Technical Description

SMA FUEL SAVE CONTROLLER Modbus® Interface

Legal Provisions

Trademarks

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1 Information on this Document

Validity

This document is valid for the device type "FSC11CONT" as of firmware version 1.4. It describes the Modbus interface of the SMA Fuel Save Controller, the variant of the communication protocol "Modbus® Application Protocol" implemented by SMA as well as the corresponding parameters, measured values and data exchange formats.

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", p. 6)

Additional Information

SMA Documents

Additional information is available at www.SMA-Solar.com:

Document title	Document type
SMA Fuel Save Controller	Installation manual
SMA Fuel Save Controller	Quick reference guide
SMA Fuel Save Controller	User manual

Additional Documents

Document title	Source
Service Name and Transport Protocol Port Number Registry	http://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.xml
Modbus Application Protocol Specification	http://www.modbus.org/specs.php

Symbols

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

Nomenclature

Complete designation	Designation in this document
Modbus register	Register
SMA Fuel Save Controller	Fuel Save Controller

Abbreviations

Abbreviation	Designation	Explanation
PV	Photovoltaics	

2 Safety

2.1 Intended Use

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

- Remote control of the grid-relevant parameters.
- Remote-controlled querying of measured values.
- Remote-controlled changing of parameters.

The Modbus interface can be used via TCP.

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 the Modbus specifications
- Knowledge of and compliance with this document and all safety information

2.3 Information on Data Security

Data security in Ethernet networks

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

- Take appropriate protective measures, e.g.:
  - 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 client (e.g. SCADA system) can access the data of a Modbus server (e.g. SMA Fuel Save Controller).

The SMA Modbus Profile FSC is the special Modbus profile for the Fuel Save Controller.

3.2 SMA Modbus Profile FSC

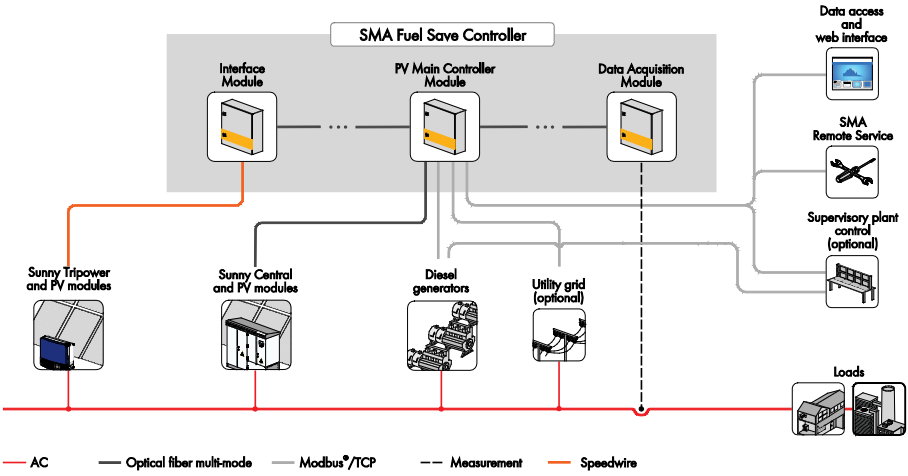
The SMA Modbus Profile FSC contains definitions for the special system topology of a stand-alone grid system. A reduction of the available device data was performed for the definition and it was then assigned to the corresponding Modbus registers. The SMA Modbus Profile FSC contains, for example, current power and consumption levels in the stand-alone grid.

3.3 PV System Topology

The SMA Modbus Profile FSC was developed for a stand-alone grid. In such a structure, the Fuel Save Controller is a communication device that is equipped with a Modbus TCP/IP interface. All other devices of the stand-alone grid supply are connected via various fieldbus systems to the Fuel Save Controller.

From the perspective of the Modbus protocol, the Fuel Save Controller represents a Modbus server that provides a gateway to further devices of the stand-alone grid supply. The data of the devices connected to the Fuel Save Controller are only addressable via this gateway.

Example: PV system topology from the perspective of the stand-alone grid



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3.4 Addressing and Data Transmission in the Modbus Protocol

3.4.1 Unit IDs

The Unit ID is a superordinate addressing type in the Modbus protocol. The SMA Modbus Profile FSC is not bound to the concept of the Unit ID. We recommend, however, the use of Unit ID = 2.

