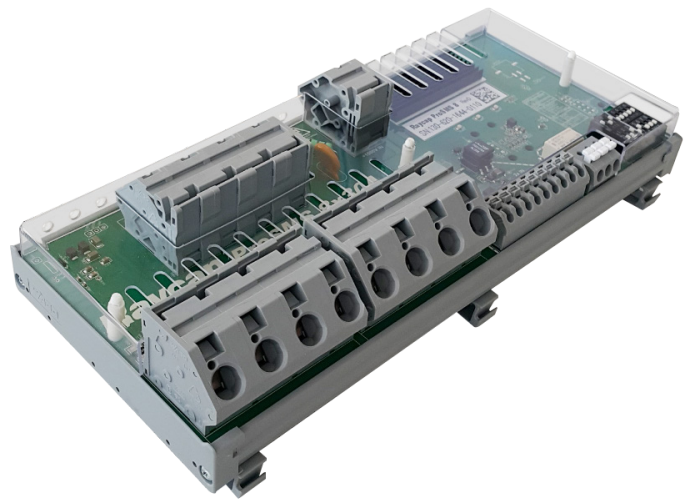


**Installation Manual:**

## **ProSMS 8**

Protection and Monitoring Solution  
for PV Systems





## Contents

1.1	Copyright .....	4
1.2	Introduction .....	4
2.1	Disclaimer .....	4
2.2	Warnings .....	4
2.3	Symbols .....	5
3.1	Package contents .....	5
3.2	Prerequisites.....	5
3.3	Installation tools.....	5
4.1	Device overview.....	6
5.1	Installation .....	7
5.2	Device setting .....	7
5.3	Cabling recommendations .....	8
5.4	Digital Input/Output.....	9
6.1	MODBUS interface .....	10
6.2	MODBUS typical communication connections .....	11
6.3	ProSMS settings.....	13
6.4	MODBUS registers .....	15
7.1	Device operation .....	20
7.2	Energy measurement per string .....	20
7.3	Operation principles .....	21
7.4	Min/Max measurement.....	22
7.5	Surge counter .....	22
8.1	Technical data.....	23

## 1.1 Copyright

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## 1.2 Introduction

String monitoring enables early detection of site failures such as the loss of output or the failure of a particular Photovoltaic (PV) panel, and can minimize energy losses and expand the lifetime of a PV system.

The Raycap ProSMS 8 string monitoring solution has innovative features including surge protected inputs, the ability to remotely detect bad contacts, and a range of communication options that enable PV park operators to immediately understand and respond to field maintenance needs, resulting in reduced operating expenses.

For conditions other than those described above, please contact a Raycap Account Representative at sales@raycap.com

Thank you for choosing quality products from Raycap.

## 2.1 Disclaimer

The information in this document is subject to change without notice and describes only the product defined in the introduction of this documentation. This documentation is intended for the use of Raycap customers only for the purposes of the agreement under which the document is submitted, and no part may be used, reproduced, modified or transmitted in any form or means without the prior written permission of Raycap. The documentation has been prepared to be used by professional and properly trained personnel, and the customer assumes full responsibility when using it. Raycap welcomes customer comments as part of the process of continuous development and improvement of the documentation.

Raycap has made all reasonable efforts to ensure that the instructions contained in this document are adequate and free of material errors and omissions. Raycap will, if deemed necessary, explain issues which may not be covered by this document.

The contents of this document are subject to revision without notice due to continued progress in methodology, design and manufacturing. Raycap shall have no liability for any error damage of any kind resulting from the use of this document.

## 2.2 Warnings

Please read this manual before using ProSMS 8. It is important to become familiar with the product's numerous features and operating procedures. To maintain the maximum degree of safety, follow the sequences as outlined.

Before using the product, read all instructions and cautionary markings on the product and on any equipment connected to the product.



Unless otherwise noted, product usage that is not recommended or sold by the product manufacturer can result in risk of fire, electric shock, or injury to persons.

Do not operate the product if it has been damaged in any way. Return damaged products to their manufacturer for repair or replacement.

Do not disassemble the product as incorrect reassembling can risk electrical shock or fire.



Disconnect or disable the DC power source to the product prior to beginning its installation. Ensure that the DC power source to the product remains de-energized until the completion of the installation and after all connections have been verified to be correctly configured.

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the device may be impaired.

## 2.3 Symbols



The DANGER sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a DANGER sign until the indicated conditions are fully understood and met.



The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.



The Caution sign indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.



The Indication sign Indicates a situation that can result in property or device damage if not avoided.



Refer to all the documentation supplied with the ProSMS String Monitor Solution.



Warning of dangerous electrical voltage. The ProSMS String Monitor solution is connected to high voltages. All work on the device must only be carried out by electrically skilled persons.



Disconnect before installing, removing, carrying out maintenance or repair.



Direct current marking (DC)



The CE marking is the legal required labeling for several EU Directives of the European Union. This CE marking shows that the product complies with all the relevant European Legal Directives.



Indicates important information.

## 3.1 Package contents

1 ProSMS 8 unit

## 3.2 Prerequisites

This document describes how to install the ProSMS 8. It covers how to mount the units as well as connections to its interfaces.

Installers of Raycap's ProSMS 8 should read this installation guide thoroughly prior to installation of the unit.

## 3.3 Installation tools

WAGO 210-721 Type 3 partially insulated Operating Tool (5.5 mm Blade, 0.8 mm Tip) or similar (Common negative output, String inputs and Voltage input terminals)

WAGO 210-619 Type 1 partially insulated Operating Tool (2.5 mm Blade, 0.4 mm Tip) or similar (MODBUS, digital inputs, digital outputs terminals and DIP switch settings)

### 4.1 Device overview

String monitoring enables the early detection of site failures such as the loss of output or the failure of a particular Photovoltaic (PV) panel, and can minimize energy losses and extend the operating lifetime of a PV system.

The Raycap ProSMS 8 string monitoring solution has some unique and innovative features in comparison to basic string monitoring solutions. These include:

- Build-in power supply. ProSMS is self-powered from the strings being monitored
- Built-in surge protection on all inputs
- Internal energy measurement of each connected string and total power measurement.
- Dynamic averaging value registers. Reports precise voltage mean value and current between two reads from MODBUS master
- Minimum and Maximum current values
- Positive or Negative current flow indication
- Integrated surge event counter
- User-configurable relay output for general remote control of auxiliary equipment
- Built-in communication diagnostic registers per MODBUS standard

These features assist PV system operators to better understand and respond to field maintenance needs, thereby resulting in reduced operating expense and potential downtime.

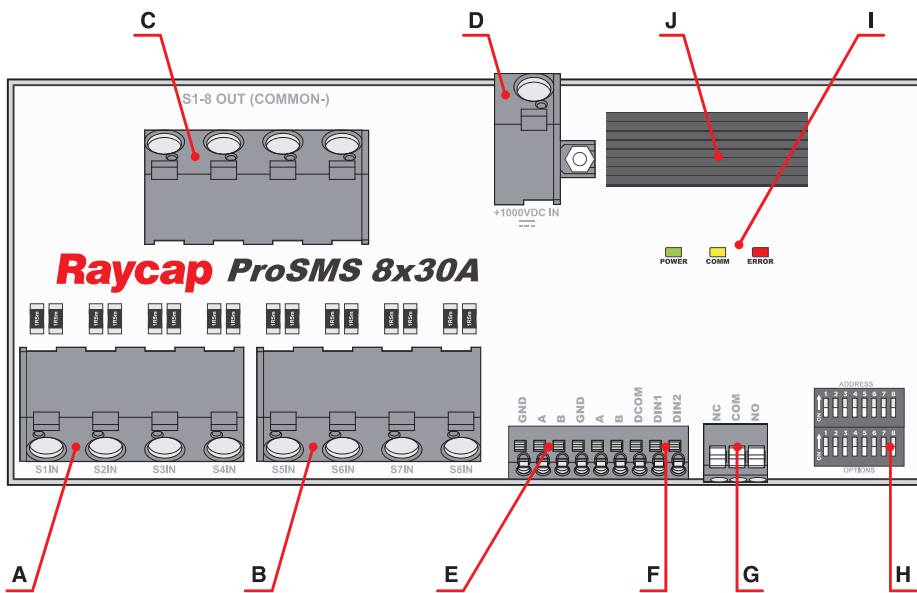


Fig. 4-1: Device overview – front side of ProSMS 8

Position	Description
A	Input negative terminal from string 1 through 4 (max 30A per string)
B	Input negative terminal from string 5 through 8 (max 30A per string)
C	Output common terminal from string 1 through 8
D	Voltage sense terminal (ProSMS powers itself from this terminal)
E	Modbus interface terminals. Two parallel GND, A, B terminals each
F	Digital input terminals. Use potential free contact closure of DIN1 & DIN2 to DCOM
G	Signal relay output with change-over contacts
H	DIP switches used for settings system configuration and modbus address
I	Status LEDs. green for power, yellow communication, red for error
J	Power supply heatsink. Do not cover!

