Technical Information

SMA CLUSTER CONTROLLER Modbus® Interface

Legal Provisions

Trademarks

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1 Information on this Document

Validity

This document is applicable for device type "CLCON-10" and device type "CLCON-S-10"* (SMA Cluster Controller). It describes the Modbus interface of the SMA Cluster Controller, the variant of the "Modbus® Application Protocol" implemented by SMA, and the corresponding parameters, measured values and data exchange formats.

* Not available in all countries (see the SMA Cluster Controller product page at www.SMA-Solar.com)

This document does not contain any information on software which can communicate with the Modbus interface (see the software manufacturer's manual).

Target Group

This document is intended for qualified persons. Only persons with appropriate skills are allowed to perform the tasks described in this document (see Section 2.2 "Skills of Qualified Persons", page 7)

Symbols

Icon	Explanation
⚠ DANGER	Indicates a hazardous situation that, if not avoided, will result in death or serious injury.
⚠ WARNING	Indicates a hazardous situation that, if not avoided, can result in death or serious injury.
⚠ CAUTION	Indicates a hazardous situation that, if not avoided, can result in minor or moderate injury.
NOTICE	Indicates a situation that, if not avoided, can result in property damage.
	Information that is important for a specific topic or goal, but is not safety-relevant.
☐	Indicates a requirement for meeting a specific goal.

Typographies

Typography	Application	Example
bold	• Elements to be selected • Elements on a user interface • File names • Parameters	• Select **Settings.** • Control via **communication**. • The file **usrprofile.xml** • The values **Major** and **Minor**

Nomenclature

Complete designation	Designation in this document
Modbus register	Register
Photovoltaic system	PV system
SMA Cluster Controller	Cluster Controller

Abbreviations

Abbreviation	Designation	Explanation
GFDI	Ground-Fault Detection and Interruption	Detection of the grounding error and subsequent interruption of the electric circuit.
PMAX	Set active power limit	The device can generate active power up to this limit.
Power Balancer	-	The Power Balancer is a function in Sunny Mini Central devices for controlling three-phase grid feed-in, for example, to avoid unbalanced loads.
SMA fieldbus	-	Hardware interface for communication between SMA devices (e.g. Speedwire). For information on the supported communication interfaces, refer to the datasheet of the SMA device being used.
SUSy ID	SMA update system ID	Numeric value that identifies a specific SMA device type, e.g. 128 = STP nn000TL-10.

2 Safety

2.1 Intended Use

The Modbus interface of the SMA Cluster Controller is designed for industrial use and has the following tasks:

- Remote control of the grid management services of a PV system.
- Remote-controlled querying of the measured values of a PV system.
- Remote-controlled changing of the parameters of a PV system.

The Modbus interface can be used via the protocol Modbus TCP and by the protocol Modbus UDP.

The enclosed documentation is an integral part of this product:

- Read and observe the documentation.
- Keep the documentation in a convenient place for future reference.

2.2 Skills of Qualified Persons

The activities described in this document must only be performed by qualified persons. Qualified persons must have the following skills:

- Knowledge of IP-based network protocols
- Training in the installation and configuration of IT systems
- Knowledge of and compliance with this document and all safety information

2.3 Safety Information

This section contains safety information that must be observed at all times when working on or with the product. To prevent personal injury and property damage and to ensure long-term operation of the product, read this section carefully and observe all safety information at all times.

NOTICE

Damage to SMA inverters

The parameters of the SMA inverters that can be changed with writable Modbus registers (RW) are intended for long-term storage of device settings. Cyclical changing of these parameters leads to destruction of the flash memory of the devices.

- Device parameters must not be changed cyclically.

Contact the SMA Service Line if you would like to automate the remote control of your PV system (see Section 9 "Contact", page 39).

2.4 Information on Data Security

Data security in Ethernet networks

You can connect the Cluster Controller to the Internet. When connecting to the Internet, there is a risk that unauthorized users can access and manipulate the data of your PV system.

- Take appropriate protective measures, for example:
  - Set up a firewall
  - Close unnecessary network ports
  - Only enable remote access via VPN tunnel
  - Do not set up port forwarding at the Modbus port in use

3 Product Description

3.1 Modbus Protocol

The Modbus Application Protocol is an industrial communication protocol that is currently used in the solar sector mainly for system communication in PV power plants.

The Modbus protocol has been developed for reading data from or writing data to clearly defined data areas. The Modbus specification does not prescribe what data is within which data area. The data areas must be defined device-specifically in Modbus profiles. With knowledge of the device-specific Modbus profile, a Modbus master (e.g. SCADA system) can access the data of a Modbus slave (e.g. SMA Cluster Controller). Information on firmware versions and device-specific Modbus registers of SMA products can be found on our product pages or Modbus page at www.SMA-Solar.com.

The special Modbus profile for SMA devices is the SMA Modbus profile.

3.2 SMA Modbus Profile

The SMA Modbus profile contains definitions for SMA devices. A reduction of the available data on SMA devices was carried out for the definition and this was then assigned to the corresponding Modbus registers. The SMA Modbus profile contains, for example, the total and daily energy, current power, voltage and current levels. The assignment between SMA device data and Modbus addresses is split into ranges in the SMA Modbus profile and these can be addressed via unit IDs (see Section 3.5 "Addressing and Data Transmission in the Modbus Protocol", page 12).

To enable access to data of an SMA device, a special gateway is required and this is provided by way of the Cluster Controller.

