Product Manual (v1.01)

BSM-WS36A-H01-1311-0000

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Contents

1. Properties and Use

1.1. Intended Use

The meters are to be used exclusively to measure electrical energy.

1.2. General Description

The BSM-WS36A-H01-1311-0000 is a digital energy meter for active energy in 4-conductor networks.

The field of application is the recording of energy consumption in the energy supply sector. With the integrated module to sign measured values, the BSM meter is particularly suitable for installation in calibration-compliant charging stations for e-mobility. The meter can provide signed measured values via a Modbus interface and independently carries out a tested switch and measurement coordination, whereby the amount of energy per consumption process is always exactly determined.

1.3. Manufacturing

Place of manufacturing:
Gebr. Bauer GbR
Breitenbergstraße 2
87719 Mindelheim

Quality management
ISO 9001:2005

In cooperation with

chargeIT mobility GmbH
Steigweg 24

97318 Kitzingen

1.4. Main Characteristics

Measurement of active energy
Designed as a directly measuring meter
Pulse outputs (S0) for passing on impulses proportional to the active energy
Test LED with 10000 Imp/kWh for meter testing
Status indicator for installation control on the display
Optical interface
Data interface RS485, Modbus RTU
Battery-buffered real-time clock
Counter for charging quantity (E-Mobility)
Signing of measured values (E-Mobility calibration regulations)
Switch and measurement coordination (E-Mobility calibration regulations)

1.5. Standards and Regulations

EN 50470-1:2006	Alternating current electricity meters, General requirements

EN 50470-3:2006	Alternating current electricity meters, special requirements-. Electronic meters of active consumption of Accuracy classes A,B, and C
EN 62053-21:2003	Alternating current electricity meters, special requirements-. Electronic active consumption meters of accuracy classes 1 and 2
EN 62052-11:2003	Electricity metering equipment (a.c.) - General requirements, and Tests and test conditions - Part 11: Measuring equipment.
PTB-A 20.1:2003	PTB requirements for electronic and software-controlled
PTB-A 50.7:2002	measuring instruments
TR 50579:2012	Alternating current electricity meter Test severity, immunity and test method for conducted Interference
WELMEC 7.2	WELMEC Software Guide 7.2 (European Measuring Instruments Directive 2014/32/EU)

2. Safety

2.1. General Safety Instructions

The installation of the meters may only be carried out by competent and trained personnel.
The meter is to be used exclusively in accordance with its intended use.
The meter may not be operated outside the specified technical data.

Contact with live parts can result in fatal injury!

All cables to the meter must be de-energized during mounting and installation work.

Circuit breakers used for switching a system must be made secure from restart.

The back-up fuse used for switching a system must be secured against being switched on again by other persons without being noticed.

2.2. Maintenance and warranty

The meter is maintenance-free. If the enclosure is opened, the warranty becomes void. Defects caused by external influences (lightning, water, fire, improper use, etc.) are excluded from the warranty.

In case of damage caused by transport or storage, no repairs may be carried out by the customer.

3. Mounting and Installation

During mounting and installation work, observe all safety instructions in the chapter “Safety”.

3.1. Mounting

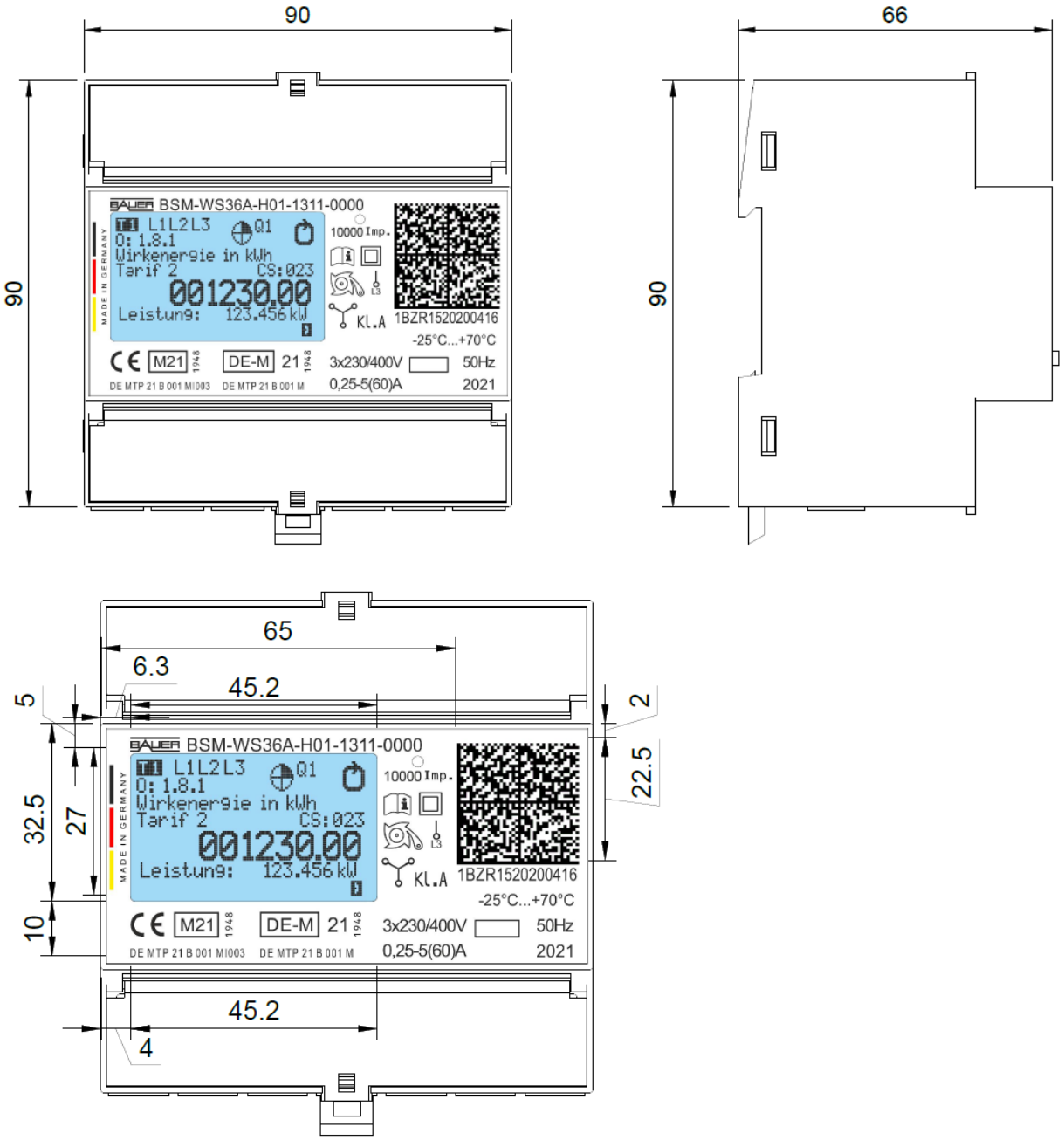
The meter is usually mounted on mounting rails (top-hat rail) T35 mm. To achieve the protection against ingress of dust and water required by the standard (IP51, EN50470-1, Section 5.9), the devices may only be used in meter cabinets that comply with class IP51.

3.2. Mounting control

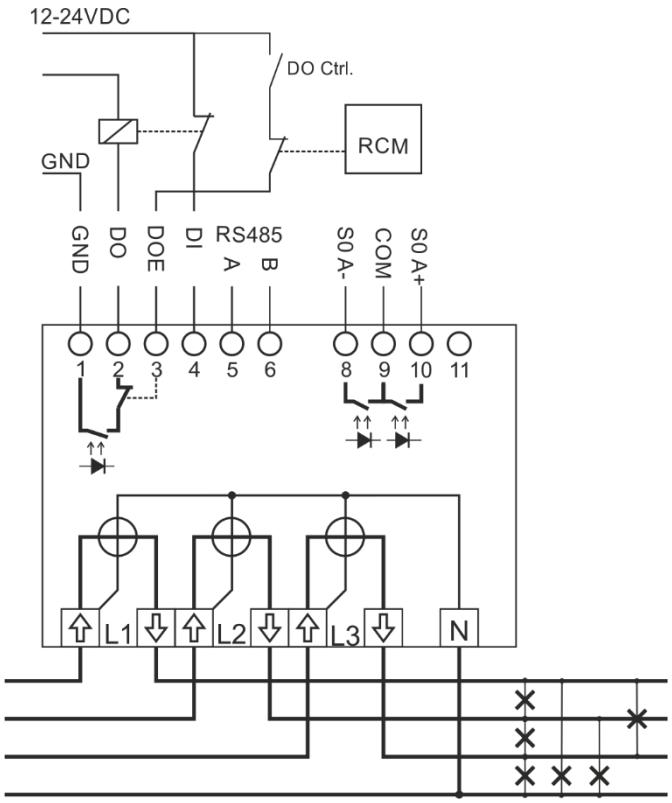
The symbols L1; L2 and L3 on the display are used to control the mounting

Symbols	Status	Function
L1; L2; L3	displayed	clockwise phase sequence
L1; L2; L3	blinking	counter-clockwise phase sequence
L1; L2	blinking	L3 missing or starting threshold not exceeded
L1; ; L3	blinking	L2 missing or starting threshold not exceeded
; L2 ; L3	blinking	L1 missing or starting threshold not exceeded

3.3. Dimensions



3.4. Circuit diagram



Terminals		Designation	elect. Data
Out	1; 2	Opto-MOSFET 212EH	24V ; 0,55A
DOE	3	Digital Out Enable (input)	„high“ (6-30VDC) „low“ (0-1VDC)
DI	4	Digital IN	„high“ (6-30VDC) „low“ (0-1VDC)
A , B	5; 6	RS485 Interface	
SOA +	8	impulse output Opto-MOSFET P+	max 24V; 0,20A 100Imp/kWh
COM	9	common	
SOA -	10	impulse output Opto-MOSFET P-	max 24V; 0,20A 100Imp/kWh
	11	not connected	No fuction
L1; L2; L3; N		Power terminals	Up to 16mm²

4. Device description

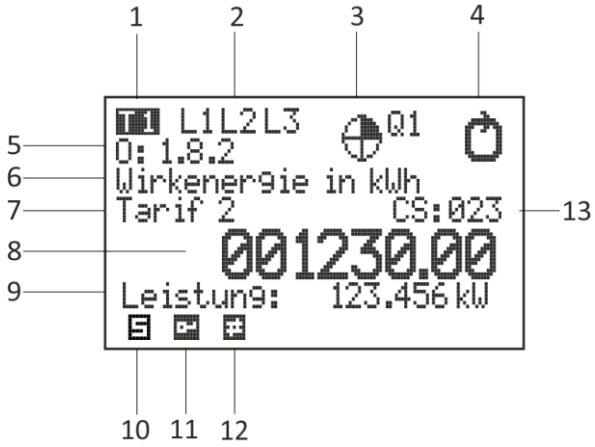
4.1. LCD display

The BSM-WS36A-H01-1311-0000 has an illuminated LCD graphic display with 128 x 64 pixels. This display enables the various measured values and the associated units and registers to be shown in plain text. The texts can be displayed in German or English. By pressing the control key 1, the display switches to the next display page. On meters without control keys, the individual pages are automatically displayed in a rolling sequence.
To check the visual meter reading, a checksum is displayed for the places before the decimal point.

