Interface for Modbus Communication

SMA CLUSTER CONTROLLER Modbus® Interface

Technical Description

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1 Information on this Document

Validity

This document is valid for the device type "CLCON-10.GR1". It describes the Modbus interface of the SMA Cluster Controller, the variant of the "Modbus® Application Protocol" implemented by SMA and the corresponding data exchange formats for SMA devices.

This document does not contain any information on software with which the Modbus interface can communicate. For information on such software, see the manual of the respective software manufacturer.

Target Group

This document is for skilled persons. Only persons with the appropriate skills are allowed to perform the tasks set forth in this document (see Section 2.2 "Skills of Skilled Persons", p. 8)

Additional information

SMA documents

Additional information is available in the Download area of the respective subsidiary at www.SMA-Solar.com:

Document title	Document type
SMA Cluster Controller	Installation manual
SMA Cluster Controller	User manual

Additional documents

You can find additional information on the "Modbus Application Protocol" on the Internet:

Source initials	Source
[IANA]	Internet Assigned Numbers Authority (IANA), Service Name and Transport Protocol Port Number Registry: http://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.xml
[MBAP]	Modbus Application Protocol Specification V1.1b, Modbus Organization, Inc. PO Box 628 Hopkinton, MA 01748, December 2006
[Modbus Serial]	Modbus over Serial Line Specification and Implementation Guide V1.02, Modbus Organization, Inc. PO Box 628 Hopkinton, MA 01748, December 2006

Symbols

Symbol	Explanation
	Information that is important for a specific topic or goal, but is not safety-relevant
☑	Desired result

Typographies

Typography	Usage	Example
"light"	• Elements of a user interface	• Read out the configured port in the "Port" field
bold	• Elements to be selected • Elements to be entered	• Select **Settings**
>	• Several elements that are to be selected	• Select **Settings > Port**
[Button/Key]	• Link to a literature source • Button or key to be selected or pressed	• See source [MPAP] • Select [Next]

Abbreviations

Abbreviation	Designation	Explanation
ADR (DEC)	MODBUS start address as decimal value	
CNT (2 bytes)	Number of assigned MODBUS registers. One register contains 2 bytes.	
Cluster Controller	SMA Cluster Controller	
DT, FW, RAW, FIXn	SMA data types; see Section SMA Data Types, page 25	
DWORD	Data with a width of 32 bit, according to IEC 61131-3	
Hex	Hexadecimal number	
MBAP	Modbus Application Protocol	Protocol for the Modbus from "Modbus Organization, Inc."
MPP	Maximum Power Point	Maximum power point
NaN	Not a Number	No useable value is returned
PV plant	PV plant	
RO	Read Only	Value can only be read
RW	Read/Write	Value can be read and written
SCADA	Supervisory Control and Data Acquisition	Concept for monitoring and controlling technical processes
SMA Fieldbus	Hardware interface for communication between SMA devices (e.g. Speedwire). For information on the various communication interfaces, please pay attention to the respective datasheets of the SMA devices used	
SUSy ID	SMA Update System ID	3-digit numeric value that identifies a specific SMA device type
WMAX	Set active power limitation	The device can generate active power up to this limit
WORD	Data with a width of 16 bit, according to IEC 61131-3	

2 Safety

2.1 Intended Use

The Modbus Application Protocol [MBAP] is designed for industrial use.

- Read and follow this documentation to ensure proper and optimum use of MODBUS implementation in SMA devices.
- Keep this documentation in a convenient place for future reference.

2.2 Skills of Skilled Persons

The work described in this document must only be performed by skilled persons. Skilled persons must have the following skills:

- Knowledge of IP-based network protocols
- Vocational training for installation and configuration of IT systems
- Knowledge of and compliance with this document and all the safety precautions

Skilled persons must be allowed to modify parameters of connected devices.

2.3 Safety Precautions

Data Security in Ethernet Networks

You can connect the Cluster Controller to the Internet. Note that connecting to the Internet carries the risk that unauthorised users can gain access to and manipulate the data or devices in your plant.

Take suitable protective measures, for example:

- Set up a firewall
- Close unnecessary network ports
- Only enable remote access via VPN tunnel

3 Product Description

3.1 Modbus Protocol

The MODBUS Application Protocol (MBAP) is an industrial communication protocol that is currently mainly used in the solar sector for plant communication in PV power stations.

The MODBUS protocol has been developed for reading data from or writing data to clearly defined data areas. The Modbus specification [MBAP] does not stipulate which data is to be in which data area; the data areas must be defined in a device-specific manner in so-called Modbus profiles. With knowledge of the device-specific Modbus profile, a Modbus master (e.g. a SCADA system) can access the data of a Modbus slave (e.g. the SMA Cluster Controller).

The special Modbus profile for SMA devices is the SMA Modbus profile (see Section 3.2).

3.2 SMA Modbus Profile

The SMA Modbus profile is a special Modbus profile for SMA devices and contains definitions for SMA devices that can be connected via Modbus. The figure of the measured values and parameters of particular SMA devices on the MODBUS is individually defined in the SMA MODBUS profile. An SMU (String Monitoring Unit), for example, only provides the information on the string currents, whereas an inverter, for example, provides the opportunity to call up power and voltage.

A reduction of the available data on SMA devices, such as overall and daily energy, current powers, voltages and currents, was performed and this data was assigned to the respective Modbus registers. This reduction and assignment between SMA device data and Modbus addresses is illustrated in an assignment table (see Section 7).

It is not intended to provide every SMA device with a physical Modbus interface. To enable access to data of an SMA device without Modbus capability, a special gateway is required via which the SMA Cluster Controller can be made available.

3.3 User-Defined Modbus Profile

The SMA Modbus profile can be used as the basis for a user-defined Modbus profile (see Section 5.2). There, the address assignments that were defined in the SMA Modbus profile can be reassigned to other Modbus addresses.

One advantage of reassigning Modbus addresses can be that the measured values and parameters which are relevant for controlling your plant can be applied to consecutive Modbus addresses. These addresses can therefore be read and set in a block.

3.4 Possible Network Topologies

The SMA Modbus profile has been designed for a hierarchical plant structure. In this structure, the Cluster Controller is a communication device which is equipped with a Modbus TCP/IP and Modbus UDP/IP interface. All additional SMA devices that are connected to the Cluster Controller via the SMA fieldbus are subordinate to the Cluster Controller.

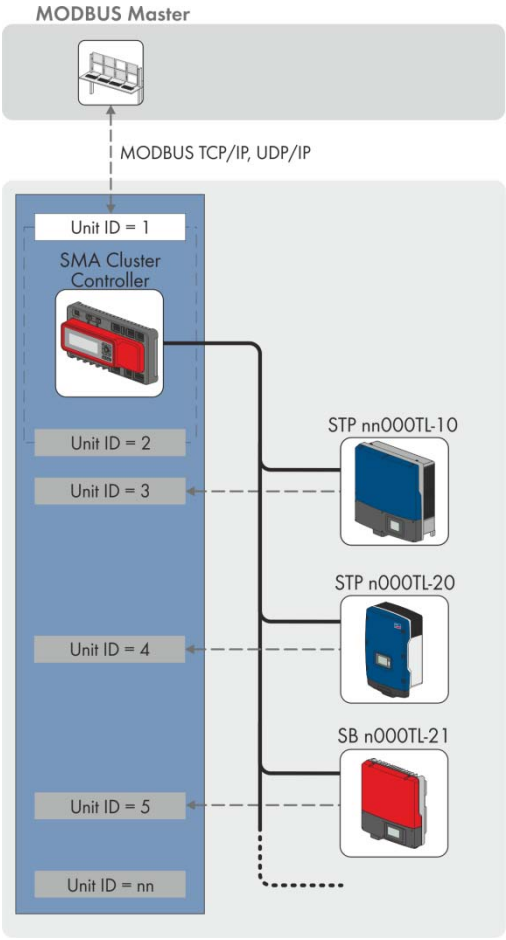
From the perspective of the Modbus, the SMA Cluster Controller represents a Modbus slave that prepares a gateway to subordinate SMA devices. The subordinate SMA devices can only be addressed using this gateway via unit ID.

