury or death.

There are three different categories of personal injury that are indicated with a signal word.

DANGER This indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING This indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION This indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

This symbol together with the signal word **NOTE** and the accompanying text alert the reader to a situation which may cause damage or malfunction to the device, hardware/software, or surrounding property.

This symbol and the accompanying text provide the reader with additional information or refer to detailed sources of information.

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1 Introduction

1.1 Product overview

Solarcheck is a modular monitoring system for photovoltaic systems. It consists of a communication module (SCK-C-MODBUS, Order No. 2901674) and various measuring modules for current and voltage measurement.

The communication module collects the data from all connected measuring modules and forwards it to a higher-level controller via Modbus RTU using an RS-485 connection.

At the same time, the connected measuring modules are supplied with power via the communication cable (SCK BUS) between the measuring modules and the communication module.
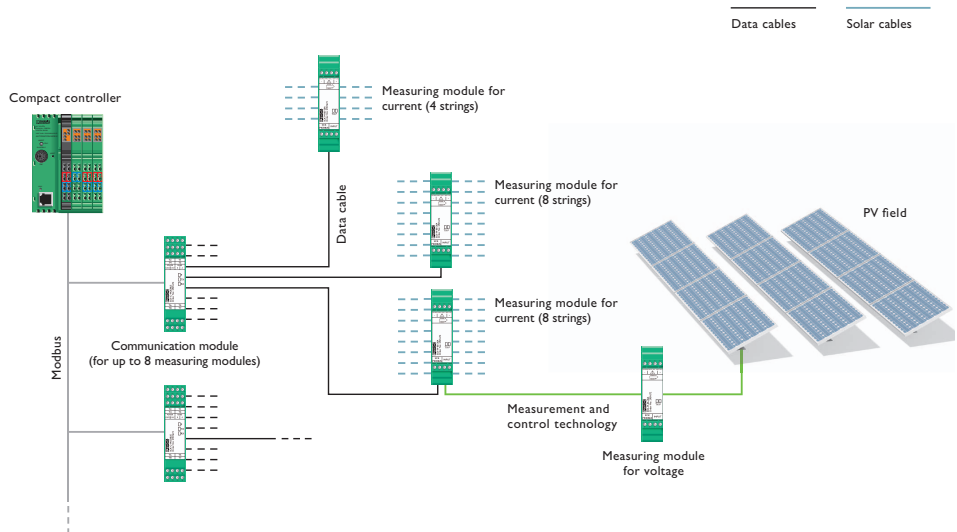
Figure 1-1   Solarcheck topology

1.2 Area of application

The Solarcheck device range is designed for use in medium to large PV systems and PV power stations. Currents up to 20 A, reverse currents, and voltages up to 1500 V can be acquired. Even at the lowest level of utilization (one communication device with maximum assignment of measuring device connections), it is possible to monitor 64 strings of a PV system.

With an average string power of approximately 4 kW, it is therefore possible to monitor a segment of approximately 250 kW with just this basic design.

Typically the communication devices in a PV system are positioned centrally in a control room. The measuring modules are located in string combiner boxes in the field. The internal communication protocol enables the connected measuring modules to be supplied with power via the communication cable. As a result, an additional power supply is not required for the measuring devices in the field.

1.3 General safety notes

- Installation, operation, and maintenance may only be carried out by qualified electricians. Follow the installation instructions as described. When installing and operating the device, the applicable regulations and safety directives (including national safety directives), as well as generally approved technical regulations, must be observed. The safety data is provided in this user manual and on the certificates (conformity assessment, additional approvals where applicable).
- The devices are only to be used as described here. Phoenix Contact accepts no liability if the devices are used for anything other than their designated use. Any use other than the designated use may lead to malfunction or irreversible damage of the devices.

NOTE: Electrostatic discharge

The devices contain components that can be damaged or destroyed by electrostatic discharge. When handling the device, observe the necessary safety precautions against electrostatic discharge (ESD) according to EN 61340-5-1 and EN 61340-5-1.

NOTE: Degree of protection

The IP20 protection (IEC 60529/EN 60529) of the devices is intended for use in a clean and dry environment. Install the module in housing with at least IP54 protection according to EN 60529. The stated limits concerning mechanical or thermal loads on the modules must not be exceeded.

WARNING: Risk of electric shock

Do not install voltage measurement while the system is in operation. High voltages may be present in parts of the system even in diffuse daylight. Observe all statutory requirements for live working.

2 General notes on PV systems

2.1 Typical structure of large PV systems and PV power stations

PV generator with central inverter
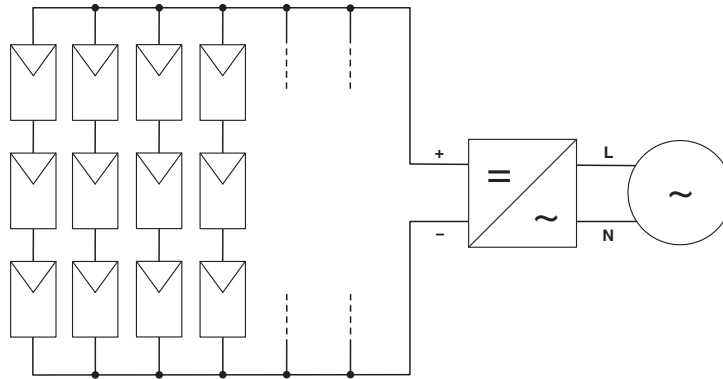
Figure 2-1   PV generator with central inverter

Generator with string inverters
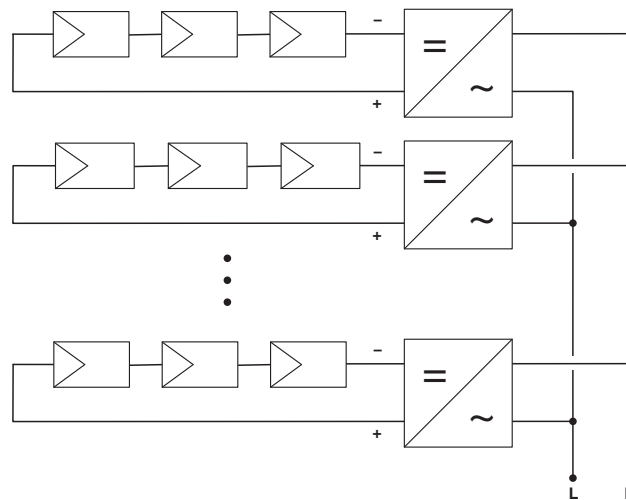
Figure 2-2   Generator with string inverters

Inverters with and without an internal transformer are used in PV systems. This results in various electrical characteristics which must be considered with regard to the design of the system, cabling, the use of other devices, and the grounding concept.

Inverters with transformers, for example, can be arranged without grounding as well as with grounding on the negative or positive side.

As illustrated in the example below, this results in the following possible voltage levels in the system:
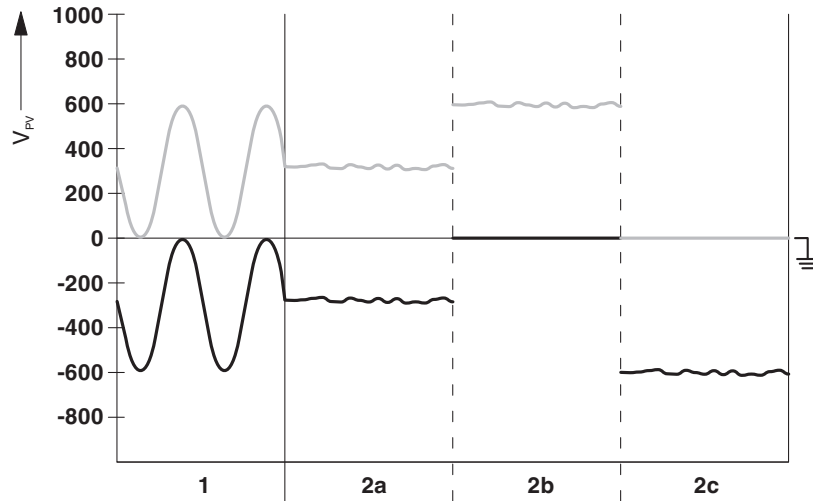
Figure 2-3   Voltage ratio with and without transformer

1: Transformerless inverter
2a: Inverter with transformer, without grounding
2b: Inverter with transformer, with grounding at negative pole
2c: Inverter with transformer, with grounding at positive pole

The diagram also clearly shows that using transformerless inverters can mean that the total PV generator potential oscillates to ground, even though the generator voltage itself supplies a DC voltage.

In the case of transformerless inverters, it should also be noted that there is no electrical isolation to ground here. This is particularly important if devices are incorporated in the system which are only intended for IT systems, i.e., they have no ground connection.

Example diagram of generator with transformer inverter
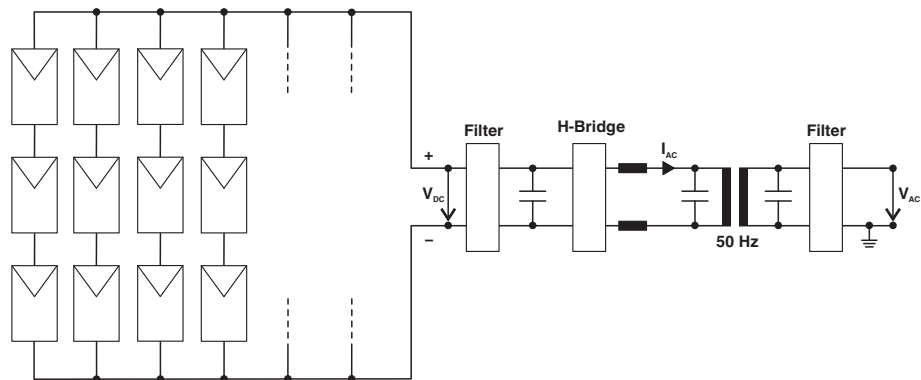
Figure 2-4   Example diagram of generator with transformer inverter

Example diagram of generator with transformer inverter and grounding on the positive side
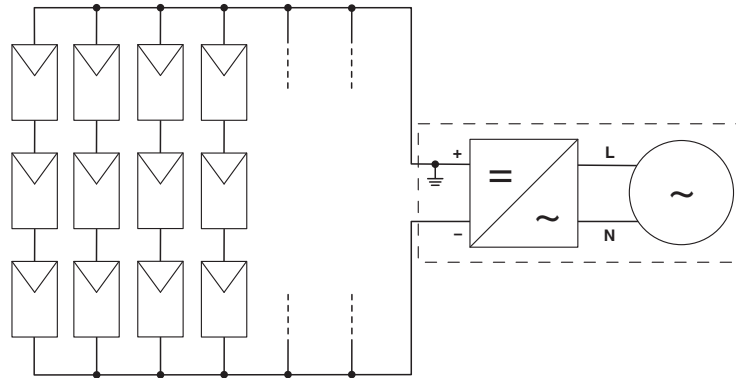
Figure 2-5   Example diagram of generator with transformer inverter and grounding on the positive side

Example diagram of generator with transformer inverter and grounding on the negative side
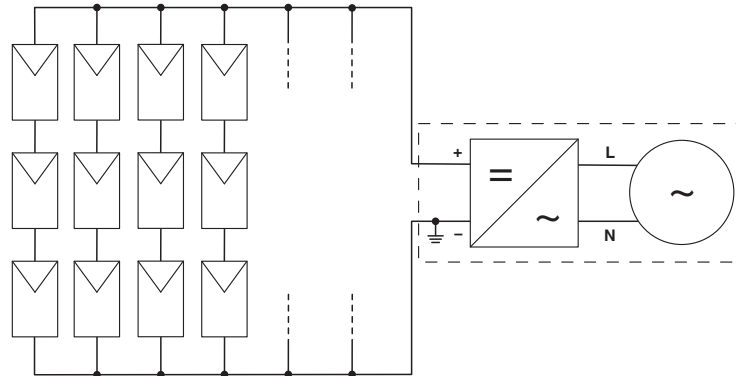
Figure 2-6   Example diagram of generator with transformer inverter and grounding on the negative side

Example diagram of generator with transformerless inverter
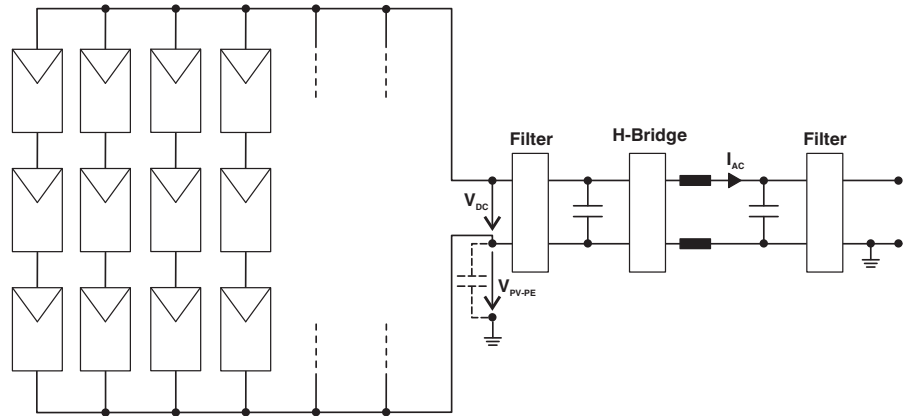
Figure 2-7   Example diagram of generator with transformerless inverter

The individual strings of a PV generator, particularly in large systems with central inverters, are connected in so-called string combiner boxes. In these string combiner boxes, multiple PV strings are connected together in parallel and appropriate protective devices and monitoring devices are provided.

When creating your PV system, observe the necessary standards for planning and installing PV systems, such as IEC 60364-7-712, together with corresponding references and equivalent standards.

2.2 Data collection in large PV systems
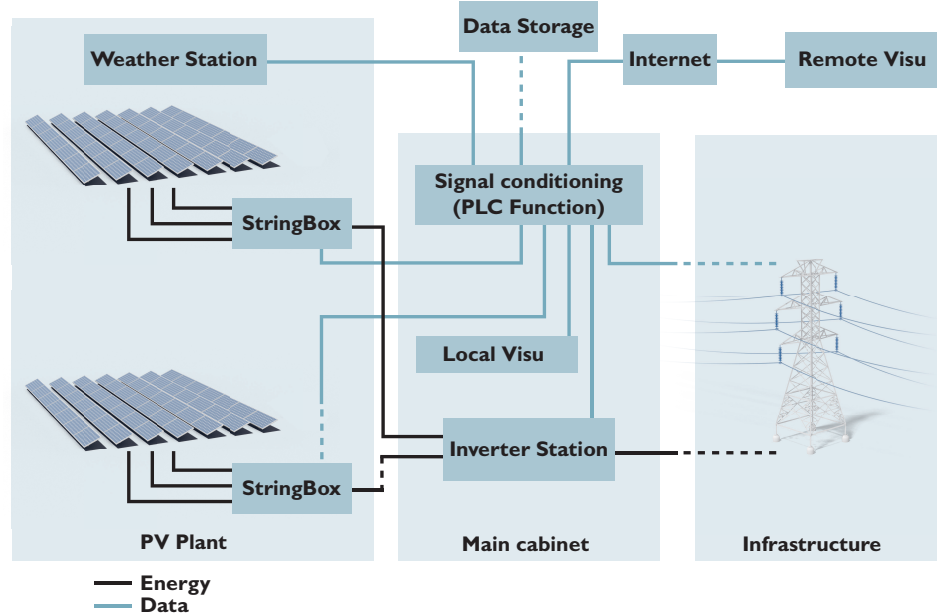
Figure 2-8   Data collection in large PV systems

Data collection in large, extensive PV systems presents a challenge with regard to the network technology. On the one hand, the reliable assignment of data and data security must be implemented well; on the other hand, the hardware design needs to be inexpensive and straightforward. This is particularly relevant in the special electrical environment of a PV power station.

Although the PV generator generates a direct current in principle, the inverters in the system likewise have an impact on the power cables. This means that in a PV system, the inverter's method of operation generates AC voltage components on the DC side. This may lead to inductive interference of cables and devices in the proximity of the generator's DC cabling. Depending on the inverter type and connection, the effect of these AC voltage components can vary.

In order to avoid any influence on signals and data cables, corresponding standards regarding the installation of data cables in the vicinity of power cables must be observed. Standard DIN EN 50174 provides comprehensive guidelines on planning and installing communication cables in the vicinity of power cables.

3 Solarcheck string current measurement with SCK-M-I-…
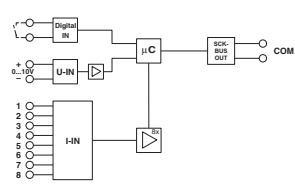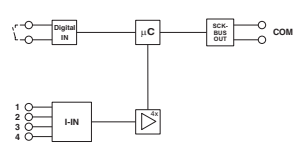
Various device versions are available for string current measurement. The device designation indicates the number of current measuring channels and their measuring range final value. Hall sensors are used for contact-free current measurement. The devices also have a digital input, internal temperature indication, and some have an analog interface for connecting a Solarcheck voltage measuring device.

3.1 Safety notes for the device

• Do not open or modify the device. Do not repair the device yourself; replace it with an equivalent device. Repairs may only be performed by the manufacturer. The manufacturer is not liable for damage resulting from noncompliance.

• The termination area must be covered after installation to ensure sufficient protection against accidental contact with live parts (e.g., installation in a distributor box or control cabinet).

3.2 Function

Table 3-1   Function matrix for current measuring modules

Module	8-channel current measurement up to 20 A	4-channel current measurement up to 20 A	Reverse current detection	Analog input for voltage measuring devices	Digital input	Internal temperature measurement	Power supply via SCK-C-MODBUS	Block diagram
SCK-M-I-8S-20A	x	-	x	x	x	x	x	
SCK-M-I-4S-20A	-	x	x	-	x	x	x	

3.2.1   Current measurement

Hall sensors are used for contact-free current measurement. For measurement purposes, the PV string cables are led through the holes in the module in the specified direction. Each channel is equipped with a separate sensor. This means that all connected strings can be measured independently of one another.
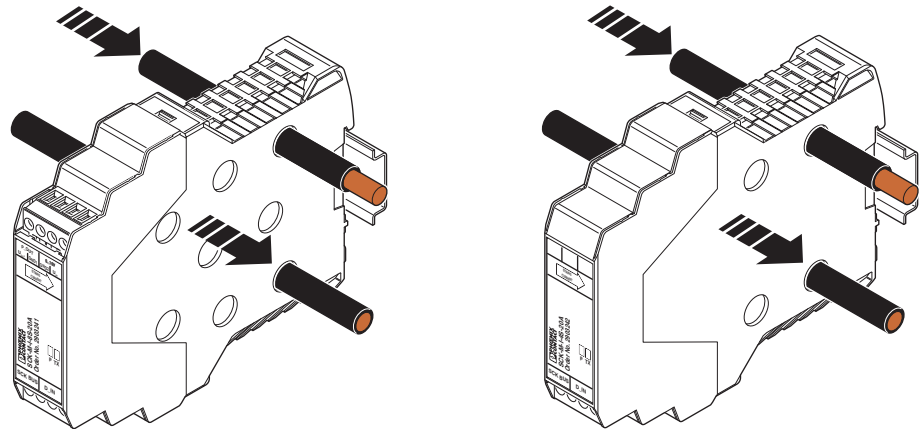
Figure 3-1   Channels for current measurement/feed-through direction

The channel assignment is printed on the side of the housing.
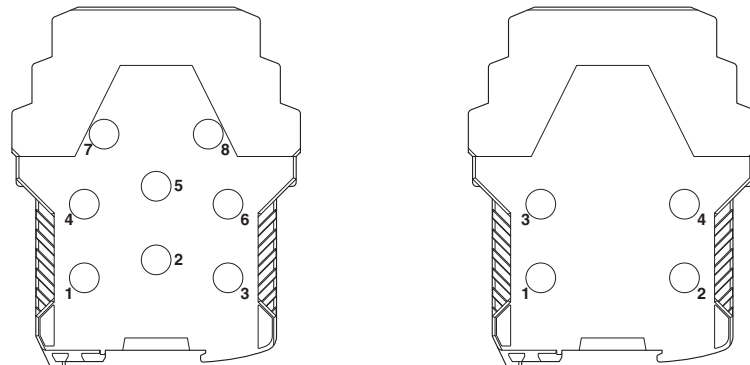
Figure 3-2   Assignment of the current measuring channels

Hall sensor measuring technology

The cable feed-throughs in the device are surrounded by magnetic cores which absorb and concentrate the magnetic field of the live conductor. A Hall sensor positioned in an air gap in the magnetic core generates a voltage signal proportional to the strength of the magnetic field. This voltage signal can then be used directly to determine the current strength. Since the current direction also determines the direction of the magnetic field, this measuring technology can also be used to indicate the current direction. As a result, reverse current detection is integrated in the Solarcheck current measuring devices.

Value ranges

Reverse currents of up to -1 A can be measured. Positive and negative current values are stored in a signed register. The values can be interpreted and a corresponding alarm function can be activated via a higher-level controller.

Values outside the measuring range from -1 A to +20 A are not accurate enough. Values outside the overcurrent range from -1.5 A to +25 A are removed from the register.
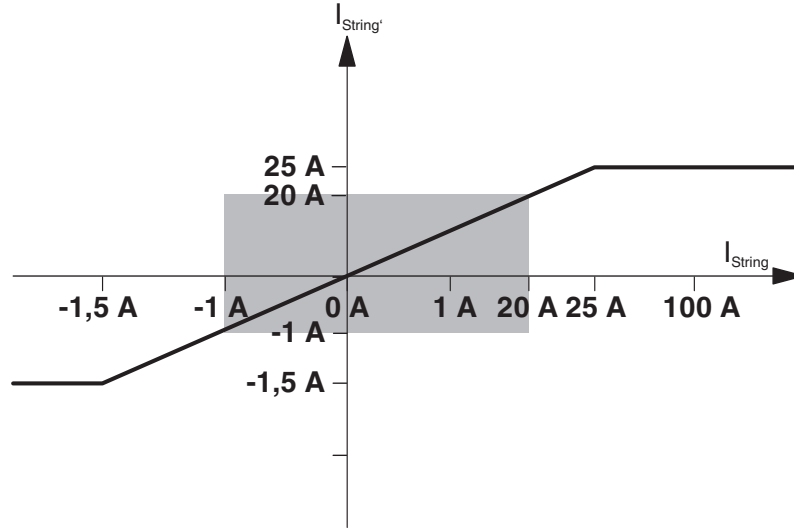
Figure 3-3   Valid value range for current measurement

Measuring accuracy

Current measurement has an accuracy of ±1%. This value is based on the measuring range final value (20 A) and is valid for the entire measuring range from -1 A to +20 A. Furthermore, a temperature coefficient TC_{20} is applied to the measurement. This is ±0.02%/Kelvin. The deviation occurs above and below the production-related compensation temperature of 20°C.

Example:

Ambient temperature: 30°C

Deviation of measurement ±1% + (±0.02% x ($T_{Ambient}$ − $T_{Compensation}$))

Deviation at $T_{30°C}$ = ±1.2% of measuring range final value (±1.2% of 20 A = ±240 mA)

3.2.2 Digital input

⊙ | **NOTE: Risk of material damage due to incorrect wiring**
The digital signal input may not be wired to an active signal.

Wire floating contacts of, e.g., door contacts or remote indication contacts of surge protection elements directly to digital input D_IN.