4.2. LCD illumination

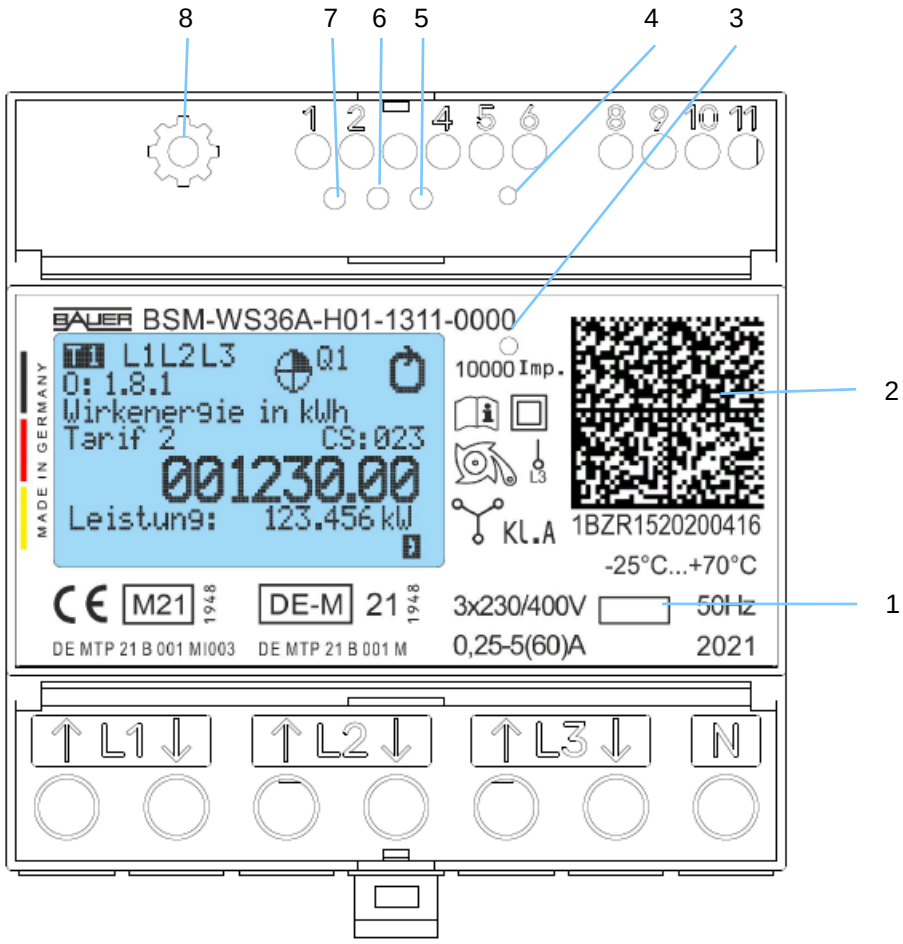
The illumination of the LCD display is automatically switched on when a charging process is started.

If the power supply of the charging point is only 1 phase, the connections L1, L2, and L3 must be connected together so that the LCD lighting is activated.



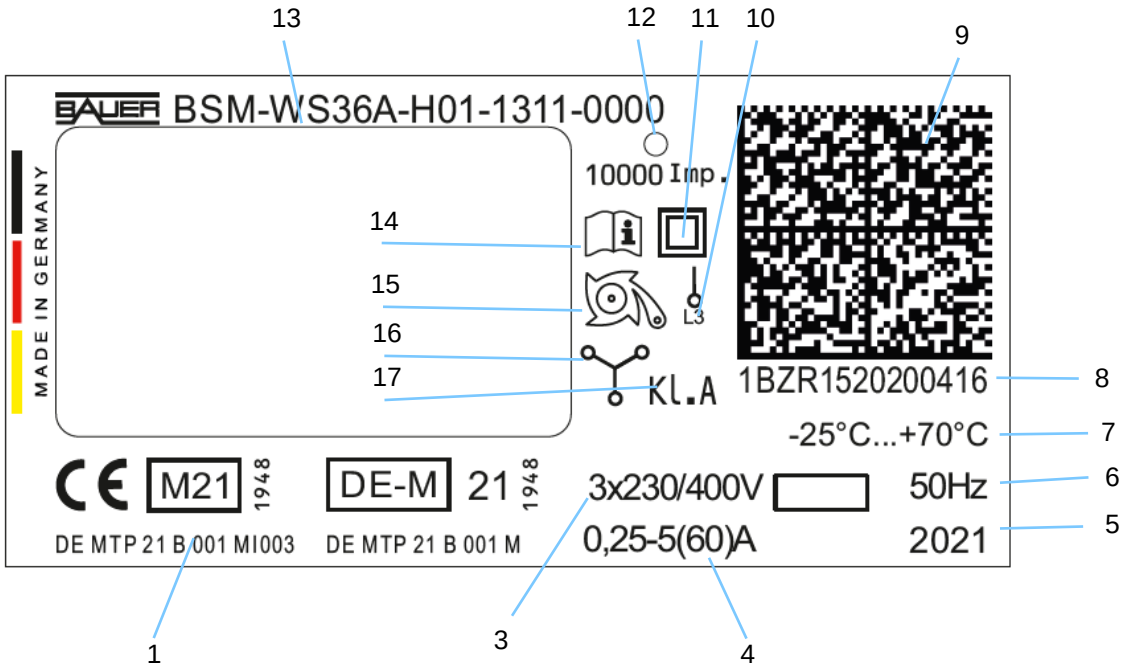
No.	Description
1	Shows the currently active tariff
2	Display for connected phases and phase sequence
3	Display of the quadrant
4	Display of energy direction (clockwise when start-up threshold is exceeded)
5	OBIS key figures
6	Display of the selected measuring unit
7	Display of the corresponding tariff
8	Eight-digit display of the measured value
9	Display of the current power value
10	Symbol for service mode (visible only during production)
11	Symbol for verification mode (visible only during production)
12	Symbol for interface activity
13	Checksum of the meter readings (only for digits before the decimal point)

4.3. Control elements



Nr.	Name	Description
1	Key 1	rolling display, parameter change
2	Optical interface (Info Interface)	Data output for customer purposes
3	Test LED	Displays power proportional impulses for test purpose 10000 imp/kWh
4	Key 3	to set the bus address (see 4.6)
5	LED	LED-ADR (bus address change mode)
6	LED	Digital Output enable DOE
7	LED	Digital Output DO
8	Key 2	Change mode Parameters (see 4.5)

4.4. Type plate



No.	Designation
1	Metrology marking, EU type-examination certificate
2	Metrology marking, national type-examination certificate
3	Nominal voltage
4	Current range
5	Year of manufacture
6	mains frequency
7	Temperature range -25°C to 70°C
8	Serial number
9	Data Matrix Code includes Public Key and Serial number
10	Mains and connection type 1-phase operation on L3
11	Protection class II
12	Test LED, constant
13	Type designation and type code
14	Note Observe operating instructions
15	reverse rotation lock
16	Mains and connection type 3-phase operation
17	Accuracy class

4.5. Language setting

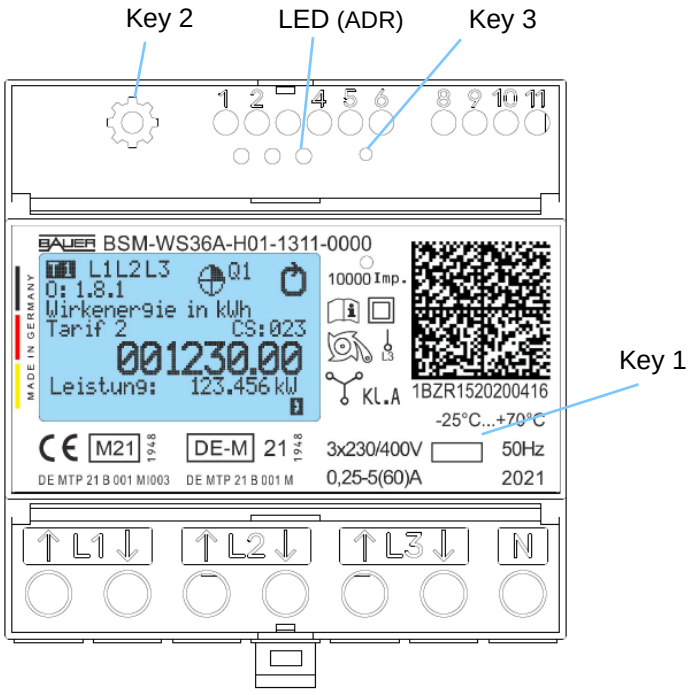
The texts shown on the display can be displayed in German or English.

- Press key **1** until the checksum appears on the display.
- Press key **2** for at least 4 seconds. The blinking display shows the current language.
- Press key **1** to select the language.
- Press key **2** for at least 4 seconds. The setting is saved.

4.6. Bus address

The bus address is predefined to 42 by default. You can change the bus address using the procedure below. The bus address may only be changed if there is no load.

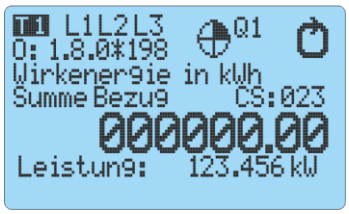
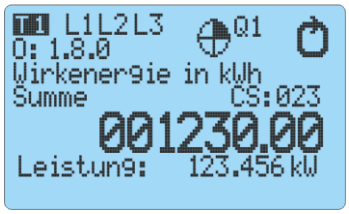
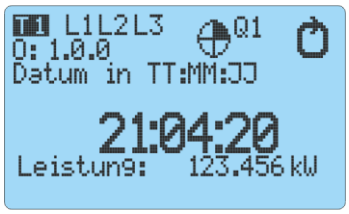
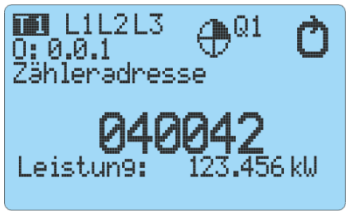
- Press key **1** until the current address is shown on the display.
- Press key **3** for at least 4 seconds - LED (ADR) lights up
- Press key **3** briefly - the address is incremented by 1.
- Press key **3** for at least 4 seconds - the address is saved
-



5. Display indication

The texts on the display scroll through cyclically. The next display appears every 8 seconds. The next display can also be called up by pressing (key 1). While the meter is measuring a consumer, the display is continuously backlit and the scrolling of the display continues.

The total active energy consumption is identified in the OCMF data with OBIS code 1-0:1.8.0*255. The corresponding totalizer is identified in the display with OBIS code 1.8.0.

Start:	Display sequence in the display:
	Resettable Energy register
	Energy register not resettable
	Time
	Date
	Modbus address Version Firmware hash Signature module
	Version Checksum Measuring module Language selection

6. Identification firmware

6.1. Signature module

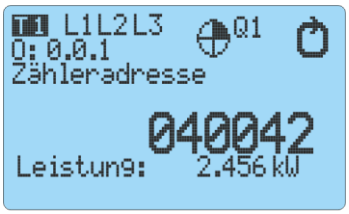
For identification of the firmware, its checksum and version designation are shown in the display. The values for Modbus parameters, firmware version, firmware hash part 1 and firmware hash part 2 appear alternately in the display field of the meter address.

The display scrolls in a rhythm of approx. 48 seconds.

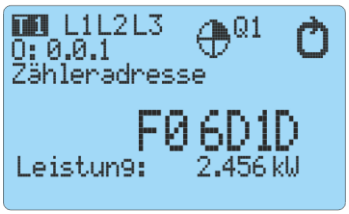
Firmware version and firmware hash are shown in abbreviated form.

The complete form can be read out via Modbus.

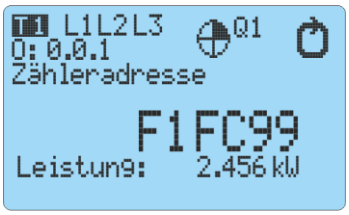
The following are examples:



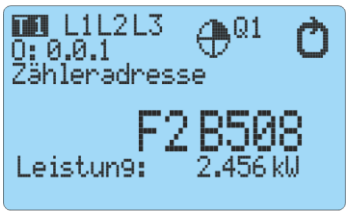
Modbus parameter
04 = Baud rate 19,200
42 = Bus address



F0 = Firmware version **6D1D**



F1 = Firmware hash part 1: **FC99**



F2 = Firmware hash part 2: **B508**

Identifier and hash can be read and compared via the following registers.