3.4.2 Modbus Register Address, Register Width and Data Block

A Modbus register is 16 bits wide. The address of the first Modbus register in a data block is the start address of the data block. The number of connected Modbus registers results from the data type. Several Modbus registers with different start addresses, that can only be processed as a data block, are specially marked. In addition, larger data blocks can be formed.

3.4.3 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 3.5.

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.

3.5 Reading and Writing of Data

The Modbus interface can be used via the protocol Modbus TCP. Using Modbus TCP enables read- and write access (RW, RO, 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 Multiple Registers	0x10	1 to 123

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

3.6 SMA Data Types

3.6.1 SMA Data Types and NaN Values

The following table shows the data types used in the SMA Modbus Profile FSC and their possible NaN values. The SMA data types are listed in the **Type** column of the assignment table. They describe the data widths of the assigned values:

Type	Description	NaN value
U32	A double word (32-bit).	0xFFFF FFFF
U32	For status values (ENUM), only the lower 24 bits of a double word (32-bit) are used.	0xFFFF FD
S32	A signed double word (32-bit).	0x8000 0000

3.6.2 32-Bit Integer Values

32-bit integers are stored in two Modbus registers.

Modbus register	1		2	
Byte	0	1	2	3
Bits	24 to 31	16 to 23	8 to 15	0 to 7

3.7 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 table.

Format	Explanation
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 FSC assignment table.
FIX0	Decimal number, commercially rounded, no decimal place.

4 Commissioning and Configuration

The Modbus interface of the Fuel Save Controller is activated upon commissioning of the Fuel Save Controller and must not be commissioned separately (See the SMA Fuel Save Controller installation manual for commissioning).

5 SMA Modbus Profile – Assignment Table

5.1 Information on the Assignment Table

The assignment table provides the following information:

Information	Explanation
ADR (DEC)	Decimal Modbus address (see Section 3.4.2, page 9 onwards)
Description/number code(s)	Short description of the Modbus register and the number codes used.
Type	Data type, e.g. U32 = 32 bits without prefix (see Section 3.6, page 10).
Format	Data format of the saved value, e.g. FIX0 = output without decimal places (see Section 3.7, page 10).
Access	Access type: RO: Read only RW: Read and write WO: Write only 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 SMA Modbus Profile FSC - Register Overview

In the following table you will find all the measured values and parameters of the SMA Modbus Profile FSC to which you have access. You access these Modbus registers via the IP address of the Fuel Save Controller.

ADR (DEC)	Description/number code(s)	Type	Format	Access
30247	Current, comprehensive event number (a maximum of five decimal places)	U32	FIX0	RO
30775	Active power across all line conductors (W) (Total current active power of all PV and battery inverters in the PV system).	S32	FIX0	RO
30805	Reactive power across all line conductors (VAr) (Total current reactive power of all PV- and battery inverters in the PV system).	S32	FIX0	RO
30861	Load power (W)	S32	FIX0	RO
30863	Current generator power (W)	U32	FIX0	RO
30867	Power grid feed-in (W)	S32	FIX0	RO
31133	Internal PV power limitation (W). In operating mode C this register contains the active power setpoint (W).	S32	FIX0	RO
31135	Reactive power of the load (VAr)	S32	FIX0	RO
31137	Maximum short-term decrease in power (W)	S32	FIX0	RO
31143	Monitoring value return. For description see register 40835.	S32	FIX0	RO
31225	Current generator reactive power (VAr), measured with an energy counter at the generator connection	S32	FIX0	RO
31233	Reactive power supplied to the grid in all phases (VAr)	S32	FIX0	RO
40009	Operating state: 381 = Stop 569 = Activated	U32	ENUM	RW

40011	Acknowledge fault: 26 = Acknowledge fault	U32	ENUM	RW
40018	Rapid shutdown: 381 = Stop 1467 = Start After rapid shutdown was started you have to acknowledge fault with register 40011 before the system can be restarted again.	U32	ENUM	WO
40029	Operating status: 381 = Stop 1392 = Error 1467 = Start (start-up) 1469 = Shut down (requires restart) 3129 = Manual mode	U32	ENUM	RO
40149	Active power setpoint (W), only available in operating mode C	S32	FIX0	WO
40153	Reactive power setpoint (VAr), only available in operating mode C	S32	FIX0	WO
40835	Input monitoring value. In operating mode C you have to write a random number (-2147483647 to +2147483647) per second in this register. The random number will be copied to the register 31143 within one second. If you can not read the monitoring value entered from the register 31143 in each case, it is possible that communication between your Modbus client and the Fuel Save Controller is disrupted. We recommend the setting of a timeout for a loss of communication of two seconds in your Modbus client.	S32	FIX0	RW