Unit ID

The Unit ID is a device identification in the Modbus protocol. The assignment of the SMA devices to a Unit ID is saved in the Cluster Controller in an assignment table under Unit ID = 1 (gateway). The general plant parameters are saved under Unit ID = 2. Every additional SMA device (e.g. an inverter) therefore receives a Unit ID > 2 (3 to 247).

Examples for network topologies

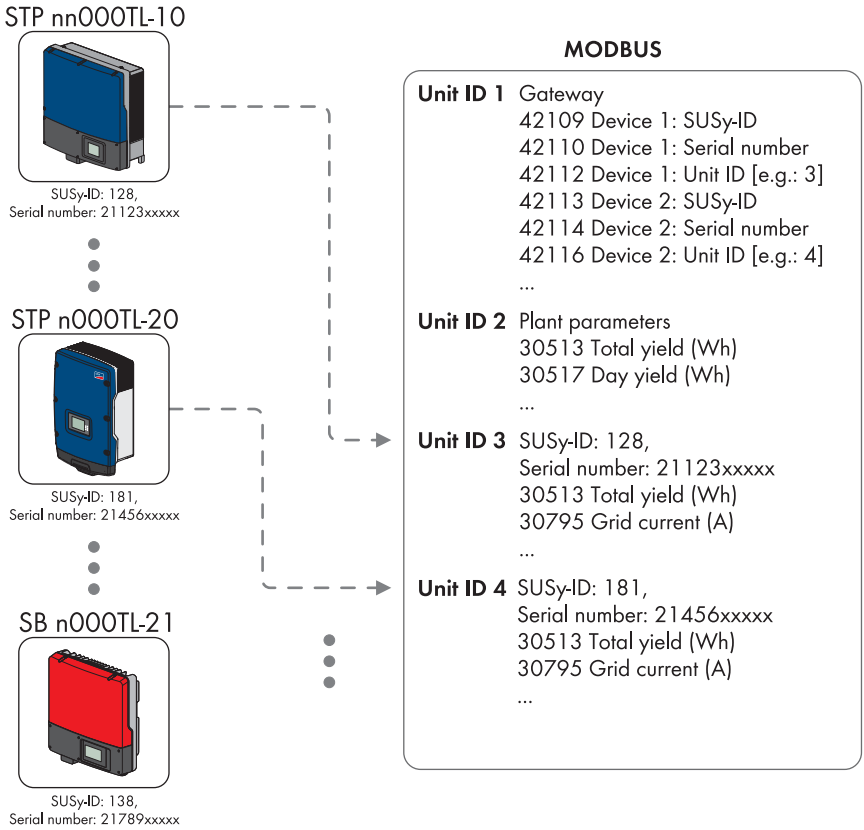
Network topology from the perspective of the SMA devices



SMA fieldbus

Logical assignment of SMA device to unit ID

Network topology from the perspective of the Modbus



From the perspective of the Modbus, an inverter is respectively assigned to a Unit ID in the above example. This means that the inverter data is available in Modbus. Unit ID 1 and Unit ID 2 represent the gateway to the Modbus and the plant parameters.

4 Commissioning

Requirement:

☑ The devices in the plant must be connected to the Cluster Controller and the plant must be commissioned (see the installation manual of the Cluster Controller).

1. Activate the Modbus server(s) and configure the communication port if required (see the Cluster Controller user manual).

Automatic plant detection required prior to activating the Modbus servers

As a result of the activation of the TCP server and/or the UDP server of the Cluster Controller, the previously detected SMA devices are assigned Unit IDs. If additional SMA devices are added following the activation of one or both of the servers or if SMA devices are replaced, these are automatically detected by the Cluster Controller. These devices are then assigned Unit ID = 255 (NaN) by default. With this Unit ID, the devices cannot be addressed and therefore cannot be access via the Modbus. For this reason, you must manually assign these devices individual Unit IDs (see Section 5.1).

If one or both of the servers are deactivated and reactivated, the previously assigned Modbus Unit IDs are maintained.

2. Change the Unit IDs if required (see Section 5)
3. Create a user-defined Modbus profile if required (see Section 5.2)
4. Activate the user-defined Modbus profile if required (see Section 5.2)

5 Configuration

5.1 Changing Unit IDs

5.1.1 Information on Unit IDs

You can change the Unit IDs of SMA devices. A change is required, for example, if additional or modified SMA devices are assigned the Modbus Unit ID = 255 (NaN) via automatic detection. With this Unit ID, the devices cannot be addressed and cannot be accessed via the Modbus. You must assign these devices individual Unit IDs. On the other hand, the user may wish to restructure the plant topology so that the physical assignment of the devices can be better depicted in Modbus.

Depending on whether you wish to change individual unit IDs or restructure the entire plant topology, you have two options for personally changing the Unit IDs of the detected devices.

- Changing Unit IDs via the assignment table of the gateway (recommended for changing individual Unit IDs)
- Changing Unit IDs via a user-defined plant file (recommended for the restructuring of the plant topology)

Both of these methods are described in separate Sections. It is the case for both methods of modifying Unit IDs that 247 devices can be addressed in Modbus via the Unit ID (see source [Modbus Serial]). The following table shows a summary of the reserved and free Unit IDs:

Unit ID	Explanation
1	Reserved for the Cluster Controller gateway
2	Reserved for the plant parameters
3 to 247	Freely available

Do not assign duplicate Unit IDs

You must not assign duplicate Unit IDs. If there is a duplicate assignment of a Unit ID, the device data that is entered in the assignment table of the gateway under the lowest Modbus address is always read out in the event of a Modbus request of this Unit ID.

5.1.2 Changing Unit IDs via the Gateway

Procedure:

- Read out gateway
- Change the Unit ID in the gateway assignment table

Read out the gateway assignment table

You can read out the individual Unit IDs of the SMA devices from the assignment table of the gateway via the Modbus interface. You can access this table via Unit ID = 1.

The assignment of Unit IDs 3 to 247 is saved in the Modbus registers from address 42109. For this purpose, every assignment comprises an address area of 4 Modbus registers (see the following example). You can find the assignment table for the gateway in Section 7.2.1.

Example for an assignment table

After the automatic detection of a new SMA device (C), the assignment table in your Modbus master system may appear as follows:

Modbus address	Content	Description	Device #
...	...	...	
42109	*158*	*SUSy ID*	A
42110	*2145600972*	*Serial number*	A
42112	*3*	*Unit ID*	A
42113	*158*	*SUSy ID*	B
42114	*2145600320*	*Serial number*	B
42116	*4*	*Unit ID*	B
42117	*158*	*SUSy ID*	C
42118	*2145600934*	*Serial number*	C
42120	*255*	*Unit ID*	C
...	...	...	...
43085	*65535*	*SUSy ID*	X
43086	*4294967294*	*Serial number*	X
43088	*65535*	*Unit ID*	X

Changing the Unit ID in the gateway assignment table

You change a Unit ID by writing it to the corresponding Modbus address; you can do this using your Modbus master system, e.g. a SCADA system.