Address	Register	ID	Name	Type
40228	8	VrC	Software Version Communication Module	string

The version number can be read out at this address.

Permissible values can be found under:

https://github.com/chargeITmobility/bsm-python

Address	Register	ID	Name	Type
40506	1	B	Firmware hash	uint16

In the model instance "Hash Firmware Communication Module" the hash can be read out.

Permissible values can be found at:

https://github.com/chargeITmobility/bsm-python

6.2. Meter

6.2.1. On Display

The version number and the checksum of the software are shown in the display and can be read out via the two interfaces.

Checksum 32CA:AFF4 (example)

The checksums are calculated with a CRC-16 algorithm.

6.2.2. With Modbus

In the meter, there is separate firmware for the signature and meter units, each with its own identifier and hash. These can be read out and compared via the following registers.

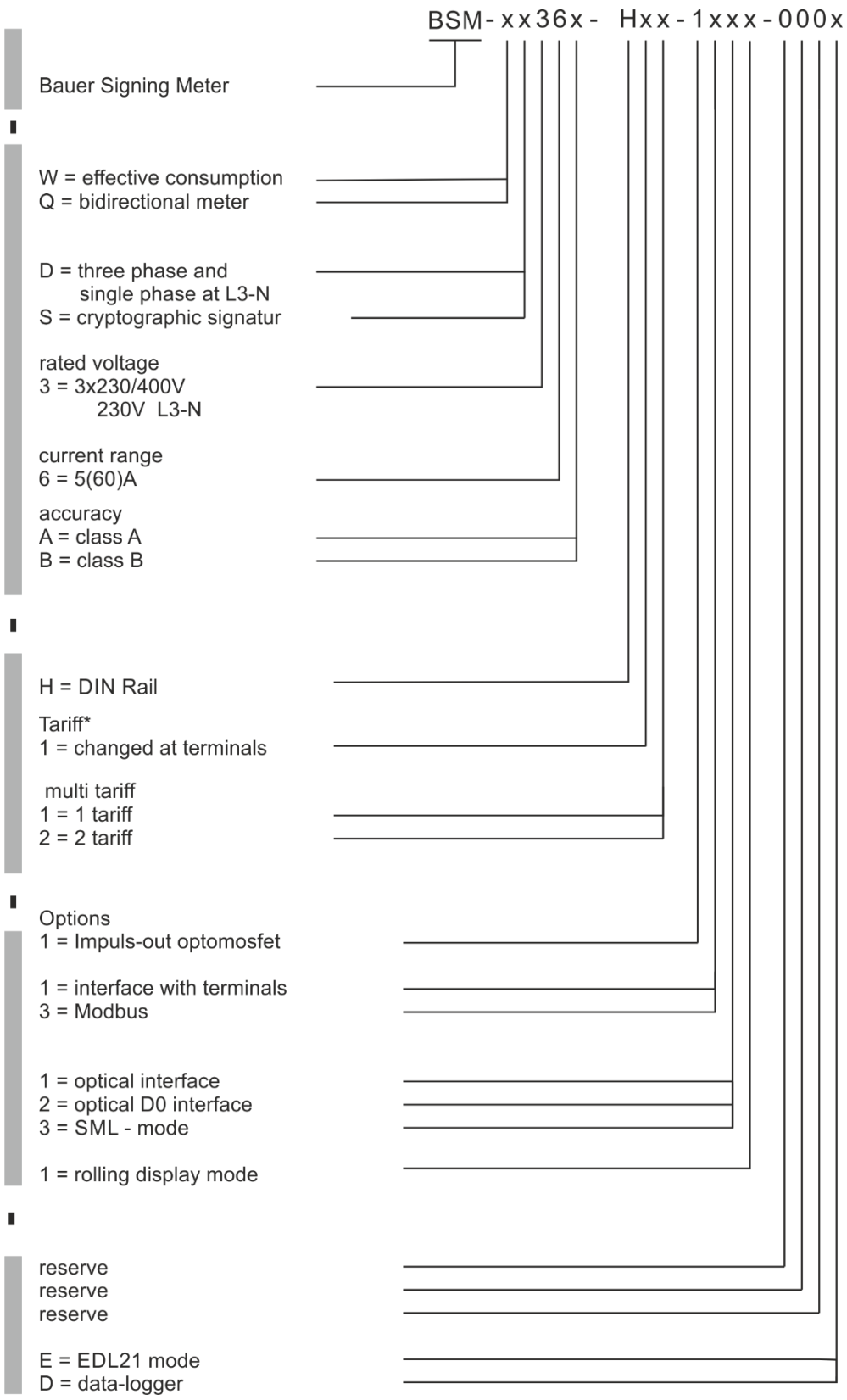
Address	Register	ID	Name	Type
40220	8	VrM	Software Version Meter	string

The version number and hash can be read at this address.

Permissible values can be found at:

https://github.com/chargeITmobility/bsm-python

7. Form designation system



8. Measuring unit Description

The current and voltage curves are read off and digitised by analogue-digital converters at short intervals. Based on this, a microcontroller calculates the measured values.

8.1. Current measurement

The current is measured by precision current transformers. The output signals are fed to the inputs of the A/D converter. The current proportional momentary values are digitalised and processed by the microcontroller 2048 times per second.

8.2. Voltage measurement

Voltage dividers are used to reduce the voltage to suitable voltage values. The reduced voltage signal is fed to the inputs of the A/D converter. The voltage proportional momentary values are digitalised and processed by the microcontroller 2048 times per second

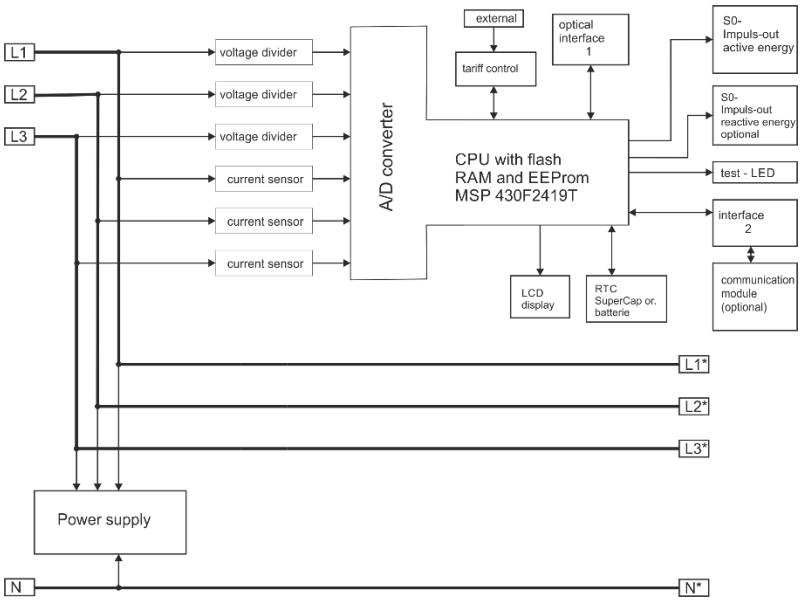
8.3. Measured values

The measured values determined for energy consumption are added to the corresponding energy register. The meter readings formed are shown on the display and can be read out via the interfaces with other measured values.

8.4. Data backup

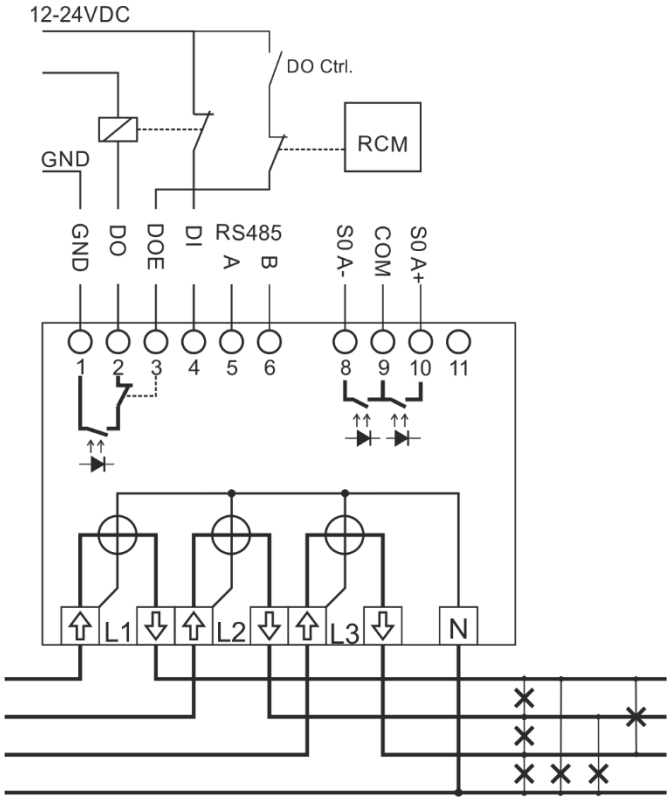
During normal operation, the microcontroller works with data stored in the volatile RAM of the microcontroller. To avoid data loss in case of power failure, all relevant data of the volatile RAM are written to a non-volatile EEProm in case of power failure.
This is done when the operating voltage level falls below a defined level. The energy reserve of the electronics is sufficiently large to save all data.
All relevant data are automatically saved in the non-volatile EEProm every 24 hours. The data are retained in the non-volatile EEProm for at least 20 years. A buffer battery is not required for data retention.

8.5. Block diagram



9. Interfaces

The following figure shows the connections on the meter, which are explained in the following subchapters.



9.1. Modbus RTU via RS485

The Modbus RTU runs via an RS-485 interface with the two data lines A/B (5; 6) at a possible transmission rate of 2,400 to 115,200 baud; 19,200 baud is pre-set at the factory.

The meter provides data via the Modbus interface using holding registers - one or more contiguous registers depending on the entry. The values are coded according to the SunSpec Information Model Specification [1], which corresponds to a binary representation in big endian in word and byte order.

For reading and writing the holding registers, the meter supports the Modbus functions Read Holding Register (function code 3) for reading and Write Multiple Registers (function code 16). Other function codes are not supported. For details, refer to the register overview (Appendix A – Overview Modbus registers) For examples of communication requests, refer to "Appendix B: Communication".

9.2. Digital interface

The digital interface, consisting of digital input (DI), digital output (DO) and ground (GND), is used to implement the switch and measurement coordination [1; 2; 3; 4]. If the digital interface is used for this purpose, the auxiliary contacts of an external contactor are connected to it. The more detailed operating principles of the switch measurement coordination are explained in chapter 10.2.

For DI “high” 6-30 VDC “low” 0-1 VDC

The digital output is connected to ground via an internally controlled solid state relay, which can switch the circuit. A maximum of 550 mA at max. 30 V may flow. Normally a 12 V /24 V contactor is used here.

The digital interface can also be used for other purposes if the switch and measurement coordination is not needed:

- Digital output can be switched individually
- Digital input can be read off

Another special feature of the meter is the digital contact DOE (DOE = DO enable). This is intended as an enable for fast switching of the contactor.

For DOE “high” 6-30 VDC “low” 0-1 VDC

For example, if an RCM module is installed, the signal to this module is connected here. The contactor can only be switched on if the RCM is not tripped, or an emergency shutdown is initiated if the RCM is tripped. In this case the switch-off is only done by the internal hardware and is software independent. The switch-off is guaranteed after < 1ms.

The enable contact can also be used for other safety functions.

If you do not want to use the enable contact, it must be permanently connected to "high" (6-30VDC).

If you want to carry out the switch and measurement coordination on an external control unit yourself, release the contacts on the meter.