### 5.1 Installation



Very high voltages are present on this ProSMS device.

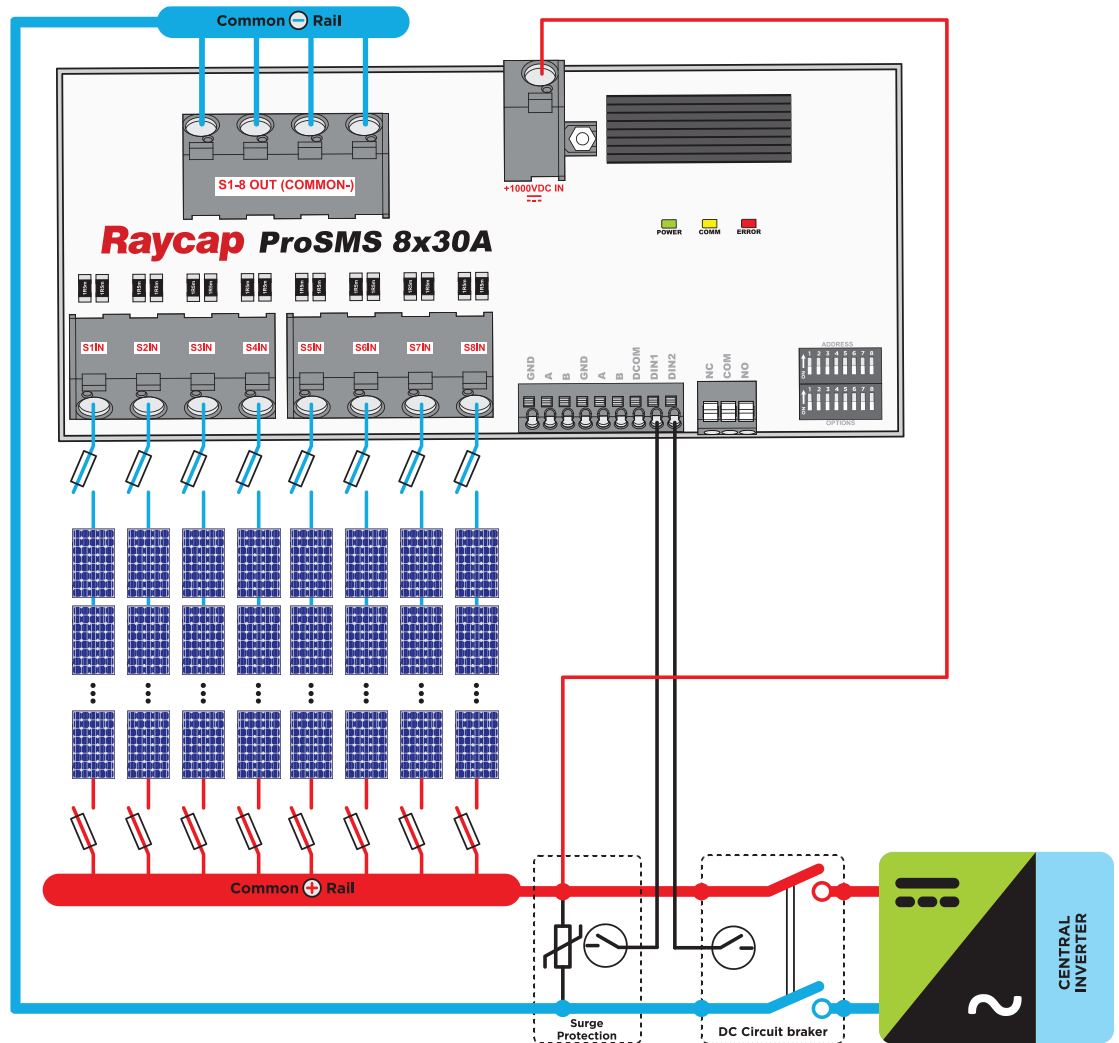


Disconnect the PV Array and make sure all sources of power are locked out before performing any work, removing or mounting the device.

**NOTICE**

For proper operation, external surge protection in combination with correct overcurrent fusing must be provided in the combiner box where the device is installed, otherwise the ProSMS device may be damaged. Overcurrent fusing should be installed on all string channels, preferable on the negative side (ref. picture below).

The unit should be installed in an enclosure with at least IP5x (dust test) environmental rating per IEC60529.



### 5.2 Device setting

Before powering device for the first time set device address and communication options as per the ProSMS settings tables on page 13.



No reboot or removing/applying power is necessary for changes in settings or address to take effect. ProSMS has an advanced built in mechanism that recognizes settings change and sets internal parameters to match the settings immediately when settings are changed. This also applies to baud rate and parity change.

### 5.3 Cabling recommendations

#### String input connections (S1IN .. S8IN)

- For 30A per string installations, 6mm<sup>2</sup> tinned double insulated fine stranded cable (fitted with ferrules) is required.
- Cables with lower cross-sectional area may be used for installations where less than 20A per string can be expected.

#### String output connections (COMMON)

- When ProSMS 8 is operating at full capacity (30A per string, 240A total), four 16mm<sup>2</sup> tinned double insulated fine stranded cable (without ferrules) is required
- Cables with lower cross-sectional area may be used for installations where less than 20A per string can be expected.

#### String voltage measurement connections (+1000VDC)

- At least 1mm<sup>2</sup> tinned, double insulated, fine stranded, cable with ferrules, is required.

#### MODBUS (GND,A,B)

- Shielded twisted-pair cable, designed for RS485 interfacing is required. Cable should have at least two twisted pairs with cross-section area of 0.2mm<sup>2</sup> (24AWG) up to 0.5mm<sup>2</sup> (20AVG).
- Cable should have a characteristic impedance of 100–120 ohm for optimal performance.

#### Digital inputs (DIN1,DIN2)

- Any appropriate cable up to 1mm<sup>2</sup> with ferrules, or 1.5mm<sup>2</sup> without ferrules may be used.

#### Digital outputs (NO,C,NC)

- Any appropriate cable up to 1.5mm<sup>2</sup> with ferrules, or 2.5mm<sup>2</sup> without ferrules, may be used.



### 5.4 Digital Input/Output

Two potential-free digital inputs are provided on the ProSMS to facilitate the monitoring of external ancillary equipment. *Examples may include:* monitoring of installed SPD, cabinet door, interlock switches, alarm functions etc. These inputs are by default internally pulled to 5V. In order to activate the digital inputs they must be connected to the DCOM terminal via potential-free contact closures. Contact closure is read as value 1 (Contact ON). The status of these two auxiliary inputs are read from the Modbus input register 00052 (see page 15).

The ProSMS also provides an optional output control via the SPDT relay contacts. These contacts can be used for a variety of purposes, such as the control of a safety disconnect switch, or the signal to a PLC or other relay/contactor. The output is controlled by writing to the Modbus holding register 00000 (see page 16).

**⚠WARNING** Relay output terminals and connecting wiring should not be accessible to the user when the device is powered. The relay provides only functional insulation to PV potential (2000Vrms@1min). Connections and wiring should not extend outside the combiner box enclosure.