Changing the Unit ID in the gateway assignment table

To change a Unit ID in the Gateway assignment table, all three registers belonging to a device must be written in one block. For the following example, this means that all the data of the three Modbus addresses 42113, 42114 and 42116 must be written.

Example for changing the Unit ID in the assignment table

The following table shows an example assignment. An inverter with SUSy ID = 160 and serial number 1134365300 was subsequently detected as a second device in the plant (Modbus addresses 42113 to 42116). The Unit ID of this device was manually set to 4:

Modbus address		After detection	Modified
42113	SUSy ID	160	160
42114	Serial number	1134365300	1134365300
42116	Unit ID	255 (NaN)	4

5.1.3 Changing Unit IDs via a User-Defined Plant File

The Modbus IDs assigned during the automatic plant detection and the subsequent activation of the Modbus server are saved by the Cluster Controller in an XML file titled "sysplant.xml". This file is an excerpt of the gateway; see Section 7.2.1. If new SMA devices are added or if SMA devices are replaced, these are respectively added to the available XML structure with Unit ID = 255 by the Cluster Controller.

You specify a user-defined plant topology via the plant file "usrplant.xml". The files "sysplant.xml" and "usrplant.xml" have the same tag structure.

The basic structure of the files is as follows:

<?xml version="1.0" encoding="UTF-8"?>

<plant version="001">

<device regoffs="aaa" susyid="bbb" serial="ccccccccc" unitid="ddd" />

...

</plant>

Legend for XML tags and attributes:

XML tag or attribute	Explanation
<device>...</device>	A device entry must be created for each Unit ID that is to be defined for a Modbus device; see also the example below.
regoffs="aaa"	Serial number of the SMA device in the gateway assignment table; see also Section 7.2.1. There are four Modbus register addresses between two devices in the gateway assignment table. Regoffs = 0 defines the (first) device under the Modbus address 42109, Regoffs = 244 defines the last (245th) device under the Modbus address 43085. The serial number must not be assigned consecutively. **Calculation example:** What is being searched for is the serial number of the device that is saved under the Modbus address 42189: 42189 - 42109 = 80 / 4 Modbus registers = 20
susyid="bbb"	Defines the SUSy ID
serial="ccccccccc"	Defines the serial number
unitid="ddd"	Defines the Modbus Unit ID to be used

You can download the file "sysplant.xml" from the Cluster Controller, use it as a template for the file "usrplant.xml"and adjust it to your needs.

Uploading and downloading XML files

For further information on uploading and downloading XML files via the web interface, refer to the SMA Cluster Controller user manual.

Activating the file "usrplant.xml"**:**

To activate your adjustments, upload the file "usrplant.xml" to the Cluster Controller. For this purpose, the specifications in the file "usrplant.xml" are transferred to the system. A modified "userplant.xml" becomes effective a few seconds after saving to the Cluster Controller.

Deactivating the file "usrplant.xml"**:**

To deactivate your adjustments, upload a "usrplant.xml" that does not contain any tags to the Cluster Controller. Both of the following lines show the structure of such a "usrplant.xml" file:

<?xml version="1.0" encoding="UTF-8"?>

<plant version="001"></plant>

Without the device tags in the file "usrplant.xml", the system returns to the specifications saved in the file "sysplant.xml". A modified "userplant.xml" becomes effective a few seconds after saving to the Cluster Controller.

Examples for a customer-specific plant file "userplant.xml**":**

The Unit IDs of the following two SMA devices are to be changed to Unit ID 3 and 4:

- SB 5000 TL-21, SUSy ID = 138, serial number = 2178909920, current position in gateway = 7
- STP 15000TL-10, SUSy ID = 128, serial number = 2112303920, current position in gateway = 8

The exact structure of the XML file looks like this:

```
<?xml version="1.0" encoding="UTF-8"?>
<plant version="001">
        <device regoffs="7" susyid="138" serial="2178909920" unitid="3" />
        <device regoffs="8" susyid="128" serial="2112303920" unitid="4" />
</plant>
```

5.1.4 Restoring Default Settings

By resetting the Cluster Controller to default settings, the previously assigned Unit IDs are deleted and reassigned – the file "sysplant.xml" is therefore rewritten. As a result, all connected SMA devices are assigned a new Unit ID.

Save data prior to restoring default settings

By resetting the Cluster Controller to default settings, the user-defined plant file "user-plant.xml" and the customer-defined Modbus profile "usrprofile.xml" are deleted. If required, please save these files before resetting.

For further information on resetting to default settings and saving XML files, refer to the SMA Cluster Controller user manual.

5.2 Creating a User-Defined Modbus Profile

You can change the assignment of the Modbus addresses by creating a user-defined Modbus profile. In the user-defined Modbus profile, the address assignments that were defined in the SMA Modbus profile can be reassigned to other Modbus addresses. You can use the whole Modbus address range between 0 and 65535. The user-defined Modbus profile can be called up via the gateway like an additional device and has its own Unit ID, which you can specify between 3 and 247 (for rules concerning Unit IDs, see Section 5.1.1).

The user-defined Modbus profile is defined in the file "usrprofile.xml" in addition to the SMA Modbus profile.

One advantage of the user-defined Modbus profile can be that the measured values and parameters which are relevant for controlling your plant can be applied to consecutive Modbus addresses and can therefore be read out or set in one block.

The basic structure of the XML file is as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<virtual_modbusprofile>
        <channel unitid="aaa" source="bbbbb" destination="ccccc" />
        ...
</virtual_modbusprofile>
```

Legend for XML tags and attributes:

XML tag or attribute	Explanation
<virtual_modbusprofile> </virtual_modbusprofile>	A user-defined Modbus profile is specified within this XML structure.
<channel />	Within a Channel tag, a new Modbus address can be defined in a Unit ID:
unitid=”aaa”	Specifies the Unit ID of a device whose Modbus addresses have to be redefined. Available Unit IDs for individual devices are 1 to 247.
source=”bbbbb”	Specifies a Modbus address of a device selected under "unitid" whose value is to be used as source. (For information on the assignment tables, see Section 7.)
destination=”ccccc”	Specifies the new Modbus address from which the value is to be retrieved (0 to 65535) Please consider the number of Modbus registers that are stored at the initial address. The destination registers must not overlap. If definitions are entered in invalid addresses, a Modbus exception is generated. If definitions are entered in addresses which don't have values, inquiries are answered with NaN.
<!- - Part commented out- ->	Comments out an area in the XML file, e.g. in order to deactivate an instruction.

Modbus exceptions

You will find information on Modbus exceptions in the source [MBAP], page 5.

To activate your user-defined Modbus profile, upload the file "usrprofile.xml" to the Cluster Controller, restart this and activate the customer-defined Modbus profile as described below.

If the usage of the user-defined Modbus profile on the Cluster Controller is deactivated, the user-defined assignments are lost and only the SMA Modbus profile remains active.

Uploading and downloading XML files

For further information on uploading and downloading XML files via the web interface, refer to the SMA Cluster Controller user manual.

Activating user-defined Modbus profile

You activate a user-defined Modbus profile by creating a device entry with the attribute "susyid=0" in the user-defined plant file "usrplant.xml". You can find more information on the user-defined plant file in the previous Section 5.1.3

Example:

The following device entry activates a user-defined Modbus profile that is entered as the tenth device in the gateway.

<device regoffs="9" susyid="0" serial="0" unitid="100" />

Deactivating user-defined Modbus profile

You deactivate a user-defined Modbus profile by commenting out in its device line in the user-defined plant file "usrplant.xml" and re-uploading this to the Cluster Controller. Commenting out in XML is structured as follows: <!--Part commented out-->. In the following example, you can see a commenting out applied to the line with the customer-defined Modbus profile:

<!--<device regoffs="0" susyid="128" serial="8700654300" unitid="3" />-->

Example for a customer-defined Modbus profile "usrprofile.xml":

The apparent power, active power and reactive power of the devices stored under the Unit IDs 3 and 4 are to be written as consecutively running Modbus addresses from address 00000 on. The number of Modbus registers per value (CNT) must be considered; every third value equals 2.

(The following table is an excerpt from the SMA Modbus profile)

ADR (DEC)	Description / return code	CNT (2 bytes)	Format	Display	Type	Access
30813	Apparent power on all line conductors (VA)	2	S32	Scalar	FIX0	RO
30775	AC active power on all line conductors (W)	2	S32	Scalar	FIX0	RO
30805	Reactive power on all line conductors (VAr)	2	S32	Scalar	FIX2	RO

The exact structure of the XML file looks like this:

```
<?xml version="1.0" encoding="UTF-8"?>
<virtual_modbusprofile>
        <channel unitid="3" source="30813" destination="00000" />
        <channel unitid="3" source="30775" destination="00002" />
        <channel unitid="3" source="30805" destination="00004" />
        <channel unitid="4" source="30813" destination="00006" />
        <channel unitid="4" source="30775" destination="00008" />
        <channel unitid="4" source="30805" destination="00010" />
</virtual_modbusprofile>
```

6 Interface Definition

6.1 SMA Data Formats

SMA data formats have a width of 16 bit, 32 bit or 64 bit. The width of a Modbus register is 16 bit. The registers are transmitted in Motorola format (big-endian), meaning that the high byte is transmitted first and then the low byte is transmitted.

Reading and writing from Modbus registers

The background to the Modbus interface described in this document is that n Modbus registers must each be read and written in one step. If for example two 16 bit Modbus registers are read into a 32 bit SMA data format, the 4 bytes of both registers must be read in with a read operation.

The SMA data formats are listed in the "Format" column of the assignment tables. They describe the data width and the properties of the assigned values. If an assignment is not implemented, a Modbus exception will be returned as an error.

6.1.1 Data Formats and NaN Values

The following data formats are supported by the SMA Modbus profile:

Format	Explanation	NaN value
U16	A word (16 bit/WORD) in the local processor format	0xFFFF
S16	A signed word (16 bit/WORD) in the local processor format	0x8000
U32	A double word (32 bit/DWORD) in the local processor format	0xFFFFFFFF
U32	For status values, only the lower 24 bit of a double word (32 bit/DWORD) is used in the local processor format!	0xFFFFFD
S32	A signed double word (32 bit/DWORD) in the local processor format	0x80000000
U64	A quad word (64 bit/2 x DWORD) in the local processor format	0xFFFFFFFFFFFFFFFF

6.1.2 16 Bit Integer Values

16 bit integers are stored in a register in big-endian sorting.

MODBUS register	**1**	
Byte	0	1
Bits	8 ... 15	0 ... 7

U16: 0 ... 65535 Not implemented: 0xFFFF

S16: -32767 ... 32767 Not implemented: 0x8000

Example: 32,000 (U16) = 01111101 00000000

6.1.3 32 Bit Integer Values

32 bit integers are stored in two registers in big-endian sorting.

MODBUS register	**1**		**2**	
Byte	0	1	2	3
Bits	24 ... 31	16 ... 23	8 ... 15	0 ... 7

U32: 0 ... 4294967294 Not implemented: 0xFFFFFFFF

U32 (status/24 bit): 0 ... 1677212 Not implemented: 0xFFFFFD

S32: -2147483647 ... 2147483647 Not implemented: 0x80000000

Example: 136,534,944 (U32) = 00001000 00100011 01011011 10100000

6.1.4 64 Bit Integer Values

64 bit integers are stored in four registers in big-endian sorting.

MODBUS register	**1**		**2**	
Byte	0	1	2	3
Bits	56 ... 63	48 ... 55	40 ... 47	32 ... 39
MODBUS register	**3**		**4**	
Byte	4	5	6	7
Bits	24 ... 31	16 ... 23	8 ... 15	0 ... 7

U64: 0 ... 18446744073709551614 Not implemented: 0xFFFFFFFFFFFFFFFF

6.2 SMA Data Types

The following SMA data types describe the types of data that are transmitted. The SMA data types are listed in the "Type" column of the assignment tables.

Type	Explanation
Duration	**Time period** Output in seconds
DT	**Date/time** Output of date/time, in accordance with country setting. Transmission as UTC (without daylight saving time) in seconds since 1970-01-01.
FIX0	**Factor 1** Output as decimal number, commercially rounded, no decimal places
FIX1	**Factor 0.1** Output as decimal number, commercially rounded, one decimal place
FIX2	**Factor 0.01** Output as decimal number, commercially rounded, two decimal places
FIX3	**Factor 0.001** Output as decimal number, commercially rounded, three decimal places
FIX4	**Factor 0.0001** Output as decimal number, commercially rounded, four decimal places
FW	Firmware version, e.g., 1.12.0.R, see abstract below
RAW	Output as text or number, depending on data format of the value. Numbers without decimal places and without thousand or other separation indicators.
ENUM	This type of parameter can provide various status values. The parameters are returned as code. You will find the breakdown of the code in the appropriate section of the SMA MODBUS Profile assignment table.
TEMP	**Temperature** The values are given in degrees Celsius. The output is commercially rounded to one decimal place.

Firmware version extract (FW): Four values are extracted from the delivered DWORD. The "Major" and "Minor" values are BCD-coded in bytes 1 and 2. Byte 3 contains the "Build" value (not BCD-coded). Byte 4 contains the "Release Type" value according to the following table:

Value	Output	Explanation
0	N	NOREV
1	E	EXPERIMENTAL
2	A	ALPHA
3	B	BETA
4	R	RELEASE
5	S	SPECIAL
> 5	As number	No special interpretation

Example:

Values from DWORD: Major: 1, Minor: 5, Build: 10, Release Type: 4
(Hex: 0x1 0x5 0xA 0x4)

6.3 Addressing and Data Transfer in Modbus

The Modbus register address forms the start address of a data block. A data block equates to a single data set and can consist of one or more Modbus registers. The quantity of required Modbus registers is given in the assignment table.

Addressing Modbus registers

The address range 0-0xFFFF with 65536 addresses is available for addressing Modbus registers. One register is 16 bits wide. For broader data formats, connected registers are used.

In order to avoid inconsistencies, data blocks must always be read or written completely.

Depending on the Modbus specification, a maximum of 253 bytes of user data can be transmitted during the transfer of a message. Function-dependent parameters (e.g. function code, start address, number of registers) also count as user data. Thus, a maximum of 125 Modbus registers can be transmitted in one message. This must be taken into consideration during the request.

6.4 Reading and Writing Data from Modbus Registers

The following Modbus commands are supported by the implemented Modbus interface:

Modbus command	Hexadecimal value
Read Holding Registers	0x03
Read Input Registers	0x04
Write Single Register	0x06
Write Multiple Registers	0x10
Read Write Multiple Registers	0x17

NaN as answer

If an undefined value is called up from a Modbus register, "NaN" is returned as the answer. You will find possible NaN values in section 6.1.1.