9.3. S0 pulse outputs

The meter BSM-WS36A-H01-1311-0000 has a S0 pulse output according to EN 62053-31.
The S0 output provides energy-proportional impulses which can be counted and evaluated by a higher-level control system.

9.4. Impulse LED

The pulse LED is suitable for testing purposes.

Pulse constant = 10000 imp./kWh

Pulse duration = 2ms

Flashes proportionally to the amount of energy when the start-up threshold is exceeded.

If the energy quantity is below the start-up threshold, the LED does not light up.

9.5. Engineering Tool

A comprehensive example of communication with the BSM-WS36A-H01-1311-0000 is provided by the Modbus tool. This command line program written in Python 3, shows all the important aspects of communication with the device and lets you experience them live:

- Modbus Communication
- Reading and interpretation of data blocks and individual values
- Creation of snapshots (including switch and measurement coordination)
- Reading the public key and signature verification for snapshots

The Modbus tool is available at:

https://github.com/chargeITmobility/bsm-python

as download and Git-Repository. This project is an Open Source software offer provided under the Apache 2 license. Please contact us if you need commercial support for integrating the product into your environment.

9.6. Optical interface

On the front side there is an optical data interface according to EN 62056-21, for a corresponding magnetically fixable probe.

The interface is used to read out the measured values and to set parameters. For the data protocol, mode A, C or mode D0 can be selected according to EN 62056-21.

The interface can also be designed unidirectionally as a D0 interface. In this case, a defined data packet is sent continuously at defined intervals.

(see chapter 7)

At the customer's request, the parameters contained in the data packet can be defined.

(Settings can only be made by the manufacturer)

The interface works in any case free of reactions.

9.7. Access rights parameter opt. interface

Parameters changeable by:

O = Measurement point operator
M = Manufacturer (change only possible when housing is open)
P = user
U = unidirectional output possible (change only possible when housing is open)

Parameter readable	Read access	Write access	Uni-directional	Code number
Activate service mode	--	O	--	see 13.1; 13.2
Error message	X	--	U	1-0:F.F.0
Customer number	X	M	U	1-0:C.1.1
Serial number	X	M	U	1-0:C.1.0
Device address	X	O	U	1-0:0.0.1
Version	X	--	U	1-0:0.2.0
Momentary active power	X	--	U	1-0:15.7.0
Mom. Active power L1	X	--	U	1-0:21.7.0
Mom. Active power L2	X	--	U	1-0:41.7.0
Mom. Active power L3	X	--	U	1-0:61.7.0
Energy register 1 Tariff 1	X	--	U	1-0:1.8.1
Momentary voltage L1	X	--	U	1-0:32.7.0
Momentary voltage L2	X	--	U	1-0:52.7.0
Momentary voltage L3	X	--	U	1-0:72.7.0
Momentary current Total	X	--	U	1-0:25.7.0
Momentary current L1	X	--	U	1-0:31.7.0
Momentary current L2	X	--	U	1-0:51.7.0
Momentary current L3	X	--	U	1-0:71.7.0
Form factor L1	X	--	U	1-0:33.7.0
Form factor L2	X	--	U	1-0:53.7.0
Form factor L3	X	--	U	1-0:73.7.0

Mom. Mains frequency	X	--	U	1-0:14.7.0
Number of voltage failures	X	--	U	1-0:C.7.0
S0 Pulse valence	X	M	--	1-0:0.3.2
S0 Pulse duration	X	M	--	1-0:0.3.3
Date Time	X	O	U	1-0:1.0.0
Reset ref. counter	--	O	--	
Resettable counter	X	--	U	1-0:1.8.0*198

9.8. Parameter setting via keys

Description and position of the keys see chapter 4.3

O = Measurement point operator (user seal must be open, terminal cover)

P = User

Functions	Access	Key
Rolling display	P	Key 1
Bus address	O	Key 3 (see 4.6)
Language selection	O	Key 1 and 2 (see 4.5)

10. Functions for calibration law (Eichrecht) conformity in e-mobility

In a type examination certificate (Baumusterprüfbescheinigung) according to module B, a charging station is assessed for conformity with calibration law (according to MessEG/MessEV). This certification procedure is carried out by the conformity assessment bodies. The meter is optimized for use in charging stations that comply with calibration law. When used correctly, it can be a complete measuring capsule. These specific functions are explained in the following subchapters.

10.1. Signing

10.1.1. Snapshots

When creating a signature, a data package of selected measured and characteristic values from the meter memory is always signed at a specific time. This signed data packet is referred to below as a snapshot.

They are available via a register block.

Among others, a snapshot contains the following data:

- Energy consumption
- momentary power
- Status DI/DO
- Timestamp
- various metadata

Via the Modbus interface, the meter receives the command to create or update a snapshot. As soon as the process is completed, the snapshot status is set to “valid” by the meter and the snapshot can be read.

The pure signing time is about 150 ms, but due to the communication of the data being signed, the process expands so that a signed momentary status is available within 2 - 6 s.

There are the following types of snapshots:

- Signed current snapshot (intermediate value).
- Signed turn-on snapshot
- Signed turn-off snapshot
- Signed start snapshot
- Signed end snapshot

The integrated switch and measurement coordination is described in more detail in chapter 10.2. If you use an external switch and measurement coordination, use the snapshot types: "Signed start/end snapshot ".

In “Appendix C: Create snapshots” a complete process of a snapshot request as an example is described.

10.1.2. Key pair

The signing is based on an asymmetrical key pair: Private key and public key. The private key, which is secret, is used to create the signature. To confirm the signature, the public key is required, which is printed on the enclosure and can be read electronically via the Modbus interface.

During signature generation, a hash (SHA-256) is generated over the data, which is then signed according to ECDSA (curve secp256r1).

For security reasons, key generation cannot be repeated. A key pair is permanently valid for the corresponding meter.

10.1.3. Validation

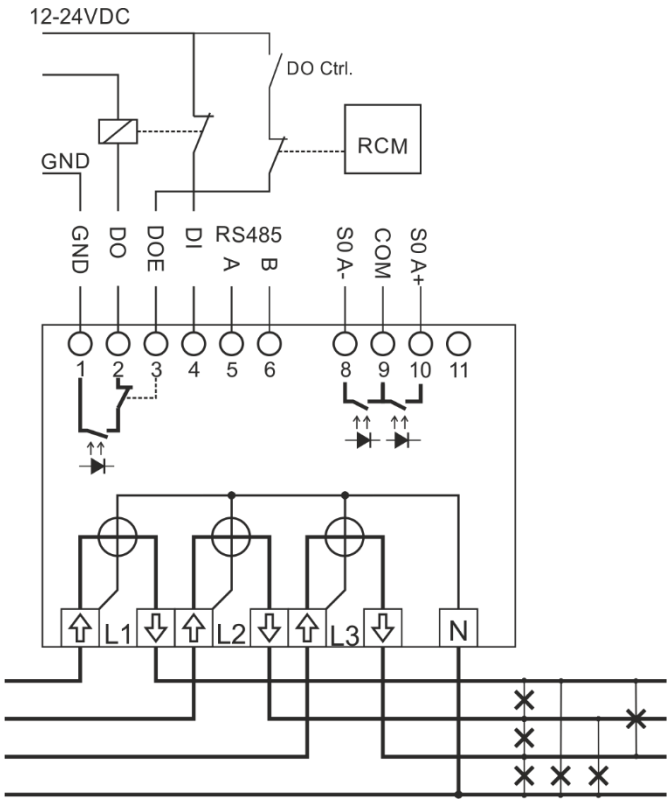
To validate the signature, the data record with signature and the public key (not included in the signed data record) are required. By recalculating the hash over this data (in an abstract representation) and then checking the signature for this hash, the authenticity of the data can be confirmed. Transparency software supporting the format of the signed data record can be used for this process. The format for the respective transparency software is described in chapter 10.4. After validation, the transparency software displays the validity of the digital signature. More details can be found in the manual of the transparency software.

In „Appendix D: “ are further details from signature creation described.

10.2. Switch-measurement coordination

The switch and measurement coordination is the synchronised control of a switch output, the evaluation of a feedback input to determine the status and the elicitation of measured values. It can ensure that the energy consumption of a consumer connected via a contactor is precisely recorded by carrying out initial and final measurement in the switched-off state. This is particularly useful for billing purposes. However, it is not mandatory to use the switch-measurement-coordination at the meter.

The following circuit diagram shows the connection of the meter according to the switching-measurement-coordination.



If the command “turn-on switch-measurement coordination” is requested, the following steps are carried out:

- DO to contactor switch off, if it is not yet off
- Feedback from contactor to DI for switch off is checked
- Collect measurement values
- DO to contactor is switched high
- Sign and provide snapshot

For signing always the reference counter is used, so the start value is always 0 kWh.

If the command “turn-off switch-measurement coordination” is requested, the following steps are carried out:

- DO to contactor goes low
- Feedback from contactor to DI for switch off is checked
- Collect measurement values
- Sign and provide snapshot

For switching the DO off and on to the contactor, the associated feedback of an NC feedback contact to DI is evaluated. The switching operation is only regarded as successful if this takes place in the expected form and time. The timeout for the feedback from the contactor is 0.5 s. If the meter cannot determine the expected switching state via the feedback contact by the end of this period, the snapshot is invalid. The meter provides the snapshot only if the necessary switching operations were successful. Otherwise an error and invalid snapshot data are reported.

Further details on the communication of the switch and measurement coordination are given in “Appendix E: Switch and measurement coordination.“

The switching operation at the contactor is determined by DO. The switching state of DO is in turn dependent on two things: The internal switching demand of the meter and the state of DOE. Both must be active (switching demand DO active & DOE active/high) so that the contactor is closed.

The DO contact is controlled by the meter and ensures correct switch-measurement-coordination. Accordingly, it gives the release to the switching operation after the measurement data has been collected for signing. For a closed contactor, DO is pulled to GND.

The DOE contact is the switching contact for an external control (DO Ctrl.). Accordingly, it gives the release to the switching operation according to the rules of the control. The switching of the contactor by the DOE is exclusively coupled to hardware and is therefore suitable for a quick turn-off and turn-on. For a closed contactor DOE must be high. The DOE can also be used simultaneously as an emergency shutdown contact of an RCM.

When using the switch-measurement-coordination, the following sequences result:

Load-free status:

A 12 V / 24 V contactor is connected via the A2 contact. The internal switch (solid state relay) to DO is open, so the contactor is open as well. This is the case if at least one of the following conditions is met:

- Internal switching release for DO is inactive

- DOE low

In the normal case of switch-measurement-coordination both are inactive.

Turning on process

1. DOE and the internal DO switching release are inactive. Metadata are set via Modbus
2. The command turn-on switch-measurement-coordination comes from the controller via the Modbus interface.
3. The meter opens the internal solid state relay to DO and thus the circuit to the contactor (if this is not already the case).
4. The feedback contact of the contactor (DI) is evaluated. If the contactor is still closed despite the switching command, the snapshot is invalid and the further procedure depends on the system strategy.
5. In the secured open state of the contactor, the measurement data for a snapshot are collected (meter values and others).
6. Via the firmware of the meter, the switching demand for DO is then activated. Due to the closed circuit, the switching contact DO is now at GND and thus active. The snapshot is signed and declared valid. (Contactor does not have to be switched on with DOE yet)
7. The control (DO Ctrl.) releases the load via DOE (high).The contactor switches on.

Notes:

- A too early release by DOE is delayed at the contactor by DO to a state with collected measured values. A running meter value is prevented from being signed.
- If DOE is not to be used for switching or fusing, this must be permanently set to high

Status under load:

A consumer is connected which can obtain energy and causes the meter reading to increase accordingly. As long as no error occurs, this state remains unchanged. DOE can terminate the charging process immediately

as a safety contact (e.g. by an RCM). Signed intermediate statuses can be created (pagination increases) if required.