6 Troubleshooting

Problem	Cause and corrective measures
The Fuel Save Controller cannot be accessed by the Modbus client.	The correct IP address for the Fuel Save Controller may not be set in the Modbus client. **Corrective measures:** • Read off the IP address of the Fuel Save Controller (see router manual). • Ensure that the correct IP address for the Fuel Save Controller is set in the Modbus client (see the Modbus client manufacturer's manual).
	The firewall may not be set correctly. **Corrective measures:** • Enable port 9522 in the firewall (see firewall manual).
	There may not be a network connection to the Fuel Save Controller. **Corrective measures:** • Check the network connection between the Fuel Save Controller and your Modbus client system.
The Fuel Save Controller does not send a reply within the response time specified by the Modbus client.	The Modbus server of the Fuel Save Controller may be currently overloaded. **Corrective measures:** • Extend the response time set in the Modbus client successively by one second respectively.
	It is possible that communication between the Modbus client and the Fuel Save Controller is disrupted. Check whether the entry value in Modbus register 40835 can be read off from register 31143 within one second. **Corrective measures:** • Check the electricity supply of the Fuel Save Controller. • Check the communication connections in the PV system for damages.

A NaN value is reported in the Modbus client (see Section 3.6.1 "SMA Data Types and NaN Values", page 10).	You may be trying to read from a Modbus register that is not supported by the Fuel Save Controller. **Corrective measures:** • Contrast and compare the available measured values for the Fuel Save Controller with the Modbus registers requested by the Fuel Save Controller.
	You may be trying to read from a Modbus register that is not defined in the SMA Modbus Profile FSC. **Corrective measures:** • Remove the register address used from the data processing. • Install a newer version of the Modbus profile via a firmware update.
	You may be trying to read from a write-only Modbus register. **Corrective measures:** • Read off the access type of the affected register from the "Access" column of the corresponding assignment table and correct it in the Modbus client.
Modbus exception 1 "Illegal Function" is reported in the Modbus client.	You may be trying to write to a data block whose target address range has registers that are not writable. **Corrective measures:** • Check whether all registers to be written to are writable.

Modbus exception 2 "Illegal Data Address" is reported in the Modbus client.	You may be trying to write to a Modbus register that is not defined in the SMA Modbus Profile FSC. **Corrective measures:** • Check the Modbus address to be written to in the Modbus client for errors.
	You may be trying to read or write to a data block whose start or end address does not correspond with that of a register (alignment not correct). **Corrective measures:** • Check the start or end address of the data block. • Check the register at the start or end address of the data block to be read for consistency. It may be that one of the two registers is inconsistent.
	You may be trying to write to a data block and one of the registers to be written to are not supported by the device. **Corrective measures:** • Check whether the register to be written to is available from the Fuel Save Controller.
Modbus exception 3 "Illegal Data Value" is reported in the Modbus client.	You may be trying to write to a data block (Modbus commands 0x10) and one of the values has a data type that is not permitted. **Corrective measures:** • Read off the data type of the register to be written to from the "Type" column of the corresponding assignment table and correct it in the Modbus client.
Other Modbus exceptions	**Corrective measures:** • For Modbus exceptions, see "Modbus Application Protocol Specification" at http://www.modbus.org/specs.php.

7 Technical Data

7.1 Modbus Communication Port

The following table shows the default setting of the supported network protocol:

Network protocol	Communication port, default setting
TCP	502

The Modbus communication port cannot be changed.

7.2 Data Processing and Time Behavior

In this Section you will find typical data processing and reaction times of the Modbus interface of the Fuel Save Controller as well as time information for saving parameters in SMA devices.

Signal run time through the Fuel Save Controller

The signal run time through the Fuel Save Controller is a maximum of 200 ms.

The signal run time is the time required by the Fuel Save 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 at one time.

Reaction time of the Modbus interface

The reaction time of the Modbus interface is 5 to 10 seconds

The reaction time of the Modbus interface is the time between the arrival of the parameter specifications in the Fuel Save Controller until the corresponding measured values are provided to the Modbus interface of the Fuel Save 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 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:

- Device types and serial numbers of the modules of the SMA Fuel Save Controller
- Error and warning messages displayed
- Type of generator control used

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