Modbus exception if access to a register fails

For each inverter type, only certain Modbus registers are available. If a Modbus register is not available for an inverter type, a Modbus exception will be generated upon accessing this register.

Modbus exception if the setting of several registers fails

If several registers in the packet are set one after another (Modbus commands 0x10 and 0x17) an error occurs during setting, the faulty register as well as all the following registers in the packet will not be set. In the event of an error a Modbus exception will be generated.

Modbus exceptions

You will find information on Modbus exceptions in the source [MBAP], page 5.

7 SMA Modbus Profile – Assignment Tables

7.1 Information on the Assignment Tables

The following subsections are sorted by Unit ID. Each contains a table of the Modbus addresses which can be accessed under the corresponding unit ID. This means that SMA device registers are assigned Modbus addresses under a Unit ID. The tables display the following information:

Information	Explanation
ADR	Decimal Modbus address (see also Section 6.3 onwards)
Description/return code	Brief description of the stored numerical value and the possible return codes.
CNT	Number of utilized Modbus registers (see also Section 6.4 onwards).
Format	Format and width of the stored values, e.g. U32 = 32 bit without sign (see also Section 6.1).
Display	Scalar or status. Scalar delivers a directly interpretable numerical value, the type of which is specified in the "Type" column. Status delivers one or more code(s), as specified in the corresponding "Description/return code" column.
Type	The value type of the saved value, e.g. DT = date, FIX n = to n decimal places, TEMP = temperature (see also Section 6.2).
Access	Access type, e.g. RO = read-only access. If an access type is not supported, a Modbus exception will be generated.

7.2 SMA Cluster Controller

7.2.1 Gateway

You can access the parameters prepared by the gateway of the Cluster Controller via Unit ID = 1. In the following table, you can also find the assignment of the subordinate SMA devices to the Unit IDs:

ADR (DEC)	Description/return code	CNT (2 bytes)	Format	Display	Type	Access
30001	Version number of the SMA Modbus profile	2	U32	Scalar	RAW	RO
30003	SUSy ID (SMA Cluster Controller)	2	U32	Scalar	RAW	RO
30005	Serial number (SMA Cluster Controller)	2	U32	Scalar	RAW	RO
30007	Modbus data change: meter value is increased by the Cluster Controller if new data is available.	2	U32	Scalar	RAW	RO
34609	Ambient temperature (°C)	2	S32	Scalar	TEMP	RO
34611	Highest measured ambient temperature (°C)	2	S32	Scalar	TEMP	RO
34613	Total irradiation on the sensor surface (W/m²)	2	U32	Scalar	FIX0	RO
34621	PV cell temperature (°C)	2	S32	Scalar	TEMP	RO
34623	Total irradiation on the external irradiation sensor/pyranometer (W/m²)	2	U32	Scalar	FIX0	RO
34625	Ambient temperature (°F)	2	S32	Scalar	TEMP	RO
34627	Ambient temperature (K)	2	S32	Scalar	TEMP	RO
34629	PV cell temperature (°F)	2	S32	Scalar	TEMP	RO
34631	PV cell temperature (K)	2	S32	Scalar	TEMP	RO

34637	Analogue current input 1 (mA)	2	S32	Scalar	FIX2	RO
34639	Analogue current input 2 (mA)	2	S32	Scalar	FIX2	RO
34641	Analogue current input 3 (mA)	2	S32	Scalar	FIX2	RO
34651	Analogue current input 4 (V)	2	S32	Scalar	FIX2	RO
34653	Digital input group 1 coded as status: 311 = Open 2055 = DI1 2056 = DI1 DI2 2057 = DI1 DI2 DI3 2058= DI1 DI2 DI3 DI4 2059 = DI1 DI2 DI4 2060 = DI1 DI3 2061 = DI1 DI3 DI4 2062 = DI1 DI4 2063 = DI2 2064 = DI2 DI3 2065 = DI2 DI3 DI4 2066 = DI2 DI4 2067 = DI3 2068 = DI3 DI4 2069 = DI4	2	U32	Status	ENUM	RO
34655	Digital input group 2 coded as status: 311 = Open 2070 = DI5 2071 = DI5 DI6 2072 = DI5 DI6 DI7 2073 = DI5 DI6 DI7 DI8 2074 = DI5 DI6 DI8 2075 = DI5 DI7 2076 = DI5 DI7 DI8	2	U32	Status	ENUM	RO

	2077 = DI5 DI8 2078 = DI6 2079 = DI6 DI7 2080 = DI6 DI7 DI8 2081 = DI6 DI8 2082 = DI7 2083 = DI7 DI8 2084 = DI8					
	Unit ID assignment – SMA devices (see also Section 5.1):					
42109	Device 1: SUSy ID	1	U16	Scalar	RAW	RO
42110	Device 1: serial number	2	U32	Scalar	RAW	RO
42112	Device 1: Unit ID (e.g. 3)	1	U16	Scalar	RAW	RW
42113	Device 2: SUSy ID	1	U16	Scalar	RAW	RO
42114	Device 2: serial number	2	U32	Scalar	RAW	RO
42116	Device 2: Unit ID (e.g. 4)	1	U16	Scalar	RAW	RW
...	...	...	...	...	...	...
43085	Device 245: SUSy ID	1	U16	Scalar	RAW	RO
43086	Device 245: serial number	2	U32	Scalar	RAW	RO
43088	Device 245: Unit ID (e.g. 247)	1	U16	Scalar	RAW	RW

For Unit ID = 255, please observe Section 5.1.1.

Changing Unit ID in the gateway

To change a Unit ID in the gateway, all three registers belonging to a device must be written; see Section 5.1.2

7.2.2 Plant Parameters

You can access the plant parameters stored in the SMA Cluster Controller via Unit ID = 2:

ADR (DEC)	Description / return code	CNT (2 bytes)	Format	Display	Type	Access
30007	Modbus data change: meter value is increased by the Cluster Controller if new data is available.	2	U32	Scalar	RAW	RO
30513	Total AC energy fed in on all line conductors (Wh)	4	U64	Scalar	FIX0	RO
30517	Energy fed in on the current day on all line conductors (Wh)	4	U64	Scalar	FIX0	RO
30775	AC active power on all line conductors (W)	2	S32	Scalar	FIX0	RO
34609	Ambient temperature (°C)	2	S32	Scalar	TEMP	RO
34611	Highest measured ambient temperature (°C)	2	S32	Scalar	TEMP	RO
34613	Total irradiation on the sensor surface (W/m²)	2	U32	Scalar	FIX0	RO
34621	PV cell temperature (°C)	2	S32	Scalar	TEMP	RO
34623	Total irradiation on the external irradiation sensor/pyranometer (W/m²)	2	U32	Scalar	FIX0	RO
34625	Ambient temperature (°F)	2	S32	Scalar	TEMP	RO
34627	Ambient temperature (K)	2	S32	Scalar	TEMP	RO
34629	PV cell temperature (°F)	2	S32	Scalar	TEMP	RO
34631	PV cell temperature (K)	2	S32	Scalar	TEMP	RO

34637	Analogue current input 1 (mA)	2	S32	Scalar	FIX2	RO
34639	Analogue current input 2 (mA)	2	S32	Scalar	FIX2	RO
34641	Analogue current input 3 (mA)	2	S32	Scalar	FIX2	RO
34651	Analogue current input 4 (V)	2	S32	Scalar	FIX2	RO
34653	Digital input group 1 coded as status: 311 = Open 2055 = DI1 2056 = DI1 DI2 2057 = DI1 DI2 DI3 2058= DI1 DI2 DI3 DI4 2059 = DI1 DI2 DI4 2060 = DI1 DI3 2061 = DI1 DI3 DI4 2062 = DI1 DI4 2063 = DI2 2064 = DI2 DI3 2065 = DI2 DI3 DI4 2066 = DI2 DI4 2067 = DI3 2068 = DI3 DI4 2069 = DI4	2	U32	Status	ENUM	RO