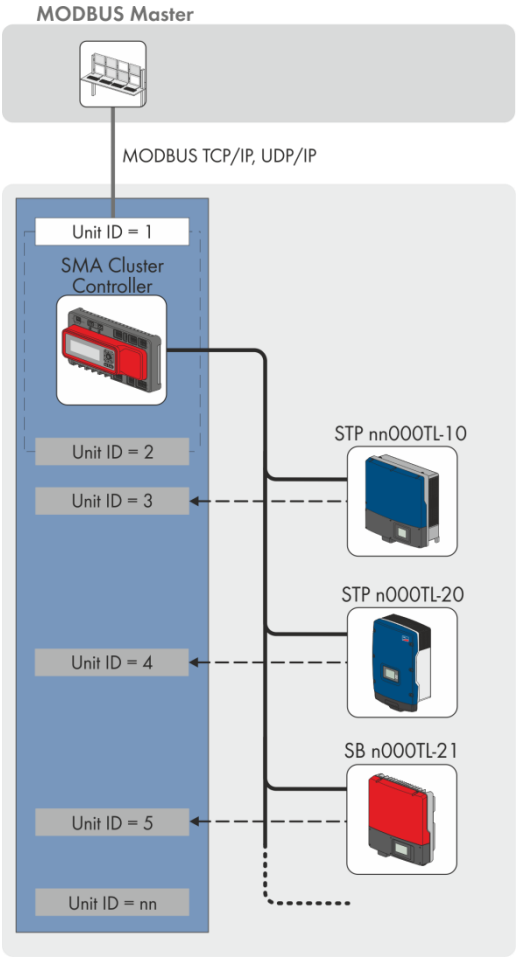
3.3 User-Defined Modbus Profile

The user-defined Modbus profile enables you to reassign Modbus addresses of the SMA Modbus profile. One advantage of reassigning Modbus addresses is, for example, that you can arrange relevant measured values and parameters in sequence for a specific purpose. These addresses can then be read and written in a single data block.

3.4 PV System Topology

The SMA Modbus profile was developed for a hierarchical system 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 protocol, the Cluster Controller represents a Modbus slave that provides a gateway to SMA devices. The SMA devices can only be addressed using this gateway per unit ID.

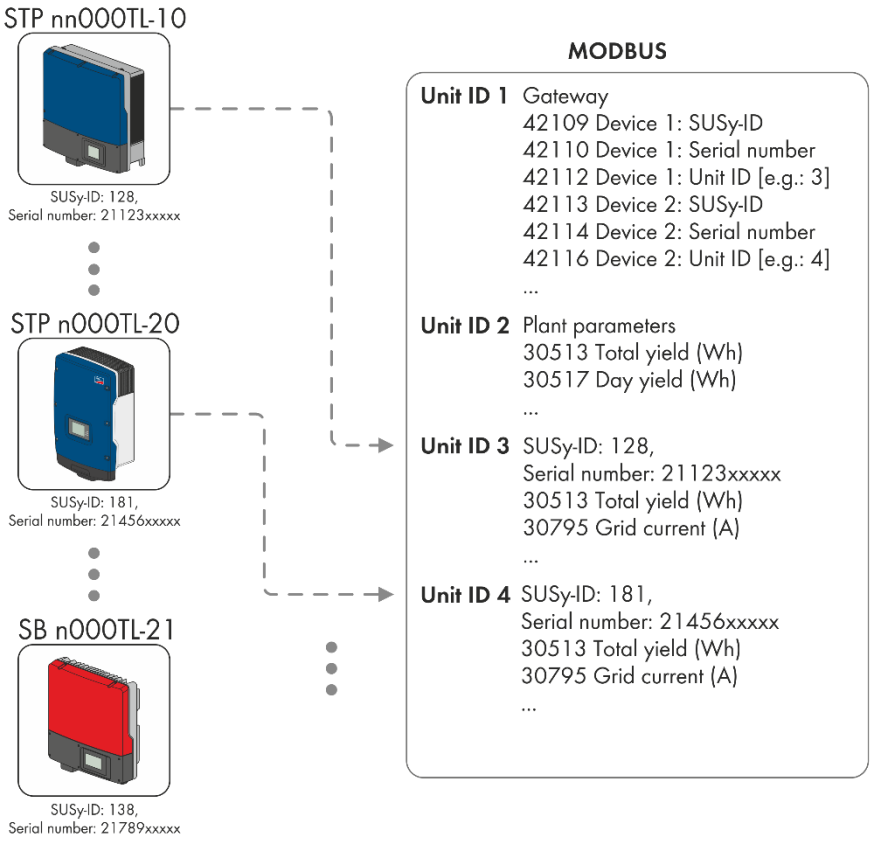
Example 1: PV System Topology from the Perspective of the SMA Devices



Line	Explanation
———	IP network connection between SCADA system and Cluster Controller (PV system router)
———	SMA fieldbus
- - -	Logical assignment of SMA device to unit ID

Example 2: PV System Topology from the Perspective of the Modbus Protocol

In the following example, an inverter is assigned to a unit ID between 3 and 247 in each case. This way the inverter data can be addressed in the Modbus protocol. Unit ID 1 represents the gateway to the Modbus protocol and unit ID 2, the PV system parameters.



3.5 Addressing and Data Transmission in the Modbus Protocol

3.5.1 Unit IDs

The Unit ID is a superordinate addressing type in the Modbus protocol. The SMA Modbus protocol has 247 unit IDs, of which, 245 can be assigned to individual devices. If a unit ID is assigned to a device, then the parameters and measured values of this device can be accessed.

The following table shows an overview of the unit IDs in the SMA Modbus profile:

Unit ID	Explanation
1	This unit ID is reserved for the gateway of the Cluster Controller.
2	This unit ID is reserved for the system parameters.
3 to 247	The unit IDs 3 to 247 are used for addressing individual devices and for the user-defined Modbus profile. Information on firmware versions and device-specific Modbus registers of SMA products can be found on our product pages or Modbus page at www.SMA-Solar.com. You can change the assignment of these unit IDs (see Section 4.2 "Information on Changing Unit IDs", 17).
255	Devices which are assigned to this unit ID, were connected to the Cluster Controller or replaced after activation of the Modbus server. The devices cannot be addressed with this unit ID. You must assign unit IDs from the range 3 to 247 to these devices (see Section 4.2 "Information on Changing Unit IDs", page 17).