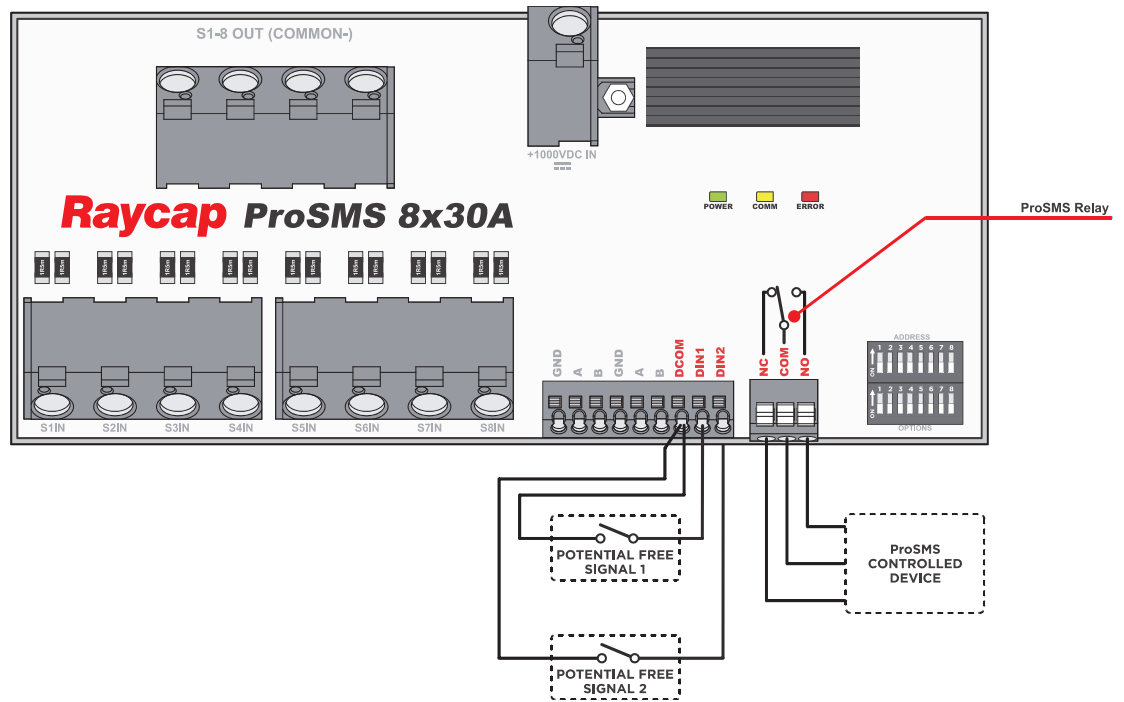


Fig. 5-4: Typical wiring of potential free inputs and relay output

### 6.1 MODBUS interface



The MODBUS interface is not intended to be accessible to the user during operation.



The MODBUS interface is protected by a three-stage built-in circuit which meets IEC 61643-21 class D1/C1/C2/C3. There is no need to install additional external DATA protection devices.

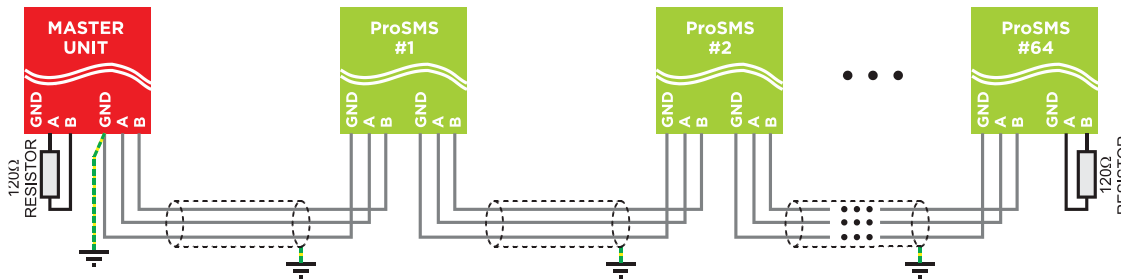


Fig. 6-1: Example of master at beginning of bus

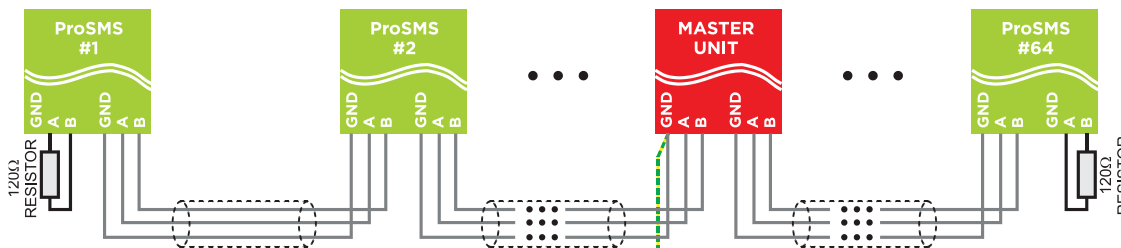


Fig. 6-2: Example of master in the middle of bus

- Use one twisted pair for A and B signals
- Connect both wires of the remaining twisted pair to GND MODBUS Terminal
- If a cable has more than two twisted pairs, connect all unused pairs to GND MODBUS terminals at each ProSMS unit. For optimal data communication, do not leave these floating
- The last unit in the chain must be terminated with a 120 ohm resistor
- GND Modbus wires (Data signal common potential) should be grounded once at the master unit
- Cable shield should be grounded at each combiner box or at least at the Master unit with all shields in all combiner boxes connected together
- The Master unit must be terminated with a 120 ohm resistor if it is at the beginning of the bus

## 6.2 MODBUS typical communication connections

The ProSMS provides duplicate MODBUS interface terminals (GND, A, B). Communication cabling from the previous device, and cabling to the next device, can be directly connected to these terminals to save cost (Fig. 6-3).

For more convenient field installation a larger intermediate external communication terminal can be added in the cabinet (Fig. 6-4). When using an external terminal, cable lengths of less than 1m are recommended. The cable from the intermediate terminal to the ProSMS does not have to be the same as the main communication cable and can be of a smaller cross-section, *for example*: 0.2mm<sup>2</sup> but still needs to be RS485 certified twisted pair shielded cable.

The third solution with external terminals is to wire both RS485 connections from ProSMS to the external terminal (Fig. 6-5) so no Stub forms in the communication bus but care has to be taken to use the same cross-section and electrical properties cable as it's used for the main lines between combiner boxes.



The second solution (Fig. 6-4) is recommended since it provides a good compromise between connection convenience and reliability.