34655	Digital input group 2 coded as status: 311 = Open 2070 = DI5 2071 = DI5 DI6 2072 = DI5 DI6 DI7 2073 = DI5 DI6 DI7 DI8 2074 = DI5 DI6 DI8 2075 = DI5 DI7 2076 = DI5 DI7 DI8 2077 = DI5 DI8 2078 = DI6 2079 = DI6 DI7	2	U32	Status	ENUM	RO

	2080 = DI6 DI7 DI8 2081 = DI6 DI8 2082 = DI7 2083 = DI7 DI8 2084 = DI8					
40001	Reading and setting the plant time (UTC)	2	U32	Scalar	DT	RW
40003	Reading and setting the time zone. For possible values, see Section "Return Codes – Time Zones", page 49.	2	U32	Status	ENUM	RW
40005	Automatic daylight saving time conversion active: 1129 = Active 1130 = Not active	2	U32	Status	ENUM	RW

7.3 SMA Devices

The following table contains the measured values and parameters that you can access via Unit IDs = 3 to 247. The table does not apply for Unit IDs 1 and 2.

Availability of the Modbus register

For each inverter type, only certain Modbus registers are available. If a Modbus register is not available for an inverter type, a Modbus exception will be generated upon accessing this register.

You will find information on Modbus exceptions in the source [MBAP], page 5.

ADR (DEC)	Description / return code	CNT (2 bytes)	Format	Display	Type	Access
30003	SUSy ID	2	U32	Scalar	RAW	RO
30005	Serial number	2	U32	Scalar	RAW	RO
30051	Device class: 267 = Inverter	2	U32	Status	ENUM	RO
30053	Device model: For possible values, see Section "Supported SMA Inverters", page 48.	2	U32	Status	ENUM	RO
30055	Manufacturer specification: 461 = SMA	2	U32	Status	ENUM	RO
30057	Serial number	2	U32	Scalar	RAW	RO
30059	Software package	2	U32	Scalar	FW	RO
30197	Event ID of the current event (number of characters limited by device); for information on event numbers, see Section 8.	2	U32	Scalar	FIX0	RO
30199	Time until grid connection attempt (s)	2	U32	Scalar	Dura-tion	RO
30201	Condition: 35 = Fault 303 = Off 307 = OK 455 = Warning	2	U32	Status	ENUM	RO

30203	Nominal power in mode: 307 = OK	2	U32	Scalar	FIX0	RO
30205	Nominal power in mode: 455 = Warning	2	U32	Scalar	FIX0	RO
30207	Nominal power in mode: 35 = Fault	2	U32	Scalar	FIX0	RO
30209	Nominal power in mode: 303 = Off	2	U32	Scalar	FIX0	RO
30211	Recommended action: 336 = Contact manufacturer service 337 = Contact electrically qualified person 338 = Invalid	2	U32	Status	ENUM	RO
30213	Status message: 886 = No message nnnnn = Last event number (number of characters limited by device); for information on event numbers, see Section 8.	2	U32	Status	ENUM	RO
30215	Status description: 885 = No description nnnnn = Last event number (number of characters limited by device); for information on event numbers, see Section 8.	2	U32	Status	ENUM	RO
30217	Grid contactor: 51 = Contactor closed 311 = Contactor open	2	U32	Status	ENUM	RO

30219	Temperature derating: 302 = No derating 557 = Temperature derating 1704 = WMax derating 1705 = Frequency derating 1706 = Derating due to PV current limitation	2	U32	Status	ENUM	RO
30225	Insulation resistance (ohms)	2	U32	Scalar	FIX0	RO
30227	Status of key switch: 381 = Switched off 569 = Switched on	2	U32	Status	ENUM	RO
30229	Local time of device	2	U32	Scalar	DT	RO
30231	Maximum possible continuous active power, fixed configuration. Can be greater than the nominal power (W)	2	U32	Scalar	FIX0	RO
30233	Permanent active power limitation (W)	2	U32	Scalar	FIX0	RO
30257	State of DC switch: 51 = Closed 311 = Open	2	U32	Status	ENUM	RO
30513	Total AC energy fed in on all line conductors (Wh)	4	U64	Scalar	FIX0	RO
30517	Energy fed in on the current day on all line conductors (Wh)	4	U64	Scalar	FIX0	RO
30521	Operating hours (s)	4	U64	Scalar	Duration	RO
30525	Feed-in hours (s)	4	U64	Scalar	Duration	RO
30529	Total AC energy fed in on all line conductors (Wh)	2	U32	Scalar	FIX0	RO
30531	Total AC energy fed in on all line conductors (kWh)	2	U32	Scalar	FIX0	RO

30533	Total AC energy fed in on all line conductors (MWh)	2	U32	Scalar	FIX0	RO
30535	Energy fed in on the current day on all line conductors (Wh)	2	U32	Scalar	FIX0	RO
30537	Energy fed in on the current day on all line conductors (kWh)	2	U32	Scalar	FIX0	RO
30539	Energy fed in on the current day on all line conductors (MWh)	2	U32	Scalar	FIX0	RO
30541	Operating hours (s)	2	U32	Scalar	Dura-tion	RO
30543	Feed-in hours (s)	2	U32	Scalar	Dura-tion	RO
30545	Operating hours, interior fan 1 (s)	2	U32	Scalar	Dura-tion	RO
30547	Operating hours, interior fan 2 (s)	2	U32	Scalar	Dura-tion	RO
30549	Operating hours, heat sink fan (s)	2	U32	Scalar	Dura-tion	RO
30559	Number of events at user level	2	U32	Scalar	FIX0	RO
30561	Number of events at electri-cally qualified person level	2	U32	Scalar	FIX0	RO
30769	DC current input (A)	2	S32	Scalar	FIX3	RO
30771	DC voltage input (V)	2	S32	Scalar	FIX2	RO
30773	DC power input (W)	2	S32	Scalar	FIX0	RO
30775	AC active power on all line conductors (W)	2	S32	Scalar	FIX0	RO
30777	AC active power L1 (W)	2	S32	Scalar	FIX0	RO
30779	AC active power L2 (W)	2	S32	Scalar	FIX0	RO

30781	AC active power L3 (W)	2	S32	Scalar	FIX0	RO
30783	Line voltage, line connector L1 to N (V)	2	U32	Scalar	FIX2	RO
30785	Line voltage, line connector L2 to N (V)	2	U32	Scalar	FIX2	RO
30787	Line voltage, line connector L3 to N (V)	2	U32	Scalar	FIX2	RO
30795	AC current (A)	2	U32	Scalar	FIX3	RO
30797	Line current, line conductor L1 (A)	2	U32	Scalar	FIX3	RO
30799	Line current, line conductor L2 (A)	2	U32	Scalar	FIX3	RO
30801	Line current, line conductor L3 (A)	2	U32	Scalar	FIX3	RO
30803	Power frequency (Hz)	2	U32	Scalar	FIX2	RO
30805	Reactive power on all line conductors (VAr)	2	S32	Scalar	FIX2	RO
30807	Reactive power L1 (VAr)	2	S32	Scalar	FIX0	RO
30809	Reactive power L2 (VAr)	2	S32	Scalar	FIX0	RO
30811	Reactive power L3 (VAr)	2	S32	Scalar	FIX0	RO
30813	Apparent power on all line conductors (VA)	2	S32	Scalar	FIX0	RO
30815	Apparent power L1 (VA)	2	S32	Scalar	FIX0	RO
30817	Apparent power L2 (VA)	2	S32	Scalar	FIX0	RO
30819	Apparent power L3 (VA)	2	S32	Scalar	FIX0	RO

30821	Displacement power factor from "AC active power on all line conductors" and "Reactive power on all line conductors"	2	U32	Scalar	FIX2	RO
30823	Excitation type of cos(Phi): 1041 = Overexcited 1042 = Underexcited	2	U32	Scalar	ENUM	RO