3.5.2 Assignment of the Modbus Register to Unit IDs

The assignment of the parameters and measured values of the SMA devices to Modbus register addresses is achieved using assignment tables and is also shown in this document (see Section 5 "SMA Modbus Profile–Assignment Tables", page 23).

In the assignment table "Gateway (unit ID = 1)", the assignment of SMA devices to individual unit IDs is saved in the Modbus registers from address 42109. Each assignment has an address range of four Modbus registers, although only the corresponding register is writable with the unit ID.

In the assignment table "PV System Parameters (unit ID = 2)", parameters and measured values of the Cluster Controller and the PV system are stored.

In the assignment table "SMA devices (unit ID = 3 to 247)", the parameters and measured values intended for all SMA devices are stored. The individual SMA devices use a subset of these for their device-specific parameters and measured values. Information on firmware versions and device-specific Modbus registers of SMA products can be found on our product pages or Modbus page at www.SMA-Solar.com.

3.5.3 Modbus Register Address, Register Width and Data Block

A Modbus register is 16 bits wide. For wider data items, connected Modbus registers are used and considered as data blocks. The number of connected Modbus registers is indicated in the assignment tables. The address of the first Modbus register in a data block is the start address of the data block.

3.5.4 Address Range for Modbus Register

For addressing Modbus registers, the address range 0 to 0xFFFF is available with 65536 addresses.

3.5.5 Data Transmission

In accordance with the Modbus specification, only a specific volume of data can be transported in a single data transmission in a simple protocol data unit (PDU). The data also contains function-dependent parameters such as the function code, start address or number of Modbus registers to be transmitted. The amount of data depends on the Modbus command used and has to be taken into account during data transmission. You can find the number of possible Modbus registers per command in section 3.6.

With data storage in the Motorola format "Big Endian", data transmission begins with the high byte and then the low byte of the Modbus register.

3.6 Reading and Writing of Data

The Modbus interface can be used via the protocol Modbus TCP and by the protocol Modbus UDP. Using Modbus TCP enables read- and write access (RW) and using Modbus UDP enables only write access (WO) to the Modbus register.

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

Modbus command	Hexadecimal value	Data volume (number of registers)[1]
Read Holding Registers	0x03	1 to 125
Read Input Registers	0x04	1 to 125
Write Single Register	0x06	1
Write Multiple Registers	0x10	1 to 123
Read Write Multiple Registers	0x17	Read: 1 to 125, Write: 1 to 121

Error messages on reading or writing individual Modbus registers

If a Modbus register is accessed, which is not contained in a Modbus profile, or if a Modbus command is incorrect, a Modbus exception is generated. Modbus exceptions are also generated when write access occurs on a read-only Modbus register or read access occurs on a write-only Modbus register.

Reading or writing of data blocks

To prevent inconsistencies, data blocks of associated registers or register ranges must be read or written consecutively. The 4 bytes of a 64-bit Modbus register must, for example, be read with an operation in a 64-bit SMA data type.

Error message on writing multiple Modbus registers as a data block

If multiple registers are written as a data block (Modbus commands 0x10 and 0x17) and an error occurs during writing, the faulty register as well as all the subsequent registers in the packet will be rejected. In the event of an error, a Modbus exception will be generated.

Modbus exceptions

For Modbus exceptions, see "Modbus Application Protocol Specification" at http://www.modbus.org/specs.php.

[1] Number of Modbus registers transferable as data block per command

3.7 SMA Data Types and NaN Values

The following table shows the data types used in the SMA Modbus profile and compares these to possible NaN values. The SMA data types are listed in the assignment tables in the **Type** column. They describe the data widths of the assigned values:

Type	Description	NaN value
S16	A signed word (16-bit).	0x8000
S32	A signed double word (32-bit).	0x8000 0000
STR32	32 byte data field, in UTF8 format.	ZERO
U16	A word (16-bit).	0xFFFF
U32	A double word (32-bit).	0xFFFF FFFF or -1
U32	For status values, only the lower 24 bits of a double word (32-bit) are used.	0xFFFF FD or 0xFFFF FE or -1
U64	A quadruple word (64-bit).	0xFFFF FFFF FFFF FFFF or -1

3.8 SMA Data Formats

The following SMA data formats describe how SMA data is to be interpreted. The data formats are important, for example, for the display of data or for its further processing. The SMA data formats are listed in the **Format** column of the assignment tables.

Format	Explanation
Duration	Time in seconds, in minutes or in hours, depending on the Modbus register.
DT	Date/time, in accordance with country setting. Transmission as UTC (seconds since 1970-01-01).
ENUM	Coded numerical values. The breakdown of the possible codes can be found directly under the designation of the Modbus register in the SMA Modbus profile–assignment tables (see also Section 8.6 "Frequently Used Number Codes", page 38).
FIX0	Decimal number, commercially rounded, no decimal place.
FIX1	Decimal number, commercially rounded, one decimal place.

FIX2	Decimal number, commercially rounded, two decimal places.
FIX3	Decimal number, commercially rounded, three decimal places.
FW	Firmware version (see "Firmware version extract" below)
IP4	4-byte IP address (IPv4) of the form XXX.XXX.XXX.XXX.
RAW	Text or number. A RAW number has no decimal places and no thousand or other separation indicators.
REV	Revision number of the form 2.3.4.5.
TEMP	Temperature values are stored in special Modbus registers in degrees Celsius (°C), in degrees Fahrenheit (°F), or in Kelvin K. The values are commercially rounded, with one decimal place.
UTF8	Data in UTF8 format.