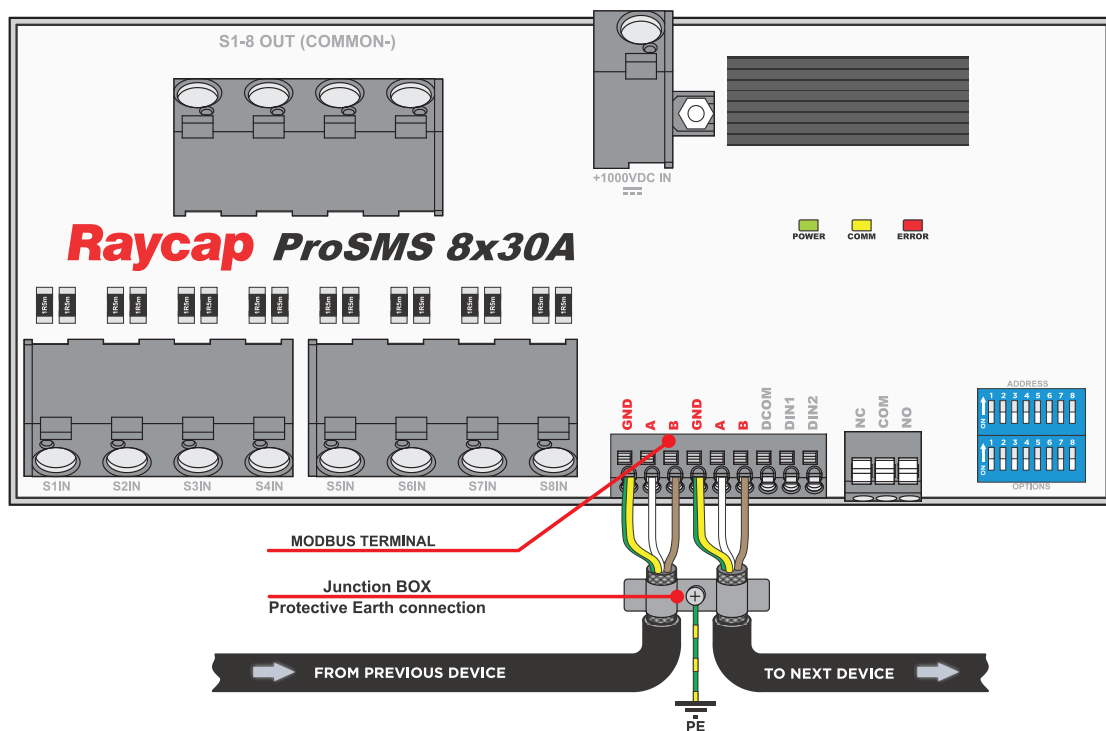


Fig. 6-3: Direct MODBUS cabling connection to ProSMS in combiner box enclosure

6.2 MODBUS typical communication connections (continued)

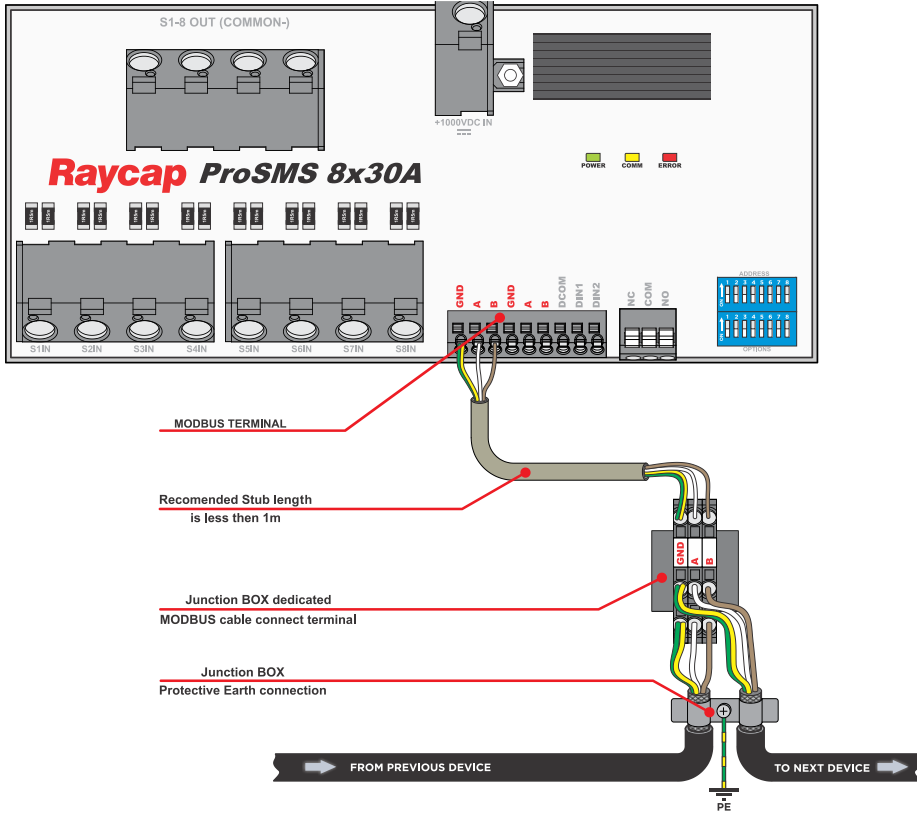


Fig. 6-4: MODBUS cabling connection to ProSMS via intermediate connection terminal in combiner box enclosure

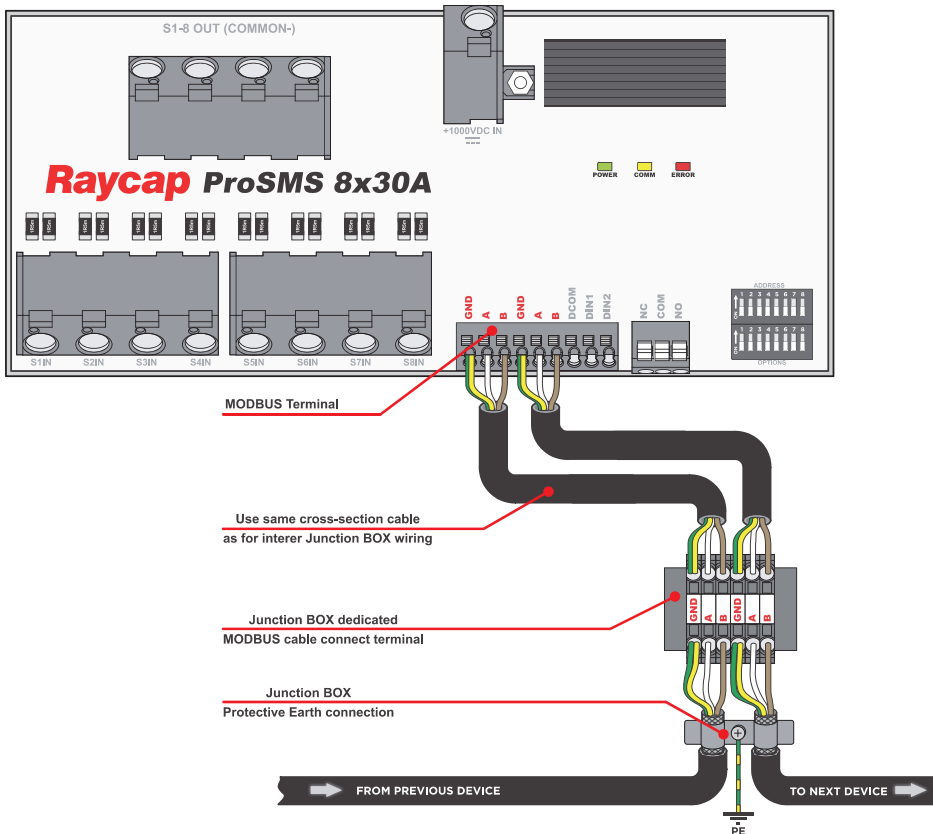
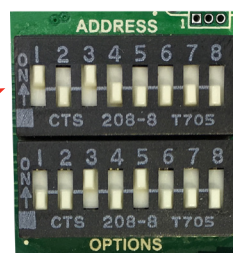


Fig. 6-5: MODBUS cabling connection to ProSMS via intermediate connection terminal in combiner box enclosure (No Stub variant)

### 6.3 ProSMS settings

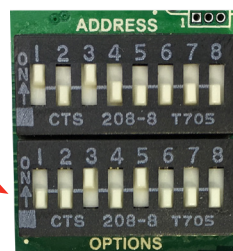
MODBUS address (Address DIP Switch 1..7)



1	2	3	4	5	6	7	8	DIP Switch Position
1	0	0	0	0	0	0	0	Slave address #1
0	1	0	0	0	0	0	0	Slave address #2
1	1	0	0	0	0	0	0	Slave address #3
0	0	1	0	0	0	0	0	Slave address #4
1	0	1	0	0	0	0	0	Slave address #5
•	•	•	•	•	•	•	•	
•	•	•	•	•	•	•	•	
1	1	0	0	1	1	1	1	Slave address #243
0	0	1	0	1	1	1	1	Slave address #244
1	0	1	0	1	1	1	1	Slave address #245
0	1	1	0	1	1	1	1	Slave address #246
1	1	1	0	1	1	1	1	Slave address #247

- Any valid MODBUS address between 1 and 247 can be selected using the on-board DIP switches. The switches are 2<sup>n</sup> binary coded. Address on each ProSMS 8 is factory preset to Nr. 5.
- Address can be changed during operation, no restart or power cycle is required.

Communication settings (DIP switch 1..6)



DIP Switch Position	1	2	3	Meaning (Baud Rate)
	0	0	0	2400 bps
	1	0	0	4800 bps
	0	1	0	9600 bps
	1	1	0	19200 bps
	0	0	1	38400 bps - factory preset

- For harsh environments or areas with high EM disturbances. It might be needed to set baud rate to a lower speed.