30825	Operating mode of the reactive power regulation: 303 = Off 1069 = Reactive power/voltage characteristic curve Q(U) 1070 = Reactive power Q, direct default setting 1071 = Reactive power const. Q (kVAr) 1072 = Reactive power Q, default setting via plant control 1073 = Reactive power Q(P) 1074 = cos(Phi), direct default setting 1075 = cos(Phi), default setting via plant control 1076 = cos(Phi)(P) characteristic curve 1387 = Reactive power Q, default setting via analogue input 1388 = cos(Phi), default setting via analogue input 1389 = Reactive power/voltage characteristic curve Q(U) with hysteresis and deadband	2	U32	Status	ENUM	RO

30827	Reactive power setpoint (VAr)	2	S32	Scalar	FIX0	RO
30829	Reactive power setpoint (%)	2	S32	Scalar	FIX1	RO
30831	cos(Phi) target value	2	S32	Scalar	FIX2	RO
30833	Target value, excitation type of cos(Phi): 1041 = Overexcited 1042 = Underexcited	2	U32	Status	ENUM	RO
30835	Active power limitation operating mode 303 = Off 1077 = Active power limitation P (W) 1078 = Active power limitation P (% (Pmax)) 1079 = Active power limitation P via plant control 1390 = Active power limitation P via analogue input 1391 = Active power limitation P via digital inputs	2	U32	Status	ENUM	RO
30837	Active power setpoint (W)	2	U32	Scalar	FIX0	RO
30839	Active power setpoint (%)	2	U32	Scalar	FIX0	RO
34097	Operating hours, interior fan 1 (s)	4	U64	Scalar	Duration	RO
34101	Operating hours, interior fan 2 (s)	4	U64	Scalar	Duration	RO
34105	Operating hours, heat sink fan (s)	4	U64	Scalar	Duration	RO
34109	Heat sink temperature 1 (°C)	2	S32	Scalar	TEMP	RO
34113	Interior temperature 1 (°C)	2	S32	Scalar	TEMP	RO

34121	Transformer temperature 1 (°C)	2	S32	Scalar	TEMP	RO
34125	External temperature 1 (air supply) (°C)	2	S32	Scalar	TEMP	RO
34127	Highest measured external temperature 1 (°C)	2	S32	Scalar	TEMP	RO
35377	Number of events for user	4	U64	Scalar	FIX0	RO
35381	Number of events for electrically qualified person	4	U64	Scalar	FIX0	RO
40003	Reading and setting the time zone. For possible values, see Section "Return Codes – Time Zones", page 49.	2	U32	Status	ENUM	RW
40005	Automatic daylight saving time conversion active: 1129 = Active 1130 = Not active	2	U32	Status	ENUM	RW
40007	Type of inverter regulation: 295 = MPP 443 = Constant voltage 565 = Specified power output above characteristic curve	2	U32	Status	ENUM	RW
40009	Operating state: 381 = Stop 569 = Switched on	2	U32	Status	ENUM	RW

40013	Set language: 777 = DE 778 = EN 779 = IT 780 = ES 781 = FR 782 = EL 783 = KO 784 = CS 785 = PT 786 = NL 796 = SL 797 = BG 798 = PL	2	U32	Status	ENUM	RO
40020	External measurement of the insulation resistance: 303 = Off 308 = On	2	U32	Status	ENUM	RW
40200	Operating mode of the reactive power regulation: 303 = Off 1069 = Reactive power/voltage characteristic curve Q(U) 1070 = Reactive power Q, direct default setting 1071 = Reactive power const. Q (kVAr) 1072 = Reactive power Q, default setting via plant control 1073 = Reactive power Q(P) 1074 = cos(Phi), direct default setting	2	U32	Status	ENUM	RW

	1075 = cos(Phi), default setting via plant control 1076 = cos(Phi)(P) characteristic curve 1387 = Reactive power Q, default setting via analogue input 1388 = cos(Phi), default setting via analogue input 1389 = Reactive power/voltage characteristic curve Q(U) with hysteresis and deadband					
40202	Reactive power setpoint (VAr)	2	S32	Scalar	FIX0	RW
40204	Reactive power setpoint (%)	2	S32	Scalar	FIX1	RW
40206	cos(Phi) target value	2	S32	Scalar	FIX2	RW
40208	Target value, excitation type of cos(Phi): 1041 = Overexcited 1042 = Underexcited	2	U32	Status	ENUM	RW
40210	Active power limitation operating mode 303 = Off 1077 = Active power limitation P (W) 1078 = Active power limitation P (% (Pmax)) 1079 = Active power limitation P via plant control 1390 = Active power limitation P via analogue input 1391 = Active power limitation P via digital inputs	2	U32	Status	ENUM	RW

40212	Active power setpoint (W)	2	U32	Scalar	FIX0	RW
40214	Active power setpoint (%)	2	U32	Scalar	FIX0	RW

8 Troubleshooting

For troubleshooting purposes, use the event numbers displayed by the inverters under Modbus address 30197.

Event numbers cannot be decoded via return codes

The event numbers are device-specific. Therefore, you cannot decode the event numbers using the return codes listed in Section 9.7.

- In order to decode the event numbers, observe the inverter manual.

You will find information on error analysis of the SMA Modbus profile in section "Reading and Writing Data from Modbus Registers", page 28.

9 Technical Data

9.1 Supported SMA Inverters

- Sunny Boy (SB) with Speedwire data module:
  - SB 2500TLST-21, device model = 9184
  - SB 3000TLST-21, device model = 9185
  - SB 3000TL-21, device model = 9074
  - SB 3600TL-21, device model = 9165
  - SB 4000TL-21, device model = 9075
  - SB 5000TL-21, device model = 9076
- Sunny Tripower (STP) with Speedwire data module:
  - STP 8000TL-10, device model = 9101
  - STP 10000TL-10, device model = 9067
  - STP 12000TL-10, device model = 9068
  - STP 15000TL-10, device model = 9069
  - STP 17000TL-10, device model = 9070
  - STP 15000TLHE-10, device model = 9140
  - STP 20000TLHE-10, device model = 9139
  - STP 15000TLEE-10, device model = 9182
  - STP 20000TLEE-10, device model = 9181
- All inverters with retrofitted Speedwire data module. You can find a list of the supported inverters in the Speedwire data module installation manual.

9.2 Modbus Communication Port

Communication port	Default setting
TCP	502
UDP	502

Use free communication ports

You should only use free communication ports. The following range is generally available: 49152 to 65535

You can find additional information on occupied ports under [IANA].

9.3 Modbus Reaction Time

The reaction time is the interval within which changes in value are available in the SMA devices at the Modbus interface of the SMA Cluster Controller. Changes in value can therefore only be displayed in your Modbus master system (e.g. in a SCADA system) in a corresponding or larger interval.

The reaction time of the inverters is 5 to 10 seconds.

9.4 Interval of the data request and number of the values

Limit of the data processing capacity

Due to system stability the time period between data requests via the Modbus protocol should be at least 10 seconds, whereupon no more than 30 values should be requested. This specification is the upper limit for the SMA devices controlled via the Modbus protocol, in accordance with section "Number of SMA Devices".