The state of the switch contact is set as a bit in the communication module and can be read by a controller.
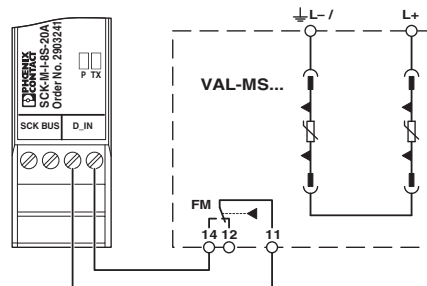
Figure 3-4   Digital input

The refresh time for this status monitoring depends on the SCK-internal communication loop. For additional information, please refer to "SCK-internal communication cycle" on page 33.

3.2.3 Analog input

The analog input is designed for analog 0 … 10 V standard signals. Incoming 0 … 10 V signals are stored as a 16-digit INT value.

Using the analog connection for devices in the Solarcheck device range

The 2 … 10 V analog output of the voltage measuring module can be connected to the analog 0 ... 10 V input of the 8-channel current measuring module. Use of this function is optional. Due to the live zero point of the output, cable break detection is integrated automatically ("live zero"). Output P_OUT is designed specifically for connection of the SCK-M-U-1500V voltage measuring module (Order No. 2903591). The maximum distance between current and voltage measuring modules is 0.5 m.

The value range is defined as -2000 … 12000 (for -2 ... 12 V). For further details on voltage measurement, refer to Section 5.2.

Using the analog connection for analog devices that are not part of the Solarcheck device range

The data cable of any analog module with 0 ... 10 V, 0 … 5 V or 2 … 10 V standard signals can be connected to the 0 ... 10 V input of the measuring module.   Please note that 0 … 10 V and 0 … 5 V signals do not support the live zero function.

The supply output of the SCK-M-I-8S-20A is specifically tailored to the performance characteristics of the SCK-M-U-1500V. Power supply to other devices is therefore not supported or only supported to a limited extent and usually has to be implemented separately. When designing this separate power supply, observe the relevant requirements from the data sheet of the module to be connected.

Also observe the input resistance of the analog input (200 kΩ) if you want to connect analog devices that are not part of the Solarcheck device range.

Make sure that the connected analog device is electrically isolated from the supply of the remaining Solarcheck devices. Otherwise invalid values may occur on the analog input side.

3.2.4   Internal temperature measurement

The internal device controller is equipped for temperature measurement. This means that the device temperature inside the module can be monitored. The device is designed for operation under temperature conditions ranging from -20°C .… +70°C. From experience, depending on the ambient conditions (ventilation situation, etc.) the temperatures inside the device are approximately 10°C above the temperature outside the device.

To that effect normal device operation is ensured if the temperatures measured inside indicate ≤ 80°C. If the temperature inside the device exceeds 80°C, this may affect the function, electronics, and service life of the device.

3.3   Data acquisition and transfer

The acquired data is transferred to the SCK-C-MODBUS Solarcheck communication module via an internal communication cycle. A proprietary protocol is used for transmission. This protocol also ensures that power is supplied to the measuring module. For this reason, it is only possible to operate the current measuring modules via the corresponding SCK-C-MODBUS Solarcheck communication module (Order No. 2901674).   The Solarcheck current measuring modules cannot be connected directly to a higher-level control unit.

The internal communication cycle ensures that the measuring data in the communication module is updated very quickly within 2 s. The data is acquired and then transferred at the request of the communication module. It is then available in the communication module for a higher-level controller via Modbus. For further details on data retrieval, refer to Section 5.2.1 on page 33 and 5.2.2 on page 33.

3.4 Power supply

The Solarcheck current measuring modules are supplied via the communication interface to the Solarcheck communication module (SCK BUS). The transmission protocol includes a corresponding power transmission function which ensures the permanent operation of the connected measuring modules. Observe the installation instructions in Section 6.6 on page 54 and the notes on designing the power supply of the overall Solarcheck system in Section 6.8 on page 61.

3.5 Technical data

Current measurement	SCK-M-I-8S-20A (2903241)	SCK-M-I-4S-20A (2903242)
Supply		
Supply voltage	Via SCK-C-MODBUS	
Typical internal power consumption	43 mA	
Maximum internal power consumption	50 mA	
Measuring inputs		
Current measuring range	0 … 20 A DC	
Maximum transmission error from measuring range final value	±1%	
Temperature coefficient TC_{20}	0.02% / K	
Reverse current detection	-1 … 0 A DC	
Number of measuring channels	8	4
Overload capacity	$5 \times I_N$	
Connection method	9.5 mm through connection	
Digital input		
Controlled by external floating contact	Yes	
Cable length	≤ 30 m	
Analog input		
Input voltage range	0 … 10 V	-
Analog output		
Output voltage range	24 V supply for 2903591	-
Cable length (for 0.15 mm²)	0.5 m, maximum	-
Cable type	Twisted, shielded	-
Data interface for SCK-C-MODBUS		
Cable length (for 0.15 mm²)	≤ 300 m	
Cable length (for 1.5 mm²)	≤ 500 m	
Cable type	Twisted, shielded	
Communication protocol	Proprietary	

Current measurement	SCK-M-I-8S-20A (2903241)	SCK-M-I-4S-20A (2903242)
General data		
Degree of protection	IP20	
Ambient temperature range (operation)	-20°C ... 70°C	
Ambient temperature range (storage)	-40°C ... 85°C	
Dimensions W / H / D	22.5 / 102 / 128.5 mm	
Screw connection solid / stranded / AWG	0.2 ... 2.5 mm² / 0.2 ... 2.5 mm² / 24 - 12	
Tightening torque	0.5 - 0.6 Nm	
Humidity at 25°C, no condensation	≤ 95%	
Altitude	≤ 2000 m	
Installation on DIN rail	35 mm (DIN EN 50022)	
Pollution degree	2	2
Conformance/approvals		
Conformance	CE-compliant	
	Conformance with EMC Directive 2004/108/EC and Low Voltage Directive 2006/95/EC	
Referenced standard	EN 61010-01:2011-7	

4 Solarcheck string voltage measurement with the SCK-M-U-1500V

4.1 Function

The Solarcheck voltage measuring module is used to measure PV voltages up to 1500 V DC. Voltage measurement can be performed in isolated systems as well as systems grounded on the positive or negative side.

The analog output of the device maps the measured system voltage as a 2 ... 10 V signal. The module is usually connected to the corresponding 8-channel current measuring module (SCK-M-I-8S-20A, Order No. 2903241).

As an option, the voltage measuring module can also be operated as a simple analog measuring device outside of the Solarcheck device range.

Observe the installation instructions in "Installing the SCK-M-U-1500V voltage measuring module" on page 57.

4.1.1 Voltage measurement

The voltage is measured via two impedance chains, one of which measures the voltage of + to PE and the other the voltage of - to PE. Both measured values are first determined individually and are then added. This gives the system voltage value. This value is then output as a 2 … 10 V analog signal via the analog output.
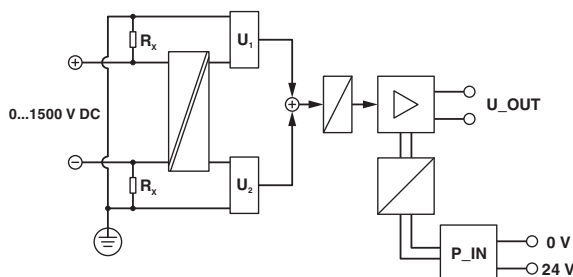
Figure 4-1   Block diagram (Rx = 20 MΩ)

Marginal conditions for valid voltage values:

1. $U+ \geq PE \geq U-$
2. $0 < U+ < 1500\ V$
3. $0 < U- < -1500\ V$
4. $(U+) - (U-) \leq 1500\ V$

The difference between U+ and U- must not exceed 1500 V. Negative differential mode voltages are not permitted.

> ℹ️ It is imperative that the PE contact is connected, as in addition to its safety-related function it is also used as the reference potential for measurement.

Different potential levels may occur depending on the structure and connection of the PV system. The following voltage ranges can be acquired by the device and represented as an analog value.

Table 4-1 Valid voltage ranges - part 1

U-	U+ 0	-100	-200	-300	-400	-500	-600	-700
0	2.00 V	2.53 V	3.07 V	3.60 V	4.13 V	4.67 V	5.20 V	5.73 V
100	2.53 V	3.07 V	3.60 V	4.13 V	4.67 V	5.20 V	5.73 V	6.27 V
200	3.07 V	3.60 V	4.13 V	4.67 V	5.20 V	5.73 V	6.27 V	6.80 V
300	3.60 V	4.13 V	4.67 V	5.20 V	5.73 V	6.27 V	6.80 V	7.33 V
400	4.13 V	4.67 V	5.20 V	5.73 V	6.27 V	6.80 V	7.33 V	7.87 V
500	4.67 V	5.20 V	5.73 V	6.27 V	6.80 V	7.33 V	7.87 V	8.40 V
600	5.20 V	5.73 V	6.27 V	6.80 V	7.33 V	7.87 V	8.40 V	8.93 V
700	5.73 V	6.27 V	6.80 V	7.33 V	7.87 V	8.40 V	8.93 V	9.47 V
800	6.27 V	6.80 V	7.33 V	7.87 V	8.40 V	8.93 V	9.47 V	10.00 V
900	6.80 V	7.33 V	7.87 V	8.40 V	8.93 V	9.47 V	10.00 V	
1000	7.33 V	7.87 V	8.40 V	8.93 V	9.47 V	10.00 V		
1100	7.87 V	8.40 V	8.93 V	9.47 V	10.00 V			
1200	8.40 V	8.93 V	9.47 V	10.00 V				
1300	8.93 V	9.47 V	10.00 V					
1400	9.47 V	10.00 V						
1500	10.00 V							

Table 4-2 Valid voltage ranges - part 2

U-	U+ -800	-900	-1000	-1100	-1200	-1300	-1400	-1500
0	6.27 V	6.80 V	7.33 V	7.87 V	8.40 V	8.93 V	9.47 V	10.00 V
100	6.80 V	7.33 V	7.87 V	8.40 V	8.93 V	9.47 V	10.00 V	
200	7.33 V	7.87 V	8.40 V	8.93 V	9.47 V	10.00 V		
300	7.87 V	8.40 V	8.93 V	9.47 V	10.00 V			
400	8.40 V	8.93 V	9.47 V	10.00 V				
500	8.93 V	9.47 V	10.00 V					
600	9.47 V	10.00 V						
700	10.00 V							

The inner range represents the respective analog value that is issued by the device under the respective voltage conditions.

Calculation basis for Table 4-1 and Table 4-2:

If

$(0 < U+ < 1500 \text{ V})$ and

$(0 < U- < -1500 \text{ V})$ and

$(0 < \text{Difference }(U+, U-) < 1500 \text{ V}$

Then

Analog Out:

$$\frac{\text{Difference }(U+, U-) \times 8 \text{ V}}{1500 \text{ V}} + 2 \text{ V}$$

The maximum measured value deviation of 1% (of the measuring range final value) is based on the 100 …. 1500 V DC system voltage range. The deviation may be greater below 100 V DC.

4.1.2   Note on the parallel connection of multiple voltage measuring devices in a system

Due to the circuit architecture in the device, the voltage measuring input is connected to ground via the internal impedances. Resistance Rx is 20 MΩ respectively. If multiple voltage measuring devices are connected to the same generator in parallel, these impedances are also connected in parallel. This results in overall reduced impedance of the generator to ground. This can affect the response of any ground fault detection in the system.

The impedances of the voltage measuring devices used within a generator (per inverter input) therefore have to be taken into consideration when defining the threshold values for ground fault detection.

The following impedances result depending on the number of voltage measurements connected in parallel in a system.

Table 4-3   Impedances

Number of parallel voltage measurements	Individual impedance (+ → PE)	Total impedance (+ → PE)
1	20 MΩ	20 MΩ
2	20 MΩ	10 MΩ
4	20 MΩ	5 MΩ
8	20 MΩ	2.5 MΩ
16	20 MΩ	1.25 MΩ
32	20 MΩ	0.625 MΩ
64	20 MΩ	0.313 MΩ
128	20 MΩ	0.156 MΩ
…		

4.2 Data acquisition and transfer

The analog output of the voltage measuring module can be connected directly to the 0 … 10 V input of the corresponding SCK-M-I-8S-20A Solarcheck current measuring module. The measured values are then available via the SCK-C-MODBUS Solarcheck communication module via RS-485 Modbus RTU.

As an option, the output can also be connected to any analog 0 … 10 V input of a controller, for example.

Observe the installation instructions in "Installing the SCK-M-U-1500V voltage measuring module" on page 57 for integration and installation of the voltage measuring module.

The voltage value is mapped as a 2 … 10 V signal. Due to the live zero point of the output, cable break detection is integrated automatically ("live zero").

4.2.1 Representation of voltage values at the analog output

The following calculation is used as the basis for mapping the system voltage values:

Table 4-4   System voltage calculation

Transfer function	Resulting system voltage
$U_{2…10V\,OUT} = \left(\dfrac{2\,V - 10\,V}{0 - 1500\,V}\right) x\ U_{+ - (HVin)} + 2\,V$	$U_{+ - (HVin)} = \left(\dfrac{375}{2}\right) x\ U_{2…10V\,OUT} - 375\,V$

This results in the following value representation:
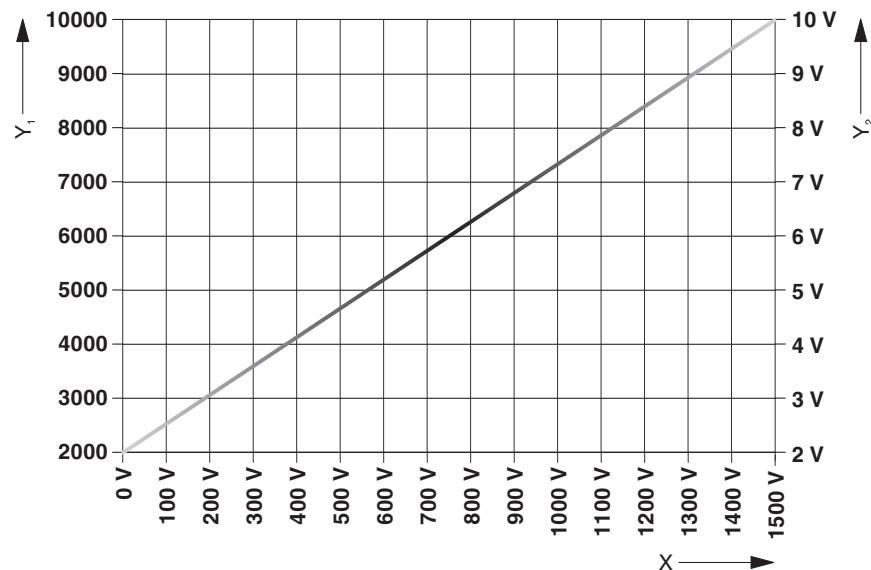
Figure 4-2   Value representation for voltage measurement

Y1 (left): decimal register value

Y2 (right): analog value (U_OUT)

X: system voltage

Example:

Nominal voltage	Lower value	Upper value	Resolution	Example operating voltage	Register representation
1500 V_{PV}	0 V_{PV} = 2 V_{ANALOG}	1500 V_{PV} = 10 V_{ANALOG}	1 V_{PV} = 0.0053 V_{ANALOG}	850 V_{PV} = 6.53 V_{ANALOG}	6530 [dec]

4.2.2 Step response time
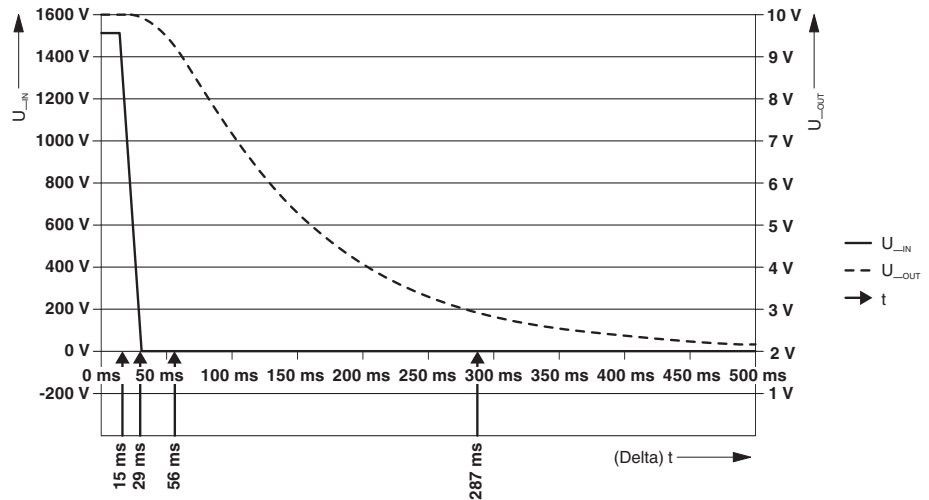
Figure 4-3   Step response time

If the module is connected to the SCK-M-I-8S-20A Solarcheck current measuring module, the measured values are available via the SCK-C-MODBUS Solarcheck communication module. In this case, the shortest possible retrieval interval depends on the refresh cycle of the Solarcheck devices. The fastest possible cycle time between SCK-C-MODBUS and SCK-M-I-8S-20A is 2 s. For further details on the internal communication cycle, refer to Section 5.2.1 on page 33.

4.3   Power supply

The voltage measuring module is usually supplied directly via the supply output of the SCK-M-I-8S-20A Solarcheck current measuring module. Design the power supply for the entire Solarcheck device chain as described in "Power supply for the Solarcheck devices" on page 61. If the voltage measuring module is connected to the SCK-M-I-8S-20A Solarcheck module, an additional power supply is not required for the device.

Alternatively, the voltage measuring device can also be used outside of the Solarcheck device range. In this case, the power supply must be implemented separately and connected directly to the supply input. To do this, proceed as described in "Installing the SCK-M-U-1500V voltage measuring module" on page 57.

4.4   Technical data

Voltage measurement	SCK-M-U-1500V (Order No. 2903591)
Supply	
Supply voltage	24 V DC (-10% … +25%) or via SCK-M-I-8S-20A
Typical internal power consumption	8 mA
Maximum internal power consumption	65 mA
Measuring inputs	
Voltage measuring range	0 ... 1500 V DC
Maximum transmission error from measuring range final value	1% after additional adjustment (valid for 100 … 1500 V DC)
Temperature coefficient from T > 25°C	0.01% / K
Number of measuring channels	1
Connection method	Screw connection
Minimum terminal block distance	32 mm
Surge voltage	6 kV
Analog output	
Output voltage range	2 … 10 V
Cable length (for 0.15 mm^2)	0.5 m, maximum
Cable type	Twisted, shielded
General data	
Degree of protection	IP20
Ambient temperature range (operation)	-20°C ... 70°C
Ambient temperature range (storage)	-40°C ... 85°C
Dimensions W / H / D	22.5 / 102 / 128.5 mm
Screw connection solid / stranded / AWG	0.2 ... 2.5 mm^2 / 0.2 ... 2.5 mm^2 / 24- 12
Tightening torque	0.5 - 0.6 Nm
Humidity at 25°C, no condensation	≤ 95%
Altitude	≤ 2000 m
Installation on DIN rail	35 mm (DIN EN 50022)
Pollution degree	2
Conformance/approvals	
Conformance	CE-compliant
	Conformance with EMC Directive 2004/108/EC and Low Voltage Directive 2006/95/EC
Referenced standard	EN 61010-01:2011-7

5 SCK-C-MODBUS Solarcheck communication module

5.1 Function

The communication module collects the data from all connected measuring modules and forwards it to a higher-level controller via RS-485 Modbus RTU.

At the same time, the connected measuring modules are supplied with power via the communication cable (SCK BUS) between the measuring modules and the communication module.

This distributed structure means that a power supply is not required in the string combiner box in the field.
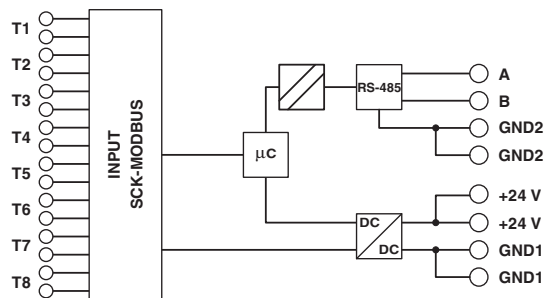
Figure 5-1   Block diagram of the SCK-C-MODBUS Solarcheck communication module

5.2 Data acquisition and transfer

The Solarcheck communication module acquires the data from all Solarcheck measuring modules connected in parallel. Each measuring module is connected to a separate data input (T1…T8). This therefore creates a star wiring configuration. A maximum of eight measuring modules can be connected to a communication module. A proprietary protocol is used for data transfer between the measuring modules and the communication module. At the same time, the communication cable is also used to supply power to the measuring modules in the field. The data is made available to the higher-level control unit via an RS-485 interface using Modbus RTU.

It is imperative that the data from the measuring modules is retrieved via the communication module. Operation without a communication module is only supported for the SCK-M-U-1500V.
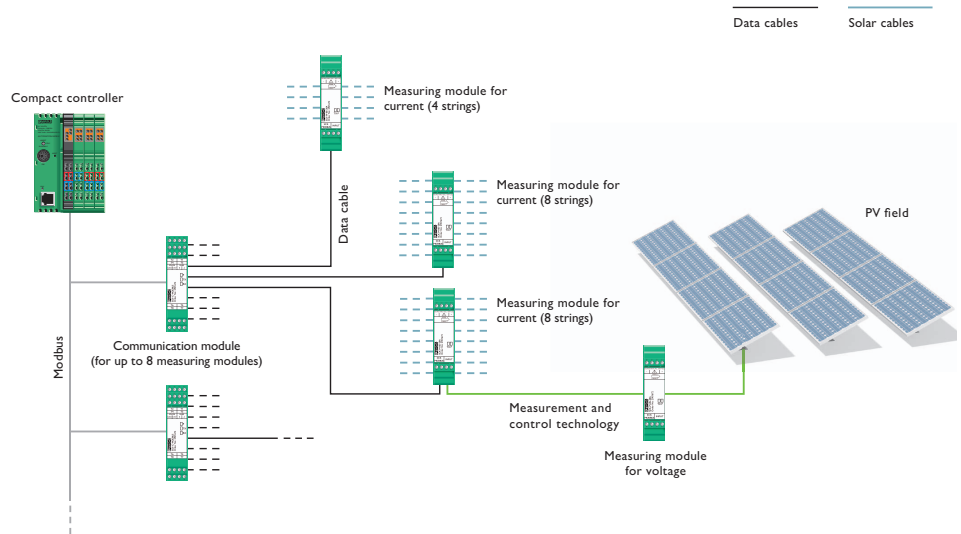
Figure 5-2   Structure of the Solarcheck communication network
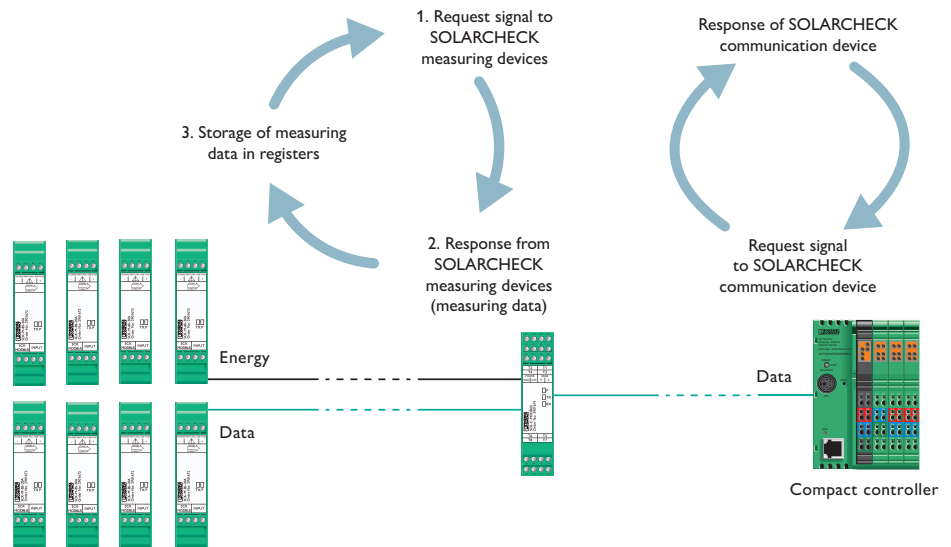
Figure 5-3   Schematic diagram of Solarcheck communication

5.2.1   SCK-internal communication cycle

In the SCK-internal communication cycle, all connected measuring modules are queried in parallel after a fixed defined request signal. The transmitted measured values are saved in the corresponding registers. This request cycle permanently runs automatically. The baud rate is fixed at 1200 baud. Depending on the amount of data transmitted, the cycle time is around 1 - 2 s on average.