DIP Switch Position	4	5	Meaning (Parity)
	0	0	None (2 stop bits)
	1	0	Odd (1 stop bit)
	0	1	Even (1 stop bit) - factory preset

DIP Switch Position	6	Meaning
	0	Normal timing requirements for master - factory preset
	1	Relaxed timing requirements for master

- All settings can be changed during operation, no restart or power cycle is needed
- Relaxed timing feature increases the MODBUS standard timing by a set factor. This can be helpful for problematic master units. MODBUS protocol uses two time restrictions per standard:
  - t1.5 is 1.5x the character time at given baud rate and is the maximum time allowed between two received character bytes before the whole received packet is out of specification and considered bad.
  - t3.5 is 3.5x the character time at given baud rate and is used for end of message detection.

When relaxed timing is enabled by DIP switch, ProSMS uses this additional timing factor located in RELAXED\_TIMING register to extend t1.5 and t3.5 timing limits.

#### **Settings lock (DIP Switch 7)**

- Settings can be additionally locked. When locked an accidental change of switches has no influence on the configuration.

#### **System reset (DIP Switch 8)**

- Hardware reset of ProSMS device (does not effect any settings or saved values).

## 6.4 MODBUS registers

### Input registers, MODBUS function 4

	Register ID	Address	Data Type	Possible Values	Unit	Description	R/W
Accumulated Values	ENERGY_STR01	0000,0001	INT32	±2147483647	kWh*100	Accumulated energy string 1 [LSW is 0000, MSW is 0001]	R
	ENERGY_STR02	0002,0003	INT32	±2147483647	kWh*100	Accumulated energy string 2 [LSW is 0002, MSW is 0003]	R
	ENERGY_STR03	0004,0005	INT32	±2147483648	kWh*100	Accumulated energy string 3 [LSW is 0004, MSW is 0005]	R
	ENERGY_STR04	0006,0007	INT32	±2147483649	kWh*100	Accumulated energy string 4 [LSW is 0006, MSW is 0007]	R
	ENERGY_STR05	0008,0009	INT32	±2147483650	kWh*100	Accumulated energy string 5 [LSW is 0008, MSW is 0009]	R
	ENERGY_STR06	0010,0011	INT32	±2147483651	kWh*100	Accumulated energy string 6 [LSW is 0010, MSW is 0011]	R
	ENERGY_STR07	0012,0013	INT32	±2147483652	kWh*100	Accumulated energy string 7 [LSW is 0012, MSW is 0013]	R
	ENERGY_STR08	0014,0015	INT32	±2147483653	kWh*100	Accumulated energy string 8 [LSW is 0014, MSW is 0015]	R
	ENERGY_STR09	0016,0017	INT32	±2147483654	kWh*100	Accumulated energy string 9 [LSW is 0016, MSW is 0017]	R
	ENERGY_STR10	0018,0019	INT32	±2147483655	kWh*100	Accumulated energy string 10 [LSW is 0018, MSW is 0019]	R
	ENERGY_STR11	0020,0021	INT32	±2147483656	kWh*100	Accumulated energy string 11 [LSW is 0020, MSW is 0021]	R
	ENERGY_STR12	0022,0023	INT32	±2147483657	kWh*100	Accumulated energy string 12 [LSW is 0022, MSW is 0023]	R
	ENERGY_STR13	0024,0025	INT32	±2147483658	kWh*100	Accumulated energy string 13 [LSW is 0024, MSW is 0025]	R
	ENERGY_STR14	0026,0027	INT32	±2147483659	kWh*100	Accumulated energy string 14 [LSW is 0026, MSW is 0027]	R
	ENERGY_STR15	0028,0029	INT32	±2147483660	kWh*100	Accumulated energy string 15 [LSW is 0028, MSW is 0029]	R
	ENERGY_STR16	0030,0031	INT32	±2147483660	kWh*100	Accumulated energy string 16 [LSW is 0030, MSW is 0031]	R
Instantaneous Values (Last 4s)	CURRENT_STR01	0032	INT16	-32000..+32000	mA	Current string 1	R
	CURRENT_STR02	0033	INT16	-32000..+32000	mA	Current string 2	R
	CURRENT_STR03	0034	INT16	-32000..+32000	mA	Current string 3	R
	CURRENT_STR04	0035	INT16	-32000..+32000	mA	Current string 4	R
	CURRENT_STR05	0036	INT16	-32000..+32000	mA	Current string 5	R
	CURRENT_STR06	0037	INT16	-32000..+32000	mA	Current string 6	R
	CURRENT_STR07	0038	INT16	-32000..+32000	mA	Current string 7	R
	CURRENT_STR08	0039	INT16	-32000..+32000	mA	Current string 8	R
	CURRENT_STR09	0040	INT16	-32000..+32000	mA	Current string 9	R
	CURRENT_STR10	0041	INT16	-32000..+32000	mA	Current string 10	R
	CURRENT_STR11	0042	INT16	-32000..+32000	mA	Current string 11	R
	CURRENT_STR12	0043	INT16	-32000..+32000	mA	Current string 12	R
	CURRENT_STR13	0044	INT16	-32000..+32000	mA	Current string 13	R
	CURRENT_STR14	0045	INT16	-32000..+32000	mA	Current string 14	R
	CURRENT_STR15	0046	INT16	-32000..+32000	mA	Current string 15	R
	CURRENT_STR16	0047	INT16	-32000..+32000	mA	Current string 16	R
VOLTAGE	0048	UINT16	00..16000	V* 10	System voltage	R	
VOLTAGE_ANALOG1	0049	INT16	-1000..+1000	V* 100	Analog input voltage 1	R	
VOLTAGE_ANALOG2	0050	INT16	-1000..+1000	V* 100	Analog input voltage 2	R	
TEMP_ENCLOSURE	0051	INT16	-400..+1600	°C* 10	Temperature of string monitor enclosure	R	
DIGITAL_INPUTS	0052	UINT16	0x0000..0x0003	Bits	Digital inputs [LSB inputs, MSB alarms]	R	
Integrated Values from last reading to present (Maximum Integration Time 24h)	CURRENT_AVE_STR01	0053	INT16	-32000..+32000	mA	Average current string 1	R
	CURRENT_AVE_STR02	0054	INT16	-32000..+32000	mA	Average current string 2	R
	CURRENT_AVE_STR03	0055	INT16	-32000..+32000	mA	Average current string 3	R
	CURRENT_AVE_STR04	0056	INT16	-32000..+32000	mA	Average current string 4	R
	CURRENT_AVE_STR05	0057	INT16	-32000..+32000	mA	Average current string 5	R
	CURRENT_AVE_STR06	0058	INT16	-32000..+32000	mA	Average current string 6	R
	CURRENT_AVE_STR07	0059	INT16	-32000..+32000	mA	Average current string 7	R
	CURRENT_AVE_STR08	0060	INT16	-32000..+32000	mA	Average current string 8	R
	CURRENT_AVE_STR09	0061	INT16	-32000..+32000	mA	Average current string 9	R
	CURRENT_AVE_STR10	0062	INT16	-32000..+32000	mA	Average current string 10	R
	CURRENT_AVE_STR11	0063	INT16	-32000..+32000	mA	Average current string 11	R
	CURRENT_AVE_STR12	0064	INT16	-32000..+32000	mA	Average current string 12	R
	CURRENT_AVE_STR13	0065	INT16	-32000..+32000	mA	Average current string 13	R
	CURRENT_AVE_STR14	0066	INT16	-32000..+32000	mA	Average current string 14	R
	CURRENT_AVE_STR15	0067	INT16	-32000..+32000	mA	Average current string 15	R
	CURRENT_AVE_STR16	0068	INT16	-32000..+32000	mA	Average current string 16	R
VOLTAGE_AVE	0069	UINT16	0..16000	V* 10	Average system voltage	R	
TEMP_ENCLOSURE_AVE	0070	INT16	-400..+1600	°C* 10	Average temp of string monitor enclosure	R	
Surge	SURGE_COUNTER	0071	INT16	0..65536	Counts	Detected lightning surges	R
	FREE_0	0072	INT16				R
	FREE_1	0073	INT16				R

Input registers, MODBUS function 4 (continued)