Firmware version extract, format "FW": From the delivered DWORD, four values are extracted. The values **Major** and **Minor** are contained 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:

Release type	Release-type coding	Explanation
0	N	No revision number
1	E	Experimental release
2	A	Alpha release
3	B	Beta release
4	R	Release
5	S	Special release
> 5	As number	No special interpretation

Example:

Firmware version of the product: 1.5.10.R
Values from DWORD: Major: 1, Minor: 5, Build: 10, Release type: 4
(Hex: 0x1 0x5 0xA 0x4)

4 Commissioning and Configuration

4.1 Commissioning Steps and Requirements

Requirements:

☐ The devices of the PV system must be connected to the Cluster Controller and the Cluster Controller must be commissioned (for information on connection and commissioning, see the Cluster Controller installation manual).

☐ You must log in as installer to the Cluster Controller (for login to or logout of the Cluster Controller, see the Cluster Controller user manual).

Procedure:

1. Activate the Modbus server(s) and, if required, configure the communication ports (for Modbus configuration, see the Cluster Controller user manual).

Allocation of unit IDs by activation of the Modbus servers

Upon activation of the Modbus servers of the Cluster Controller, unit IDs are assigned to the SMA devices already connected to the Cluster Controller. The protocol types TCP/UDP can be activated individually or together. 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, after activation of the Modbus servers, further SMA devices have been added to the PV system or SMA devices have been replaced (see the following sections).

4.2 Information on Changing Unit IDs

You can change the unit IDs of SMA devices. A change is required, for example, if additional or changed SMA devices are connected to the Cluster Controller after activation of the Modbus servers. By way of the automatic detection of the PV system, additional or changed devices are assigned the Modbus unit ID = 255 (NaN). On the other hand, it may be necessary to change the unit IDs if a restructuring of the system topology is required, for example, to better map the physical arrangement of the devices in the Modbus protocol.

Depending on whether you wish to change individual unit IDs or restructure the entire system topology, you have two options:

- Changing Unit IDs via the gateway (recommended for changing individual Unit IDs)
- Changing Unit IDs via an XML file (recommended for restructuring of the system topology)

Both of these methods are described in separate Sections.

4.3 Changing Unit IDs via the Gateway

4.3.1 Reading Out the Gateway

You can read out the individual unit IDs of the SMA devices from the gateway, for example, using a SCADA system.

Accessing the gateway

You access the gateway via the IP address of the Cluster Controller, under the unit ID = 1.

The assignment of the system devices for unit IDs 3 to 247 is stored in the Modbus registers from address 42109. Each assignment has an address range of four Modbus registers. You can find the Modbus register of the gateway in Section 5.2 "Gateway", page 24.

Example "Read out additional device from the gateway"

Via automatic detection, an additional SMA device was assigned to unit ID = 255 (indicated with C in column "Device #" in the following table). The assignments of the gateway were, as follows here, shown with a SCADA system as a table:

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
...	...	...	...

4.3.2 Changing A Unit ID in the Gateway

You change a unit ID by writing it to the relevant Modbus address. All three of the Modbus registers that belong to a device-unit-ID assignment must be transmitted in a single data block, although only the register with the unit ID is writable. For the following example, this means that all the data of the three Modbus addresses 42117, 42118 and 42120 must be contained in the data block.

Do not assign unit IDs more than once

You must not assign a Unit ID more than once. In the event of a Modbus query with a unit ID that has been assigned more than once, the data is read out for the device that is entered with this unit ID in the gateway under the lowest Modbus address.

Example "Changing A Unit ID in the Gateway"

The following table shows an example of assignment of a device to a unit ID. An inverter was subsequently detected with SUSy ID = 158 and serial number 2145600934, as the third device in the PV system (Modbus addresses 42117 to 42120). The unit ID of this device was manually set to 5:

Modbus address	Designation	After detection	Modified
42117	SUSy-ID	158	158
42118	Serial number	2145600934	2145600934
42120	Unit ID	255 (NaN)	5

4.4 Changing Unit IDs via the XML File usrplant.xml

4.4.1 Overview

The Cluster Controller stores the assignments of the devices of the PV system to unit IDs in the file **sysplant.xml**. This file contains an excerpt of the gateway (see Section 5.2 "Gateway (Unit ID = 1)", page 24). If new SMA devices are added or if SMA devices are replaced, these are respectively added to the available XML structure of this file with unit ID = 255 by the Cluster Controller. You can define your own variant of this file in the file **usrplant.xml**. You can use **sysplant.xml** as a template for **usrplant.xml**.

You can download the file **sysplant.xml** from the Cluster Controller.

Uploading and downloading XML files

For more information on uploading and downloading XML files via the user interface, see the SMA Cluster Controller user manual.

The file **usrplant.xml** must be activated in the Cluster Controller. Once the file **usrplant.xml** is activated, the file **sysplant.xml** is not taken into consideration for the duration of the activation.

4.4.2 Structure of the XML 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.../>	Within the tag "Device" is the assignment of a device to a unit ID.
regoffs="aaa"	Number of the device in file sysplant.xml. The number must not necessarily be assigned sequentially. There are four Modbus register addresses between two devices. Regoffs = 0 defines the first device under the Modbus address 42109, Regoffs = 244 the last device under the Modbus address 43085.
susyid="bbb"	SUSy ID of the device

serial="ccccccccc"	Serial number of the device
unitid="ddd"	Unit ID of the device

Example of the file usrplant.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 appearance of the XML file is then as follows:

```
<?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>
```

4.4.3 Activating and Deactivating usrplant.xml

Activating the file usrplant.xml:

To activate the file **usrplant.xml**, upload the file to the Cluster Controller. All the specifications in the file are checked. If the file contains no errors, its contents are entered into the system.
A changed **usrplant.xml** becomes effective a few seconds after it is activated. Once the file **usrplant.xml** is activated, the file **sysplant.xml** is not taken into consideration for the duration of the activation.