New measured values are therefore only available in the registers of the communication module for the higher-level controller once a cycle has been run (refer to Figure 5-3 on page 32).

In the event of a data transmission error between the measuring and communication modules, the data is requested again up to three times. If no valid data is available after the third request, the device indicates an internal error.

If the module does not receive a response after 10 s, it enters "Timeout" status.

For further details on error messages, refer to "Troubleshooting" on page 75.

5.2.2   RS-485 communication

The register entries (measured data) are transmitted to the higher-level controller via the RS-485 interface using Modbus RTU.

A unique address is set on the communication module for module and data assignment. The DIP switches inside the device are used for this. The procedure for setting the module address is described in "Installing the SCK-C-MODBUS communication module" on page 49.

Table 5-1   Modbus settings

Protocol	Modbus RTU
Valid addresses	1...247 Default setting: 0 (invalid address, must be changed)
Baud rate	Default setting: 9600 bps
Parity	Default setting: none
Stop bits	Default setting: 1
Code	8-bit binary
Function code	Function for reading the SCK-MODBUS measured values. All measured values are stored in a 16-bit word.

The module address is set to "0" by default and must be changed. Communication is not possible when the address is set to "0". For additional information on setting the module address, please refer to "Addressing the SCK-C-MODBUS communication module" on page 49.

Assign appropriate addresses in the 1 ... 247 address area according to your system configuration. By default, the address area from 248 ... 255 is assigned to non-stationary devices and cannot be used.

You must design the Modbus data request for the communication module according to the following schematic:

Client address	Function code	Start register	Total number of registers	CRC (Cyclic Redundancy Check)
03	03	04B1	0015	D4F0
Client No. 3	Read holding register	1201	21	Resulting checksum
Response: 03 03 xx xx xx xx xx ... (address + function code + data + CRC)				

Example data record:

Request for module information data from module No. 3:

Tx: 03 03 04 B1 00 15 D4 F0

Response from module:

Rx: 03 03 2A 00 01 01 23 45 67 89 AB CD EF 43 53 2D 4B 2D 43 4F 4D 42 44 53 55 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 97 3A

Response in plain text:

03 → Addressed module ID

03 → Function code

2A → Number of subsequent bytes (here: 42 bytes, 21 registers)

00 01 → Module ID (SCK-C-MODBUS module type)

01 23 45 67 89 AB CD EF → 4 registers, module serial number

43 53 2D 4B 2D 43 4F 4D 42 44 53 55 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 → Module designation in ASCII code: "SCK-C-MODBUS" (occupies a maximum of 32 characters)

97 3A → Checksum

5.2.3   Register addresses

5.2.3.1   Structure of the register areas

Table 5-2   Structure of the register areas

Modbus address HEX [DEC]	Contents	Designation
0000..005D [0..93]	Data register Rev. 02	Copy of the data register for device revision 02 to ensure compatibility
0080..00B0 [128..176]	Status register, PD0…PD47	Process data SCK channel 1 (device at T1)
00B1..00E0 [177..244]	MI0…MI47	Module information data SCK channel 1 (device at T1)
0100..0130 [256..304]	Status register, PD0…PD47	Process data SCK channel 2 (device at T2)
0131..0160 [305..523]	MI0…MI47	Module information data SCK channel 2 (device at T2)
0180..01B0 [384..432]	Status register, PD0…PD47	Process data SCK channel 3 (device at T3)
01B1..01E0 [433..480]	MI0…MI47	Module information data SCK channel 3 (device at T3)
0200..0230 [512..560]	Status register, PD0…PD47	Process data SCK channel 4 (device at T4)
0231..0260 [561..608]	MI0…MI47	Module information data SCK channel 4 (device at T4)
0280..02B0 [640..688]	Status register, PD0…PD47	Process data SCK channel 5 (device at T5)
02B1..02E0 [689..736]	MI0…MI47	Module information data SCK channel 5 (device at T5)
0300..0330 [768..816]	Status register, PD0…PD47	Process data SCK channel 6 (device at T6)
0331..0360 [817..864]	MI0…MI47	Module information data SCK channel 6 (device at T6)
0380..03B0 [896..944]	Status register, PD0…PD47	Process data SCK channel 7 (device at T7)
03B1..03E0 [945..992]	MI0…MI47	Module information data SCK channel 7 (device at T7)
0400..0430 [1024..1072]	Status register, PD0…PD47	Process data SCK channel 8 (device at T8)

Table 5-2   Structure of the register areas [...]

Modbus address HEX [DEC]	Contents	Designation
0431..0460 [1073..1120]	MI0…MI47	Module information data SCK channel 8 (device at T8)
0480..04B0 [1152..1200]	Status register, PD0…PD47	Process data SCK-C-MODBUS device
04B1..04E0 [1201..1248]	MI0…MI47	Module information data SCK-C-MODBUS device

The status register is always stored in the first register of the respective channel.

Example:

Channel	Status register address	Process data	Module information data
3 (T3)	0280h	From 0281h…	From 02B1h…

5.2.3.2   Structure of the status register

The status register of each individual channel (T1…T8) is a 16-digit bitmasked word and contains relevant information on the device status of the respective connected measuring module. The status register of the communication module contains the relevant information on the device status of the communication module.

Table 5-3   Structure of the status register

High byte								Low byte							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	DIS	ER	NC	CC	0	0	0	0

Bit	Short name	Meaning
4	CC	Short circuit
5	NC	Not connected (no module connected)
6	ER	Error (communication error)
7	DIS	Disabled (channel disabled)

5.2.3.3   Data registers of the connected measuring modules

In general, 48 items of process data and 48 items of module information data are available per connected measuring module.

Various amounts of data are present depending on the device type; this data is successively written to the available process data and module information data registers.

The communication module detects the connected measuring modules by their ID. This form of detection means that invalid data and communication errors can be detected reliably.

The register tables for all modules in the Solarcheck device range can be found in "Register tables" on page 85.

5.2.3.4 Compatibility with previous modules

The Revision 03 Solarcheck communication module is backwards compatible with its predecessor (Revision 02). Furthermore, the device is compatible with all existing Solarcheck measuring modules, including devices from the previous generation (SCK-M-8S-20A, Order No. 2901672).

This ensures that new and old-generation devices can be operated on the current communication module. Mixed operation of devices from both generations is possible on a Revision 03 communication module.

Furthermore, this ensures that the existing programming of the higher-level controller does not have to be modified if a device is replaced.

5.3 Power supply

In addition to collecting data, the communication module also supplies power to the connected measuring modules. The power supply for the communication module and the connected measuring modules therefore has to be incorporated in the design.

– 24 V DC input voltage (-10% ... +25%)
– For current consumption, all connected measuring modules must also be taken into consideration

Let us assume 20 mA for the communication module and the sum of the typical current consumption of all connected measuring modules. To account for the current peaks, the result must be multiplied by 3. This calculation applies if 24 V is supplied. Otherwise, please refer to the current consumption diagrams for the modules in "Design of the power supply" on page 61.
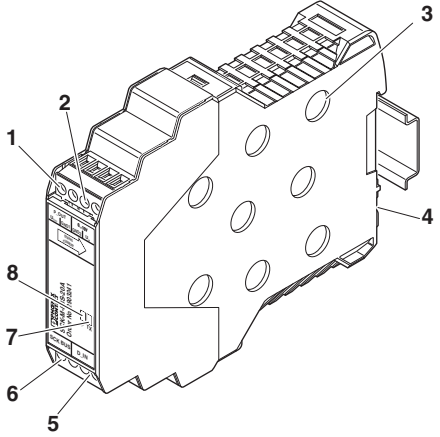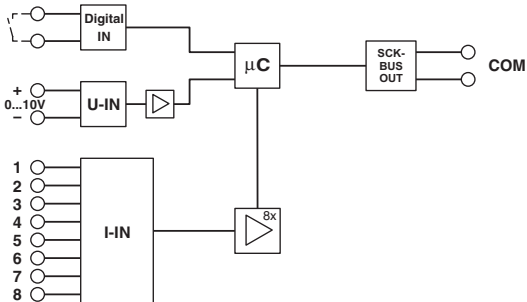
5.4 Technical data

Communication	SCK-C-MODBUS (Order No. 2901674)
Supply	
Supply voltage	24 V DC (-10% … +25%)
Typical internal power consumption	22 mA
Maximum internal power consumption	45 mA
Maximum current consumption	800 mA
Data interface for SCK bus	
Cable type	Twisted, shielded
Communication protocol	Proprietary
Serial interface (RS-485)	
Serial transmission speed	9.6 / 14.4 / 19.2 / 38.4 kbps
Cable length	1200 m, maximum
Cable type	Twisted, shielded
Communication protocol	Modbus RTU
Optional termination resistor (not supplied as standard)	180 Ω
Operating mode	Half duplex
General data	
Degree of protection	IP20
Ambient temperature range (operation)	-20°C ... 70°C
Ambient temperature range (storage)	-40°C ... 85°C
Dimensions W / H / D	22.5 / 102 / 106 mm
Screw connection solid / stranded / AWG	0.2 ... 2.5 mm² / 0.2 ... 2.5 mm² / 24 - 12
Tightening torque	0.5 - 0.6 Nm
Humidity at 25°C, no condensation	≤ 95%
Altitude	≤ 2000 m
Installation on DIN rail	35 mm (DIN EN 50022)
Pollution degree	2
Conformance/approvals	
Conformance	CE-compliant
	Conformance with EMC Directive 2004/108/EC and Low Voltage Directive 2006/95/EC
Referenced standard	EN 61010-01:2011-7

6 Installation

6.1 Connection description

SCK-C-MODBUS (Order No. 2901674)

1	Connection terminal blocks for SCK measuring module T1 ... T4
2	Connection terminal blocks for SCK measuring module T5 ... T8
3	Connection terminal blocks for +24 V DC/GND1 power supply
4	Connection terminal blocks for RS-485 Modbus A (+)/B (-)
5	Green LED status/diagnostics indicator, P - power supply, error diagnostics
6	Green LED status indicator, TX - transmit data
7	Green LED status indicator, RX - receive data
8	GND2, shield
9	Snap-on foot for DIN rail mounting

Block diagram

SCK-M-I-8S-20A (Order No. 2903241)

1. Connection terminal blocks for power supply of optionally connected voltage measuring module (P_OUT)
2. Analog input (0 ... 10 V)
3. Through connections for current measurement 1 ... 8 (max. 20 A per connection)
4. Snap-on foot for DIN rail mounting
5. Connection terminal blocks for digital switch contact (D_IN)
6. Connection terminal blocks for communication cable (SCK BUS)
7. Green LED status indicator, TX - transmit data
8. Green LED status/diagnostics indicator, P - power supply, error diagnostics

Block diagram

SCK-M-I-4S-20A (Order No. 2903242)
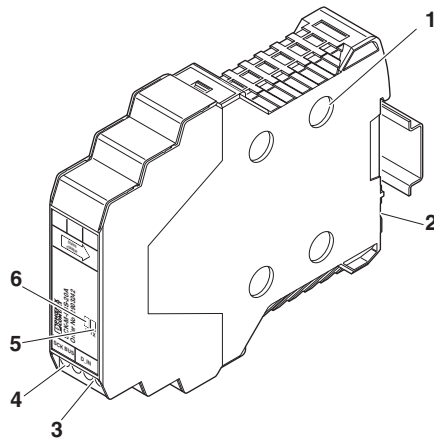
1	Through connections for current measurement 1 ... 4 (max. 20 A per connection)
2	Snap-on foot for DIN rail mounting
3	Connection terminal blocks for digital switch contact (D_IN)
4	Connection terminal blocks for communication cable (SCK BUS)
5	Green LED status indicator, TX - transmit data
6	Green LED status/diagnostics indicator, P - power supply, error diagnostics

Block diagram
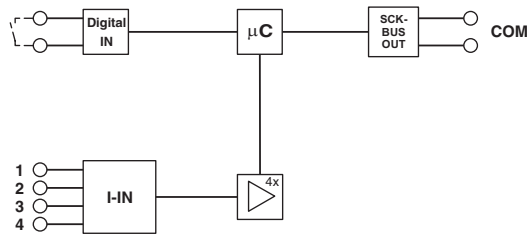
SCK-M-U-1500V (Order No. 2903591)
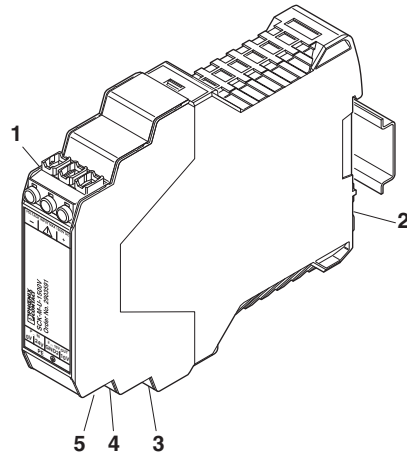
1 Connection for +/- PV system voltage

2 Snap-on foot for DIN rail mounting

3 PE grounding terminal blocks

4 Connection terminal blocks for +24 V/0 V power supply

5 Connection terminal blocks for analog voltage output 2 ... 10 V OUT

Block diagram
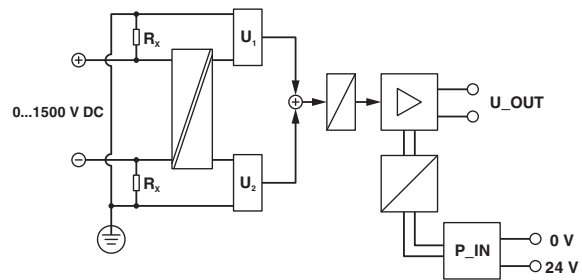
Important installation instructions:
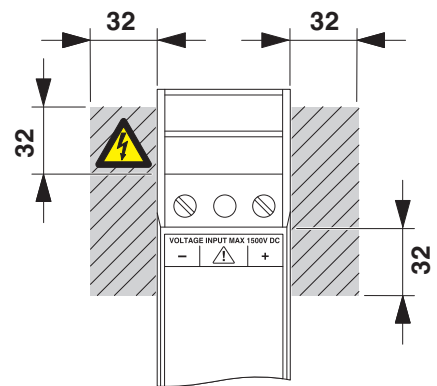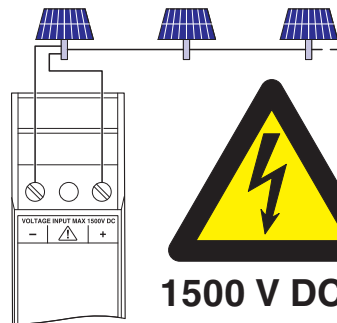
6.2 Measuring category and notes on insulation

The SCK-C-MODBUS communication module is assigned to measuring category CAT II according to DIN EN 61010-2-30 and must therefore not be used in other category areas. This means that the communication module is designed for use in low-voltage data processing. It must not be located in the immediate vicinity of equipment for power generation or power distribution systems.

Table 6-1 Notes on insulation

	SCK-C-MODBUS (2901674)	SCK-M-I-8S-20A (2903241)	SCK-M-I-4S-20A (2903242)	SCK-M-U-1500V (2903591)
Rated voltage	SELV/PELV area			PV system voltage, max. 1500 V
Surge voltage according to IEC 61010				6 kV
Pollution degree	2	2	2	2

The termination area of the devices must be inaccessible after installation to ensure sufficient protection against accidental contact with live parts (e.g., installation in a distributor box or control cabinet).

In the case of the voltage measuring module, plexiglass covers should also be used to protect against accidental contact.

6.3 Control cabinet

Snap the devices onto a 35 mm DIN rail according to DIN EN 50022 in the control cabinet.

NOTE: Degree of protection
The IP20 protection (IEC 60529/EN 60529) of the device is intended for use in a clean and dry environment. Install the module in housing with at least IP54 protection according to EN 60529. The stated limits concerning mechanical or thermal loads on the module must not be exceeded.

6.4 Cabling

The Solarcheck devices have been designed and tested according to IEC 61010 and corresponding references to EMI behavior. As long as the installation instructions are followed they will withstand the specified influences.

6.4.1 Installation instructions

In general, you should keep a sufficient distance between the power and data cables in order to avoid interference from the generator. Furthermore, make sure that the data cables are shielded properly and that the shield is connected correctly.

Installing the data cables and power cables in separate cable ducts is therefore the best and recommended form of installation.
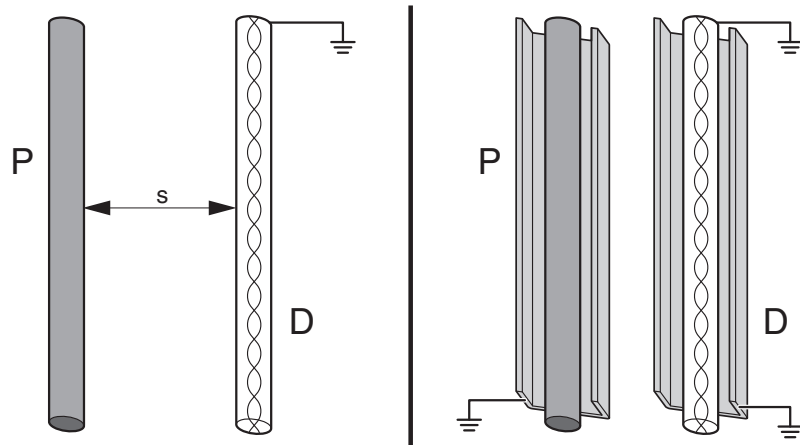
Figure 6-1   Distances between data and power cables

Option a: installation of data (D) and power (P) cables at distance (s)

Option b: installation of data (D) and power (P) cables in separately grounded cable ducts

On the basis of the aforementioned DIN EN 50174 standard, let us take here as an example a calculation of the required distances between data and power cables at defined power levels and interference frequencies of 50 Hz. The interference frequencies in a PV field can differ significantly and exert a greater influence accordingly. For example, for the most part the inverter emits high-energy interference with 10 ... 20 kHz. A distance of at least 0.3 m must always be maintained.

Table 6-2   Distances between data and power cables

	Isolation distance (s) at 50 Hz		
Power (power cable)	**Without cable duct**	**Open metal cable duct**	**Perforated cable duct**
30 A	0.06 m	0.05 m	0.03 m
120 A	0.24 m	0.18 m	0.12 m
300 A	0.6 m	0.45 m	0.3 m
600 A	1.2 m	0.9 m	0.6 m

Shielding and correct connection of the shield have a considerable effect on the signal quality of data cables in PV systems. In order to prevent inductive interference couplings by the PV power cables, the shield should be connected at both ends.

Example:
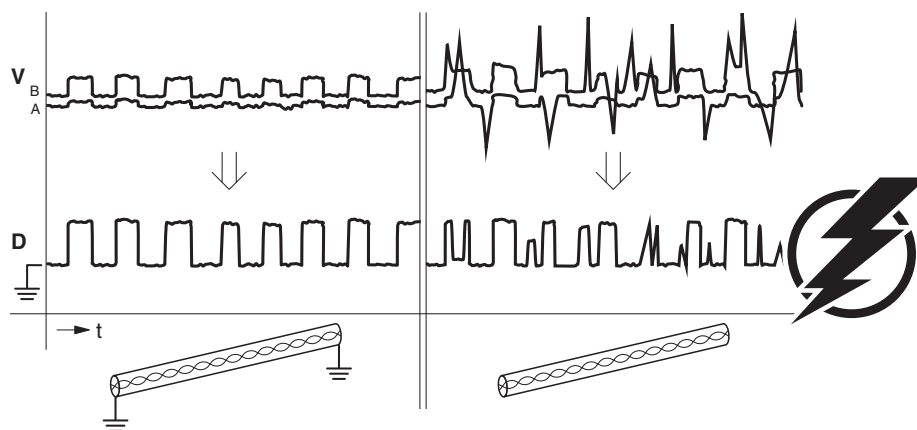
Figure 6-2   Influence of shielding on the signal quality

The left shows the differential signal (V) and the data quality (D) with shielding at both ends; the right shows a differential signal affected by inductive interference coupling. This leads to poor data quality. Communication is error-prone or not even possible, the device could be destroyed.

When installing the data cables, the cable routing is also an important consideration: never install the data cables (D) parallel to the power cables (P). If crossovers are unavoidable, data cables must cross at a right angle to the power cable.
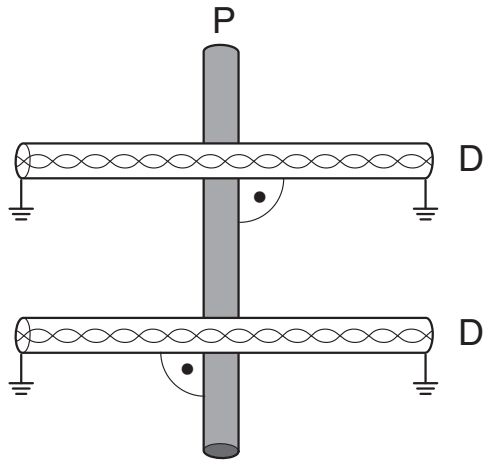
Figure 6-3   Installation of the data cables

When installing the cables, note the following:

– Do not install the data cables in direct proximity parallel to the power cables (see Figure 6-1 on page 44), instead install them in separate grounded metal cable ducts with a cover, for example.
– Always install the data cables as close as possible to grounded metal parts such as housing panels.
– Data cables may only cross power cables at a right angle (see Figure 6-3 on page 46).
– Avoid unnecessary cable lengths (antenna effect).
– For connection to ground, use suitable shield connection clamps such as the SK 35-D shield connection clamp (Order No. 3026890).
– For shield connection to GND2 of the communication module, use suitable shield connection clamps such as the ME-SAS shield connection clamp (Order No. 2853899).
– Remove the shielding only a few cm before the connection terminal block on the device.
– Untwist the twisted pairs only a few cm before the connection terminal block on the device.

Please note the following recommendations for cabling.