	Register ID	Address	Data Type	Possible Values	Unit	Description	R/W
Min/Max Values from last reading to present	CURRENT_MIN_STR01	0074	INT16	-32000..+32000	mA	Minimum current string 1	R
	CURRENT_MIN_STR02	0075	INT16	-32000..+32000	mA	Minimum current string 2	R
	CURRENT_MIN_STR03	0076	INT16	-32000..+32000	mA	Minimum current string 3	R
	CURRENT_MIN_STR04	0077	INT16	-32000..+32000	mA	Minimum current string 4	R
	CURRENT_MIN_STR05	0078	INT16	-32000..+32000	mA	Minimum current string 5	R
	CURRENT_MIN_STR06	0079	INT16	-32000..+32000	mA	Minimum current string 6	R
	CURRENT_MIN_STR07	0080	INT16	-32000..+32000	mA	Minimum current string 7	R
	CURRENT_MIN_STR08	0081	INT16	-32000..+32000	mA	Minimum current string 8	R
	CURRENT_MIN_STR09	0082	INT16	-32000..+32000	mA	Minimum current string 9	R
	CURRENT_MIN_STR10	0083	INT16	-32000..+32000	mA	Minimum current string 10	R
	CURRENT_MIN_STR11	0084	INT16	-32000..+32000	mA	Minimum current string 11	R
	CURRENT_MIN_STR12	0085	INT16	-32000..+32000	mA	Minimum current string 12	R
	CURRENT_MIN_STR13	0086	INT16	-32000..+32000	mA	Minimum current string 13	R
	CURRENT_MIN_STR14	0087	INT16	-32000..+32000	mA	Minimum current string 14	R
	CURRENT_MIN_STR15	0088	INT16	-32000..+32000	mA	Minimum current string 15	R
	CURRENT_MIN_STR16	0089	INT16	-32000..+32000	mA	Minimum current string 16	R
	CURRENT_MAX_STR01	0090	INT16	-32000..+32000	mA	Maximum current string 1	R
	CURRENT_MAX_STR02	0091	INT16	-32000..+32000	mA	Maximum current string 2	R
	CURRENT_MAX_STR03	0092	INT16	-32000..+32000	mA	Maximum current string 3	R
	CURRENT_MAX_STR04	0093	INT16	-32000..+32000	mA	Maximum current string 4	R
	CURRENT_MAX_STR05	0094	INT16	-32000..+32000	mA	Maximum current string 5	R
	CURRENT_MAX_STR06	0095	INT16	-32000..+32000	mA	Maximum current string 6	R
	CURRENT_MAX_STR07	0096	INT16	-32000..+32000	mA	Maximum current string 7	R
	CURRENT_MAX_STR08	0097	INT16	-32000..+32000	mA	Maximum current string 8	R
	CURRENT_MAX_STR09	0098	INT16	-32000..+32000	mA	Maximum current string 9	R
	CURRENT_MAX_STR10	0099	INT16	-32000..+32000	mA	Maximum current string 10	R
	CURRENT_MAX_STR11	0100	INT16	-32000..+32000	mA	Maximum current string 11	R
	CURRENT_MAX_STR12	0101	INT16	-32000..+32000	mA	Maximum current string 12	R
	CURRENT_MAX_STR13	0102	INT16	-32000..+32000	mA	Maximum Current String 13	R
	CURRENT_MAX_STR14	0103	INT16	-32000..+32000	mA	Maximum current string 14	R
	CURRENT_MAX_STR15	0104	INT16	-32000..+32000	mA	Maximum current string 15	R
	CURRENT_MAX_STR16	0105	INT16	-32000..+32000	mA	Maximum current string 16	R
POWER	0106,0107	INT32	-50000000..+50000000	KW*100	Summed power of all strings [LSW is 0106, MSW is 0107]	R	
Hardware Info.	DEVICE_STATUS	0500	UINT16		Bits	Status bits	R
	DEVICE_ID	0501, 0502	UINT32		2x Word	Device identification number (130-620)	R
	SERIAL_NUMBER	0503, 0504	UINT32		2x Word	Device serial number (1234-4567)	R
	SM_CONFIG	00505	UINT16	0x0000..0xFFFF	Bits	Options present (Bat charging, analog inputs,dig output...)	R
	VERSION_SOFT	0506	UINT16		2xByte	Software version [LSB main, MSB current]	R
	VERSION_HW	0507	UINT16		2xByte	PCB version [LSB Mod#, MSB Letter, A,B,C...]	R
	PRODUCTION_DATE	0508	UINT16		2xByte	Date of production [LSB week, MSB year]	R
	CALIBRATION_DATE	0509	UINT16		2xByte	Date of production [LSB week, MSB year]	R

- Averaging registers are reset on each read, so the correct average between two master reads is always reported correctly. The time between consecutive readings on each new reading does not need to be constant, but there is a maximum integration time of 24 hours.
- Min/Max current registers are automatically updated. It is not necessary to reset them manually.
- Energy holding registers are accumulating registers that are saved during device power down. They can be cleared to 0 with the "Reset Accumulated Energy KWh Counters" command if needed (See Command's section on page 17).

Bit locations of DIGITAL\_INPUTS register

	Digital Inputs (0052)	Bit Location
LSB Digital Inputs	Digital Input 1	0
	Digital Input 2	1
		2
		3
		4
		5
		6
	7	





**Holding registers, MODBUS function read 3, rite function 6 or 16**

	Register ID	Address	Data Type	Possible Values	Unit	Description	R/W
Output Settings	DIGITAL_OUTPUTS	0000	UIN16	0x0000..0xFFFF	Bits	Digital outputs register	R/W
	SM_COMMAND	0001	UIN16	0..100		Various commands (KWh reset...)	R/W
	RESPONSE_DELAY	0005	UIN16	0..100 (coerced)	ms	To delay responses for master queries	R/W
	RELAXED_TIMING	0006	UIN16	3..6 (coerced)	Factor/2	Relaxed MODBUS t1.5 and t3.5 timing factor (DIPSW enabled)	R/W

- The response delay (after the Master queries ProSMS and then releases the bus) is typically 3.5 times the baud rate character time, per MODBUS guidelines. If an older Master is used, then the response from ProSMS may be too fast and data may be corrupted. In such circumstances, an additional delay of a few milliseconds can be set in the RESPONSE\_DELAY register to aid data integrity.
- ProSMS follows the MODBUS timing guidelines for communication frame Start, Stop and character-to-character delay. With older Master units, (especially non real-time PC/Linux based Master units that do not meet required timing), the Relaxed Timing Mode can be used. In this way ProSMS will allow the Master unit a greater byte-to-byte transmit delay and time to transmit complete data before flagging it as bad. The Relaxed Timing mode is enabled by setting DIP switch position 6 to ON. When this switch is in the OFF position, timing factor 1 is used, independent of what factor is set in the RELAXED\_TIMING register.
- Example for baud rate set to 19200bps: Character time for this baud rate would be 0.52ms. Standard permitted maximum character to character delay t1.5 is 0.78ms and end of message time t3.5 is 1.82ms. With relaxed timing set to 4 (Factor=2) this changes the delay time of t1.5 to 1.56ms and t3.5 to 3.64ms, giving the master twice as much time for a message to be still accepted by ProSMS as good.

**Bit location of DIGITAL\_OUTPUTS register**

	DIGITAL_OUTPUTS (0000)	Bit Location
Digital Outputs	Digital Output #1Relay	0
		1
		2
		3
		4
		5
		6
		7
		8
		9
		10
		11
		12
		13
		14
		15

- When the DIGITAL\_OUTPUTS register is written it is automatically saved to internal EEPROM. Last register value is always loaded from EEPROM in the case of a power cycle (Night time).