Deactivating the file usrplant.xml:

To deactivate the file **usrplant.xml**, upload a version of this file containing no device 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 changed **usrplant.xml** becomes effective a few seconds after it is saved to the Cluster Controller.

4.5 Resetting the Cluster Controller to the Default Settings

By resetting the Cluster Controller to the default settings, the previously assigned unit IDs are deleted and reassigned – 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 PV system topology usrplant.xml and the user-defined Modbus profile usrprofile.xml are deleted. 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 SMA Modbus Profile—Assignment Tables

5.1 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 using this unit ID. The tables present the following information:

Information	Explanation
ADR (DEC)	Decimal Modbus address (see Section 3.5.3 "Modbus Register Address, Register Width and Data Block", page 13 onwards)
Description/ number code(s)	Short description of the Modbus register and the number codes used.
CNT	Number of assigned Modbus registers.
Type	Data type, e.g. V32 = 32 bits without prefix (see Section 3.7 "SMA Data Types and NaN Values", page 15).
Format	Data format of saved value, e.g. DT = date, FIX n = output with n decimal places, TEMP = output as temperature (see Section 3.8 "SMA Data Formats", page 15).
Access	Access type: RO: Read only (only Modbus TCP) RW: Read and write (only Modbus TCP). With Modbus UDP, all RW registers are write-only (WO register). WO: Write only (Modbus TCP and Modbus UDP) If an access type is not allowed, a Modbus exception is generated in the event of access with an access type that is not allowed.

5.2 Gateway (Unit ID = 1)

In the following table you can find the parameters and measured values provided by the gateway, which you can access under unit ID = 1as well as the assignment of the SMA devices to the unit IDs. You can access the gateway via the IP address of the Cluster Controller:

ADR (DEC)	Description/number code(s)	CNT (WORD)	Type	Format	Access
30001	Version number of the SMA Modbus profile	2	U32	RAW	RO
30003	SUSy ID (of the Cluster Controller)	2	U32	RAW	RO
30005	Serial number (of the Cluster Controller)	2	U32	RAW	RO
30007	Modbus data change: meter value is increased by the Cluster Controller if new data is available.	2	U32	RAW	RO
30051	Device class: 8000 = All devices 8001 = PV inverter 8002 = Wind power inverter 8007 = Battery inverter 8033 = Load 8064 = Sensor technology general 8065 = Energy meter 8128 = Communication products	2	U32	ENUM	RO
30193	UTC system time (s)	2	U32	DT	RO
30513	Total energy fed in across all line conductors, in Wh (accumulated values of the inverters)	4	U64	FIX0	RO
30517	Energy fed in on current day across all line conductors, in Wh (accumulated values of the inverters)	4	U64	FIX0	RO
30775	Current active power on all line conductors (W), accumulated values of the inverters	2	S32	FIX0	RO
30805	Reactive power on all line conductors (var), accumulated values of the inverters	2	S32	FIX0	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	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 2080 = DI6 DI7 DI8 2081 = DI6 DI8 2082 = DI7 2083 = DI7 DI8 2084 = DI8	2	U32	ENUM	RO
40001	Set UTC system time, in s		2	U32	DT	RW
Unit ID assignment – SMA devices:						
42109	Device 1: SUSy ID		1	U16	RAW	RO
42110	Device 1: Serial number		2	U32	RAW	RO
42112	Device 1: Unit ID (e.g. 3)		1	U16	RAW	RW
42113	Device 2: SUSy ID		1	U16	RAW	RO
42114	Device 2: Serial number		2	U32	RAW	RO
42116	Device 2: Unit ID (e.g. 4)		1	U16	RAW	RW
...	...		...	...	...	...
43085	Device 245: SUSy ID		1	U16	RAW	RO
43086	Device 245: Serial number		2	U32	RAW	RO
43088	Device 245: Unit ID (e.g. 247)		1	U16	RAW	RW

Unit ID = 255

For unit ID = 255, observe Section 4.3 "Changing Unit IDs via the Gateway", page 18.

Modbus exception on accessing empty assignments

If, in the address range 42109 to 43088, individual Modbus registers or a data block are accessed which do not contain any assignment of unit IDs to SMA devices, a Modbus exception is generated.

5.3 System Parameters (Unit ID = 2)

In the following table , you can find the PV system parameters that you can access using unit ID = 2. The system parameters represent measured values and parameters of the Cluster Controller and also PV system devices that are connected via the Modbus protocol. Parameters such as time settings are transferred by the Cluster Controller to the devices of the PV system and there, depending on the device type, processed further. Measured values such as energy meter values are queried by the devices and made available as accumulated values:

ADR (DEC)	Description/number code(s)	CNT (WORD)	Type	Format	Access
30193	UTC system time, in s	2	U32	DT	RO
30513	Total energy fed in across all line conductors, in Wh (accumulated values of the inverters)	4	U64	FIX0	RO
30517	Energy fed in on current day across all line conductors, in Wh (accumulated values of the inverters)	4	U64	FIX0	RO
30775	Current active power on all line conductors (W), accumulated values of the inverters	2	S32	FIX0	RO
30805	Reactive power across all line conductors (VAr) (accumulated values of the inverters)	2	S32	FIX0	RO
31235	Active power setpoint Digital I/O in %	2	U32	FIX2	RO
31237	Active power setpoint Analog input in %	2	U32	FIX2	RO
31239	Active power setpoint in %s	2	U32	FIX2	RO