Turning off process:

1. The control (DO Ctrl.) withdraws the release for load via DOE (low). The contactor switches off.
2. From the control via the Modbus interface comes the command switch-measurement-coordination off.
3. The meter opens the internal solid state relay and thus the circuit to the contactor, making DO an open contact.
4. The feedback contact of the contactor (DI) is evaluated. If the contactor position does not change despite the switching command, the snapshot is invalid and further action depends on the system strategy.
5. In the secured open state of the contactor, the measurement data for a snapshot are collected (meter values and others). The snapshot is signed and declared valid.

Note: A too late withdrawal of the release by DOE is brought forward by DO at the contactor. It is prevented that a running meter reading get signed.

Timings

In the logical AND operation of DO and DOE, the DO ensures that no incorrect (running) meter reading is measured and signed. However, the switch-on time of the contactor is delayed accordingly, should DO take effect. This should therefore be seen as a safeguard for correct switch-measurement coordination (SMC). The DOE should normally be the contact that switches on the contactor by its release after preparation. The DOE enables faster switching times in this case. At the shutdown, the DOE release must first be withdrawn to ensure fast shutdown.

The following timings result from these processes:

Start-Event	Stop-Event	Time (max.)
DOE release withdrawn	DO open contact (DOE)	1 ms
DOE release given	DO to GND (DOE)	2 ms
SMC turn-off via Modbus	DO open contact (relay)	2 s
SMC turn-on via Modbus	DO to GND (relay)	9,7 s
SMC turn-off via Modbus	Providing signed data	8 s
SMC turn-on via Modbus	Providing signed data	10 s*

* From switched off to switched on

IEC 61851-1 requires the following times:

- Switch-on time after PWM is ready to charge max. 3 s
- Switch-off time after PWM is ready to charge max. 100 ms

This can only be achieved if the DOE is the switching contact. The signing of the meter start value via RS-485 and the resulting release of internal relay to DO must be performed in the status of preparation (before B2).

10.3. Transparency software format

Signed measurement values of a charging process must be able to be validated by users in transparency software, enabling billing control. This meter is prepared for use with Chargy transparency software (from chargeIT) and S.A.F.E. transparency software.

Format of the signed data

The meter always signs single momentary values as snapshots and makes them available in the form of signed data in the registers. To completely map a charging process, two measuring points are required: Start value and End value. Accordingly, there is a format for single measurement time points (single format) and a higher-level format (meta format).

Basic structure of a signed data set for a transparency software:

Meta format:

Additional data (not signed)

Single format (start, signed)

Single format (end, signed)

A snapshot is always automatically signed or it is invalid. The metadata must be set before the snapshot is created. The snapshot can be retrieved both directly as OCMF or through the corresponding registers of the data model.

In the following, the formats are briefly introduced. A comprehensive explanation with examples can be found on Github:

https://github.com/chargeITmobility/bsm-python

Signed data for Chargy (single format)

Retrieval via:

Register Signed Turn-On Snapshot: 40776 - 41029

Register Signed Turn-Off Snapshot: 41030 – 41283

Register Signed Start Snapshot: 41284 – 41537

Register Signed End Snapshot: 41538 – 41791

From the registers of the signed data, the controller of the charging station must form the format for a single measuring point. The format of a single value is not the final format for the transparency software.

Signed data as OCMF (single format)

Retrieval via:

Register OCMF Signed Turn-On Snapshot: 42292 – 42791

Register OCMF Signed Turn-Off Snapshot: 42792 – 43291

Register OCMF Signed Start Snapshot: 43292 – 43791

Register OCMF Signed End Snapshot: 43792 – 44291

When signed data is output for the S.A.F.E. transparency software, it is already provided in the final single format (OCMF). The format of a single value is not the final format for the transparency software.

Creation of the meta format

The two signed snapshots (start & end) have to be integrated into a parent meta format. This is normally done in a backend, which can still add additional metadata within the format.

The meta format can be inserted into the corresponding transparency software.

Again, examples can be found on Github:

https://github.com/chargeITmobility/bsm-python

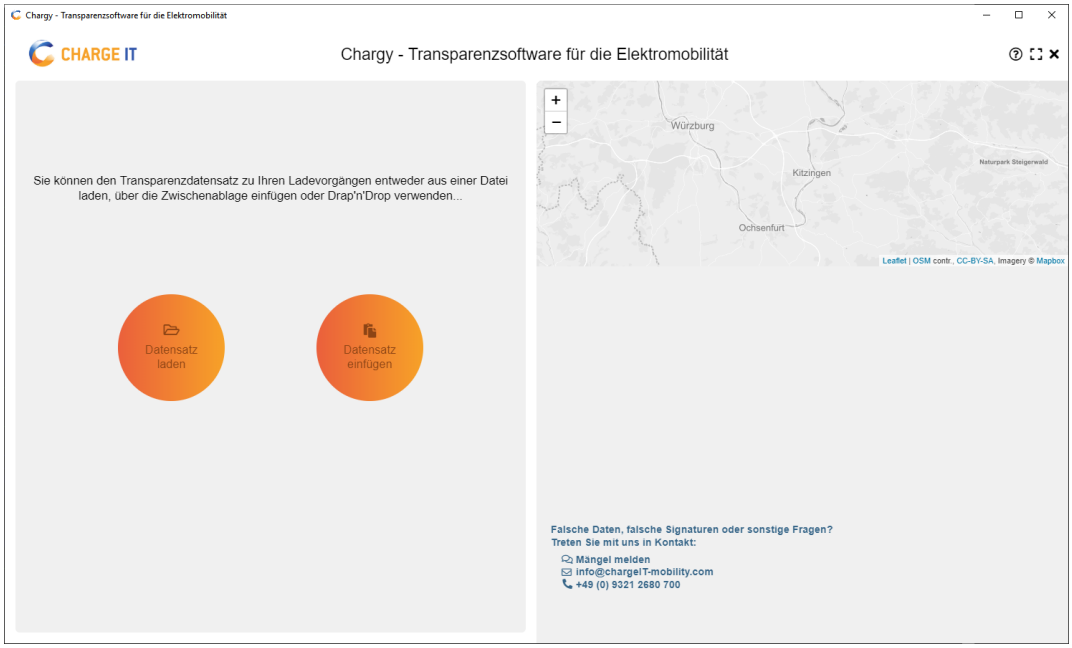
If you implement these formats, you can use ready-made transparency software without much effort. Furthermore, there is always the possibility to create a new single format as well as a new meta format from the signed data of the meter. The compatibility of an existing transparency software is lost here.

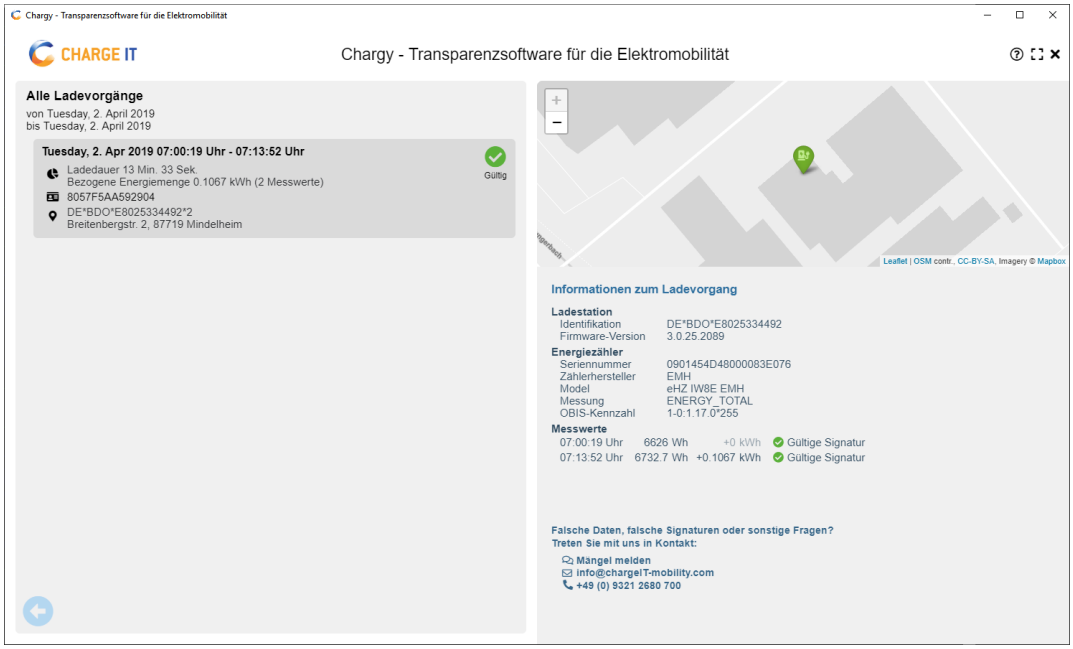
Validation with transparency software

A Transparency software is required to validate the data set (meta format). By using our preparation, it can be decided between Chargy and S.A.F.E..

Chargy:

Chargy is an open source transparency software from chargeIT and already in use in charging systems certified according to calibration law. A user manual is available on chargeIT's website. The transparency software is completely free of charge.

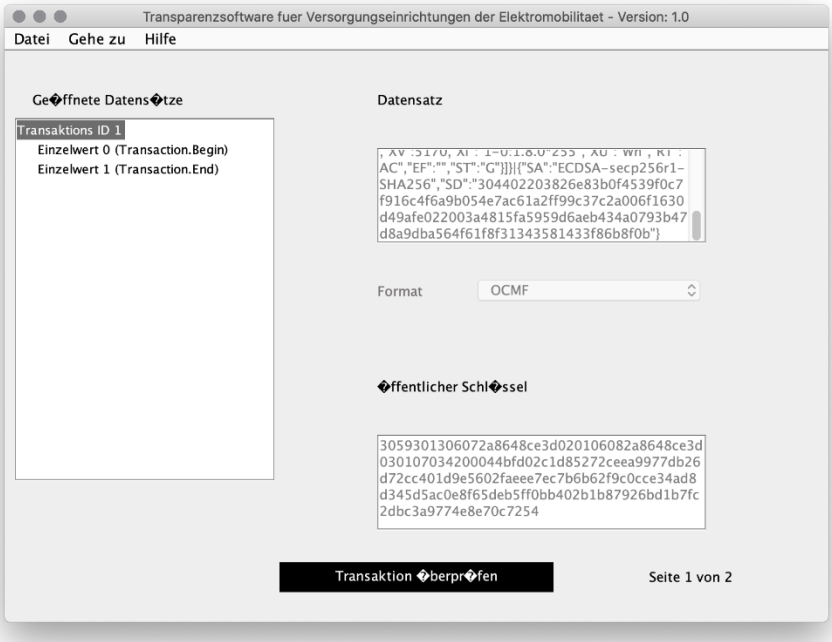


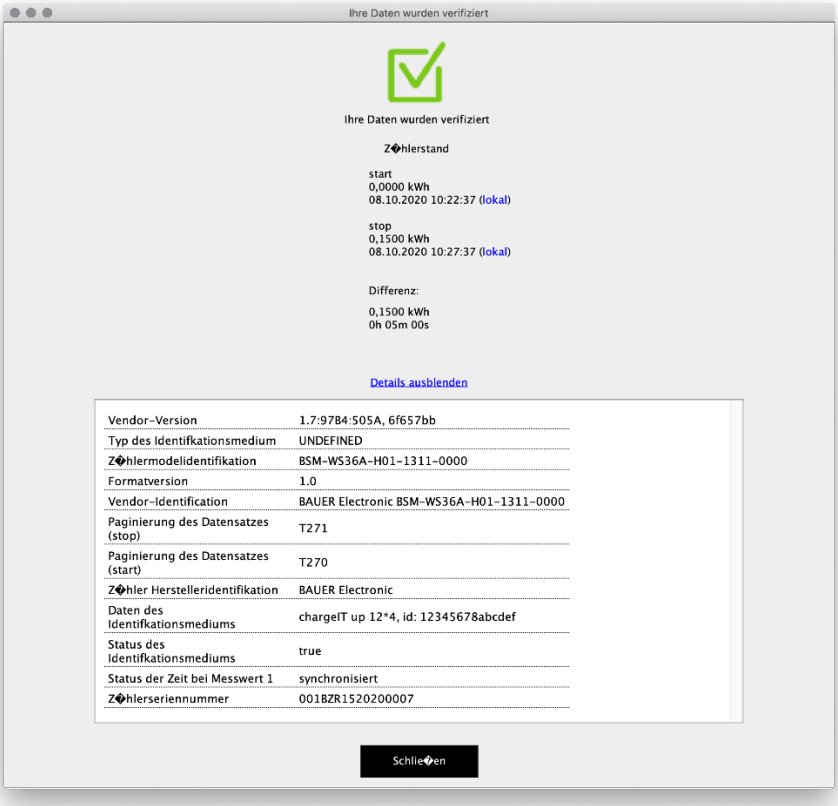


In cooperation with chargeIT mobility we offer our support for the implementation of the format for Chargy. Please feel free to contact us if you have any questions.