**Commands (Write to SM\_COMMAND register)**

Command	Description	Note
0	Do nothing	
1	Save all changed holding registers to EEPROM	Wait 2 seconds after command, exception #6
2		
3		
4		
5		
6		
7		
8		
9		
10	Reset accumulated energy KWh counters	
11	Clear current, voltage, temperature average registers	
12	Clear min, max registers	

Command #  
(Holding register 0001)

**Detailed command description:**

- 1 (0x01) Saves All Changed Holding registers to EEPROM for permanent storage. To store RESPONSE\_DELAY and RELAXED\_TIMING registers permanently execute this command after writing to the Holding registers. DIGITAL\_OUTPUTS register is saved automatically on every write, it is not necessary to execute command 1.
- 10 (0x0A) Cumulative Energy registers in the device can be cleared to zero if desired.
- 11 (0x0B) This command clears all the averaging registers. After execution ProSMS starts creating new averages. It is not necessary to clear the registers during normal operation as new averages are formed automatically after a read by the Master of at least one of the averaging registers. This command is intended to allow precise comparison of the measured average values between multiple ProSMS units following a multicast write of this command to all units on the bus.
- 12 (0x0C) This command clears the Min-Max registers. After execution ProSMS starts creating new minimum and maximum values. It is not necessary to clear the registers during normal operation as minimum and maximum are formed automatically after a read by the Master of at least one of the Min-Max registers. This command is intended to allow a precise comparison of the Min-Max values between multiple ProSMS units following a multicast write of this command to all units on the bus.



**Diagnostic registers, MODBUS function Read 8**

MODBUS function code 08 provides a series of tests to check communication between the client (Master) and the Slave (ProSMS), or to check various internal error conditions within the ProSMS. This functionality is most useful during installation to check that there are no communication problems across the network before commissioning. It is recommended to read diagnostics registers once per month to confirm that the network is still performing optimally.

The function uses a two-byte sub-function code field in the query to define the type of test to be performed. ProSMS echoes both the function code and sub-function code in a normal response.

The following diagnostic functions are supported by ProSMS:

	Subfunction	Data Type	Possible Ret. Values	Unit	Description
Diagnostics	00	UINT16	0..65536	Return	Return query data
	01-09				Not used
	10	UINT16	0..65536	Return	Clear counters and diagnostic registers
	11	UINT16	0..65536	Counter	Return bus message count
	12	UINT16	0..65536	Counter	Return bus communication error count
	13	UINT16	0..65536	Counter	Return bus exception error count
	14	UINT16	0..65536	Counter	Return slave message count
	15	UINT16	0..65536	Counter	Return no response count
	16	UINT16	0..65536	Counter	Return slave NAK count
	17	UINT16	0..65536	Counter	Return slave busy count
	18	UINT16	0..65536	Counter	Return bus character overrun count

**Sub function diagnostic return codes response data filed. Detailed description:**

- 10 (0x0A) Clears all MODBUS diagnostic counters and registers. After the command is issued all counters start to count from zero.
- 11 (0x0B) Quantity of messages that the ProSMS has detected on the communications system since: last power-up (every morning), last clearing of this counters or after a remote ProSMS restart.
- 12 (0x0C) Quantity of CRC errors encountered by the ProSMS since: last power-up (every morning), last clearing of this counters or after a remote ProSMS restart.
- 13 (0x0D) Quantity of MODBUS exception responses returned by the ProSMS since: last power-up (every morning), last clearing of this counters or after a remote ProSMS restart.
- 14 (0x0E) Quantity of messages addressed to the ProSMS (including broadcast messages) that the remote device has processed since: last power-up (every morning), last clearing of this counters or after a remote ProSMS restart.
- 15 (0x0F) Quantity of messages addressed to the ProSMS for which it has returned no response (neither a normal response nor an exception response), since: last power-up (every morning), last clearing of this counters or after a remote ProSMS restart.
- 16 (0x10) Quantity of messages addressed to the ProSMS for which it returned a Negative Acknowledge (NAK) exception response, since: last power-up (every morning), last clearing of this counters or after a remote ProSMS restart.
- 17 (0x11) Quantity of messages addressed to the ProSMS for which it returned a Slave Device Busy exception response, since: last power-up (every morning), last clearing of this counters or after a remote ProSMS restart.
- 18 (0x12) Quantity of messages addressed to the ProSMS that it could not handle due to a character overrun condition, since: last power-up (every morning), last clearing of this counter or after a remote ProSMS restart. A character overrun is caused by data characters arriving at the port faster than they can be stored, or by the loss of a character due to a hardware malfunction.

**Diagnostic registers, MODBUS function Read 8 (continued)**

The MODBUS function code 08 provides a series of tests to check communications between the client (Master) and the Slave (ProSMS), or to check various internal error conditions within the ProSMS. This functionality is most useful during installation to check that there are no communication problems across the network before commissioning. It is recommended to read the Diagnostics registers periodically (once per month) to confirm that the network is still performing optimally.

The function uses a two-byte sub-function code field in the query to define the type of test to be performed. ProSMS echoes both the function code and sub-function code in a normal response. The following diagnostic functions are supported by ProSMS:

	Slave Address	Function	Sub-Function	Data	CRC
Master Query (HEX)	05	08	0000	1234	ECF8
Slave Response (HEX)	05	08	0000	1234	ECF8

**Example Return Slave Bus Message Count from device with address #5  
(Slave had processed 200 messages):**

	Slave Address	Function	Sub-Function	Data	CRC
Master Query (HEX)	05	08	000B	0000	904D
Slave Response (HEX)	05	08	000B	00C8	91DB



In normal operation only “Return Bus Message Count” and “Return Slave Message Count” will increment with each valid reading. The other registers (when there are no problems on the bus) will read as 0.



It is not necessary to read the Diagnostic Registers on a regular basis since they are only provided to assist the user in checking the MODBUS communications performance and in identifying possible problems or troubleshooting.



The Diagnostic Registers are accessed one-by-one via sub-functions, per the MODBUS specifications.

**7.1 Device operation**

When there is sufficient solar panel illumination to produce at least 90V system voltage, ProSMS will self-power and begin to operate. Start of operation is signaled via a short blink of the Green, Yellow, and Red LEDs simultaneously. Immediately after powering up, measurements begin to be taken, averages form and energy yield is accumulated in various registers used for such logs. Normal device operation is signaled via a steady short blinks of the Green Power LED at 1s intervals (system heartbeat). During MODBUS communications, the Yellow communication LED will blink. Illumination of the Red LED signifies an Error condition of the Power Supply or the central CPU.

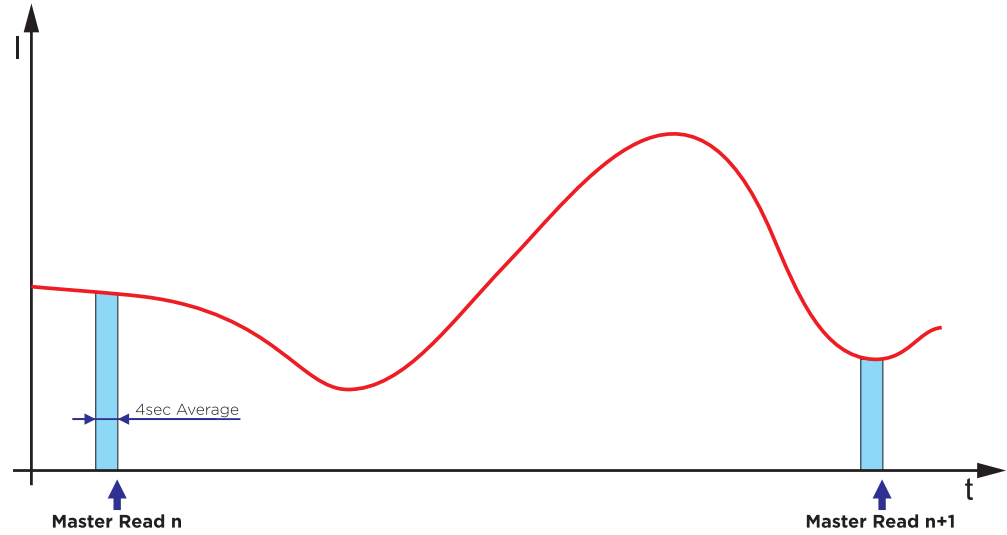
**7.2 Energy measurement per string**

To identify those strings which may be operating at less than optimal efficiency ProSMS includes an internal functions whereby the energy consumption of each string is measured and recorded. This function can be useful to the system operator when trying to identify those strings not performing correctly (due to dirt, poor connections, of general failure). In its simplest form, the energy of each string can be logged on external software to identify trends and anomalies of certain strings.