	Specification Modbus Electric utility company				
31241	Active power setpoint in %s Specification Modbus Direct marketing	2	U32	FIX2	RO
31243	Resulting setpoint in % (minimum value definition of all specifications)	2	U32	FIX2	RO
31249	Current utility grid export active power P in W (actual value of the active power fed in at the grid-connection point; measured with an external measuring device).	2	S32	FIX0	RO
31251	Current utility grid export reactive power Q in VAr (actual value of the reactive power fed in at the grid-connection point; measured with an external measuring device).	2	S32	FIX0	RO
34609	Ambient temperature (°C)	2	S32	TEMP	RO
34611	Highest measured ambient temperature (°C)	2	S32	TEMP	RO
34613	Total irradiation on the sensor surface (W/m²)	2	U32	FIX0	RO
34615	Wind speed (m/s)	2	U32	FIX1	RO
34617	Humidity (%)	2	U32	FIX2	RO
34619	Air pressure (Pa)	2	U32	FIX2	RO
34621	PV module temperature (°C)	2	S32	TEMP	RO
34623	Total irradiation on the external irradiation sensor/pyranometer (W/m²)	2	U32	FIX0	RO
34625	Ambient temperature (°F)	2	S32	TEMP	RO
34627	Ambient temperature (K)	2	S32	TEMP	RO
34629	PV module temperature (°F)	2	S32	TEMP	RO
34631	PV module temperature (K)	2	S32	TEMP	RO
34633	Wind speed (km/h)	2	U32	FIX1	RO
34635	Wind speed (mph)	2	U32	FIX1	RO
34637	Analog current input 1 (mA)	2	S32	FIX2	RO
34639	Analog current input 2 (mA)	2	S32	FIX2	RO

34641	Analog current input 3 (mA)		2	S32	FIX2	RO
34643	Analog current input 4 (mA)		2	S32	FIX2	RO
34645	Analog voltage input 1 (V)		2	S32	FIX2	RO
34647	Analog voltage input 2 (V)		2	S32	FIX2	RO
34649	Analog voltage input 3 (V)		2	S32	FIX2	RO
34651	Analog voltage input 4 (V)		2	S32	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	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 2080 = DI6 DI7 DI8 2081 = DI6 DI8 2082 = DI7 2083 = DI7 DI8 2084 = DI8	2	U32	ENUM	RO
40001	Reading and setting the UTC system time (s)		2	U32	DT	RW
40003	Reading and setting the time zone (see Section 8.5 "Number Codes of the Time Zones", page 36).		2	U32	ENUM	RW
40005	Automatic daylight saving time conversion active: 1129 = Active 1130 = Not active		2	U32	ENUM	RW

40493	Direct marketer: Active power setpoint P, in % of the maximum active power (PMAX) of the PV plant. Value range: -100.00% to < 0% = Load 0% = No active power < 0% to +100.00% = Generator	1	S16	FIX2	WO
41167	Active power setpoint in % (manual specification)	2	U32	FIX2	RO

6 User-Defined Modbus Profile

With the user-defined Modbus profile, the Modbus addresses that are available in the SMA Modbus profile for the individual unit IDs can be assigned to different Modbus addresses. You can use the entire Modbus address range from 0 to 65535. One advantage of the user-defined Modbus profile can be that the measured values and parameters relevant for controlling your system can be applied to consecutive Modbus addresses. These addresses can then be read or written in a single data block.

The user-defined Modbus profile can be called up via the gateway like an additional device and has a separate unit ID which you can define between 3 and 247 (see Section 3.5.1 "Unit IDs", page 12).

6.1 Structure of the XML File for the User-Defined Modbus Profile

The user-defined Modbus profile is created in the file **usrprofile.xml** .

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" />
        ...
        <!–End of the instructions–>
</virtual_modbusprofile>
```

Legend for XML tags and attributes:

XML tag or attribute	Explanation
<virtual_modbusprofile> </virtual_modbusprofile>	A user-defined Modbus profile is created within this XML structure.
<channel />	Within a channel tag, a Modbus address of a unit ID is redefined:
unitid="aaa"	Specifies the unit ID of the device whose Modbus addresses are to be used as a source. Possible unit IDs for individual devices are 3 to 247.
source="bbbbb"	Specifies a Modbus address of the devices selected under "unitid", whose parameters or measured values are to be used as source (see Section 5 "SMA Modbus Profile–Assignment Tables", page 23).

destination="ccccc"	Specifies the new Modbus address at which the parameter or measured value is to be accessed (0 to 65535). Note the number of Modbus registers that are stored at the original address. The destination registers must not overlap. If incomplete Modbus registers are called up later, a Modbus exception is generated. If register addresses are called up, which are not filled with values, NaN is returned.
<!–xyz–>	Comments out the range xyz, for example, to deactivate an instruction.

Modbus exceptions

For Modbus exceptions, see "Modbus Application Protocol Specification" at http://www.modbus.org/specs.php.

6.2 Example of a User-Defined Modbus Profile

The Modbus registers for apparent power, active power and reactive power of the devices stored under unit IDs 3 and 4 are to be retrievable in a user-defined Modbus profile from address 0 at consecutive Modbus addresses (the following table is an excerpt from the SMA Modbus profile):

ADR (DEC)	Description/number code(s)	CNT (WORD)	Type	Format	Access
30775	AC active power across all line conductors (W)	2	S32	FIX0	RO
30805	Reactive power across all line conductors (VAr)	2	S32	FIX0	RO
30813	Apparent power across all line conductors (VA)	2	S32	FIX0	RO

The exact appearance of the XML file follows from the example:

```
<?xml version="1.0" encoding="UTF-8"?>
<virtual_modbusprofile>
        <channel unitid="3" source="30775" destination="0" />
        <channel unitid="3" source="30805" destination="2" />
        <channel unitid="3" source="30813" destination="4" />
        <channel unitid="4" source="30775" destination="6" />
        <channel unitid="4" source="30805" destination="8" />
        <channel unitid="4" source="30813" destination="10" />
</virtual_modbusprofile>
```

6.3 Activating and Deactivating User-Defined Modbus Profile

To activate your user-defined Modbus profile, upload the file **usrprofile.xml** to the Cluster Controller, restart it, and activate the user-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 more information on uploading and downloading XML files via the user interface, see the SMA Cluster Controller user manual.

Activating A User-Defined Modbus Profile

You activate a user-defined Modbus profile by creating a device entry with the attribute "susyid=0" in file **usrplant.xml** (you can find more information on the file usrplant.xml in Section 4.4 "Changing Unit IDs via the XML File usrplant.xml", page 20).

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 A User-Defined Modbus profile

You deactivate a user-defined Modbus profile by commenting out in its device line in the file **usrplant.xml** and re-uploading this to the Cluster Controller (for more information on the usrplant.xml file, see Section 4.4 "Changing Unit IDs via the XML File usrplant.xml", page 20).

In the following example, you can see a commenting out applied to the line with the user-defined Modbus profile:

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

7 Troubleshooting

You can find information on error analysis of the SMA Modbus profile in Section 3.6 "Reading and Writing of Data", page 14.

For troubleshooting of the SMA devices, go to Modbus address 30197 and use the event numbers displayed here.

The event numbers of the SMA devices cannot be decrypted with the number codes in this document.

The event numbers of the SMA devices are device-specific and cannot be decrypted with the number codes in this document.

To decrypt the event numbers of low or medium-power inverters, you require additional information (operating parameters/measured values, see Technical Description "Measured Values and Parameters" at www.SMA-Solar.com).

To decrypt the event numbers of central inverters, contact the SMA Service Line (see Section 9 "Contact", page 39).

8 Technical Data

8.1 Supported SMA Inverters

All inverters with integrated or retrofitted Speedwire/Webconnect interfaces are supported.

Information on whether an inverter has an integrated Speedwire/Webconnect interface or can be retrofitted with a Speedwire/Webconnect interface can be found on the product page of the respective inverter at www.SMA-Solar.com.

8.2 Number of SMA Devices

The following table contains details on the maximum number of SMA devices that can be operated with the Cluster Controller.

Device type	Maximum number of SMA devices
CLCON-10	75
CLCON-S-10	25

8.3 Modbus Communication Ports

The following table shows the default settings of the supported network protocols:

Network protocol	Communication port, default setting
TCP	502
UDP	502

Using free communication ports

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

You can find more information on occupied ports in the database "Service Name and Transport Protocol Port Number Registry" at http://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.xml.

Changing the communication port

If you change one of the communication ports of the Cluster Controller, you must also change the corresponding communication port of a connected Modbus master system. Otherwise the Cluster Controller can no longer be accessed via the Modbus protocol.

8.4 Data Processing and Time Behavior

In this Section, you can find typical data processing and reaction times of the Cluster Controller Modbus interface and time details for saving parameters in SMA devices.

NOTICE

Damage to SMA inverters

The parameters of the SMA inverters that can be changed with writable Modbus registers (RW) are intended for long-term storage of device settings. Cyclical changing of these parameters leads to destruction of the flash memory of the devices.

- Device parameters must not be changed cyclically.

Contact the SMA Service Line if you would like to automate the remote control of your PV system (see Section 9 "Contact", page 39).

Signal run time through the Cluster Controller

The signal run time through the Cluster Controller is a maximum of 100 ms.

The signal run time is the time required by the Cluster Controller to process incoming Modbus commands and to forward them to the devices in the PV system.

Data transfer interval via the Modbus protocol

For system stability reasons, the time period between data transfers via the Modbus protocol must be at least ten seconds. No more than 30 parameters and measured values should be transmitted per inverter. Note the maximum number of SMA devices according to Section 8.2 "Number of SMA Devices", page 34.

Physical reaction time of the inverters

The physical reaction time of the inverters is typically approximately one second, depending on the inverters used.

The physical reaction time is the time between the changing of setpoints in the inverters until their physical implementation. Such a change would be, for example, changing cos φ.

Reaction time of the Modbus interface

The reaction time of the Modbus interface is five to ten seconds.