Table 6-3   RS-485 cabling recommendations

RS-485	
Cable	0.25 mm^2, twisted pair, (double) shielding
Shielding	Connect both ends of the outer shield to ground. Connect the inner shield on the controller to ground and on the communication module to GND2 only.
Surge protection	For cables lengths > 10 m, install appropriate surge protection for RS-485 data cables in the immediate vicinity of the SCK-C-MODBUS and of the higher-level controller (see "Accessories" on page 110).
Repeater	To decouple or improve signals in networks, e.g., to cover large distances, a repeater can be inserted in the RS-485 network. For example, use a PSI-REP-RS485W2 (Order No. 2313096) for this.

Table 6-4   SCK bus cabling recommendations

SCK bus	
Cable	0.75 mm^2, twisted pair, single shielding
Shielding	Connect both ends of the shielding to ground.
Surge protection	For cables lengths > 10 m, install appropriate surge protection for 24 V DC systems in the immediate vicinity of the SCK-C-MODBUS and of the connected Solarcheck measuring module (see "Accessories" on page 110).
Repeater	A repeater cannot be used in the SCK bus cable as it would affect power supply to the connected measuring devices.

SCK-M-U-1500V

Table 6-5   Analog connection/power supply cabling recommendations

Analog connection/power supply	
Cable	0.75 mm^2, twisted pair, single shielding, maximum length of 0.5 m
Shielding	Connect both ends of the shielding to ground.

Table 6-6   Voltage connection cabling recommendations

Voltage connection	
Cable	≥ 0.75 mm^2, double insulated (appropriate to system voltage), short-circuit-proof and ground-fault-proof installation

Table 6-7   PE connection cabling recommendations

PE connection	
Cable	Copper, 2.5 mm^2/14 AWG, color code for PE

6.4.2   Material requirements

Only use suitable connecting cables:
– Copper cable, suitable for ambient temperatures up to 75°C
– Installation method must be appropriate for the ambient conditions
– Required tightening torque of 0.5 Nm ... 0.6 Nm

6.4.3   Cable lengths and conductor cross sections

Table 6-8   Recommended conductor cross sections for cable lengths up to 500 m

Type	Cross section
RS-485	0.25 mm^2
SCK bus	0.75 mm^2
Analog connection (max. 0.5 m)	0.75 mm^2

The connection terminal blocks of the Solarcheck devices can accommodate cable cross sections from 0.14 mm^2 to 2.5 mm^2. For the minimum connectable cross section of 0.14 mm^2, even cable lengths up to 300 m can be implemented between the measuring and communication module. However, such small cross sections are generally susceptible to interference and a relatively high voltage drop in borderline cases (e.g., voltage on the supply side already at the minimum limit) can mean that the devices in the field are not adequately supplied.

It is therefore strongly recommended that the above conductor cross sections are used. In this case, distances of 500 m including the recommended surge protective devices (see "Accessories" on page 110) can be covered.

There is no reliable information about operation at distances > 500 m between the measuring and communication module.

The cable length may be exceeded at the discretion of the installer, who is then responsible for any such instances. In such cases it is recommended that a corresponding voltage drop calculation is performed for the cable and that the surge protection elements that are used are also taken into consideration. Furthermore, an on-site check should always be performed to determine whether the required supply voltage is available at the input of the Solarcheck devices under all operating conditions.

6.5 Installing the SCK-C-MODBUS communication module

6.5.1 Addressing the SCK-C-MODBUS communication module

The device may only be opened to set the required address or baud rate.

The communication module may only be addressed when disconnected from the power supply and from the RS-485 and SCK bus cables.

The Modbus address and the baud rate are binary coded with the eight DIP switches inside the communication module. To set these properties, proceed as follows:

1. Carefully open the housing cover using a suitable screwdriver.
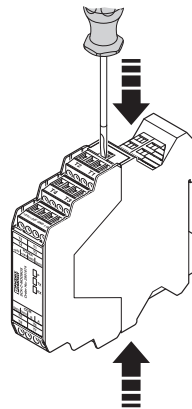
2. Remove the PCB.
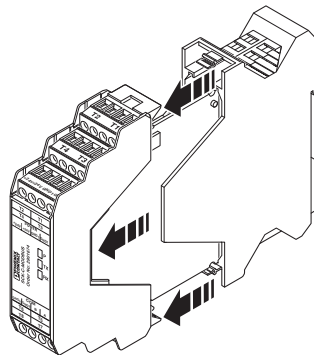
3. Locate the DIP switches (top: Modbus address, bottom: baud rate).
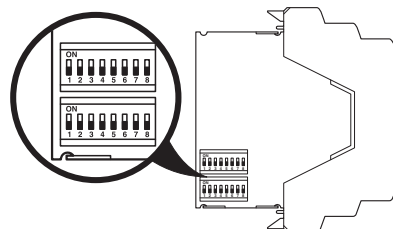
4. Remove the protective foil from the DIP switches.
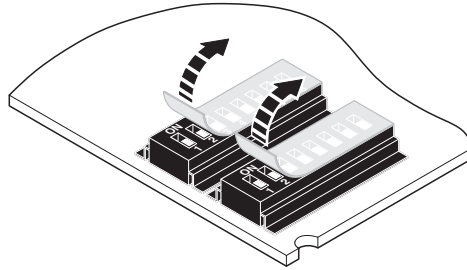
5. Set a valid Modbus address using a suitable tool, e.g., a micro screwdriver.
   Optional: set the baud rate. The default setting is 9600 bps; other rates are possible.

Value	Address
$2^0 = 1$	1
$2^1 = 2$	-
$2^2 = 4$	4
$2^3 = 8$	8
$2^4 = 16$	-
$2^5 = 32$	-
$2^6 = 64$	64
$2^7 = 128$	-
Σ	77
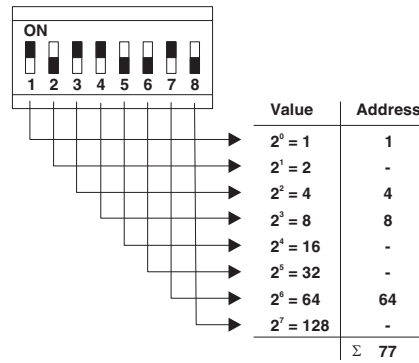
6. Place the PCB onto the guide rails and carefully reinsert it in the housing as far as it will go. Snap the housing cover into place.
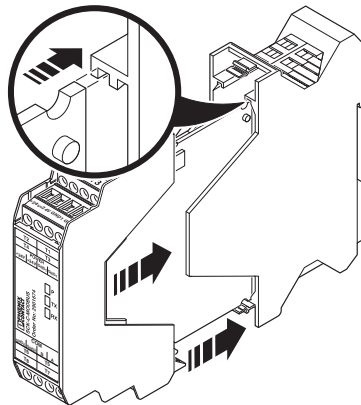
Changing the default settings

The default baud rate setting is 9600 bps. The baud rate can be changed to the following values using DIP switches S1 … S4.

Table 6-9   Setting the baud rate

Baud rate [bps]	S1	S2	S3	S4
9600	0	0	0	0
14400	1	0	0	0
19200	0	1	0	0
38400	1	1	0	0

Please note that fast baud rates are generally more susceptible to interference.

The default parity and stop bit settings can be changed using DIP switches S5 and S6 and DIP switch S7.

Table 6-10   Setting the parity

Parity	S5	S6
Even	1	0
Odd	1	1
None	0	x

Table 6-11   Setting the stop bits

Stop bits	S7
1	0
2	1

6.5.2 Connecting the SCK-C-MODBUS communication module

Snap the device onto a 35 mm DIN rail according to DIN EN 50022 in the control cabinet.

Install the power supply, RS-485 communication, and the Solarcheck measuring devices as per the connection description in Section 6.1 on page 39 and the following connection diagram:
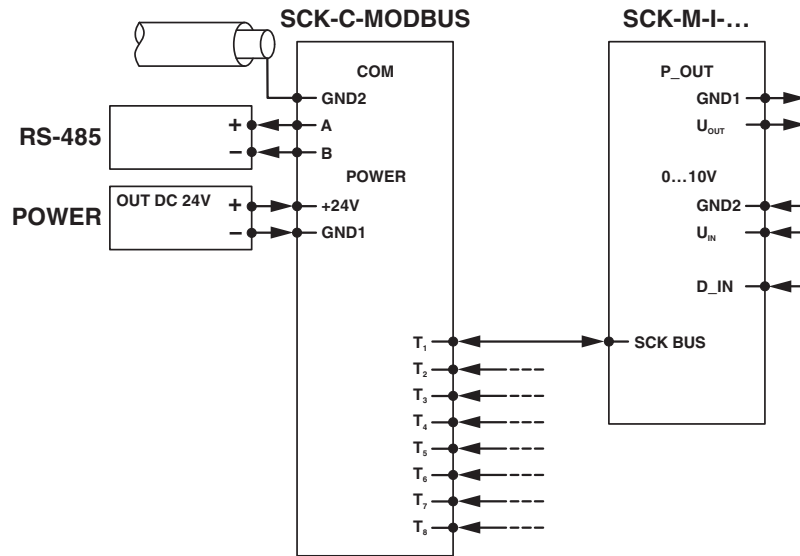
Figure 6-4   Connection diagram for SCK-C-MODBUS

1. First, connect all of the desired measuring modules to the corresponding T inputs of the device.

   To do this, wire the data inputs (T1 … T8) to the respective data outputs of the measuring modules (SCK BUS). Two cables are required for each data link to the measuring modules. The cables may be swapped.

2. Next, connect the RS-485 connections.

   To do this, wire data output A to the positive input of the RS-485 master and data output B to the negative input of the RS-485 master. The internal shield of this cable can be connected to the terminal block (GND2) so that the potential of the RS-485 network line is also routed. Instead of the internal shield, a third wire can also be used, for example, to route the potential in the RS-485 network. Also make sure that the external shield of the data cable is always connected to ground at both ends so as to prevent inductive couplings in the system from the power cables.

3. Wire the Modbus devices present in the RS-485 network with a maximum length of 1200 m. Follow the cabling recommendations in "Cabling" on page 44 and terminate the start and end of the network following the established procedure for RS-485 networks.
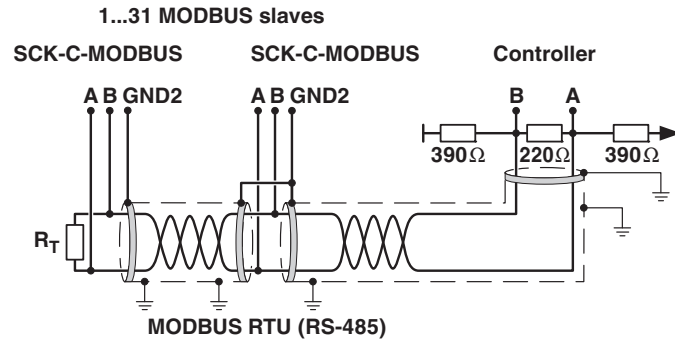
Figure 6-5   Modbus connection

4. Finally, install the supply connections.

   To do this, wire one of the supply inputs (+24V) or (GND1) to the positive or negative output of the supply device.

The remaining two free terminal blocks of the supply input on the communication module can be used to implement the supply to other 24 V devices as a parallel connection. Note the design of the power supply for all connected devices.

In order to avoid possible arc discharge during installation, do not connect the devices while the power is connected.

Only switch on the power supply once the Solarcheck devices have been installed.

6.6 Installing SCK-M-I-xx current measuring modules

Do not open or modify the device.

Snap the device onto a 35 mm DIN rail according to DIN EN 50022 in the control cabinet.

It is a good idea to install the PV string cables that are to be measured first.

Route the current measuring cables through the through connections indicated. The maximum cable diameter of the current measuring cable including insulation must not exceed 9.5 mm.
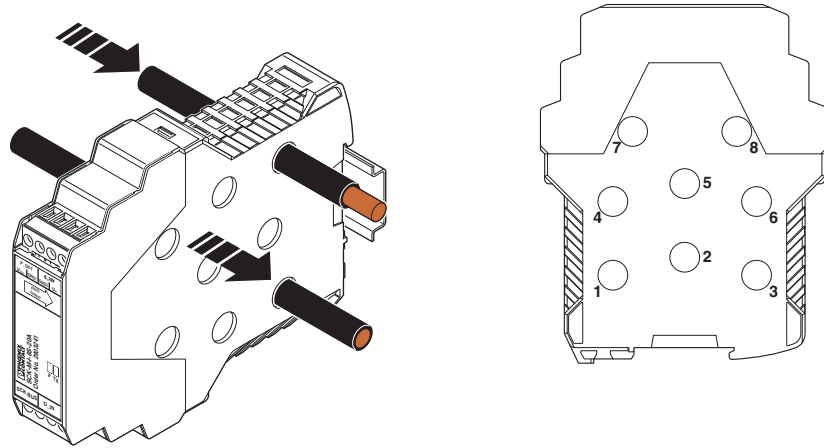
Figure 6-6   Assignment of the current measuring channels

For current measurement, only use suitable solar cables with insulation and conductor cross sections that are appropriate for the voltages and currents required in the system. For the cable design in PV systems, see relevant references, e.g., in IEC 60364-7-712 or equivalent standards.

Observe the correct current flow direction for DC current measurement in the measuring module.

As a guide, the required current flow direction is indicated with an arrow.

Next, install SCK communication, the digital input, and the analog interface as per the connection description in 6.1 on page 39 and the following connection diagram:

SCK-C-MODBUS **SCK-M-I-8S-20A** **SCK-M-U-1500V**

COM		P_OUT		P_IN
GND2		GND1		0V
A		U_{OUT}		24V
B				
POWER		0...10V		2...10V OUT
+24V		GND2		GND2
GND1		U_{IN}		10V

VOLTAGE INPUT
MAX 1500V DC

T_x SCK BUS

D_IN

+
–
PE
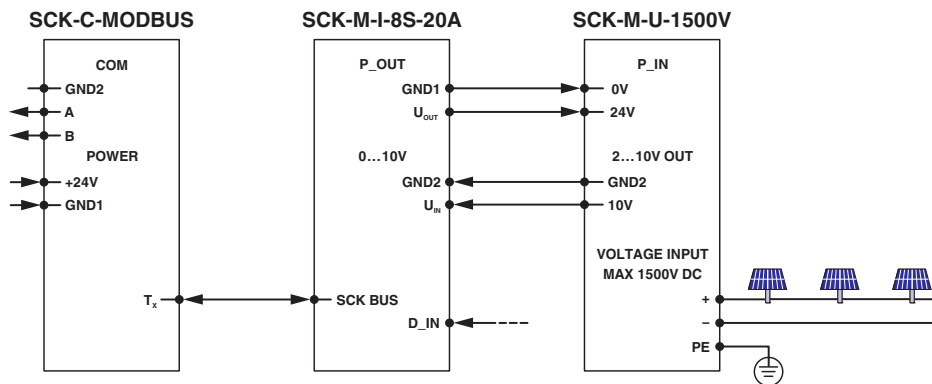
Figure 6-7   Connection diagram for SCK-M-I-8S-20A

SCK-C-MODBUS **SCK-M-I-4S-20A**

COM
GND2
A
B
POWER
+24V
GND1

T_x SCK BUS

D_IN
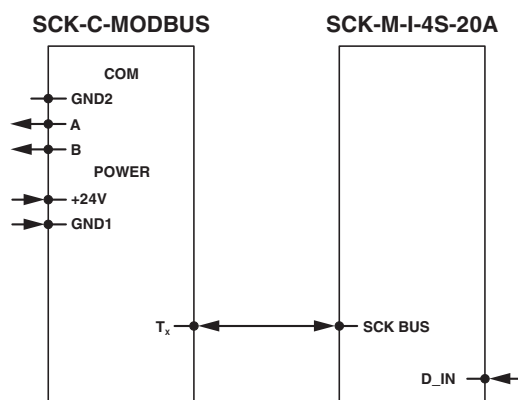
Figure 6-8   Connection diagram for SCK-M-I-4S-20A

Also follow the cabling recommendations in "Cabling" on page 44.

> **NOTE: Risk of damage to equipment**
> Only wire floating switch contacts directly to the digital input. The digital signal input must not be wired to an active signal.
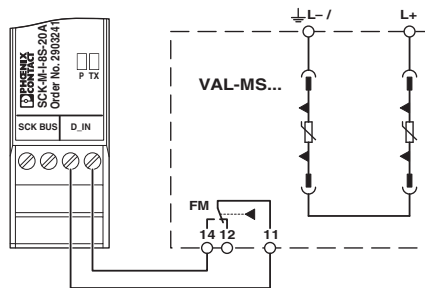
Figure 6-9   Digital input connection

6.7 Installing the SCK-M-U-1500V voltage measuring module

⊙ **NOTE: Risk of damage to equipment**
Maintain the specified distance between the voltage measuring input and other conductive parts in the vicinity. This safety distance must be observed in order to avoid electrical sparkovers.
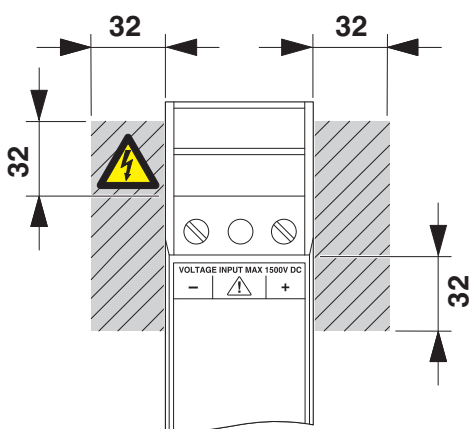
Figure 6-10   Mounting distances

⚠ **WARNING: Risk of electric shock**
Do not install voltage measurement while the system is in operation. High voltages may be present in parts of the system even in diffuse daylight. Observe all statutory requirements for live working.
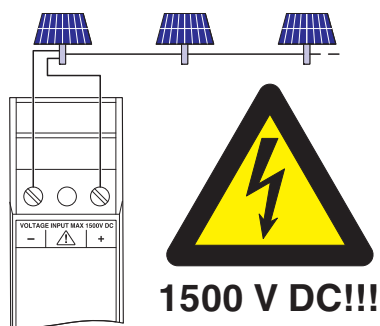
Figure 6-11   High-voltage measurement connection

The module is usually connected to the corresponding 8-channel current measuring module (SCK-M-I-8S-20A, Order No. 2903241).

As an option, the voltage measuring module can also be operated as a simple analog measuring device outside of the Solarcheck device range. Two options are described below.

Do not open or modify the device.

Snap the device onto a 35 mm DIN rail according to EN 50022 in the control cabinet.

6.7.1   PE connection

Install the PE connection first. For PE connection, use suitable copper cables with a diameter of at least 2.5 mm^2/14 AWG. Ensure reliable ground contact by using PE terminal blocks, such as the UT 2,5 PE feed-through terminal block (Order No. 3044092).
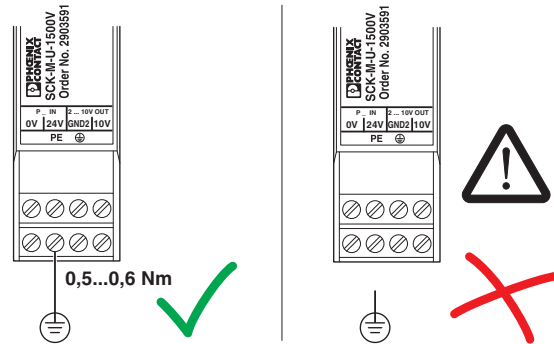
Figure 6-12   PE connection

NOTE: Risk of damage to equipment

It is imperative that the PE contact is connected correctly, as in addition to its safety-related function it is also used as the reference potential for measurement.

Operation without PE connection can result in damage to the device.

6.7.2 Connecting the measuring module to the SCK-M-I-8S-20A Solarcheck current measuring module

Connect the analog signal cable to the corresponding outputs (2 ... 10 V OUT) on the voltage measuring module and wire them to the analog input of the current measuring module (0 ... 10 V IN).
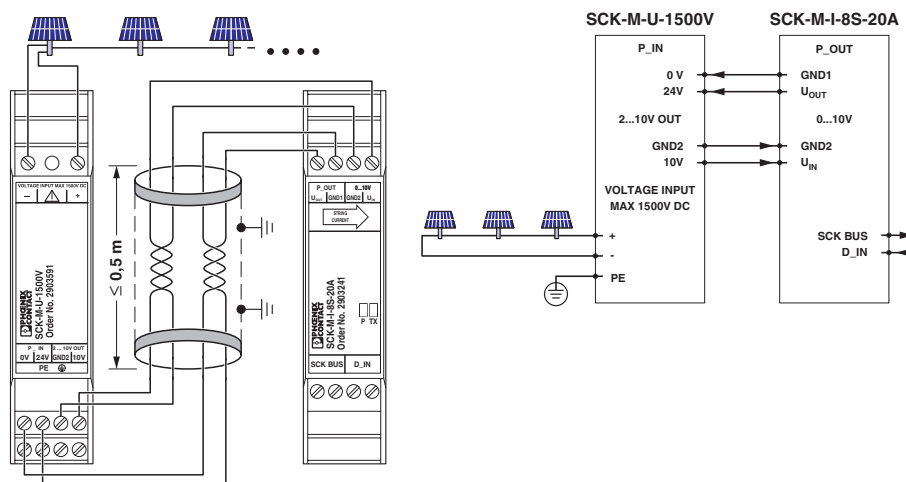
Figure 6-13   Connection to the SCK-M-I-8S-20A module

The cable length between these two devices must not exceed 0.5 m.

To supply the voltage measuring module, wire the supply input (P_IN) to the corresponding supply output on the current measuring module (P_OUT).

Use twisted and shielded cables for all signal and supply cables to avoid electromagnetic interference from the PV generator (e.g., via the string or bus cables). Ground the shield.

6.7.3 Connecting the measuring module outside of the Solar-check device range

The voltage measuring module can also be used as a simple analog measuring transducer outside of the Solarcheck device range. For this, connect the signal output (2 ... 10 V OUT) to a suitable analog voltage input of an evaluation unit.
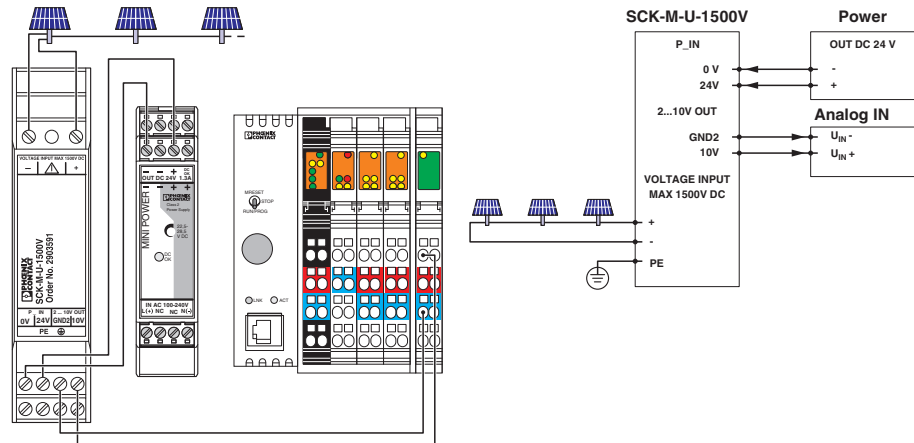
Figure 6-14   Connection outside of the Solarcheck device range

Make sure the load does not fall below 10 kΩ.

The cable length between these two devices must not exceed 0.5 m.

In this case, power is not supplied via the Solarcheck devices, it is supplied separately; for further details on the design, refer to "Design of a separate power supply for the SCK-M-U-1500V voltage measuring module" on page 63.

Use twisted and shielded cables for all signal and supply cables to avoid electromagnetic interference from the PV generator (e.g., via the string or bus cables). Ground the shield.