S.A.F.E.

The transparency software of S.A.F.E. was developed by members of the association and is available to all association members as open source. To use this transparency software in a type examination, a paid membership is required. For users the software is free of charge. A user manual is available on the website of S.A.F.E.





The S.A.F.E. Association is responsible for the maintenance, further development and support of the S.A.F.E transparency software.

11. Measurement accuracy notes

Requirements for the user in terms of § 23 of the Measuring and Calibration Ordinance
The Measuring and Calibration Ordinance [MessEV] obliges those who are users of a measuring instrument within the meaning of calibration regulations to measure and handle measuring instruments in such a way that the accuracy of the measurement is guaranteed. Taking into account the regulation of market roles by § 21 of the Energy Management Law [EnWG], the following provisions apply:

users within the meaning of the calibration regulations are:

Users of measuring instruments

Users of measuring instruments are the meter operators within the meaning of the EnWG.

User of measured values

Users of measured values are those who carry out measurement and transfer measured values to authorised third parties within the meaning of the EnWG, as well as carry out billing for network use and energy supply.

The users of measuring instruments are responsible for providing the information for users of measured values about the requirements explained below.

Traceability of tariff classification

In accordance with the recognised engineering practice within the meaning of the calibration regulations, the end user must be able to trace his settlement. The user of the measured value is responsible.

The user of the measured value must provide the power customer with a “tariff schedule” if the meter-internal clock functions as a tariff timer. Tariff schedule is understood here to be information clarifiying when and which tariff changes or tariff allocations and storage processes relevant to billing take place. The tariff schedule activated in the meter must be made identifiable for the power customer by means of a code number which can be called up on the display. The code digits under which the code number can be called up must be brought to the attention of the power customer.

Error messages

The description of the error messages can be found in this product description. If an error or more occurs (deviation of the display 00000000), the device must not be used for billing purposes and the stored measurement results are to be considered dubious. The devices must be removed, repaired if necessary, and placed on the market in conformity with calibration regulations if they are to continue to be used for billing purposes.

Use of the communication interfaces

The data transmitted via the meter's interfaces may only be stored and further processed in devices that do not have the character of auxiliary devices according to § 3 no. 24 MessEG and require a declaration of conformity from their manufacturers according to § 6, para. (3) MessEG.

12. Calibration test

The PTB test regulations Volume 6 for electricity meters and additional equipment as well as the approval documents apply.

Output device and function control

The test LED serves as the test output.

The test LED pulses proportionally to the applied load.

Without load, the LED does not light up.

Minimum measuring time to achieve repeatability is 10 seconds.

13. Operating modes

13.1. Service mode

In the service mode, energy registers with a higher specified accuracy (more decimal places) can be displayed and read out.

In this mode, the meter can be checked by the operator and some parameters can be reset.

The service mode can only be set with suitable software and password.

13.2. Parameter setting in the service mode

Parameter	Range	Type	Change with
Date	dd.mm.yy	numeric	Keys
Time	hh:mm:ss	numeric	Keys
Meter address	8 digits	numeric	Keys
Switching table (not usable)	Switching times of the int. tariff time switch (not usable)	numeric	Interface 1,2

13.3. Normal mode

The normal mode is the normal operating state of the meter.

The meter automatically switches back from the service mode to the normal mode after one minute.

The service mode can be restored with a telegram via the interfaces.

13.4. Calibration mode (calibration mode)

In this mode the meter is calibrated and all parameters can be set.

This mode can only be switched on after opening a hardware bridge and with a telegram via the interfaces.

The access protection (seals) must be removed here.

(only for manufacturer)

14. Technical Specifications

Energy meters	Quantity	1 T1
Voltage	4-conductor meter	3x230/400 V
Current Imin Iref Imax	direct	250 mA 5 A 60 A
Frequency		50 Hz
Class accuracy	Active energy	Cl. B, A
Type of measurement	Active energy	+A
Pulse value	Test LED	10000 imp/kWh 2 ms
Pulse value	S0 output	100 imp/kWh
Data interface	Optical SML RS485 / Modbus RTU	according to EN 60065-31
Temperature range	Operating temperature range Storage/Transport	-25°C to +70°C -25°C to +80°C
Ambient conditions/humidity		90% at 40°C non-condensing
Mechanical environmental conditions	Class	M1
Location of the meter		Indoors
Power Supply		3-phase from measuring voltage
Own consumption	Voltage path Current path	< 8.0 VA / < 0.8 W < 0.03 VA
EMV properties	Class Insulation resistance Resistance to HF fields	E1, E2 4 kV AC, 50 Hz, 1 min. 6 kV, pulse 1.5/50 µs 500Ω 10 V/m (under load)
Enclosure	Dimensions Protection class Protection type Enclosure material	90 x 90 x 66 mm II IP20* Polycarbonate flame retardant

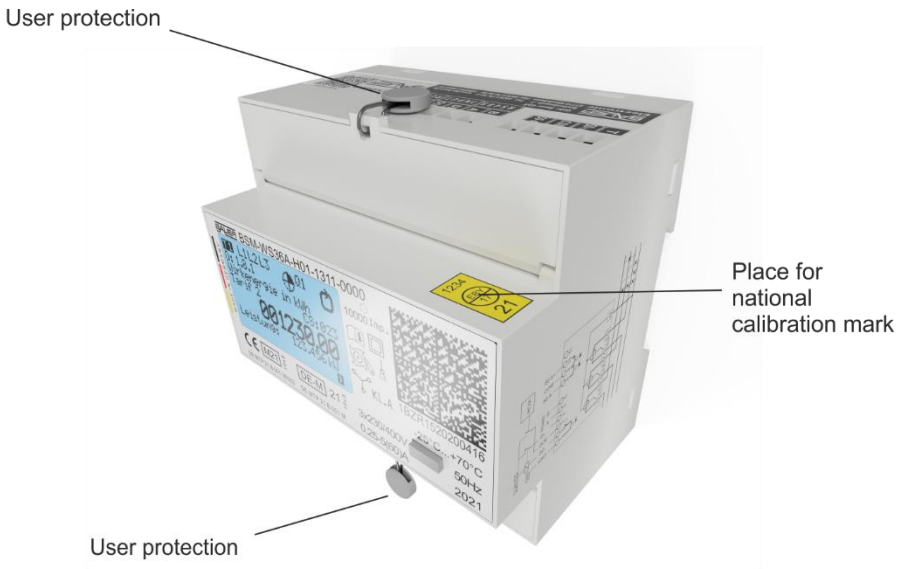
* To achieve the protection against ingress of dust and water required by the standard (IP51, EN50470-1, Section 5.9), the devices may only be used in meter cabinets that comply with class IP51.

15. Error messages

If an internal error occurs, an error message is set. This is shown on the LCD display and can also be read out via the serial interfaces.

Error messages	F.F(00000000)	No error set, meter is OK
	F.F(xxxxxxx0)	Meter gauged (calibrated).
	F.F(xxxxxxx1)	Meter is not gauged (calibrated).
	F.F(xxxxxxx8)	Calibration release, the meter is calibrated, but can be re-calibrated.
	F.F(xxxxxxx9)	Calibration release, the meter is not yet calibrated and can now be calibrated.
	F.F(xxxxxxxF)	Meter initialized again, the default parameters are loaded.
	F.F(xxxxxx0x)	Meter in normal mode.
	F.F(xxxxxx1x)	Meter in service mode.
	F.F(xxxxx0xx)	Checksums Micro FLASH and EEPROM OK.
	F.F(xxxxx1xx)	Error Checksum Micro FLASH.
	F.F(xxxxx2xx)	Error Checksum EEPROM.
	F.F(xxxxx3xx)	Error Checksum Micro FLASH and EEPROM.
	F.F(xxxx0xxx)	Micro RAM and STACK OK.
	F.F(xxxx1xxx)	Error Checksum Micro RAM.
	F.F(xxxx2xxx)	Error Micro STACK (Overflow).
	F.F(xxxx3xxx)	Error checksum micro RAM and error micro STACK.
	F.F(xxx0xxxx)	Micro OK.
	F.F(xxx1xxxx)	Error in micro.
	F.F(xx0xxxxx)	Hardware OK.
	F.F(xx1xxxxx)	Hardware error.
	F.F(x0xxxxxx)	Time base (Real Time Clock) OK
	F.F(x1xxxxxx)	Time base error (Real Time Clock).
	F.F(0xxxxxxx)	Real Time Clock set.
	F.F(1xxxxxxx)	Real Time Clock with default date/time (after repeated initialization).

16. Access security



The seal label is glued on the enclosure separation as an access protection. The label is self-destructive when attempting to remove it.

User security is provided by the sealing of the terminal covers.

17. Appendix A – Overview Modbus registers

17.1. General information

The device provides information about so-called data points grouped in models. A data point defines the representation of a value by one or more Modbus registers depending on the type. A model groups several data points and can be repeated to display data with the same structure, for example for the different snapshots of the device.

Data points from standard models that are not provided are marked Reserved in the following and several successive ones are grouped together.

Read accesses:

Any sequence of registers can be read. For maximum speed, the read data should be aligned with the boundaries of the data points.

Write accesses:

Some registers are writable, for non-writable registers a request is ignored. When writing a data point, all its registers must be included in a write access. Write accesses that are only made to a part of the registers of a data point are rejected.

Addressing:

Modbus distinguishes between the register addresses of the protocol and the data model (see [6], section 4.4 MODBUS Addressing Model)

In the data model, register addresses start at 1 - our data model therefore starts at address 40001.

In the protocol, register addresses start at 0 - our data model therefore starts at address 40000. The SunSpec specification describes the addresses of the data model.

Depending on the tool used one of the two addressings is used and it must be checked individually what they will be. The registers are all uniformly offset by one. In the following tables the data model address is always given. You can find a table with both addressings on Github or request it from our support.

17.2. Data representation

General information

Numbers and character strings are displayed according to SunSpec. Binary data, such as keys and signatures, are represented by the repeating block at the end of a model.

Numbers

The byte and word order for numbers is Big-Endian.

The respective measurand results from three components:

- Numerical value from interpretation of register values
- If necessary, scaling factor to form a decimal power $10^{\text{scaling factor}}$ which this numerical value is multiplied.
- If necessary, with a unit

Type	Description	Forming the value from register contents	Value range	Not available or invalid
acc32	32 bit meter, unsigned	like uint32	0 - 4294967295	0
bitfield32	Collection of 15 bit information	like uint32	0 - 0x7fff	If bit 32 is set (0x80000000)
enum16	16 bit enumeration	like uint16	0 - 65534	65535 (0xffff)
int16	16 bit integer, signed	(int16_t)R[n]	-32767 ... 32767	-32768 (0x8000)
pad	Filling data	like int16	0x8000	-32768 (0x8000)
sunsf	Scaling factor	(int16_t)R[n]	-10 to 10	-32768 (0x8000)
uint16	16 bit integer, unsigned	(uint16_t)R[n]	0 to 65534	65535 (0xffff)
uint32	32 bit integer, unsigned	(uint32_t)R[n] << 16 | (uint32_t)R[n + 1]	0 to 4294967294	4294967295 (0xffffffff)

Character strings

Character strings (Type: string) are provided in a continuous sequence of registers, each register containing two ASCII characters. A character string is refilled with null character ('\x00' if it is shorter than the register sequence. The entire register sequence must always be written.