The reaction time of the Modbus interface is the time between the arrival of the parameter specifications in the inverters until the corresponding measured values are provided to the Modbus interface of the Cluster Controller. Due to this reaction time, parameter specifications can only be displayed via a Modbus master system (e.g. a SCADA system) at a corresponding or larger interval.

8.5 Number Codes of the Time Zones

The following table contains the most important time zones and their number codes in the SMA Modbus profile. If the location is known, you can determine the numerical key (code) and the time zone. In the tables in Section 5 "SMA Modbus Profile–Assignment Tables", from page 23, with specification of the time zone, this table is referenced.

City/Country	Code	Time zone
Abu Dhabi, Muscat	9503	UTC+04:00
Adelaide	9513	UTC+09:30
Alaska	9501	UTC-09:00
Amman	9542	UTC+02:00
Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna	9578	UTC+01:00
Arizona	9574	UTC-07:00
Astana, Dhaka	9515	UTC+06:00
Asuncion	9594	UTC-04:00
Athens, Bucharest, Istanbul	9537	UTC+02:00
Atlantic (Canada)	9505	UTC-04:00
Auckland, Wellington	9553	UTC+12:00
Azores	9509	UTC-01:00
Baghdad	9504	UTC+03:00
Baku	9508	UTC+04:00
Bangkok, Hanoi, Jakarta	9566	UTC+07:00
Beirut	9546	UTC+02:00
Belgrade, Bratislava, Budapest, Ljubljana, Prague	9517	UTC+01:00
Bogotá, Lima, Quito	9563	UTC-05:00
Brasilia	9527	UTC-03:00
Brisbane	9525	UTC+10:00
Brussels, Copenhagen, Madrid, Paris	9560	UTC+01:00
Buenos Aires	9562	UTC-03:00
Canberra, Melbourne, Sydney	9507	UTC+10:00
Caracas	9564	UTC-04:30
Casablanca	9585	UTC+00:00
Cayenne	9593	UTC-03:00
Chennai, Kolkata, Mumbai, New Delhi	9539	UTC+05:30
Chicago, Dallas, Kansas City, Winnipeg	9583	UTC-06:00
Chihuahua, La Paz, Mazatlán	9587	UTC-07:00
Darwin	9506	UTC+09:30
Denver, Salt Lake City, Calgary	9547	UTC-07:00
Dublin, Edinburgh, Lisbon, London	9534	UTC+00:00
Yerevan	9512	UTC+04:00
Fiji, Marshall Islands	9531	UTC+12:00
Georgetown, La Paz, San Juan	9591	UTC-04:00
Greenland	9535	UTC-03:00
Guadalajara, Mexico City, Monterrey	9584	UTC-06:00
Guam, Port Moresby	9580	UTC+10:00
Harare, Pretoria	9567	UTC+02:00
Hawaii	9538	UTC-10:00
Helsinki, Kiev, Riga, Sofia, Tallinn, Vilnius	9532	UTC+02:00
Hobart	9570	UTC+10:00
Indiana (East)	9573	UTC-05:00
International Date Line (West)	9523	UTC-12:00
Irkutsk	9555	UTC+08:00
Islamabad, Karachi	9579	UTC+05:00
Yakutsk	9581	UTC+09:00
Yekaterinburg	9530	UTC+05:00
Jerusalem	9541	UTC+02:00
Kabul	9500	UTC+04:30
Cairo	9529	UTC+02:00
Cape Verde Islands	9511	UTC-01:00
Katmandu	9552	UTC+05:45
Caucasus Standard Time	9582	UTC+04:00
Krasnoyarsk	9556	UTC+07:00
Kuala Lumpur, Singapore	9544	UTC+08:00
Kuwait, Riyadh	9502	UTC+03:00
Magadan, Solomon Islands, New Caledonia	9519	UTC+11:00
Manaus	9516	UTC-04:00
Midway Islands, Samoa	9565	UTC-11:00
Minsk	9526	UTC+02:00
Mid-Atlantic	9545	UTC-02:00
Monrovia, Reykjavík	9536	UTC+00:00

Montevideo	9588	UTC-03:00
Moscow, St. Petersburg, Volgograd	9561	UTC+03:00
Nairobi	9524	UTC+03:00
Newfoundland	9554	UTC-03:30
New York, Miami, Atlanta, Detroit, Toronto	9528	UTC-05:00
Novosibirsk	9550	UTC+06:00
Nuku'alofa	9572	UTC+13:00
Osaka, Sapporo, Tokyo	9571	UTC+09:00
Pacific (U.S., Canada)	9558	UTC-08:00
Beijing, Chongqing, Hong Kong, Ürümqi	9522	UTC+08:00
Perth	9576	UTC+08:00
Petropavlovsk-Kamchatsky	9595	UTC+12:00
Port Louis	9586	UTC+04:00
Santiago	9557	UTC-04:00
Sarajevo, Skopje, Warsaw, Zagreb	9518	UTC+01:00
Saskatchewan	9510	UTC-06:00
Seoul	9543	UTC+09:00
Sri Jayawardenepura	9568	UTC+05:30
Taipei	9569	UTC+08:00
Tashkent	9589	UTC+05:00
Teheran	9540	UTC+03:30
Tbilisi	9533	UTC+04:00
Tijuana, Lower California (Mexico)	9559	UTC-08:00
Ulan Bator	9592	UTC+08:00
West-Central Africa	9577	UTC+01:00
Windhoek	9551	UTC+02:00
Vladivostok	9575	UTC+10:00
Yangon (Rangoon)	9549	UTC+06:30
Central America	9520	UTC-06:00

8.6 Frequently Used Number Codes (ENUM)

The following table contains number codes which, as function coding in data format ENUM, are frequently used in the SMA Modbus profile.

Event Numbers

The event numbers displayed by the inverters under the Modbus address 30197 are device-specific. You cannot decrypt the event numbers with the number codes in this document (see Section 7 "Troubleshooting", page 33).

Code	Meaning
51	Closed
276	Instantaneous value
295	MPP
303	Off
308	On
309	Operation
311	Open
336	Contact the manufacturer
337	Contact the installer
338	Invalid
381	Stop
455	Warning
461	SMA (manufacturer specification)
1041	Leading
1042	Lagging
1069	Reactive power/voltage characteristic curve Q(V)
1070	Reactive power Q, direct setpoint
1071	Reactive power const. Q (kVAr)
1072	Reactive power Q, setpoint via system control
1073	Reactive power Q(P)
1074	cos φ, direct setpoint
1075	cos φ, setpoint via system control
1076	cos φ(P) characteristic curve
1077	Active power limitation P, in W
1078	Active power limitation P (%) of PMAX
1079	Active power limitation P via system control
1387	Reactive power Q, setpoint via analog input
1388	cos φ, setpoint via analog input
1389	Reactive power/voltage characteristic curve Q(U) with hysteresis and deadband
1390	Active power limitation P via analog input
1391	Active power limitation P via digital inputs
1392	Error
1393	Wait for PV voltage
1394	Wait for valid AC grid
1395	DC section
1396	AC grid
1455	Emergency switch
1466	Waiting
1467	Starting
1468	MPP search
1469	Shutdown
1470	Disturbance
1471	Warning/error e-mail OK
1472	Warning/error e-mail not OK
1473	System info e-mail OK
1474	System info e-mail not OK
1475	Error e-mail OK
1476	Error 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

9 Contact

If you have technical problems with our products, please 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 your PV system

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