6.7.4 Connecting voltage measurement

To connect voltage measurement, use suitable cables with appropriate insulation for your system voltage (double or reinforced insulation).

The installation and connection of cables must be short-circuit-proof and ground-fault-proof. Tap the voltage at suitable points in the string combiner box in parallel and connect the negative and positive poles to the corresponding connection terminal blocks.

Voltage measurement can be used in PV systems grounded on the positive or negative side as well as in ungrounded PV systems with voltages up to 1500 V DC.

The specified measuring accuracy applies for the 100 ... 1500 V DC measuring range.

Snap the device onto a 35 mm DIN rail according to DIN EN 50022 in the control cabinet.

6.8   Power supply for the Solarcheck devices

> ⊙ **NOTE:**
> Only use power supply units with safe isolation and SELV/PELV according to
> EN 50178/VDE 0160 (SELV/PELV)

Use shielded twisted pair cables for the supply cable.

Ground the 24 V supply just once on the power supply unit.

6.8.1   Design of the power supply

In addition to collecting data, the communication module also supplies power to the connected measuring modules. The power supply for the communication module and the connected measuring modules therefore has to be incorporated in the design.

– 24 V DC input voltage (-10% ... +25%)
– For current consumption, all connected measuring modules must also be taken into consideration

Let us assume 22 mA for the communication module and the sum of the typical current consumption of all connected measuring modules. To account for the current peaks, the result must be multiplied by 3. This calculation applies if 24 V is supplied. Otherwise, please refer to the current consumption diagrams for the modules.
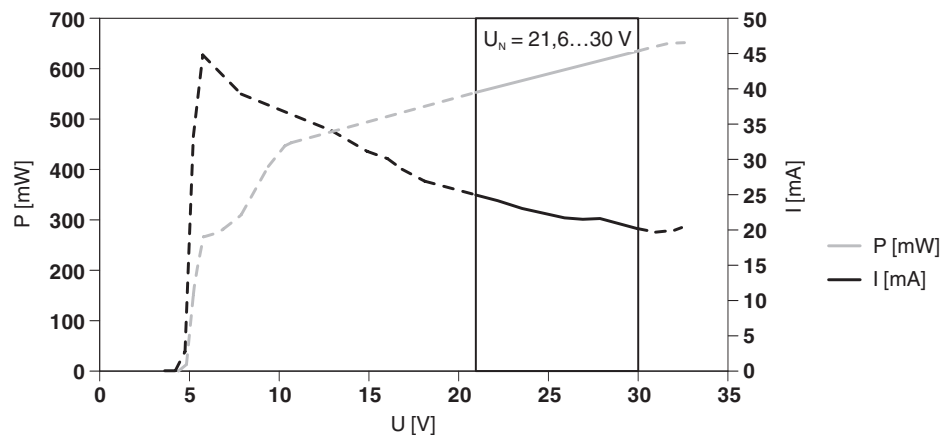
Figure 6-15   Performance characteristics of the SCK-C-MODBUS communication module without connected measuring devices
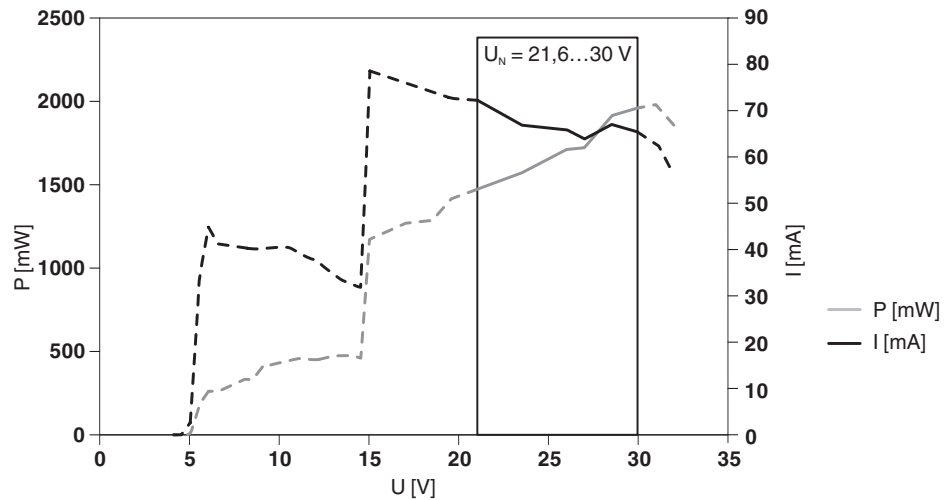
Figure 6-16   Performance characteristics of the communication module (SCK-C-MOD-
              BUS) with connected measuring modules (SCK-M-I-…) including voltage
              measuring modules (SCK-M-U-1500V)

The typical values for current consumption apply if the input voltage is in the required range
of 24 V DC. If the input voltage drops, current consumption may increase up to the specified
maximum value. Any further deviation results in device shutdown.

Example:
1 x SCK-C-MODBUS with 8 connected SCK-M-I-8S-20A modules each of which includes
voltage measurement via SCK-M-U-1500V

Table 6-12   Current consumption

Module	Typical (at 24 V)	Maximum
SCK-C-MODBUS	22 mA	45 mA
SCK-M-I-8S-20A	43 mA	50 mA
SCK-M-U-1500V	8 mA	65 mA

22 mA + (8 x (43 mA + 8 mA)) = 430 mA

With safety factor 3 → 1290 mA

6.8.2 Design of a separate power supply for the SCK-M-U-1500V voltage measuring module

The voltage measuring module can also be used as a simple analog measuring transducer outside of the Solarcheck device range. In this case, power is not supplied via the connection to the SCK-M-I-8S-20A Solarcheck current measuring module, it must be supplied separately instead. A 24 V DC power supply must be provided. The typical current consumption is 8 mA. The maximum current consumption is 65 mA. The maximum current consumption only occurs if the value falls significantly below the minimum input voltage.
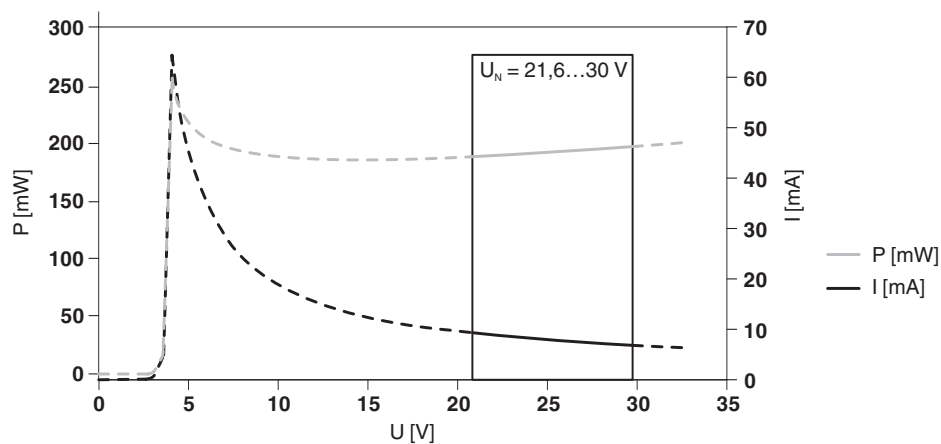
Figure 6-17   Performance characteristics of the voltage measuring module (SCK-M-U-1500V)

7 Startup

Install the devices as described in the installation instructions.

Then switch on the power supply to the devices. The communication devices take around 10 s to initialize. During this time, the start routine is indicated by the various flashing signals of the LEDs.

Start routine:
– 3 s LED test
– Ready for RS-485 communication
– Identify connected measuring modules
– Start cyclic data retrieval for connected measuring modules (see description in "SCK-internal communication cycle" on page 33)

If an error is detected when the modules are started, this is indicated by a flashing signal at the POWER LED on completion of the LED test.

The following signals are displayed:

P: Power (green)	
■	OK
□	Internal error, connection error
■ 1.4 Hz	Communication error
■ 2.8 Hz	Internal error
Tx: Send data (green)	
■	Sending data
□	No communication
Rx: Receive data (green)	
■	Receiving data
□	No communication

■ ... Hz LED flashing   ■ LED on   □ LED off

Figure 7-1   LED indicators

8 Additional functions

8.1 Energy-saving mode

So that the energy balance of the overall photovoltaic system is influenced as little as possible, the energy demands of a monitoring system should be very low. This is why the Solarcheck communication module has a switch-off function. This function is simply activated by setting a time value (in seconds) in one of the registers for the communication module. The module then remains in energy-saving mode for the specified time, meaning that the connected measuring modules are switched off. Once this time has elapsed, the communication module independently resumes communication and power supply to the connected measuring units. In this way, the energy used by monitoring equipment can be significantly reduced.

Example: switching off nighttime monitoring

Because the PV system does not operate at night, for example, nighttime monitoring for current and voltage measurement is not necessary either as there are no corresponding values during this time. Therefore monitoring could be switched off for 10 hours (21:00 to 07:00), for example. Depending on the location of the system and the time of year, the shutdown period can be further extended.

Nevertheless, if for example status monitoring is sporadically requested during the inactive nighttime period, it is possible to program a cycle to wake up the system for a few minutes, for example.

The individual operating time of the devices can be designed completely via the higher-level controller.

Programming shutdown:

A USIGN16 bit value is stored in register 04AEh for the required time.

Table 8-1   Assignment time - register value

Time	Register value
10 s	10 (decimal)
60 s	60 (decimal)
5 min	300 (decimal)
1 hr	3600 (decimal)

Entry of the value immediately places the module in energy-saving mode. The mode is active for at least 10 s (minimum value) and can be extended to 18.2 hours (65535 s, maximum value). Writing the value to the register must therefore be supported on the controller side with a corresponding timer. Energy-saving mode is either stopped automatically after the set time has elapsed or by manually setting the time value in the register to "0" via the controller.

The devices then start automatically and run as described for startup in 7 on page 65.

8.2 Locate function

Large photovoltaic power stations require good logistics and documentation in order to assign data to the actual position in the field. Checking the assignment is an important and to some extent time-consuming task during startup. In order to support and simplify this assignment, the Solarcheck communication module features a simple locate function. By setting a time value in a special register, the respective communication module is immediately placed in locate mode. It remains in this operating state until the specified time has elapsed or the module is restarted manually. This state is also exited by manually setting the time value to "0". The communication module can indicate locate mode by flashing all existing LEDs at a uniform frequency of 0.7 Hz. This behavior clearly distinguishes the module from other communication modules regardless of which operating state they are in. Because locate mode is activated via the controller, this allows the programmed module ID to be clearly assigned to the actual device.

The communication mode is still active while the modules are in locate mode, so measured data is not lost during this time. The connected measuring modules likewise continue operating normally.

Example:

The time entry is set in register 04AFh of the corresponding module.
The value is stored in the register as USIGN16.
The minimum value is 5 s (5 decimal) and the maximum value is 18.2 hrs (65535 decimal).
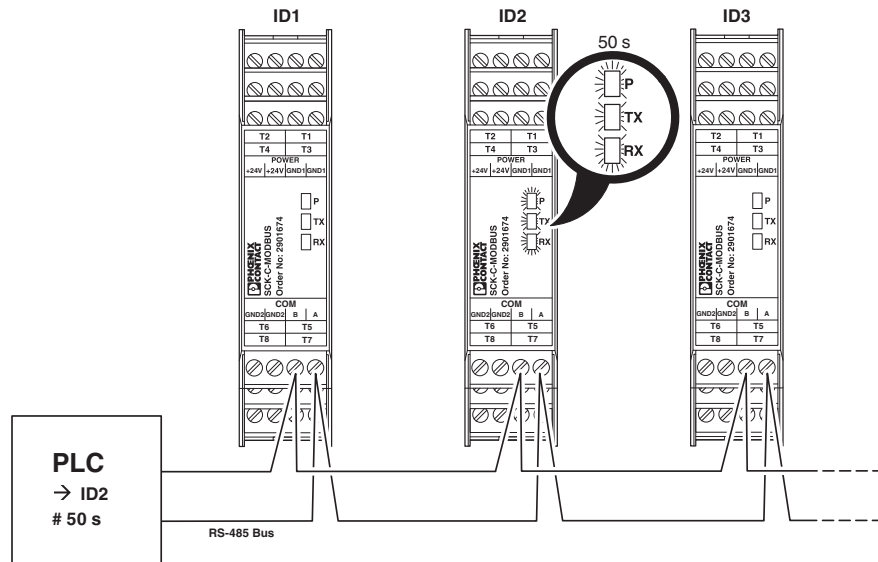
Figure 8-1   Schematic view of the locate function

8.3 System calibration

The measuring inputs of all measuring modules are tested and calibrated to high quality standards in the factory. However, due to the physical characteristics of Hall sensor measurement, under certain circumstances it is possible to generate an offset in the current measured value caused by magnetization. Very abrupt current edges, which are rather unusual in photovoltaics, or geological conditions can cause such effects.

Where present, this measured value offset is usually consistent. This means that the measured values are always increased by the same basic value. This type of offset can be detected permanently when the PV generator is switched off but a constant low current value is still displayed above the specified deviation of measurement. For example, at night when it is guaranteed that there is no current flowing and the displayed measured value shows, e.g., 0.4 A.

In this type of situation, the entire measuring system can simply be calibrated.

To do this, the current value of all measuring channels is recorded in a defined "zero-current situation" (e.g., the middle of the night) and temporarily stored. This value is the offset which would increase the actual current values for the operating time during the day.

Take this temporarily stored value and permanently subtract it from the measured value recorded during the day.

This zero calibration can also be performed each night, for example, to improve general measuring accuracy, without an actual offset being generated.

$I_{PV1} = 6,7$ A

$I_{PV2} = 6,3$ A

$I_{PV3} = 6,1$ A

$I_N = \underline{0\ A}$

$I_{PV1} = 0,4$ A

$I_{PV2} = 0,2$ A

$I_{PV3} = 0,0$ A

$I_{PV1} = 6,7$ A (-0,4 A) = 6,3 A ✓

$I_{PV2} = 6,3$ A (-0,2 A) = 6,1 A ✓

$I_{PV3} = 6,1$ A (-0 A) = 6,1 A ✓
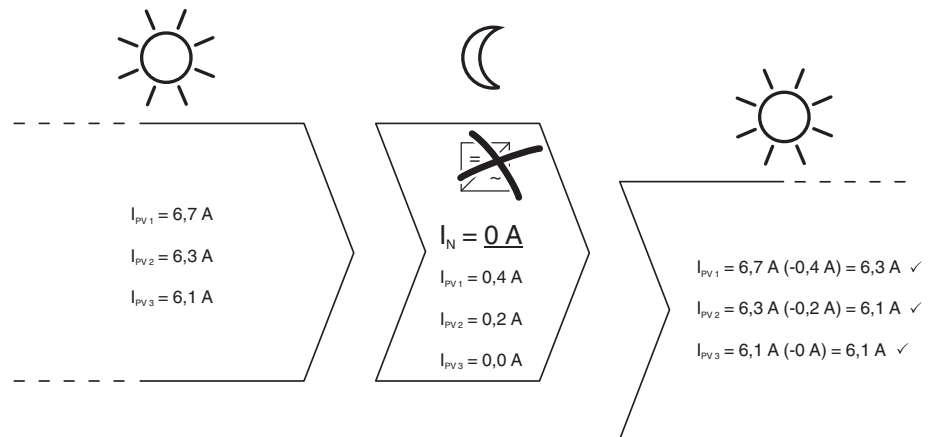
Figure 8-2   System calibration

9 Installation examples

Here you will find some typical installation examples for medium to large PV systems. The examples are schematic and simply illustrate a few possible installation options. The modularity of the Solarcheck system means that many other arrangements and combinations are possible. Solarcheck is a very flexible system which can be effectively incorporated into many system designs, making inexpensive solutions possible.

9.1 Example 1

SCK-C-MODBUS installed centrally in the inverter station. Solarcheck current measuring module(s) without voltage measurement installed in the string combiner box in the PV field.

The traditional arrangement involves installing the communication module at a central location, which allows the advantages of the modular system structure to be demonstrated to very great effect. Therefore, because power is supplied to the measuring devices in the field via the Solarcheck communication cable, a particularly efficient and inexpensive design for the power supply of the overall Solarcheck system is possible.
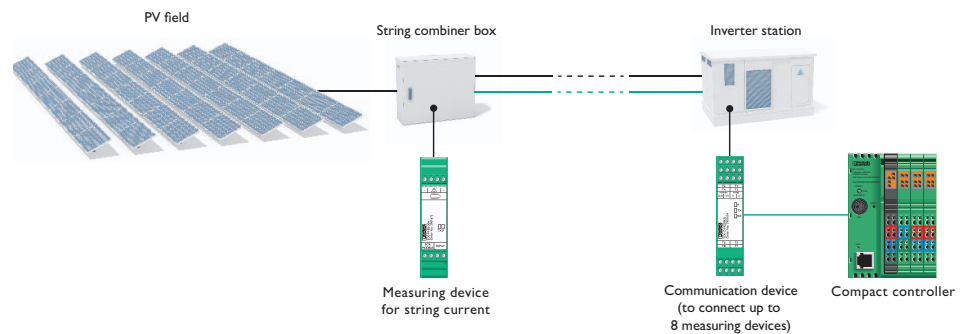
Figure 9-1   SCK-C-MODBUS in the inverter station, current measuring module without voltage measurement in the string combiner box

9.2   Example 2

SCK-C-MODBUS installed centrally in the inverter station. Solarcheck current measuring module(s) and voltage measuring modules installed in the string combiner box in the PV field.

If the voltage is to be acquired at string level, positioning the voltage measuring module in the string combiner box is advised. In this case, the analog input of the SCK-M-I-8S-20A current measuring module, which is specifically designed for this purpose, can be used for the power supply and data connection of the SCK-M-U-1500V voltage measuring module. A separate power supply for voltage measurement does not have to be provided here either. Likewise, the voltage data is available via the Solarcheck protocol.

Of course, it is possible to equip one or just a few string combiner boxes with additional voltage measurement in each system segment, because the string voltage in the system segment is usually the same everywhere due to the parallel connection.
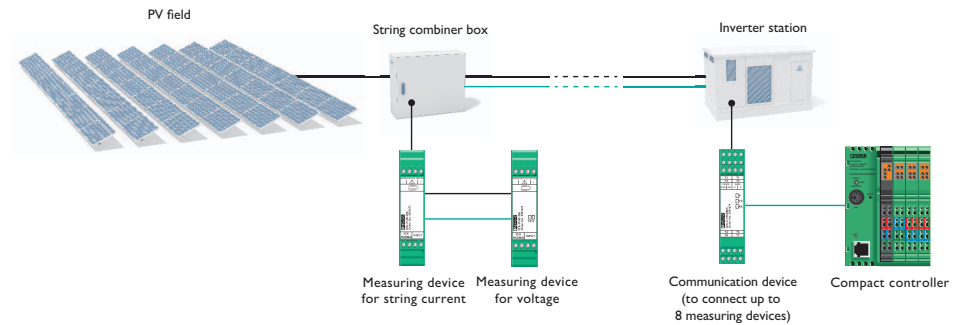
Figure 9-2   SCK-C-MODBUS in the inverter station, current measuring module with voltage measurement in the string combiner box

9.3 Example 3

SCK-C-MODBUS installed centrally in the inverter station. Solarcheck current measuring module(s) installed in the string combiner box in the PV field. Higher-level voltage measurement for each system segment.

As already indicated under Example 2, the typical parallel connection of strings in large PV systems means that the voltage in a system segment is usually the same.

This means that voltage data can be acquired very effectively and economically. Voltage measurement via the SCK-M-U-1500V voltage measuring module can also be used outside of the Solarcheck device topology.

In this case, the device is used as a simple analog device in the string combiner boxes. In this scenario, the power supply and data connection for the device must be implemented separately. This method of use is very inexpensive, as only one voltage measuring module is required per system segment.

PV field   String combiner box   Inverter station

Compact controller

Measuring device
for string current

Communication device
(to connect up to
8 measuring devices)

Measuring
device for voltage

Power Supply
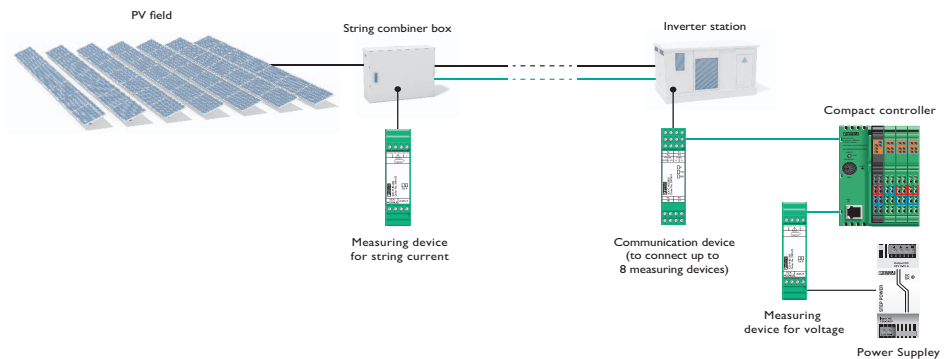
Figure 9-3   SCK-C-MODBUS in the inverter station, current measuring module in the string combiner box, SCK-M-U-1500V at higher level

9.4   Example 4

SCK-C-MODBUS installed in the communication box. Solarcheck current measuring module(s) installed in the string combiner box in the PV field.

Due to the system design, a distributed arrangement of the communication modules in a system may also be worthwhile. The use of a communication box is recommended here, so that the power supply and any other communication units (controller, wireless modules, RS-485/Ethernet converter, etc.) can be housed in this communication box. This arrangement also makes good use of the modularity of the Solarcheck system.

The arrangement can of course also be combined with the other examples listed (e.g., to also incorporate voltage measurement).
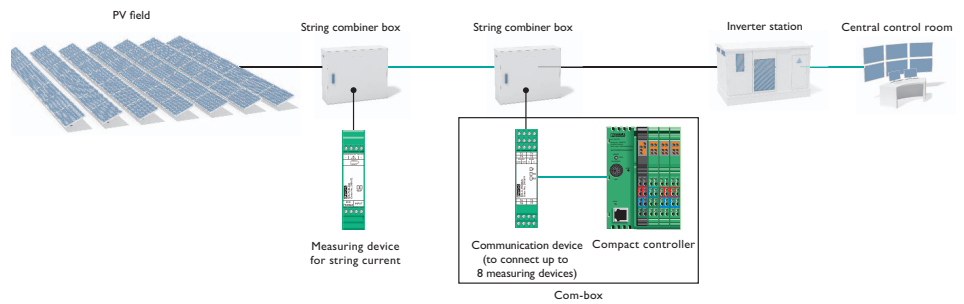
Figure 9-4   SCK-C-MODBUS in separate communication box, current measuring module without voltage measurement in the string combiner box

10 Troubleshooting

In the event of errors or malfunction during startup or operation, this table can be used to perform initial diagnostics locally and to possibly even remove the error cause directly. If troubleshooting using this table is not possible, please contact your Phoenix Contact representative.

Error states can be read on the device via the LED indicators or by reading the status registers.