For example: ABC' in a character string that is four register long

Register	R[n]		R[n + 1]		R[n + 2]		R[n + 3]	
Byte	0	1	2	3	4	5	6	7
Character	A	B	C	0x00	0x00	0x00	0x00	0x00

Binary data

Binary Large Objects (BLOBs) are provided in a data area consisting of a contiguous sequence of uint16 registers. Two further registers specify the length of this area and the number of bytes currently provided in it.

The data points are named according to the following convention: If the data point of the binary data is called B, NB indicates the number of registers in the data area and BB indicates the number of bytes allocated in it. The length information is typically found at the end of the fixed block of a model - the data area is in the repeating block. To align the binary data, a padding register may be included at the end of the fixed block.

For example, data 0x123456 is represented as follows:

Register	NB		BB		Pad		B[0]		B[1]	
Byte							0	1	2	3
Function	Number of register		Number of bytes		Padding		valid binary data			invalid
Data	0x00	0x02	0x00	0x03	0x80	0x00	0x12	0x23	0x56	0x00

Units

Units are explicitly mentioned in the following tables. For signing data, they are coded according to the COSEM interface classes and OBIS object identification system in the following table [5]:

Unit	Unit symbol	Value
Dimensionless / without unit		255
minute	min	6
second	s	7
Watt	W	27
Watt-hour	Wh	30

17.3. Data blocks

Overview of model instances

The following table lists the model instances. Each instance starts with a header consisting of model ID and payload length of one register each. These two registers are not included in the payload length.

A summary of all writeable registers in 17.4.

Data Model Address	Payload	Label	Model ID	Description
40001	0	SunSpec ID		Identification number
40003	66	Common	1	Standard SunSpec model with general information
40071	4	Serial Interface Header	10	Standard SunSpec model with general information of a communication interface
40077	12	Serial Interface	17	Standard SunSpec model of a serial interface
40091	105	AC Meter	203	Standard SunSpec model of a three-phase energy meter
40198	300	Signing Meter	64900	Custom model with extended information for this signing energy meter
40500	20	Communication Module Firmware Hash	64902	Own model with the binary representation of the hash of the firmware of the communication module
40522	260	Signed Current Snapshot	64901	Own model of a signed snapshot of a selection of the data of the momentary state of the device

40776	260	Signed Turn-On Snapshot	64901	Own model of a signed snapshot of a selection of data collected in the course of turning on the digital output via the switch-measurement coordination
41030	260	Signed Turn-Off Snapshot	64901	Own model of a signed snapshot of a selection of data collected in the course of turning off the digital output via the switch-measurement coordination
41284	252	Signed Start Snapshot	64901	Own model of a signed snapshot of a selection of data collected at the start of a charging process (without switching)
41538	252	Signed End Snapshot	64901	Own model of a signed snapshot of a selection of data collected to finish a charging process (without switching)
41792	498	OCMF Signed Current Snapshot	64903	Own model of an OCMF representation of the signed momentary state
42292	498	OCMF Signed Turn-On Snapshot	64903	Own model of an OCMF representation of the signed switch-measurement coordination turn-on
42792	498	OCMF Signed Turn-Off Snapshot	64903	Own model of an OCMF representation of the signed switch-measurement coordination turn-off
43292	498	OCMF Signed Start Snapshot	64903	Own model of an OCMF representation of the signed measurement to start
43792	498	OCMF Signed End Snapshot	64903	Own model of an OCMF representation of the signed measurement to the end
44292	0	End	65535	Standard SunSpec model to display the end of the models of this device

SunSpec ID

The SunSpec ID is a magic number for identification. It does not follow the block structure.

Data Model Address	Register	Label	Type	Default Value	Description
40001	2	SunSpec-ID	uint32	0x53756e53	Identification number, interpreted as a character string 'SunS‘

Common

The Common model contains the general information about the device. It contains the data point DA for setting the Modbus address, which can also be done together with the communication speed in the Signing meter model.

Data Model Address	Register	ID	Label	Type	Unit	Writable	Default Value	Description
40003	1	ID	Model ID	uint16		no	1	SunSpec Common model
40004	1	L	Model Payload Length	uint16		no	66	Without the fields 'Model ID' and 'Length payload'.
40005	16	Mn	Manufacturer	string		no		
40021	16	Md	Model	string		no		
40037	8	Opt	Options	string		no		
40045	8	Vr	Version	string		no		
40053	16	SN	Serial Number	string		no		
40069	1	DA	Device Address	uint16		yes	42	
40070	1	Pad	Padding	pad		no	206696	

Serial Interface header

The model Interface Header contains general information about the Modbus interface.

Data Model Address	Register	ID	Label	Type	Unit	Writable	Default Value	Description
40071	1	ID	Model ID	uint16		no	10	SunSpec model interface header (Interface Header)
40072	1	L	Model Payload Length	uint16		no	4	Without the fields 'Model ID' and 'Length of payload‘.
40073	1	St	Interface Status	enum16		no	1	See chapter 17.5
40074	1	Ctl	Interface Control	uint16		no	65535	Meaning of this value in the specification still open
40075	1	Typ	Physical Access Type	enum16		no	2	Fixed 2 for twisted pair of wires
40076	1	Pad	Padding	pad		no	32768	

Serial interface

The data block Serial interface contains information and configurations for the Modbus interface. Only the communication speed can be set here, the other parameters are not configurable.

Data Model Address	Register	ID	Label	Type	Unit	Writable	Default Value	Description
40077	1	ID	Model ID	uint16		no	17	SunSpec model serial interface

40078	1	L	Model Payload Length	uint16		no	12	Without the fields 'Model ID' and 'Length payload'.
40079	4	Nam	Name	string		no		
40083	2	Rte	Rate	uint32	bps	yes		
40085	1	Bits	Bits	uint16		no	8	Fixed 8
40086	1	Pty	Parity	enum16		no	2	Fixed 2 for even parity
40087	1	Dup	Duplex	enum16		no	1	Fixed 1 for half duplex
40088	1	Flw	Flow Control	enum16		no	0	Fixed 0 for no flow control
40089	1	Typ	Interface Type	enum16		no	2	Fixed 2 for RS-485
40090	1	Pcol	Protocol	enum16		no	1	Fixed 1 for Modbus

AC Meter

The AC meter data block contains the standardized information of a three-phase energy meter.

Data Model Address	Register	ID	Label	Type	Unit	Writable	Default Value	Description
40091	1	ID	Model ID	uint16		no	203	SunSpec Model AC Meter
40092	1	L	Model Payload Length	uint16		no	105	Without the fields 'Model ID' and 'Length of payload.
40093	1	A	Amps	int16	A	no		

40094	1	AphA	Amps PhaseA	int16	A	no		
40095	1	AphB	Amps PhaseB	int16	A	no		
40096	1	AphC	Amps PhaseC	int16	A	no		
40097	1	A_SF		sunssf		no		
40098	1					no		Reserved
40099	1	PhVphA	Phase Voltage AN	int16	V	no		
40100	1	PhVphB	Phase Voltage BN	int16	V	no		
40101	1	PhVphC	Phase Voltage CN	int16	V	no		
40102	4					no		Reserved
40106	1	V_SF		sunssf		no		
40107	1	Hz	Hz	int16	Hz	no		
40108	1	Hz_SF		sunssf		no		
40109	1	W	Watts	int16	W	no		
40110	1	WphA	Watts phase A	int16	W	no		
40111	1	WphB	Watts phase B	int16	W	no		
40112	1	WphC	Watts phase C	int16	W	no		

40113	1	W_SF		sunssf		no		
40114	1	VA	VA	int16	VA	no		
40115	1	VAphA	VA phase A	int16	VA	no		
40116	1	VAphB	VA phase B	int16	VA	no		
40117	1	VAphC	VA phase C	int16	VA	no		
40118	1	VA_SF		sunssf		no		
40119	1	VAR	VAR	int16	var	no		
40120	1	VARphA	VAR phase A	int16	var	no		
40121	1	VARphB	VAR phase B	int16	var	no		
40122	1	VARphC	VAR phase C	int16	var	no		
40123	1	VAR_SF		sunssf		no		
40124	1					no		Reserved
40125	1	PFphA	PF phase A	int16	Pct	no		
40126	1	PFphB	PF phase B	int16	Pct	no		
40127	1	PFphC	PF phase C	int16	Pct	no		
40128	1	PF_SF		sunssf		no		

40129	8					no		Reserved
40137	2	TotWhImp	Total Watt-hours Imported	acc32	Wh	no		
40139	6					no		Reserved
40145	1	TotWh_SF		sunssf		no		
40146	50					no		Reserved
40196	2	Evt	Events	bitfield32		no		See chapter 17.5 Event flags of critical events of counter and communication module. A problem exists if this value is different from zero.

Signing meter

The "Signing meter" model contains information that goes beyond that of the "AC meter". Among them are most of the configurable values of the device:

- Current time
- Metadata for inclusion in signed data
- Direct control of the digital output

The Modbus communication parameters can be set via the model instances "Common" and "Serial interface".

Data Model Address	Register	ID	Label	Type	Unit	Scale factor	Writable	Default Value	Description
40198	1	ID	Model ID	uint16			no	64900	Own block Signing meter

40199	1	L	Model Payload Length	uint16			no	292	Without the fields 'Model ID' and 'Length payload'.
40200	4	ErrM	Error Code Meter	string			no		This error code is stored in one bit of the 'Evt' field of the model of the three-phase meter.
40204	8	SNM	Serial Number Meter	string			no		
40212	8	SNC	Serial Number Communication Module	string			no		
40220	8	VrM	Software Version Meter	string			no		The checksum of this firmware is also indicated in this field.
40228	8	VrC	Software Version Communication Module	string			no		The checksum of this firmware can be found in the 'Communication Module Firmware Hash' instance of the BLOB model (64902).
40236	8	MA1	Meter Address 1	string			no		
40244	8	MA2	Meter Address 2	string			no		
40252	2	RCR	Real Energy Imported Since Last Turn-On Sequence	uint32	Wh	RCR_SF	no		
40254	1	RCR_SF	Real Energy Imported Since Last Turn-On Sequence Scale Factor	sunssf			no		

40255	2	PDCnt	Power Down Counter	uint32			no		
40257	2	RCnt	Response Counter	uint32			no		Number of snapshots signed by this device so far
40259	2	OS	Operation-Seconds Counter	uint32	s		no		Operating seconds of this device
40261	2	Epoch	Current Epoch Time	uint32	s		yes		Epoch time, "Unix time", seconds since 1/1/1970 00:00
40263	1	TZO	Timezone Offset	int16	min		yes		
40264	2	EpochSet Cnt	Time Set Counter	uint32			no		
40266	2	EpochSet OS	Time Last Set At Operation-Seconds	uint32	s		no		
40268	1	DI	Digital Input State	uint16			no		Least significant bit contains the state of the digital input
40269	1	DO	Digital Output State	uint16			yes		Writing the least significant bit register switches the output

40270	2	DIChgOS	Digital Inputs Last Changed At Operation-Seconds	uint32	s		no		
40272	2	DIChgEpoch	Digital Inputs Last Changed At Epoch Time	uint32	s		no		
40274	1	DIChgTZO	Digital Inputs Last Changed Timezone Offset	int16	min		no		
40275	2	DOChgOS	Digital Outputs Last Changed At Operation-Seconds	uint32	s		no		
40277	2	DOChgEpoch	Digital Outputs Last Changed At Epoch Time	uint32	s		no		
40279	1	DOChgTZO	Digital Outputs Last Changed Timezone Offset	int16	min		no		
40280	70	Meta1	Metadata 1	string			yes		Metadata included in snapshots, identification data for OCMF
40350	50	Meta2	Metadata 2	string			yes		Metadata included in snapshots
40400	50	Meta3	Metadata 3	string			yes		Metadata included in snapshots
40450	1	NPK	Number Of Public-Key Registers	uint16			no		Number of repeating blocks PK of the BLOB range of the public key.