The onboard energy monitor also provides a means of comparing the daily energy production recorded by the unit itself, to that recorded at the output of the inverter. This can be used to provide insight as to the losses on connections between Combiner boxes and Inverter to monitor inverter’s and transformer’s efficiency and any imminent failure. The onboard energy registers can record consumption to 21.474 GWh for each string - enough for approximately 25 year of PV plant operations.

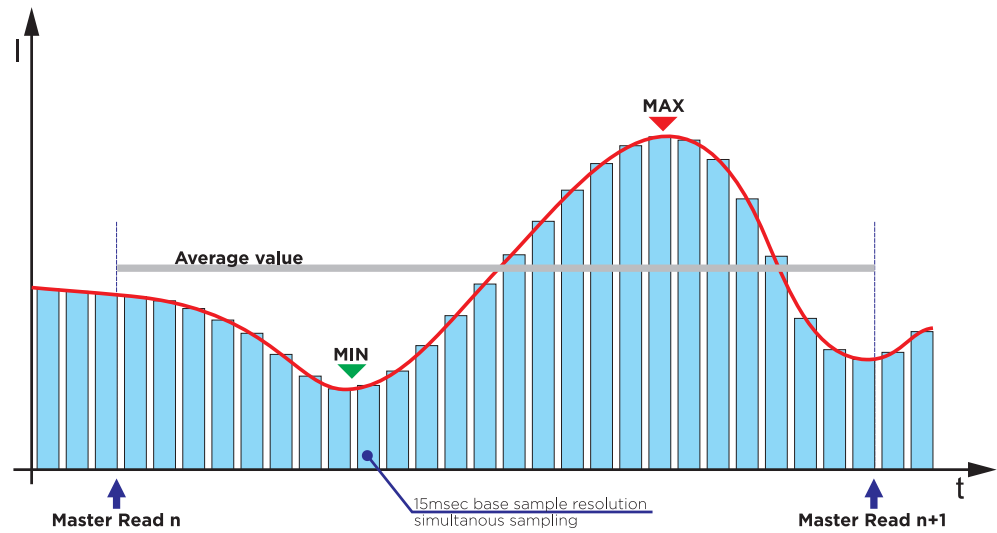
### 7.3 Operation principles

#### Instantaneous registers value



- A reading of the instantaneous input register gives the average value over the last 4s

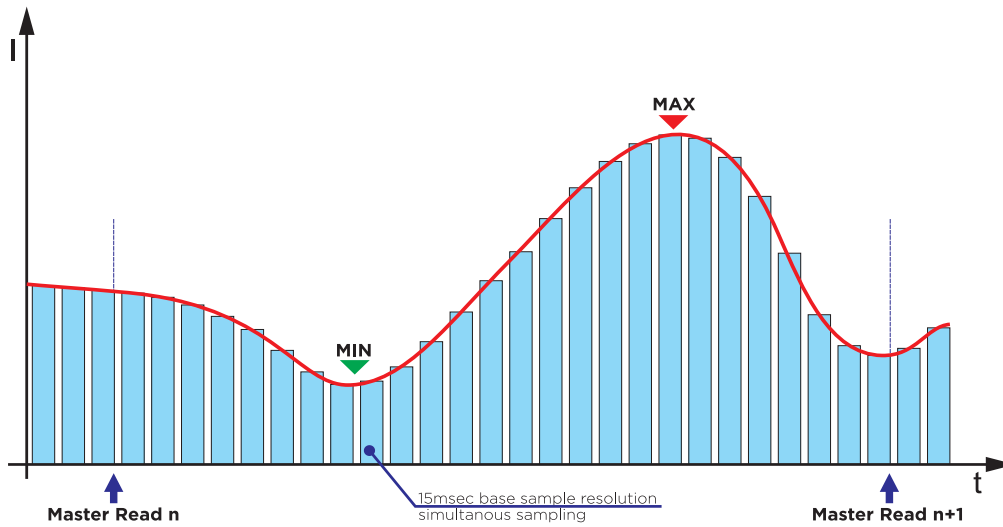
#### Integrated (average) value register



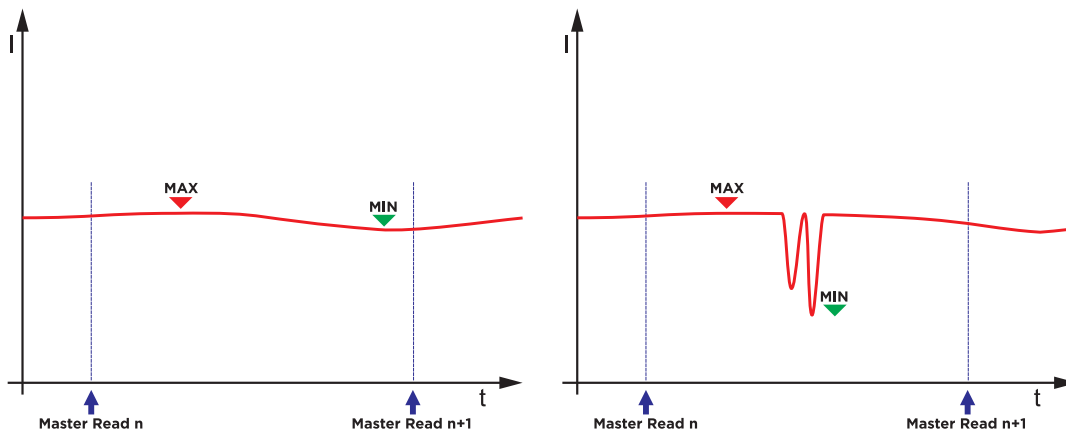
- Reading of the integrated (average) value registers reports a true average value from the last master read to the current reading. Even the smallest changes in Current or Voltage down to 15ms are sampled and integrated into the reported average.
- Reading time interval can be set to 15 mins or even more without fear of the information loss.

### 7.4 Min/Max measurement

#### Minimum/Maximum registers values



- The Min/Max registers hold the minimum and maximum values of Current from the time the registers were last reset.



- The Min/Max registers can be helpful in identifying bad electrical connections. This can be achieved by calculating difference between Min values among nearby Strings. Where one string is shown to have greater difference, it may indicate a possible problem with the terminal connections.

### 7.5 Surge counter

The ProSMS has a built in surge counter which is capable of detecting and counting direct and indirect surges to the panels, string cables or cabling to the central inverter.

**NOTICE** The Surge counter has been optimized to work best with the Raycap PV ProTEC surge protection series of SPDs.

## 8.1 Technical data

Electrical	
Number of channels	8
Max. number of strings	24 (3 strings per input)
Operational voltage range	90-1000VDC
Rated input voltage	100-800VDC
Rated input current	8 x 30A
Rated output current	240A
Voltage measurement range	0-1,000VDC
Current measurement range	±30A, bipolar
Measurement accuracy error	<1% of full scale
Power consumption of device	<1.5W
Overvoltage category	OVC III

Mechanical	
Dimensions (length x height x depth)	230 x 105 x 55mm
Net weight	420g
Installation method	35mm DIN rail, EN60715
Degree of protection	IP 20 (unit with cover)
Housing material	Polyamide (PA 6.6) / Polycarbonate for cover

Environmental	
Operating temperature [TO]	-30°C...+70°C
Relative humidity	10%...95%, non-condensing
Pollution degree	For use in pollution degree 2 environment
Max. altitude rating	2000m
Max. heat dissipation on all channels (240A)	10W

I/O interfaces	
Digital inputs	Two potential free contact closure inputs internally pulled to 5V
Relay output	SPDT relay maximum operating voltage 250VAC (0.5A at 125VAC, 2A at 30VDC)
LED status	Green for power, yellow for communication, red for error

Standards Compliance & Certifications	
Standards	EN62109, EN61000-2, EN61000-4, EN 61326-1
Certifications	CE

Communication	
Serial communication standard	RS-485, TIA-485(-A), EIA-485 (2 wire + common reference)
Serial communication protocol	Modbus RTU
Baud rate	2400bps to 38400bps
Unit load on the bus	1/8 "unit load" which allows up to 247 max possible slaves on the MODBUS network
Communication interface isolation	3750Vrms for 1 minute
Surge and highest allowable isolation overvoltage	6000Vpeak
Built in protection	Category D1,C1,C2,C3 (Three stage design with 4kA GDT)