Figure 10-1   LED indicators

Table 10-1   Structure of the status register

High byte								Low byte							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	DIS	ER	NC	CC	0	0	0	0

Bit	Short name	Meaning
4	CC	Short circuit
5	NC	Not connected (no module connected)
6	ER	Error (communication error)
7	DIS	Disabled (channel disabled)

10.1   Diagnostics and error removal

Table 10-2   Scenario 1: SCK-C-MODBUS

Device/ error description	Status register	LED indicator
SCK-C-MODBUS (2901674) There is no data from one or more connected measuring modules.	Entry "1" in bit 4 of the low byte (0001 0000)	POWER LED: flashing (1.4 Hz)
Cause		
Short circuit on the SCK bus connection.		
Measures		
1. Locate the short circuit: disconnect all measuring modules from the communication module one at a time until the affected cable is found. 2. Check the affected cable and remove the short circuit. 3. After removing the error cause, test the function of the modules. The short-circuit message should no longer be present in the status register. 4. If the message is still present: a) The short circuit has not been removed completely → see item 1. Or b) Internal components have been damaged by the short circuit (high currents possible). In this case, replace the communication module.		

Table 10-3   Scenario 2: SCK-C-MODBUS

Device/ error description	Status register	LED indicator
SCK-C-MODBUS (2901674) There is no data from one or more connected measuring modules.	Entry "1" in bit 5 of the low byte (0010 0000)	POWER LED: permanently ON
Cause		
There is no connection to the measuring module at the affected input.		
Measures		
1. Check the affected cable. 2. Check whether the SCK BUS plug of the affected measuring module is connected correctly. 3. Correct the connection, if necessary. 4. After removing the error cause, test the function of the affected modules. 5. If the message is still present: a) The connection is still faulty → see item 1. Or b) Internal components have been damaged. In this case, replace the communication module.		

Table 10-4   Scenario 3: SCK-C-MODBUS

Device/ error description	Status register	LED indicator
SCK-C-MODBUS (2901674) There is no data or incorrect data from one or more connected measuring modules.	Entry "1" in bit 6 of the low byte (0100 0000)	POWER LED: flashing (1.4 Hz) and/or Tx LED lights up sporadically
Cause		
Data transmission to the affected measuring module is faulty.		
Measures		

1.   Check the shielding and installation of the affected SCK bus data cable (see Section 2.2 on page 15 and 6.4 on page 44).
2.   Remove any interference couplings.
3.   After removing the error cause, test the function of the affected device.
4.   If the message is still present:
      a) The connection is still faulty or disrupted → see item 1.
      Or b) Internal components have been damaged. In this case, replace the communication module.
5. For closer examination of the data quality, it is recommended that you record the signals on the SCK BUS cable using an oscilloscope.		

Table 10-5   Scenario 4: SCK-C-MODBUS

Device/ error description	Status register	LED indicator
SCK-C-MODBUS (2901674) There is no data from one or more connected measuring modules.	Entry "1" in bit 7 of the low byte (1000 0000)	POWER LED: permanently ON
Cause		
The affected module or measuring modules connected to it were switched off by the energy-saving function.		
Measures		
1. If shutdown was not planned, check the source text of your program and remove the setting for the energy-saving function (see Section 8.1 on page 67). 2. After disabling the energy-saving function, test the function of the affected module. If it remains switched off and the register entry is set to "0", an error is present. Send in the device.		

Table 10-6   Scenario 5: SCK-C-MODBUS

Device/ error description	Status register	LED indicator
SCK-C-MODBUS (2901674) There is no data from the communication module and the connected measuring modules.	No entry	POWER LED: flashing (2.8 Hz)
Cause		
An internal error has occurred.		
Measures		
1. Replace the communication module.		

Table 10-7   Scenario 6: SCK-C-MODBUS

Device/ error description	Status register	LED indicator
SCK-C-MODBUS (2901674) Data is regularly unavailable or is out of date.	No entry	POWER LED: permanently ON
Cause		
The SCK internal cycle time is longer than the retrieval interval at the controller.		
Measures		
1. Set a retrieval interval > 2 s at the controller. 2. Faulty data can extend the internal cycle time. Check the data quality as described for Scenario 3 in Table 10-4 on page 77.		

Table 10-8   Scenario 7: SCK-M-I-...

Device/ error description	Status register	LED indicator
SCK-M-I-... (2903241, 2903242) Module switches off automatically or remains in an on/off loop.	No entry	POWER LED: ON/OFF
Cause		
If the supply voltage at the measuring module input falls below approximately 16 V, the module current consumption increases rapidly. Internal safety mechanisms then switch off the module. The module restarts automatically after 10 s. If the cause of the low voltage and the high current is not removed, the module switches off again. The module gets stuck in an on/off loop.		
Measures		
1. Provide the necessary power supply to the module. Voltage drops can be caused by underdimensioned power supply equipment, incorrectly dimensioned cabling or external factors influencing the cabling.		

Table 10-9   Scenario 8: SCK-M-I-8S-20A

Device/ error description	Status register	LED indicator
SCK-M-I-8S-20A (2903241) The current values of the string are all displayed as reverse current (-1.5 A).	No entry	POWER LED: ON
Cause		
The current measuring module has been installed incorrectly. Current measurement is dependent on the current direction.		
Measures		
1. Install the module the other way. Route the string cables from the other side through the holes in the device (see Section 6.6 on page 54). The current direction is indicated on the device with an arrow.		

Table 10-10   Scenario 9: SCK-M-I-8S-20A

Device/ error description	Status register	LED indicator
SCK-M-I-8S-20A (2903241) The current values do not correspond.	No entry	POWER LED: ON
Cause – Data transmission is disrupted between the measuring and communication modules and causes incorrect values in the current value registers. – The measuring channels were magnetized.		
Measures 1. In the case of incorrect transmission-related values, proceed as described in Scenario 3 in Table 10-4 on page 77. 2. In the case of permanently altered measured values, check whether a current value is also present in defined "zero current situations" (e.g., at night). If this is the case, an offset has been caused by magnetization. Proceed as described in Section 8.3 on page 69.		
Note: corresponding tests on the devices have shown that the components used are very resistant to magnetization. Magnetization therefore occurs very rarely. Nevertheless, it can be caused by multiple rising high current edges in the μs range, for example. These edges are not usually present in PV systems.		

Table 10-11   Scenario 10: SCK-M-I-8S-20A / SCK-M-U-1500V

Device/ error description	Status register	LED indicator
SCK-M-I-8S-20A (2903241) / SCK-M-U-1500V (2903591) Data from the connected SCK-M-U-1500V voltage measuring module is incorrect.	No entry	POWER LED: ON
Cause The value is outside the valid voltage range of the module.		
Measures 1. Make sure that the value does not go outside the valid voltage range of the device (see Section 4.1.1 on page 25) .		

Table 10-12   Scenario 11: SCK-M-I-8S-20A / other analog device

Device/ error description	Status register	LED indicator
SCK-M-I-8S-20A (2903241) / other analog device Data from the connected analog device is incorrect.	No entry	POWER LED: ON
Cause		
The analog device is not electrically isolated from the power supply of the Solarcheck communication module. This affects the voltage value at the analog input of the SCK-M-I-8S-20A.		
Measures		
1. Make sure that the supply for the analog device and the Solarcheck communication module are electrically isolated. For example, use a separate power supply for the analog device.		

Table 10-13   Scenario 12: SCK-M-U-1500V

Device/ error description	Status register	LED indicator
SCK-M-U-1500V (2903591) There is a voltage between 0 … 2 V at the analog input of the SCK-M-I-8S-20A or the controller.	No entry	POWER LED: ON
Cause		
A cable break has occurred or there is a faulty connection between the SCK-M-U-1500V and the SCK-M-I-8S-20A or controller. This error can be detected with the "live zero" signal.		
Measures		
1. Check the connection between the devices and remove the error.		

10.2   Additional notes

– In photovoltaic systems, the installation and surrounding area can influence the data technology in various ways. Effective error localization is usually inexpensive and more effective than simply replacing devices. Error causes must be removed reliably and permanently so as to ensure the added value achieved by monitoring your operating data for the long term as well.

– For troubleshooting, it is recommended that you disconnect the affected modules from the rest of the system and test the replacement modules as they are incorporated in the system. Successive testing should always be carried out to isolate errors and their location. When carrying out troubleshooting, always perform before/after comparisons.

– In the case of troubleshooting on the RS-485 side of the device, other baud rates can also be set for test purposes:

Table 10-14   Baud rates

Baud rate	Parity	No. of stop bits	DIP8 Not used	DIP7 Stop bit	DIP6 Parity mode	DIP5 Activate parity	DIP4 Baud rate	DIP3	DIP2	DIP1
9600	-	-	X	X	X	X	0	0	0	0
14400	-	-	X	X	X	X	0	0	0	1
19200	-	-	X	X	X	X	0	0	1	0
38400	-	-	X	X	X	X	0	0	1	1
57600	-	-	X	X	X	X	0	1	0	0
76800	-	-	X	X	X	X	0	1	0	1
115200	-	-	X	X	X	X	0	1	1	0
230400	-	-	X	X	X	X	0	1	1	1
75	-	-	X	X	X	X	1	0	0	0
150	-	-	X	X	X	X	1	0	0	1
300	-	-	X	X	X	X	1	0	1	0
600	-	-	X	X	X	X	1	0	1	1
1200	-	-	X	X	X	X	1	1	0	0
2400	-	-	X	X	X	X	1	1	0	1
4800	-	-	X	X	X	X	1	1	1	0
7200	-	-	X	X	X	X	1	1	1	1
-	None	-	X	X	X	0	X	X	X	X
-	Even	-	X	X	0	1	X	X	X	X
-	Odd	-	X	X	1	1	X	X	X	X
-	-	1 stop bit	X	0	X	X	X	X	X	X
-	-	2 stop bits	X	1	X	X	X	X	X	X

1 – ON

0 – OFF

X – either

– If other analog devices are connected to the SCK-M-I-8S-20A, you must make sure that the connected analog device is electrically isolated from the supply of the remaining Solarcheck devices. Otherwise invalid values may occur on the analog input side.

– In the event of communication errors, the communication module is set to the "Timeout" state after 10 s.

A   Appendix

A 1   Register tables

The Modbus address area is divided into 10 ranges.

Ranges 1 ... 9 contain module information (MI) and process data (PD) for the SCK interfaces. The registers in these ranges can only be read.

Range 10 contains module information (MI) and process data (PD) for the SCK-C-MODBUS module. All the data can be read. Some of the data can be written as well (see "Locate function" on page 68 and "Energy-saving mode" on page 67, for example).

A 1.1 Registers - data assignment

Table A-1   Illustration of the register table for reading 2901672 (Modbus address 0000h..005Ch)

Modbus address (HEX)	Name	Unit	Modbus address (HEX)	Name	Unit
0000	SCK channel 1 status	Bit mask	0030	SCK channel 5 current 4	Ix100 [A]
0001	SCK channel 1 current 1	Ix100 [A]	0031	SCK channel 5 current 5	Ix100 [A]
0002	SCK channel 1 current 2	Ix100 [A]	0032	SCK channel 5 current 6	Ix100 [A]
0003	SCK channel 1 current 3	Ix100 [A]	0033	SCK channel 5 current 7	Ix100 [A]
0004	SCK channel 1 current 4	Ix100 [A]	0034	SCK channel 5 current 8	Ix100 [A]
0005	SCK channel 1 current 5	Ix100 [A]	0035	SCK channel 5 temp.	[°C]
0006	SCK channel 1 current 6	Ix100 [A]	0036	SCK channel 5 voltage	[V]
0007	SCK channel 1 current 7	Ix100 [A]	0037	SCK channel 6 status	Bit mask
0008	SCK channel 1 current 8	Ix100 [A]	0038	SCK channel 6 current 1	Ix100 [A]
0009	SCK channel 1 temp.	[°C]	0039	SCK channel 6 current 2	Ix100 [A]
000A	SCK channel 1 voltage	[V]	003A	SCK channel 6 current 3	Ix100 [A]
000B	SCK channel 2 status	Bit mask	003B	SCK channel 6 current 4	Ix100 [A]
000C	SCK channel 2 current 1	Ix100 [A]	003C	SCK channel 6 current 5	Ix100 [A]
000D	SCK channel 2 current 2	Ix100 [A]	003D	SCK channel 6 current 6	Ix100 [A]
000E	SCK channel 2 current 3	Ix100 [A]	003E	SCK channel 6 current 7	Ix100 [A]
000F	SCK channel 2 current 4	Ix100 [A]	003F	SCK channel 6 current 8	Ix100 [A]
0010	SCK channel 2 current 5	Ix100 [A]	0040	SCK channel 6 temp.	[°C]
0011	SCK channel 2 current 6	Ix100 [A]	0041	SCK channel 6 voltage	[V]
0012	SCK channel 2 current 7	Ix100 [A]	0042	SCK channel 7 status	Bit mask
0013	SCK channel 2 current 8	Ix100 [A]	0043	SCK channel 7 current 1	Ix100 [A]
0014	SCK channel 2 temp.	[°C]	0044	SCK channel 7 current 2	Ix100 [A]
0015	SCK channel 2 voltage	[V]	0045	SCK channel 7 current 3	Ix100 [A]
0016	SCK channel 3 status	Bit mask	0046	SCK channel 7 current 4	Ix100 [A]
0017	SCK channel 3 current 1	Ix100 [A]	0047	SCK channel 7 current 5	Ix100 [A]

Table A-1   Illustration of the register table for reading 2901672 (Modbus address 0000h..005Ch) [...]

Modbus address (HEX)	Name	Unit	Modbus address (HEX)	Name	Unit
0018	SCK channel 3 current 2	Ix100 [A]	0048	SCK channel 7 current 6	Ix100 [A]
0019	SCK channel 3 current 3	Ix100 [A]	0049	SCK channel 7 current 7	Ix100 [A]
001A	SCK channel 3 current 4	Ix100 [A]	004A	SCK channel 7 current 8	Ix100 [A]
001B	SCK channel 3 current 5	Ix100 [A]	004B	SCK channel 7 temp.	[°C]
001C	SCK channel 3 current 6	Ix100 [A]	004C	SCK channel 7 voltage	[V]
001D	SCK channel 3 current 7	Ix100 [A]	004D	SCK channel 8 status	Bit mask
001E	SCK channel 3 current 8	Ix100 [A]	004E	SCK channel 8 current 1	Ix100 [A]
001F	SCK channel 3 temp.	[°C]	004F	SCK channel 8 current 2	Ix100 [A]
0020	SCK channel 3 voltage	[V]	0050	SCK channel 8 current 3	Ix100 [A]
0021	SCK channel 4 status	Bit mask	0051	SCK channel 8 current 4	Ix100 [A]
0022	SCK channel 4 current 1	Ix100 [A]	0052	SCK channel 8 current 5	Ix100 [A]
0023	SCK channel 4 current 2	Ix100 [A]	0053	SCK channel 8 current 6	Ix100 [A]
0024	SCK channel 4 current 3	Ix100 [A]	0054	SCK channel 8 current 7	Ix100 [A]
0025	SCK channel 4 current 4	Ix100 [A]	0055	SCK channel 8 current 8	Ix100 [A]
0026	SCK channel 4 current 5	Ix100 [A]	0056	SCK channel 8 temp.	[°C]
0027	SCK channel 4 current 6	Ix100 [A]	0057	SCK channel 8 voltage	[V]
0028	SCK channel 4 current 7	Ix100 [A]	0058	Short circuit	
0029	SCK channel 4 current 8	Ix100 [A]	0059	Not connected	
002A	SCK channel 4 temp.	[°C]	005A	Communication error	
002B	SCK channel 4 voltage	[V]	005B	Digital inputs	
002C	SCK channel 5 status	Bit mask	005C	Ready for opera-tion	
002D	SCK channel 5 current 1	Ix100 [A]	005D	SCK-C module ID	
002E	SCK channel 5 current 2	Ix100 [A]			
002F	SCK channel 5 current 3	Ix100 [A]			

Table A-2   Register contents for the SCK-C-MODBUS

Modbus address (HEX)	Designation
0480	SCK-C PD0 (short circuit)
0481	SCK-C PD1 (not connected)
0482	SCK-C PD2 (communication error)
0483	SCK-C PD3 (ready for operation)
0484	SCK-C PD4 (switched off)
0490	SCK-C PD16 (avg. request interval)
0491	SCK-C PD17 (number of packet requests)
0492	Number of packet errors SCK channel 1
0493	Number of packet errors SCK channel 2
0494	Number of packet errors SCK channel 3
0495	Number of packet errors SCK channel 4
0496	Number of packet errors SCK channel 5
0497	Number of packet errors SCK channel 6
0498	Number of packet errors SCK channel 7
0499	Number of packet errors SCK channel 8
04A0	SCK-C PD32 (temperature)
04AE	SCK-C PD46 (switch off SCK IF)
04AF	SCK-C PD47 (identify module)
04B0	SCK-C PD48 (comp. level)
04B1	SCK-C MI0 (module ID)
04B2	SCK-C MI1 (serial number)
04B3	SCK-C MI2 (serial number)
04B4	SCK-C MI3 (serial number)
04B5	SCK-C MI4 (serial number)
04B6..04C5	SCK-C MI5..MI20 (name, 32 x ASCII)

Table A-3   SCK-M-I-8S-20A register contents

Index	Designation	Data type	Value range	Unit
	Channel status		Bit mask	
PD0	Digital input	USIGN16	0..1	-
PD1	Current channel 1	INT16	-250..2500	A/100
PD2	Current channel 2		-250..2500	A/100
PD3	Current channel 3		-250..2500	A/100
PD4	Current channel 4		-250..2500	A/100
PD5	Current channel 5		-250..2500	A/100
PD6	Current channel 6		-250..2500	A/100
PD7	Current channel 7		-250..2500	A/100
PD8	Current channel 8		-250..2500	A/100
PD9	Temperature		-50..100	°C
PD10	Voltage		-2000..12000	mV
PD11…PD47	Unused			

Table A-3　　SCK-M-I-8S-20A register contents [...]

Index	Designation	Data type	Value range	Unit
MI0	Module ID	USIGN16	4	-
MI1	Serial number	USIGN64	0	-
MI2			0	-
MI3			0	-
MI4			0	-
MI5	Module name (32 characters)	32x CHAR	"SC"	-
MI6			"K-"	-
MI7			"M-"	-
MI8			"I-"	-
MI9			"8S"	-
MI10			"-2"	-
MI11			"0A"	-
MI12			0	-
MI13			0	-
MI14			0	-
MI15			0	-
MI16			0	-
MI17			0	-
MI18			0	-
MI19			0	-
MI20			0	-

Table A-4　　SCK-M-I-4S-20A register contents

Index	Designation	Data type	Value range	Unit
	Channel status		Bit mask	
PD0	Digital input	USIGN16	0..1	-
PD1	Current channel 1	INT16	-250..2500	A/100
PD2	Current channel 2		-250..2500	A/100
PD3	Current channel 3		-250..2500	A/100
PD4	Current channel 4		-250..2500	A/100
PD5	Temperature		-50..100	°C
PD6…PD47	Unused			
MI0	Module ID	USIGN16	5	-
MI1	Serial number	USIGN64	0	-
MI2			0	-
MI3			0	-
MI4			0	-

Table A-4   SCK-M-I-4S-20A register contents [...]

Index	Designation	Data type	Value range	Unit
MI5	Module name (32 characters)	32x CHAR	"SC"	-
MI6			"K-"	-
MI7			"M-"	-
MI8			"I-"	-
MI9			"4S"	-
MI10			"-2"	-
MI11			"0A"	-
MI12			0	-
MI13			0	-
MI14			0	-
MI15			0	-
MI16			0	-
MI17			0	-
MI18			0	-
MI19			0	-
MI20			0	-

A 1.2   Address area range 1

Table A-5   Register entries for connecting current measuring module 2901672
                 (Modbus address 0000h..005Fh)

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0000	Read-only	SCK channel 1 status	0030	Read-only	SCK channel 5 current 4
0001	Read-only	SCK channel 1 current 1	0031	Read-only	SCK channel 5 current 5
0002	Read-only	SCK channel 1 current 2	0032	Read-only	SCK channel 5 current 6
0003	Read-only	SCK channel 1 current 3	0033	Read-only	SCK channel 5 current 7
0004	Read-only	SCK channel 1 current 4	0034	Read-only	SCK channel 5 current 8
0005	Read-only	SCK channel 1 current 5	0035	Read-only	SCK channel 5 temperature
0006	Read-only	SCK channel 1 current 6	0036	Read-only	SCK channel 5 voltage
0007	Read-only	SCK channel 1 current 7	0037	Read-only	SCK channel 6 status
0008	Read-only	SCK channel 1 current 8	0038	Read-only	SCK channel 6 current 1
0009	Read-only	SCK channel 1 temperature	0039	Read-only	SCK channel 6 current 2
000A	Read-only	SCK channel 1 voltage	003A	Read-only	SCK channel 6 current 3
000B	Read-only	SCK channel 2 status	003B	Read-only	SCK channel 6 current 4
000C	Read-only	SCK channel 2 current 1	003C	Read-only	SCK channel 6 current 5
000D	Read-only	SCK channel 2 current 2	003D	Read-only	SCK channel 6 current 6
000E	Read-only	SCK channel 2 current 3	003E	Read-only	SCK channel 6 current 7
000F	Read-only	SCK channel 2 current 4	003F	Read-only	SCK channel 6 current 8
0010	Read-only	SCK channel 2 current 5	0040	Read-only	SCK channel 6 temperature
0011	Read-only	SCK channel 2 current 6	0041	Read-only	SCK channel 6 voltage
0012	Read-only	SCK channel 2 current 7	0042	Read-only	SCK channel 7 status
0013	Read-only	SCK channel 2 current 8	0043	Read-only	SCK channel 7 current 1
0014	Read-only	SCK channel 2 temperature	0044	Read-only	SCK channel 7 current 2
0015	Read-only	SCK channel 2 voltage	0045	Read-only	SCK channel 7 current 3
0016	Read-only	SCK channel 3 status	0046	Read-only	SCK channel 7 current 4
0017	Read-only	SCK channel 3 current 1	0047	Read-only	SCK channel 7 current 5
0018	Read-only	SCK channel 3 current 2	0048	Read-only	SCK channel 7 current 6
0019	Read-only	SCK channel 3 current 3	0049	Read-only	SCK channel 7 current 7
001A	Read-only	SCK channel 3 current 4	004A	Read-only	SCK channel 7 current 8
001B	Read-only	SCK channel 3 current 5	004B	Read-only	SCK channel 7 temperature
001C	Read-only	SCK channel 3 current 6	004C	Read-only	SCK channel 7 voltage
001D	Read-only	SCK channel 3 current 7	004D	Read-only	SCK channel 8 status
001E	Read-only	SCK channel 3 current 8	004E	Read-only	SCK channel 8 current 1
001F	Read-only	SCK channel 3 temperature	004F	Read-only	SCK channel 8 current 2
0020	Read-only	SCK channel 3 voltage	0050	Read-only	SCK channel 8 current 3
0021	Read-only	SCK channel 4 status	0051	Read-only	SCK channel 8 current 4
0022	Read-only	SCK channel 4 current 1	0052	Read-only	SCK channel 8 current 5
0023	Read-only	SCK channel 4 current 2	0053	Read-only	SCK channel 8 current 6

Table A-5   Register entries for connecting current measuring module 2901672 (Modbus address 0000h..005Fh) [...]