9.5 Number of SMA Devices

Maximum number of SMA devices

A maximum of 75 SMA devices with Modbus capability can be operated on the SMA Cluster Controller.

9.6 Return Codes for Time Zones

The following table contains a summary of the most important time zones and their numeric codes. In the tables in Section "SMA Modbus Profile – Assignment Tables", from page 29, the return codes of the time zones are referenced at various points. Here, you can determine the corresponding numerical code for the present time zone and use this to specify the time zone.

973	NaN
9500	(UTC+04:30) Kabul
9501	(UTC-09:00) Alaska
9502	(UTC+03:00) Kuwait, Riyadh
9503	(UTC+04:00) Abu Dhabi, Muscat
9504	(UTC+03:00) Baghdad
9505	(UTC-04:00) Atlantic (Canada)
9506	(UTC+09:30) Darwin
9507	(UTC+10:00) Canberra, Melbourne, Sydney
9508	(UTC+04:00) Baku
9509	(UTC-01:00) Azores
9510	(UTC-06:00) Saskatchewan
9511	(UTC-01:00) Cape Verde Islands
9512	(UTC+04:00) Yerevan
9513	(UTC+09:30) Adelaide
9515	(UTC+06:00) Astana, Dhaka
9516	(UTC-04:00) Manaus
9517	(UTC+01:00) Belgrade, Bratislava, Budapest, Ljubljana, Prague
9518	(UTC+01:00) Sarajevo, Skopje, Warsaw, Zagreb

9519 (UTC+11:00) Magadan, Solomon Islands, New Caledonia
9520 (UTC-06:00) Central America
9522 (UTC+08:00) Beijing, Chongqing, Hong Kong, Urumchi
9523 (UTC-12:00) International Date Line (West)
9524 (UTC+03:00) Nairobi
9525 (UTC+10:00) Brisbane
9526 (UTC+02:00) Minsk
9527 (UTC-03:00) Brasilia
9528 (UTC-05:00) New York, Miami, Atlanta, Detroit, Toronto
9529 (UTC+02:00) Cairo
9530 (UTC+05:00) Yekaterinburg
9531 (UTC+12:00) Fiji, Marshall Islands
9532 (UTC+02:00) Helsinki, Kiev, Riga, Sofia, Tallinn, Vilnius
9534 (UTC) Dublin, Edinburgh, Lisbon, London
9535 (UTC-03:00) Greenland
9536 (UTC) Monrovia, Reykjavík
9537 (UTC+02:00) Athens, Bucharest, Istanbul
9538 (UTC-10:00) Hawaii
9539 (UTC+05:30) Chennai, Kolkata, Mumbai, New Delhi
9540 (UTC+03:30) Tehran
9541 (UTC+02:00) Jerusalem
9542 (UTC+02:00) Amman
9543 (UTC+09:00) Seoul
9544 (UTC+08:00) Kuala Lumpur, Singapore
9545 (UTC-02:00) Mid Atlantic
9546 (UTC+02:00) Beirut
9547 (UTC-07:00) Denver, Salt Lake City, Calgary
9549 (UTC+06:30) Yangon (Rangoon)
9550 (UTC+06:00) Novosibirsk
9551 (UTC+02:00) Windhoek
9552 (UTC+05:45) Kathmandu
9553 (UTC+12:00) Auckland, Wellington
9554 (UTC-03:30) Newfoundland
9555 (UTC+08:00) Irkutsk
9556 (UTC+07:00) Krasnoyarsk
9557 (UTC-04:00) Santiago
9558 (UTC-08:00) Pacific (USA, Canada)
9559 (UTC-08:00) Tijuana, Lower California (Mexico)
9560 (UTC+01:00) Brussels, Copenhagen, Madrid, Paris
9561 (UTC+03:00) Moscow, St. Petersburg, Volgograd
9562 (UTC-03:00) Buenos Aires
9563 (UTC-05:00) Bogotá, Lima, Quito
9565 (UTC-11:00) Midway Islands, Samoa
9566 (UTC+07:00) Bangkok, Hanoi, Jakarta
9567 (UTC+02:00) Harare, Pretoria
9568 (UTC+05:30) Sri Jayewardenepura
9569 (UTC+08:00) Taipei
9570 (UTC+10:00) Hobart
9571 (UTC+09:00) Osaka, Sapporo, Tokyo
9572 (UTC+13:00) Nuku'alofa
9573 (UTC-05:00) Indiana (East)
9574 (UTC-07:00) Arizona
9575 (UTC+10:00) Vladivostok
9576 (UTC+08:00) Perth
9577 (UTC+01:00) West Central Africa
9578 (UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna
9579 (UTC+05:00) Islamabad, Karachi
9580 (UTC+10:00) Guam, Port Moresby
9581 (UTC+09:00) Yakutsk
9582 (UTC+04:00) Caucasus Standard Time
9583 (UTC-06:00) Chicago, Dallas, Kansas City, Winnipeg
9584 (UTC-06:00) Guadalajara, Mexico City, Monterrey
9585 (UTC) Casablanca
9587 (UTC-07:00) Chihuahua, La Paz, Mazatlan
9588 (UTC-03:00) Montevideo
9589 (UTC+05:00) Tashkent
9591 (UTC-04:00) Georgetown, La Paz, San Juan

9.7 General Return Codes

The following table contains the most commonly used return codes of the registers for SMA devices.

Event numbers

The event numbers displayed by the inverters under the Modbus address 30197 are device-specific. For their breakdown, please use the documentation of the respective inverter. You cannot decode the event numbers using the return codes in this Section!

Return code	Meaning
51	Closed
276	Instantaneous value
295	MPP
303	Off
308	On
309	Operation
311	Open
336	Contact manufacturer
337	Contact electrically qualified person
338	Invalid
381	Stop
455	Warning
461	SMA (manufacturer specifications)
973	Not set, NaN
1041	Overexcited
1042	Underexcited
1069	Reactive power/voltage characteristic curve Q(U)
1070	Reactive power Q, direct default setting
1071	Reactive power const. Q (kVAr)
1072	Reactive power Q, default setting via plant control
1073	Reactive power Q(P)
1074	cos(Phi), direct default setting
1075	cos(Phi), specification by plant control
1076	cos(Phi)(P) characteristic curve

1077	Active power limitation P (W)
1078	Active power limitation P (% Pmax)
1079	Active power limitation P via plant control
1387	Reactive power Q, default setting via analogue input
1388	cos(Phi), default setting via analogue input
1389	Reactive power/voltage characteristic curve Q(U) with hysteresis and deadband
1390	Active power limitation P via analogue input
1391	Active power limitation P via digital inputs
1392	Failure
1393	Wait for PV voltage
1394	Wait for valid AC grid
1395	DC range
1396	AC grid
1455	Emergency switching-off
1466	Waiting
1467	Starting
1468	MPP search
1469	Shutdown
1470	Disturbance
1471	Warnning/failure e-mail OK
1472	Warnning/failure e-mail not OK
1473	Plant info e-mail OK
1474	Plant info e-mail not OK
1475	Failure e-mail OK
1476	Failure e-mail not OK
1477	Warning e-mail OK
1478	Warning e-mail not OK
1479	Wait after grid interruption
1480	Wait for electric utility company

10 Contact

If you have technical problems concerning our products, contact the SMA Service Line. We require the following information in order to provide you with the necessary assistance:

- Modbus master software or hardware used
- Software version of your SMA Cluster Controller
- Type of communication interface between the SMA Cluster Controller and the inverters
- Type, serial numbers and software version of the inverters connected to the PV plant
- If you need to send in an SMA Cluster Controller, remove the USB stick prior to this

SMA Solar Technology AG

Sonnenallee 1

34265 Niestetal, Germany

www.SMA.de

SMA Service Line

Inverters:	+49 561 9522 1499
Communication:	+49 561 9522 2499
Text "CALL BACK" to:	+49 176 888 222 44
Fax:	+49 561 9522 4699
E-mail:	ServiceLine@SMA.de

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