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0024	Read-only	SCK channel 4 current 3	0054	Read-only	SCK channel 8 current 7
0025	Read-only	SCK channel 4 current 4	0055	Read-only	SCK channel 8 current 8
0026	Read-only	SCK channel 4 current 5	0056	Read-only	SCK channel 8 temperature
0027	Read-only	SCK channel 4 current 6	0057	Read-only	SCK channel 8 voltage
0028	Read-only	SCK channel 4 current 7	0058	Read-only	Short circuit
0029	Read-only	SCK channel 4 current 8	0059	Read-only	Not connected
002A	Read-only	SCK channel 4 temperature	005A	Read-only	Communication error
002B	Read-only	SCK channel 4 voltage	005B	Read-only	Digital inputs
002C	Read-only	SCK channel 5 status	005C	Read-only	Ready for operation
002D	Read-only	SCK channel 5 current 1	005D	Read-only	SCK-C module ID
002E	Read-only	SCK channel 5 current 2			
002F	Read-only	SCK channel 5 current 3			

A 1.3   Address area range 2

Table A-6   Range 2: SCK channel 1 (Modbus address 0080h..00E0h)

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0080	Read-only	SCK channel 1 status	00B0	Read-only	SCK channel 1 PD47
0081	Read-only	SCK channel 1 PD0	00B1	Read-only	SCK channel 1 MI0
0082	Read-only	SCK channel 1 PD1	00B2	Read-only	SCK channel 1 MI1
0083	Read-only	SCK channel 1 PD2	00B3	Read-only	SCK channel 1 MI2
0084	Read-only	SCK channel 1 PD3	00B4	Read-only	SCK channel 1 MI3
0085	Read-only	SCK channel 1 PD4	00B5	Read-only	SCK channel 1 MI4
0086	Read-only	SCK channel 1 PD5	00B6	Read-only	SCK channel 1 MI5
0087	Read-only	SCK channel 1 PD6	00B7	Read-only	SCK channel 1 MI6
0088	Read-only	SCK channel 1 PD7	00B8	Read-only	SCK channel 1 MI7
0089	Read-only	SCK channel 1 PD8	00B9	Read-only	SCK channel 1 MI8
008A	Read-only	SCK channel 1 PD9	00BA	Read-only	SCK channel 1 MI9
008B	Read-only	SCK channel 1 PD10	00BB	Read-only	SCK channel 1 MI10
008C	Read-only	SCK channel 1 PD11	00BC	Read-only	SCK channel 1 MI11
008D	Read-only	SCK channel 1 PD12	00BD	Read-only	SCK channel 1 MI12
008E	Read-only	SCK channel 1 PD13	00BE	Read-only	SCK channel 1 MI13
008F	Read-only	SCK channel 1 PD14	00BF	Read-only	SCK channel 1 MI14
0090	Read-only	SCK channel 1 PD15	00C0	Read-only	SCK channel 1 MI15
0091	Read-only	SCK channel 1 PD16	00C1	Read-only	SCK channel 1 MI16
0092	Read-only	SCK channel 1 PD17	00C2	Read-only	SCK channel 1 MI17
0093	Read-only	SCK channel 1 PD18	00C3	Read-only	SCK channel 1 MI18
0094	Read-only	SCK channel 1 PD19	00C4	Read-only	SCK channel 1 MI19
0095	Read-only	SCK channel 1 PD20	00C5	Read-only	SCK channel 1 MI20
0096	Read-only	SCK channel 1 PD21	00C6	Read-only	SCK channel 1 MI21
0097	Read-only	SCK channel 1 PD22	00C7	Read-only	SCK channel 1 MI22
0098	Read-only	SCK channel 1 PD23	00C8	Read-only	SCK channel 1 MI23
0099	Read-only	SCK channel 1 PD24	00C9	Read-only	SCK channel 1 MI24
009A	Read-only	SCK channel 1 PD25	00CA	Read-only	SCK channel 1 MI25
009B	Read-only	SCK channel 1 PD26	00CB	Read-only	SCK channel 1 MI26
009C	Read-only	SCK channel 1 PD27	00CC	Read-only	SCK channel 1 MI27
009D	Read-only	SCK channel 1 PD28	00CD	Read-only	SCK channel 1 MI28
009E	Read-only	SCK channel 1 PD29	00CE	Read-only	SCK channel 1 MI29
009F	Read-only	SCK channel 1 PD30	00CF	Read-only	SCK channel 1 MI30
00A0	Read-only	SCK channel 1 PD31	00D0	Read-only	SCK channel 1 MI31
00A1	Read-only	SCK channel 1 PD32	00D1	Read-only	SCK channel 1 MI32
00A2	Read-only	SCK channel 1 PD33	00D2	Read-only	SCK channel 1 MI33
00A3	Read-only	SCK channel 1 PD34	00D3	Read-only	SCK channel 1 MI34
00A4	Read-only	SCK channel 1 PD35	00D4	Read-only	SCK channel 1 MI35
00A5	Read-only	SCK channel 1 PD36	00D5	Read-only	SCK channel 1 MI36
00A6	Read-only	SCK channel 1 PD37	00D6	Read-only	SCK channel 1 MI37
00A7	Read-only	SCK channel 1 PD38	00D7	Read-only	SCK channel 1 MI38

Table A-6   Range 2: SCK channel 1 (Modbus address 0080h..00E0h) [...]

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
00A8	Read-only	SCK channel 1 PD39	00D8	Read-only	SCK channel 1 MI39
00A9	Read-only	SCK channel 1 PD40	00D9	Read-only	SCK channel 1 MI40
00AA	Read-only	SCK channel 1 PD41	00DA	Read-only	SCK channel 1 MI41
00AB	Read-only	SCK channel 1 PD42	00DB	Read-only	SCK channel 1 MI42
00AC	Read-only	SCK channel 1 PD43	00DC	Read-only	SCK channel 1 MI43
00AD	Read-only	SCK channel 1 PD44	00DD	Read-only	SCK channel 1 MI44
00AE	Read-only	SCK channel 1 PD45	00DE	Read-only	SCK channel 1 MI45
00AF	Read-only	SCK channel 1 PD46	00DF	Read-only	SCK channel 1 MI46
			00E0	Read-only	SCK channel 1 MI47

A 1.4 Address area range 3

Table A-7 Range 3: SCK channel 2 (Modbus address 0100h..0160h)

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0100	Read-only	SCK channel 2 status	0130	Read-only	SCK channel 2 PD47
0101	Read-only	SCK channel 2 PD0	0131	Read-only	SCK channel 2 MI0
0102	Read-only	SCK channel 2 PD1	0132	Read-only	SCK channel 2 MI1
0103	Read-only	SCK channel 2 PD2	0133	Read-only	SCK channel 2 MI2
0104	Read-only	SCK channel 2 PD3	0134	Read-only	SCK channel 2 MI3
0105	Read-only	SCK channel 2 PD4	0135	Read-only	SCK channel 2 MI4
0106	Read-only	SCK channel 2 PD5	0136	Read-only	SCK channel 2 MI5
0107	Read-only	SCK channel 2 PD6	0137	Read-only	SCK channel 2 MI6
0108	Read-only	SCK channel 2 PD7	0138	Read-only	SCK channel 2 MI7
0109	Read-only	SCK channel 2 PD8	0139	Read-only	SCK channel 2 MI8
010A	Read-only	SCK channel 2 PD9	013A	Read-only	SCK channel 2 MI9
010B	Read-only	SCK channel 2 PD10	013B	Read-only	SCK channel 2 MI10
010C	Read-only	SCK channel 2 PD11	013C	Read-only	SCK channel 2 MI11
010D	Read-only	SCK channel 2 PD12	013D	Read-only	SCK channel 2 MI12
010E	Read-only	SCK channel 2 PD13	013E	Read-only	SCK channel 2 MI13
010F	Read-only	SCK channel 2 PD14	013F	Read-only	SCK channel 2 MI14
0110	Read-only	SCK channel 2 PD15	0140	Read-only	SCK channel 2 MI15
0111	Read-only	SCK channel 2 PD16	0141	Read-only	SCK channel 2 MI16
0112	Read-only	SCK channel 2 PD17	0142	Read-only	SCK channel 2 MI17
0113	Read-only	SCK channel 2 PD18	0143	Read-only	SCK channel 2 MI18
0114	Read-only	SCK channel 2 PD19	0144	Read-only	SCK channel 2 MI19
0115	Read-only	SCK channel 2 PD20	0145	Read-only	SCK channel 2 MI20
0116	Read-only	SCK channel 2 PD21	0146	Read-only	SCK channel 2 MI21
0117	Read-only	SCK channel 2 PD22	0147	Read-only	SCK channel 2 MI22
0118	Read-only	SCK channel 2 PD23	0148	Read-only	SCK channel 2 MI23
0119	Read-only	SCK channel 2 PD24	0149	Read-only	SCK channel 2 MI24
011A	Read-only	SCK channel 2 PD25	014A	Read-only	SCK channel 2 MI25
011B	Read-only	SCK channel 2 PD26	014B	Read-only	SCK channel 2 MI26
011C	Read-only	SCK channel 2 PD27	014C	Read-only	SCK channel 2 MI27
011D	Read-only	SCK channel 2 PD28	014D	Read-only	SCK channel 2 MI28
011E	Read-only	SCK channel 2 PD29	014E	Read-only	SCK channel 2 MI29
011F	Read-only	SCK channel 2 PD30	014F	Read-only	SCK channel 2 MI30
0120	Read-only	SCK channel 2 PD31	0150	Read-only	SCK channel 2 MI31
0121	Read-only	SCK channel 2 PD32	0151	Read-only	SCK channel 2 MI32
0122	Read-only	SCK channel 2 PD33	0152	Read-only	SCK channel 2 MI33
0123	Read-only	SCK channel 2 PD34	0153	Read-only	SCK channel 2 MI34
0124	Read-only	SCK channel 2 PD35	0154	Read-only	SCK channel 2 MI35
0125	Read-only	SCK channel 2 PD36	0155	Read-only	SCK channel 2 MI36
0126	Read-only	SCK channel 2 PD37	0156	Read-only	SCK channel 2 MI37
0127	Read-only	SCK channel 2 PD38	0157	Read-only	SCK channel 2 MI38

Table A-7   Range 3: SCK channel 2 (Modbus address 0100h..0160h) [...]

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0128	Read-only	SCK channel 2 PD39	0158	Read-only	SCK channel 2 MI39
0129	Read-only	SCK channel 2 PD40	0159	Read-only	SCK channel 2 MI40
012A	Read-only	SCK channel 2 PD41	015A	Read-only	SCK channel 2 MI41
012B	Read-only	SCK channel 2 PD42	015B	Read-only	SCK channel 2 MI42
012C	Read-only	SCK channel 2 PD43	015C	Read-only	SCK channel 2 MI43
012D	Read-only	SCK channel 2 PD44	015D	Read-only	SCK channel 2 MI44
012E	Read-only	SCK channel 2 PD45	015E	Read-only	SCK channel 2 MI45
012F	Read-only	SCK channel 2 PD46	015F	Read-only	SCK channel 2 MI46
			0160	Read-only	SCK channel 2 MI47

A 1.5   Address area range 4

Table A-8   Range 4: SCK channel 3 (Modbus address 0180h..01E0h)

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0180	Read-only	SCK channel 3 status	01B0	Read-only	SCK channel 3 PD47
0181	Read-only	SCK channel 3 PD0	01B1	Read-only	SCK channel 3 MI0
0182	Read-only	SCK channel 3 PD1	01B2	Read-only	SCK channel 3 MI1
0183	Read-only	SCK channel 3 PD2	01B3	Read-only	SCK channel 3 MI2
0184	Read-only	SCK channel 3 PD3	01B4	Read-only	SCK channel 3 MI3
0185	Read-only	SCK channel 3 PD4	01B5	Read-only	SCK channel 3 MI4
0186	Read-only	SCK channel 3 PD5	01B6	Read-only	SCK channel 3 MI5
0187	Read-only	SCK channel 3 PD6	01B7	Read-only	SCK channel 3 MI6
0188	Read-only	SCK channel 3 PD7	01B8	Read-only	SCK channel 3 MI7
0189	Read-only	SCK channel 3 PD8	01B9	Read-only	SCK channel 3 MI8
018A	Read-only	SCK channel 3 PD9	01BA	Read-only	SCK channel 3 MI9
018B	Read-only	SCK channel 3 PD10	01BB	Read-only	SCK channel 3 MI10
018C	Read-only	SCK channel 3 PD11	01BC	Read-only	SCK channel 3 MI11
018D	Read-only	SCK channel 3 PD12	01BD	Read-only	SCK channel 3 MI12
018E	Read-only	SCK channel 3 PD13	01BE	Read-only	SCK channel 3 MI13
018F	Read-only	SCK channel 3 PD14	01BF	Read-only	SCK channel 3 MI14
0190	Read-only	SCK channel 3 PD15	01C0	Read-only	SCK channel 3 MI15
0191	Read-only	SCK channel 3 PD16	01C1	Read-only	SCK channel 3 MI16
0192	Read-only	SCK channel 3 PD17	01C2	Read-only	SCK channel 3 MI17
0193	Read-only	SCK channel 3 PD18	01C3	Read-only	SCK channel 3 MI18
0194	Read-only	SCK channel 3 PD19	01C4	Read-only	SCK channel 3 MI19
0195	Read-only	SCK channel 3 PD20	01C5	Read-only	SCK channel 3 MI20
0196	Read-only	SCK channel 3 PD21	01C6	Read-only	SCK channel 3 MI21
0197	Read-only	SCK channel 3 PD22	01C7	Read-only	SCK channel 3 MI22
0198	Read-only	SCK channel 3 PD23	01C8	Read-only	SCK channel 3 MI23
0199	Read-only	SCK channel 3 PD24	01C9	Read-only	SCK channel 3 MI24
019A	Read-only	SCK channel 3 PD25	01CA	Read-only	SCK channel 3 MI25
019B	Read-only	SCK channel 3 PD26	01CB	Read-only	SCK channel 3 MI26
019C	Read-only	SCK channel 3 PD27	01CC	Read-only	SCK channel 3 MI27
019D	Read-only	SCK channel 3 PD28	01CD	Read-only	SCK channel 3 MI28
019E	Read-only	SCK channel 3 PD29	01CE	Read-only	SCK channel 3 MI29
019F	Read-only	SCK channel 3 PD30	01CF	Read-only	SCK channel 3 MI30
01A0	Read-only	SCK channel 3 PD31	01D0	Read-only	SCK channel 3 MI31
01A1	Read-only	SCK channel 3 PD32	01D1	Read-only	SCK channel 3 MI32
01A2	Read-only	SCK channel 3 PD33	01D2	Read-only	SCK channel 3 MI33
01A3	Read-only	SCK channel 3 PD34	01D3	Read-only	SCK channel 3 MI34
01A4	Read-only	SCK channel 3 PD35	01D4	Read-only	SCK channel 3 MI35
01A5	Read-only	SCK channel 3 PD36	01D5	Read-only	SCK channel 3 MI36
01A6	Read-only	SCK channel 3 PD37	01D6	Read-only	SCK channel 3 MI37
01A7	Read-only	SCK channel 3 PD38	01D7	Read-only	SCK channel 3 MI38

Table A-8   Range 4: SCK channel 3 (Modbus address 0180h..01E0h) [...]

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
01A8	Read-only	SCK channel 3 PD39	01D8	Read-only	SCK channel 3 MI39
01A9	Read-only	SCK channel 3 PD40	01D9	Read-only	SCK channel 3 MI40
01AA	Read-only	SCK channel 3 PD41	01DA	Read-only	SCK channel 3 MI41
01AB	Read-only	SCK channel 3 PD42	01DB	Read-only	SCK channel 3 MI42
01AC	Read-only	SCK channel 3 PD43	01DC	Read-only	SCK channel 3 MI43
01AD	Read-only	SCK channel 3 PD44	01DD	Read-only	SCK channel 3 MI44
01AE	Read-only	SCK channel 3 PD45	01DE	Read-only	SCK channel 3 MI45
01AF	Read-only	SCK channel 3 PD46	01DF	Read-only	SCK channel 3 MI46
			01E0	Read-only	SCK channel 3 MI47

A 1.6   Address area range 5

Table A-9   Range 5: SCK channel 4 (Modbus address 0200h..0260h)

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0200	Read-only	SCK channel 4 status	0230	Read-only	SCK channel 4 PD47
0201	Read-only	SCK channel 4 PD0	0231	Read-only	SCK channel 4 MI0
0202	Read-only	SCK channel 4 PD1	0232	Read-only	SCK channel 4 MI1
0203	Read-only	SCK channel 4 PD2	0233	Read-only	SCK channel 4 MI2
0204	Read-only	SCK channel 4 PD3	0234	Read-only	SCK channel 4 MI3
0205	Read-only	SCK channel 4 PD4	0235	Read-only	SCK channel 4 MI4
0206	Read-only	SCK channel 4 PD5	0236	Read-only	SCK channel 4 MI5
0207	Read-only	SCK channel 4 PD6	0237	Read-only	SCK channel 4 MI6
0208	Read-only	SCK channel 4 PD7	0238	Read-only	SCK channel 4 MI7
0209	Read-only	SCK channel 4 PD8	0239	Read-only	SCK channel 4 MI8
020A	Read-only	SCK channel 4 PD9	023A	Read-only	SCK channel 4 MI9
020B	Read-only	SCK channel 4 PD10	023B	Read-only	SCK channel 4 MI10
020C	Read-only	SCK channel 4 PD11	023C	Read-only	SCK channel 4 MI11
020D	Read-only	SCK channel 4 PD12	023D	Read-only	SCK channel 4 MI12
020E	Read-only	SCK channel 4 PD13	023E	Read-only	SCK channel 4 MI13
020F	Read-only	SCK channel 4 PD14	023F	Read-only	SCK channel 4 MI14
0210	Read-only	SCK channel 4 PD15	0240	Read-only	SCK channel 4 MI15
0211	Read-only	SCK channel 4 PD16	0241	Read-only	SCK channel 4 MI16
0212	Read-only	SCK channel 4 PD17	0242	Read-only	SCK channel 4 MI17
0213	Read-only	SCK channel 4 PD18	0243	Read-only	SCK channel 4 MI18
0214	Read-only	SCK channel 4 PD19	0244	Read-only	SCK channel 4 MI19
0215	Read-only	SCK channel 4 PD20	0245	Read-only	SCK channel 4 MI20
0216	Read-only	SCK channel 4 PD21	0246	Read-only	SCK channel 4 MI21
0217	Read-only	SCK channel 4 PD22	0247	Read-only	SCK channel 4 MI22
0218	Read-only	SCK channel 4 PD23	0248	Read-only	SCK channel 4 MI23
0219	Read-only	SCK channel 4 PD24	0249	Read-only	SCK channel 4 MI24
021A	Read-only	SCK channel 4 PD25	024A	Read-only	SCK channel 4 MI25
021B	Read-only	SCK channel 4 PD26	024B	Read-only	SCK channel 4 MI26
021C	Read-only	SCK channel 4 PD27	024C	Read-only	SCK channel 4 MI27
021D	Read-only	SCK channel 4 PD28	024D	Read-only	SCK channel 4 MI28
021E	Read-only	SCK channel 4 PD29	024E	Read-only	SCK channel 4 MI29
021F	Read-only	SCK channel 4 PD30	024F	Read-only	SCK channel 4 MI30
0220	Read-only	SCK channel 4 PD31	0250	Read-only	SCK channel 4 MI31
0221	Read-only	SCK channel 4 PD32	0251	Read-only	SCK channel 4 MI32
0222	Read-only	SCK channel 4 PD33	0252	Read-only	SCK channel 4 MI33
0223	Read-only	SCK channel 4 PD34	0253	Read-only	SCK channel 4 MI34
0224	Read-only	SCK channel 4 PD35	0254	Read-only	SCK channel 4 MI35
0225	Read-only	SCK channel 4 PD36	0255	Read-only	SCK channel 4 MI36
0226	Read-only	SCK channel 4 PD37	0256	Read-only	SCK channel 4 MI37
0227	Read-only	SCK channel 4 PD38	0257	Read-only	SCK channel 4 MI38

Table A-9   Range 5: SCK channel 4 (Modbus address 0200h..0260h) [...]

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0228	Read-only	SCK channel 4 PD39	0258	Read-only	SCK channel 4 MI39
0229	Read-only	SCK channel 4 PD40	0259	Read-only	SCK channel 4 MI40
022A	Read-only	SCK channel 4 PD41	025A	Read-only	SCK channel 4 MI41
022B	Read-only	SCK channel 4 PD42	025B	Read-only	SCK channel 4 MI42
022C	Read-only	SCK channel 4 PD43	025C	Read-only	SCK channel 4 MI43
022D	Read-only	SCK channel 4 PD44	025D	Read-only	SCK channel 4 MI44
022E	Read-only	SCK channel 4 PD45	025E	Read-only	SCK channel 4 MI45
022F	Read-only	SCK channel 4 PD46	025F	Read-only	SCK channel 4 MI46
			0260	Read-only	SCK channel 4 MI47

A 1.7 Address area range 6

Table A-10   Range 6: SCK channel 5 (Modbus address 0280h..02E0h)

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0280	Read-only	SCK channel 5 status	02B0	Read-only	SCK channel 5 PD47
0281	Read-only	SCK channel 5 PD0	02B1	Read-only	SCK channel 5 MI0
0282	Read-only	SCK channel 5 PD1	02B2	Read-only	SCK channel 5 MI1
0283	Read-only	SCK channel 5 PD2	02B3	Read-only	SCK channel 5 MI2
0284	Read-only	SCK channel 5 PD3	02B4	Read-only	SCK channel 5 MI3
0285	Read-only	SCK channel 5 PD4	02B5	Read-only	SCK channel 5 MI4
0286	Read-only	SCK channel 5 PD5	02B6	Read-only	SCK channel 5 MI5
0287	Read-only	SCK channel 5 PD6	02B7	Read-only	SCK channel 5 MI6
0288	Read-only	SCK channel 5 PD7	02B8	Read-only	SCK channel 5 MI7
0289	Read-only	SCK channel 5 PD8	02B9	Read-only	SCK channel 5 MI8
028A	Read-only	SCK channel 5 PD9	02BA	Read-only	SCK channel 5 MI9
028B	Read-only	SCK channel 5 PD10	02BB	Read-only	SCK channel 5 MI10
028C	Read-only	SCK channel 5 PD11	02BC	Read-only	SCK channel 5 MI11
028D	Read-only	SCK channel 5 PD12	02BD	Read-only	SCK channel 5 MI12
028E	Read-only	SCK channel 5 PD13	02BE	Read-only	SCK channel 5 MI13
028F	Read-only	SCK channel 5 PD14	02BF	Read-only	SCK channel 5 MI14
0290	Read-only	SCK channel 5 PD15	02C0	Read-only	SCK channel 5 MI15
0291	Read-only	SCK channel 5 PD16	02C1	Read-only	SCK channel 5 MI16
0292	Read-only	SCK channel 5 PD17	02C2	Read-only	SCK channel 5 MI17
0293	Read-only	SCK channel 5 PD18	02C3	Read-only	SCK channel 5 MI18
0294	Read-only	SCK channel 5 PD19	02C4	Read-only	SCK channel 5 MI19
0295	Read-only	SCK channel 5 PD20	02C5	Read-only	SCK channel 5 MI20
0296	Read-only	SCK channel 5 PD21	02C6	Read-only	SCK channel 5 MI21
0297	Read-only	SCK channel 5 PD22	02C7	Read-only	SCK channel 5 MI22
0298	Read-only	SCK channel 5 PD23	02C8	Read-only	SCK channel 5 MI23
0299	Read-only	SCK channel 5 PD24	02C9	Read-only	SCK channel 5 MI24
029A	Read-only	SCK channel 5 PD25	02CA	Read-only	SCK channel 5 MI25
029B	Read-only	SCK channel 5 PD26	02CB	Read-only	SCK channel 5 MI26
029C	Read-only	SCK channel 5 PD27	02CC	Read-only	SCK channel 5 MI27
029D	Read-only	SCK channel 5 PD28	02CD	Read-only	SCK channel 5 MI28
029E	Read-only	SCK channel 5 PD29	02CE	Read-only	SCK channel 5 MI29
029F	Read-only	SCK channel 5 PD30	02CF	Read-only	SCK channel 5 MI30
02A0	Read-only	SCK channel 5 PD31	02D0	Read-only	SCK channel 5 MI31
02A1	Read-only	SCK channel 5 PD32	02D1	Read-only	SCK channel 5 MI32
02A2	Read-only	SCK channel 5 PD33	02D2	Read-only	SCK channel 5 MI33
02A3	Read-only	SCK channel 5 PD34	02D3	Read-only	SCK channel 5 MI34
02A4	Read-only	SCK channel 5 PD35	02D4	Read-only	SCK channel 5 MI35
02A5	Read-only	SCK channel 5 PD36	02D5	Read-only	SCK channel 5 MI36
02A6	Read-only	SCK channel 5 PD37	02D6	Read-only	SCK channel 5 MI37
02A7	Read-only	SCK channel 5 PD38	02D7	Read-only	SCK channel 5 MI38

Table A-10   Range 6: SCK channel 5 (Modbus address 0280h..02E0h) [...]

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
02A8	Read-only	SCK channel 5 PD39	02D8	Read-only	SCK channel 5 MI39
02A9	Read-only	SCK channel 5 PD40	02D9	Read-only	SCK channel 5 MI40
02AA	Read-only	SCK channel 5 PD41	02DA	Read-only	SCK channel 5 MI41
02AB	Read-only	SCK channel 5 PD42	02DB	Read-only	SCK channel 5 MI42
02AC	Read-only	SCK channel 5 PD43	02DC	Read-only	SCK channel 5 MI43
02AD	Read-only	SCK channel 5 PD44	02DD	Read-only	SCK channel 5 MI44
02AE	Read-only	SCK channel 5 PD45	02DE	Read-only	SCK channel 5 MI45
02AF	Read-only	SCK channel 5 PD46	02DF	Read-only	SCK channel 5 MI46
			02E0	Read-only	SCK channel 5 MI47

A 1.8   Address area range 7

Table A-11   Range 7: SCK channel 6 (Modbus address 0300h..0360h)

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0300	Read-only	SCK channel 6 status	0330	Read-only	SCK channel 6 PD47
0301	Read-only	SCK channel 6 PD0	0331	Read-only	SCK channel 6 MI0
0302	Read-only	SCK channel 6 PD1	0332	Read-only	SCK channel 6 MI1
0303	Read-only	SCK channel 6 PD2	0333	Read-only	SCK channel 6 MI2
0304	Read-only	SCK channel 6 PD3	0334	Read-only	SCK channel 6 MI3
0305	Read-only	SCK channel 6 PD4	0335	Read-only	SCK channel 6 MI4
0306	Read-only	SCK channel 6 PD5	0336	Read-only	SCK channel 6 MI5
0307	Read-only	SCK channel 6 PD6	0337	Read-only	SCK channel 6 MI6
0308	Read-only	SCK channel 6 PD7	0338	Read-only	SCK channel 6 MI7
0309	Read-only	SCK channel 6 PD8	0339	Read-only	SCK channel 6 MI8
030A	Read-only	SCK channel 6 PD9	033A	Read-only	SCK channel 6 MI9
030B	Read-only	SCK channel 6 PD10	033B	Read-only	SCK channel 6 MI10
030C	Read-only	SCK channel 6 PD11	033C	Read-only	SCK channel 6 MI11
030D	Read-only	SCK channel 6 PD12	033D	Read-only	SCK channel 6 MI12
030E	Read-only	SCK channel 6 PD13	033E	Read-only	SCK channel 6 MI13
030F	Read-only	SCK channel 6 PD14	033F	Read-only	SCK channel 6 MI14
0310	Read-only	SCK channel 6 PD15	0340	Read-only	SCK channel 6 MI15
0311	Read-only	SCK channel 6 PD16	0341	Read-only	SCK channel 6 MI16
0312	Read-only	SCK channel 6 PD17	0342	Read-only	SCK channel 6 MI17
0313	Read-only	SCK channel 6 PD18	0343	Read-only	SCK channel 6 MI18
0314	Read-only	SCK channel 6 PD19	0344	Read-only	SCK channel 6 MI19
0315	Read-only	SCK channel 6 PD20	0345	Read-only	SCK channel 6 MI20
0316	Read-only	SCK channel 6 PD21	0346	Read-only	SCK channel 6 MI21
0317	Read-only	SCK channel 6 PD22	0347	Read-only	SCK channel 6 MI22
0318	Read-only	SCK channel 6 PD23	0348	Read-only	SCK channel 6 MI23
0319	Read-only	SCK channel 6 PD24	0349	Read-only	SCK channel 6 MI24
031A	Read-only	SCK channel 6 PD25	034A	Read-only	SCK channel 6 MI25
031B	Read-only	SCK channel 6 PD26	034B	Read-only	SCK channel 6 MI26
031C	Read-only	SCK channel 6 PD27	034C	Read-only	SCK channel 6 MI27
031D	Read-only	SCK channel 6 PD28	034D	Read-only	SCK channel 6 MI28
031E	Read-only	SCK channel 6 PD29	034E	Read-only	SCK channel 6 MI29
031F	Read-only	SCK channel 6 PD30	034F	Read-only	SCK channel 6 MI30
0320	Read-only	SCK channel 6 PD31	0350	Read-only	SCK channel 6 MI31
0321	Read-only	SCK channel 6 PD32	0351	Read-only	SCK channel 6 MI32
0322	Read-only	SCK channel 6 PD33	0352	Read-only	SCK channel 6 MI33
0323	Read-only	SCK channel 6 PD34	0353	Read-only	SCK channel 6 MI34
0324	Read-only	SCK channel 6 PD35	0354	Read-only	SCK channel 6 MI35
0325	Read-only	SCK channel 6 PD36	0355	Read-only	SCK channel 6 MI36
0326	Read-only	SCK channel 6 PD37	0356	Read-only	SCK channel 6 MI37
0327	Read-only	SCK channel 6 PD38	0357	Read-only	SCK channel 6 MI38

Table A-11   Range 7: SCK channel 6 (Modbus address 0300h..0360h) [...]

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0328	Read-only	SCK channel 6 PD39	0358	Read-only	SCK channel 6 MI39
0329	Read-only	SCK channel 6 PD40	0359	Read-only	SCK channel 6 MI40
032A	Read-only	SCK channel 6 PD41	035A	Read-only	SCK channel 6 MI41
032B	Read-only	SCK channel 6 PD42	035B	Read-only	SCK channel 6 MI42
032C	Read-only	SCK channel 6 PD43	035C	Read-only	SCK channel 6 MI43
032D	Read-only	SCK channel 6 PD44	035D	Read-only	SCK channel 6 MI44
032E	Read-only	SCK channel 6 PD45	035E	Read-only	SCK channel 6 MI45
032F	Read-only	SCK channel 6 PD46	035F	Read-only	SCK channel 6 MI46
			0360	Read-only	SCK channel 6 MI47

A 1.9 Address area range 8

Table A-12   Range 8: SCK channel 7 (Modbus address 0380h..03E0h)

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0380	Read-only	SCK channel 7 status	03B0	Read-only	SCK channel 7 PD47
0381	Read-only	SCK channel 7 PD0	03B1	Read-only	SCK channel 7 MI0
0382	Read-only	SCK channel 7 PD1	03B2	Read-only	SCK channel 7 MI1
0383	Read-only	SCK channel 7 PD2	03B3	Read-only	SCK channel 7 MI2
0384	Read-only	SCK channel 7 PD3	03B4	Read-only	SCK channel 7 MI3
0385	Read-only	SCK channel 7 PD4	03B5	Read-only	SCK channel 7 MI4
0386	Read-only	SCK channel 7 PD5	03B6	Read-only	SCK channel 7 MI5
0387	Read-only	SCK channel 7 PD6	03B7	Read-only	SCK channel 7 MI6
0388	Read-only	SCK channel 7 PD7	03B8	Read-only	SCK channel 7 MI7
0389	Read-only	SCK channel 7 PD8	03B9	Read-only	SCK channel 7 MI8
038A	Read-only	SCK channel 7 PD9	03BA	Read-only	SCK channel 7 MI9
038B	Read-only	SCK channel 7 PD10	03BB	Read-only	SCK channel 7 MI10
038C	Read-only	SCK channel 7 PD11	03BC	Read-only	SCK channel 7 MI11
038D	Read-only	SCK channel 7 PD12	03BD	Read-only	SCK channel 7 MI12
038E	Read-only	SCK channel 7 PD13	03BE	Read-only	SCK channel 7 MI13
038F	Read-only	SCK channel 7 PD14	03BF	Read-only	SCK channel 7 MI14
0390	Read-only	SCK channel 7 PD15	03C0	Read-only	SCK channel 7 MI15
0391	Read-only	SCK channel 7 PD16	03C1	Read-only	SCK channel 7 MI16
0392	Read-only	SCK channel 7 PD17	03C2	Read-only	SCK channel 7 MI17
0393	Read-only	SCK channel 7 PD18	03C3	Read-only	SCK channel 7 MI18
0394	Read-only	SCK channel 7 PD19	03C4	Read-only	SCK channel 7 MI19
0395	Read-only	SCK channel 7 PD20	03C5	Read-only	SCK channel 7 MI20
0396	Read-only	SCK channel 7 PD21	03C6	Read-only	SCK channel 7 MI21
0397	Read-only	SCK channel 7 PD22	03C7	Read-only	SCK channel 7 MI22
0398	Read-only	SCK channel 7 PD23	03C8	Read-only	SCK channel 7 MI23
0399	Read-only	SCK channel 7 PD24	03C9	Read-only	SCK channel 7 MI24
039A	Read-only	SCK channel 7 PD25	03CA	Read-only	SCK channel 7 MI25
039B	Read-only	SCK channel 7 PD26	03CB	Read-only	SCK channel 7 MI26
039C	Read-only	SCK channel 7 PD27	03CC	Read-only	SCK channel 7 MI27
039D	Read-only	SCK channel 7 PD28	03CD	Read-only	SCK channel 7 MI28
039E	Read-only	SCK channel 7 PD29	03CE	Read-only	SCK channel 7 MI29
039F	Read-only	SCK channel 7 PD30	03CF	Read-only	SCK channel 7 MI30
03A0	Read-only	SCK channel 7 PD31	03D0	Read-only	SCK channel 7 MI31
03A1	Read-only	SCK channel 7 PD32	03D1	Read-only	SCK channel 7 MI32
03A2	Read-only	SCK channel 7 PD33	03D2	Read-only	SCK channel 7 MI33
03A3	Read-only	SCK channel 7 PD34	03D3	Read-only	SCK channel 7 MI34
03A4	Read-only	SCK channel 7 PD35	03D4	Read-only	SCK channel 7 MI35
03A5	Read-only	SCK channel 7 PD36	03D5	Read-only	SCK channel 7 MI36
03A6	Read-only	SCK channel 7 PD37	03D6	Read-only	SCK channel 7 MI37
03A7	Read-only	SCK channel 7 PD38	03D7	Read-only	SCK channel 7 MI38

Table A-12   Range 8: SCK channel 7 (Modbus address 0380h..03E0h) [...]

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
03A8	Read-only	SCK channel 7 PD39	03D8	Read-only	SCK channel 7 MI39
03A9	Read-only	SCK channel 7 PD40	03D9	Read-only	SCK channel 7 MI40
03AA	Read-only	SCK channel 7 PD41	03DA	Read-only	SCK channel 7 MI41
03AB	Read-only	SCK channel 7 PD42	03DB	Read-only	SCK channel 7 MI42
03AC	Read-only	SCK channel 7 PD43	03DC	Read-only	SCK channel 7 MI43
03AD	Read-only	SCK channel 7 PD44	03DD	Read-only	SCK channel 7 MI44
03AE	Read-only	SCK channel 7 PD45	03DE	Read-only	SCK channel 7 MI45
03AF	Read-only	SCK channel 7 PD46	03DF	Read-only	SCK channel 7 MI46
			03E0	Read-only	SCK channel 7 MI47

A 1.10   Address area range 9

Table A-13   Range 9: SCK channel 8 (Modbus address 0400h..0460h)

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0400	Read-only	SCK channel 8 status	0430	Read-only	SCK channel 8 PD47
0401	Read-only	SCK channel 8 PD0	0431	Read-only	SCK channel 8 MI0
0402	Read-only	SCK channel 8 PD1	0432	Read-only	SCK channel 8 MI1
0403	Read-only	SCK channel 8 PD2	0433	Read-only	SCK channel 8 MI2
0404	Read-only	SCK channel 8 PD3	0434	Read-only	SCK channel 8 MI3
0405	Read-only	SCK channel 8 PD4	0435	Read-only	SCK channel 8 MI4
0406	Read-only	SCK channel 8 PD5	0436	Read-only	SCK channel 8 MI5
0407	Read-only	SCK channel 8 PD6	0437	Read-only	SCK channel 8 MI6
0408	Read-only	SCK channel 8 PD7	0438	Read-only	SCK channel 8 MI7
0409	Read-only	SCK channel 8 PD8	0439	Read-only	SCK channel 8 MI8
040A	Read-only	SCK channel 8 PD9	043A	Read-only	SCK channel 8 MI9
040B	Read-only	SCK channel 8 PD10	043B	Read-only	SCK channel 8 MI10
040C	Read-only	SCK channel 8 PD11	043C	Read-only	SCK channel 8 MI11
040D	Read-only	SCK channel 8 PD12	043D	Read-only	SCK channel 8 MI12
040E	Read-only	SCK channel 8 PD13	043E	Read-only	SCK channel 8 MI13
040F	Read-only	SCK channel 8 PD14	043F	Read-only	SCK channel 8 MI14
0410	Read-only	SCK channel 8 PD15	0440	Read-only	SCK channel 8 MI15
0411	Read-only	SCK channel 8 PD16	0441	Read-only	SCK channel 8 MI16
0412	Read-only	SCK channel 8 PD17	0442	Read-only	SCK channel 8 MI17
0413	Read-only	SCK channel 8 PD18	0443	Read-only	SCK channel 8 MI18
0414	Read-only	SCK channel 8 PD19	0444	Read-only	SCK channel 8 MI19
0415	Read-only	SCK channel 8 PD20	0445	Read-only	SCK channel 8 MI20
0416	Read-only	SCK channel 8 PD21	0446	Read-only	SCK channel 8 MI21
0417	Read-only	SCK channel 8 PD22	0447	Read-only	SCK channel 8 MI22
0418	Read-only	SCK channel 8 PD23	0448	Read-only	SCK channel 8 MI23

Table A-13   Range 9: SCK channel 8 (Modbus address 0400h..0460h) [...]

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0419	Read-only	SCK channel 8 PD24	0449	Read-only	SCK channel 8 MI24
041A	Read-only	SCK channel 8 PD25	044A	Read-only	SCK channel 8 MI25
041B	Read-only	SCK channel 8 PD26	044B	Read-only	SCK channel 8 MI26
041C	Read-only	SCK channel 8 PD27	044C	Read-only	SCK channel 8 MI27
041D	Read-only	SCK channel 8 PD28	044D	Read-only	SCK channel 8 MI28
041E	Read-only	SCK channel 8 PD29	044E	Read-only	SCK channel 8 MI29
041F	Read-only	SCK channel 8 PD30	044F	Read-only	SCK channel 8 MI30
0420	Read-only	SCK channel 8 PD31	0450	Read-only	SCK channel 8 MI31
0421	Read-only	SCK channel 8 PD32	0451	Read-only	SCK channel 8 MI32
0422	Read-only	SCK channel 8 PD33	0452	Read-only	SCK channel 8 MI33
0423	Read-only	SCK channel 8 PD34	0453	Read-only	SCK channel 8 MI34
0424	Read-only	SCK channel 8 PD35	0454	Read-only	SCK channel 8 MI35
0425	Read-only	SCK channel 8 PD36	0455	Read-only	SCK channel 8 MI36
0426	Read-only	SCK channel 8 PD37	0456	Read-only	SCK channel 8 MI37
0427	Read-only	SCK channel 8 PD38	0457	Read-only	SCK channel 8 MI38
0428	Read-only	SCK channel 8 PD39	0458	Read-only	SCK channel 8 MI39
0429	Read-only	SCK channel 8 PD40	0459	Read-only	SCK channel 8 MI40
042A	Read-only	SCK channel 8 PD41	045A	Read-only	SCK channel 8 MI41
042B	Read-only	SCK channel 8 PD42	045B	Read-only	SCK channel 8 MI42
042C	Read-only	SCK channel 8 PD43	045C	Read-only	SCK channel 8 MI43
042D	Read-only	SCK channel 8 PD44	045D	Read-only	SCK channel 8 MI44
042E	Read-only	SCK channel 8 PD45	045E	Read-only	SCK channel 8 MI45
042F	Read-only	SCK channel 8 PD46	045F	Read-only	SCK channel 8 MI46
			0460	Read-only	SCK channel 8 MI47

A 1.11 Address area range 10

Table A-14   Range 10: SCK-C-MODBUS (Modbus address 0480h..04E0h)

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
0480	Read-only	SCK-C PD0 (short circuit)	04B0	Read/write	SCK-C PD48 (comp. level)
0481	Read-only	SCK-C PD1 (not connected)	04B1	Read-only	SCK-C MI0 (module ID)
0482	Read-only	SCK-C PD2 (communication error)	04B2	Read-only	SCK-C MI1 (serial number)
0483	Read-only	SCK-C PD3 (ready for operation)	04B3	Read-only	SCK-C MI2 (serial number)
0484	Read-only	SCK-C PD4 (switched off)	04B4	Read-only	SCK-C MI3 (serial number)
0485	Read-only	SCK-C PD5	04B5	Read-only	SCK-C MI4 (serial number)
0486	Read-only	SCK-C PD6	04B6	Read-only	SCK-C MI5 (name)
0487	Read-only	SCK-C PD7	04B7	Read-only	SCK-C MI6 (name)
0488	Read-only	SCK-C PD8	04B8	Read-only	SCK-C MI7 (name)
0489	Read-only	SCK-C PD9	04B9	Read-only	SCK-C MI8 (name)
048A	Read-only	SCK-C PD10	04BA	Read-only	SCK-C MI9 (name)
048B	Read-only	SCK-C PD11	04BB	Read-only	SCK-C MI10 (name)
048C	Read-only	SCK-C PD12	04BC	Read-only	SCK-C MI11 (name)
048D	Read-only	SCK-C PD13	04BD	Read-only	SCK-C MI12 (name)
048E	Read-only	SCK-C PD14	04BE	Read-only	SCK-C MI13 (name)
048F	Read-only	SCK-C PD15	04BF	Read-only	SCK-C MI14 (name)
0490	Read-only	SCK-C PD16 (avg. request interval)	04C0	Read-only	SCK-C MI15 (name)
0491	Read-only	SCK-C PD17 (number of packet requests)	04C1	Read-only	SCK-C MI16 (name)
0492	Read-only	Number of packet errors SCK channel 1	04C2	Read-only	SCK-C MI17 (name)
0493	Read-only	Number of packet errors SCK channel 2	04C3	Read-only	SCK-C MI18 (name)
0494	Read-only	Number of packet errors SCK channel 3	04C4	Read-only	SCK-C MI19 (name)
0495	Read-only	Number of packet errors SCK channel 4	04C5	Read-only	SCK-C MI20 (name)
0496	Read-only	Number of packet errors SCK channel 5	04C6	Read-only	SCK-C MI21
0497	Read-only	Number of packet errors SCK channel 6	04C7	Read-only	SCK-C MI22
0498	Read-only	Number of packet errors SCK channel 7	04C8	Read-only	SCK-C MI23
0499	Read-only	Number of packet errors SCK channel 8	04C9	Read-only	SCK-C MI24
049A	Read-only	SCK-C PD26	04CA	Read-only	SCK-C MI25
049B	Read-only	SCK-C PD27	04CB	Read-only	SCK-C MI26
049C	Read-only	SCK-C PD28	04CC	Read-only	SCK-C MI27
049D	Read-only	SCK-C PD29	04CD	Read-only	SCK-C MI28

Table A-14   Range 10: SCK-C-MODBUS (Modbus address 0480h..04E0h) [...]

Modbus address (HEX)	Access	Designation	Modbus address (HEX)	Access	Designation
049E	Read-only	SCK-C PD30	04CE	Read-only	SCK-C MI29
049F	Read-only	SCK-C PD31	04CF	Read-only	SCK-C MI30
04A0	Read-only	SCK-C PD32 (temperature)	04D0	Read-only	SCK-C MI31
04A1	Read-only	SCK-C PD33	04D1	Read-only	SCK-C MI32
04A2	Read-only	SCK-C PD34	04D2	Read-only	SCK-C MI33
04A3	Read-only	SCK-C PD35	04D3	Read-only	SCK-C MI34
04A4	Read-only	SCK-C PD36	04D4	Read-only	SCK-C MI35
04A5	Read-only	SCK-C PD37	04D5	Read-only	SCK-C MI36
04A6	Read-only	SCK-C PD38	04D6	Read-only	SCK-C MI37
04A7	Read-only	SCK-C PD39	04D7	Read-only	SCK-C MI38
04A8	Read-only	SCK-C PD40	04D8	Read-only	SCK-C MI39
04A9	Read-only	SCK-C PD41	04D9	Read-only	SCK-C MI40
04AA	Read-only	SCK-C PD42	04DA	Read-only	SCK-C MI41
04AB	Read-only	SCK-C PD43	04DB	Read-only	SCK-C MI42
04AC	Read-only	SCK-C PD44	04DC	Read-only	SCK-C MI43
04AD	Read-only	SCK-C PD45	04DD	Read-only	SCK-C MI44
04AE	Read/write	SCK-C PD46 (switch off SCK IF)	04DE	Read-only	SCK-C MI45
04AF	Read/write	SCK-C PD47 (identify module)	04DF	Read-only	SCK-C MI46
			04E0	Read-only	SCK-C MI47

A 2   Accessories

The following items are available as accessories.

Table A-15   List of accessories

Name	Order No.	Description
SK 35-D	3026890	Shield connection clamp for connecting the shield to PE in the string combiner box
ME-SAS	2853899	Shield connection clamp for connecting the shielding to GND2
UT 2,5-PE	3044092	Feed-through terminal block for PE connection
PT 1X2-BE	2856113	Base element for surge protection of the SCK bus cable and RS-485 Modbus cable
PT 1X2-24DC-ST	2856032	Connection element for surge protection of the SCK bus cable
PT 3-HF-12DC-ST	2858043	Connection element for surge protection of the RS-485 Modbus cable
PSI-REP-RS485W2	2313096	Repeater for signal isolation and signal amplification in RS-485 networks
FL COMSERVER UNI 232/422/485	2313452	Interface converter for RS-485/Ethernet
STEP-PS/1AC/24DC/0.5	2868596	Power supply for module connection outside of the Solarcheck device range

A   Appendix for document lists

A 1   List of figures

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Section 7

Section 8

Section 9

Section 10

A 2   List of tables

Section 10

Appendix A