40451	1	BPK	Number Of Public-Key Bytes	uint16			no		Actual number of bytes of the public key
40452	1	PK	Public Key	uint16			no		Repeating block of public key binary data in DER format

Communication Module Firmware Hash

This model instance provides the current hash of the communication module firmware in binary form.

Data Model Address	Register	ID	Label	Type	Unit	Writable	Default Value	Description
40500	1	ID	Model ID	uint16		no	64902	Model binary data
40501	1	L	Model Payload Length	uint16		no	20	Without the fields 'Model ID' and 'Length payload.
40502	1	Typ	BLOB Type	enum16		no		
40503	1	NB	Number Of BLOB Registers	uint16		no		Number of repeating blocks B of the firmware hash BLOB
40504	1	BB	Number Of BLOB Bytes	uint16		no		Actual number of bytes of the firmware hash BLOB.
40505	1	Pad	Pad	pad		no		

40506	1	B	Firmware Hash	uint16		no		Repeating block with the firmware hash (SHA-256).

Signed Current Snapshot

In this data block a signed snapshot from the current operation is mapped. Thereby the block is detached from the switch-measurement coordination and the data are collected here without a change of the digital output. The creation of a snapshot can be performed at any time and is triggered by writing the value "update" to the status register. The model (layout of the register block) is identical to that of the snapshots of the switch-measurement coordination (in the following).

Data Model Address	Register	ID	Label	Type	Unit	Scale factor	Writable	Default Value	Description
40522	1	ID	Model ID	uint16			no	64901	Model snapshot
40523	1	L	Model Payload Length	uint16			no	260	Without the fields 'Model ID' and 'Length of payload.
40524	1	Typ	Snapshot Type	enum16			no	0	Signed momentary state, See chapter 17.5
40525	1	St	Snapshot Status	enum16			yes		See Chapter 17.5, Writing 'Update' triggers the creation of a snapshot

40526	2	RCR	Real Energy Imported Since Last Turn-On Sequence	acc32	Wh	Wh_SF	no		
40528	2	TotWhExp	Total Watt-hours Exported	acc32	Wh	Wh_SF	no		
40530	1	Wh_SF		sunssf			no		
40531	1	W	Watts	int16	W	W_SF	no		
40532	1	W_SF		sunssf			no		
40533	8	MA1	Meter Address 1	string			no		
40541	2	RCnt	Response Counter	uint32			no		
40543	2	OS	Operation-Seconds Counter	uint32	s		no		
40545	2	Epoch	Current Epoch Time	uint32	s		no		

40547	1	TZO	Timezone Offset	int16	min		no		
40548	2	EpochSetCnt	Time Set Counter	uint32			no		
40550	2	EpochSetOS	Time Last Set At Operation-Seconds	uint32	s		no		
40552	1	DI	Digital Input State	uint16			no		
40553	1	DO	Digital Output State	uint16			no		
40554	70	Meta1	Metadata 1	string			no		Metadata included when taking and signing a snapshot
40624	50	Meta2	Metadata 2	string			no		Metadata included when taking and signing a snapshot

40674	50	Meta3	Metadata 3	string			no		Metadata included when taking and signing a snapshot
40724	2	Evt	Events	bitfield32			no		See chapter 17.5, Event flags of critical events of counter and communication module. A problem exists if this value is different from zero.
40726	1	NSig	Number Of Signature Registers	uint16			no		Number of repeating blocks Sig of the signature
40727	1	BSig	Number Of Signature Bytes	uint16			no		Actual number of bytes of the signature
40728	1	Sig	Digital Signature	uint16			no		Repeating block with binary data of the signature in DER format

Signed Turn-On Snapshot

When executing "Turn-on switch-measurement coordination", the switching operation takes place according to the already described switch-measurement coordination. A signed snapshot with selected data is created.

Data Model Address	Register	ID	Label	Type	Unit	Scale factor	Writable	Default Value	Description

40776	1	ID	Model ID	uint16			no	64901	Model snapshot
40777	1	L	Model Payload Length	uint16			no	260	Without the fields 'Model ID' and 'Length payload'.
40778	1	Typ	Snapshot Type	enum16			no	1	Signed switch-measure coordination Turn-on, See chapter 17.5.
40779	1	St	Snapshot Status	enum16			yes		See Chapter 17.5, Writing 'Update' triggers the creation of a snapshot
40780	2	RCR	Real Energy Imported Since Last Turn-On Sequence	acc32	Wh	Wh_SF	no		
40782	2	TotWhExp	Total Watt-hours Exported	acc32	Wh	Wh_SF	no		
40784	1	Wh_SF		sunssf			no		

40785	1	W	Watts	int16	W	W_SF	no		
40786	1	W_SF		sunssf			no		
40787	8	MA1	Meter Address 1	string			no		
40795	2	RCnt	Response Counter	uint32			no		
40797	2	OS	Operation-Seconds Counter	uint32	s		no		
40799	2	Epoch	Current Epoch Time	uint32	s		no		
40801	1	TZO	Timezone Offset	int16	min		no		
40802	2	EpochSetCnt	Time Set Counter	uint32			no		
40804	2	EpochSetOS	Time Last Set At Operation-Seconds	uint32	s		no		

40806	1	DI	Digital Input State	uint16			no		
40807	1	DO	Digital Output State	uint16			no		
40808	70	Meta1	Metadata 1	string			no		Metadata included when taking and signing a snapshot
40878	50	Meta2	Metadata 2	string			no		Metadata included when taking and signing a snapshot
40928	50	Meta3	Metadata 3	string			no		Metadata included when taking and signing a snapshot
40978	2	Evt	Events	bitfield32			no		See chapter 17.5, Event flags of critical events of counter and communication module. A problem exists if this value is different from zero.

40980	1	NSig	Number Of Signature Registers	uint16			no		Number of repeating blocks Sig of the signature
40981	1	BSig	Number Of Signature Bytes	uint16			no		Actual number of bytes of the signature
40982	1	Sig	Digital Signature	uint16			no		Repeating block with binary data of the signature in DER format

Signed Turn-Off Snapshot

When executing "Turn-off switch-measurement coordination", the switching operation takes place according to the already described switch-measurement coordination. A signed snapshot with selected data is created.

Data Model Address	Register	ID	Label	Type	Unit	Scale factor	Writable	Default Value	Description
41030	1	ID	Model ID	uint16			no	64901	Model snapshot
41031	1	L	Model Payload Length	uint16			no	260	Without the fields 'Model ID' and 'Length payload'.

41032	1	Typ	Snapshot Type	enum16			no	2	Signed switch-measure coordination Turn-off, See chapter 17.5
41033	1	St	Snapshot Status	enum16			yes		See Chapter 17.5, Writing 'Update' triggers the creation of a snapshot
41034	2	RCR	Real Energy Imported Since Last Turn-On Sequence	acc32	Wh	Wh_SF	no		
41036	2	TotWhExp	Total Watt-hours Exported	acc32	Wh	Wh_SF	no		
41038	1	Wh_SF		sunssf			no		
41039	1	W	Watts	int16	W	W_SF	no		
41040	1	W_SF		sunssf			no		

41041	8	MA1	Meter Address 1	string			no		
41049	2	RCnt	Response Counter	uint32			no		
41051	2	OS	Operation-Seconds Counter	uint32	s		no		
41053	2	Epoch	Current Epoch Time	uint32	s		no		
41055	1	TZO	Timezone Offset	int16	min		no		
41056	2	EpochSetCnt	Time Set Counter	uint32			no		
41058	2	EpochSetOS	Time Last Set At Operation-Seconds	uint32	s		no		
41060	1	DI	Digital Input State	uint16			no		

41061	1	DO	Digital Output State	uint16			no		
41062	70	Meta1	Metadata 1	string			no		Metadata included when taking and signing a snapshot
41132	50	Meta2	Metadata 2	string			no		Metadata included when taking and signing a snapshot
41182	50	Meta3	Metadata 3	string			no		Metadata included when taking and signing a snapshot
41232	2	Evt	Events	bitfield32			no		See chapter 17.5, Event flags of critical events of counter and communication module. A problem exists if this value is different from zero.
41234	1	NSig	Number Of Signature Registers	uint16			no		Number of repeating blocks Sig of the signature

41235	1	BSig	Number Of Signature Bytes	uint16			no		Actual number of bytes of the signature
41236	1	Sig	Digital Signature	uint16			no		Repeating block with binary data of the signature in DER format

Signed Start Snapshot

In this model instance, a signed snapshot of the start of a charging process (without switching) is provided.

Data Model Address	Register	ID	Label	Type	Unit	Scale factor	Writable	Default Value	Description
41284	1	ID	Model ID	uint16			no	64901	Model snapshot
41285	1	L	Model Payload Length	uint16			no	260	Without the fields 'Model ID' and 'Length payload'.
41286	1	Typ	Snapshot Type	enum16			no	3	Signed measurement start, See chapter 17.5
41287	1	St	Snapshot Status	enum16			yes		See Chapter 17.5, Writing 'Update' triggers the creation of a snapshot

41288	2	RCR	Real Energy Imported Since Last Turn-On Sequence	acc32	Wh	Wh_SF	no		
41290	2	TotWhExp	Total Watt-hours Exported	acc32	Wh	Wh_SF	no		
41292	1	Wh_SF		sunssf			no		
41293	1	W	Watts	int16	W	W_SF	no		
41294	1	W_SF		sunssf			no		
41295	8	MA1	Meter Address 1	string			no		
41303	2	RCnt	Response Counter	uint32			no		
41305	2	OS	Operation-Seconds Counter	uint32	s		no		

41307	2	Epoch	Current Epoch Time	uint32	s		no		
41309	1	TZO	Timezone Offset	int16	min		no		
41310	2	EpochSetCnt	Time Set Counter	uint32			no		
41312	2	EpochSetOS	Time Last Set At Operation-Seconds	uint32	s		no		
41314	1	DI	Digital Input State	uint16			no		
41315	1	DO	Digital Output State	uint16			no		
41316	70	Meta1	Metadata 1	string			no		Metadata included when taking and signing a snapshot

41386	50	Meta2	Metadata 2	string			no		Metadata that is included when taking and signing a snapshot
41436	50	Meta3	Metadata 3	string			no		Metadata included when taking and signing a snapshot
41486	2	Evt	Events	bitfield32			no		See chapter 17.5, Event flags of critical events of counter and communication module. A problem exists if this value is different from zero.
41488	1	NSig	Number Of Signature Registers	uint16			no		Number of repeating blocks Sig of the signature
41489	1	BSig	Number Of Signature Bytes	uint16			no		Actual number of bytes of the signature
41490	1	Sig	Digital Signature	uint16			no		Repeating block with binary data of the signature in DER format

Signed End Snapshot

A signed snapshot of the end of a charging process (without switching) is provided in this model instance.

Data Model Address	Register	ID	Label	Type	Unit	Scale factor	Writable	Default Value	Description
41538	1	ID	Model ID	uint16			no	64901	Model snapshot
41539	1	L	Model Payload Length	uint16			no	260	Without the fields 'Model ID' and 'Length payload'.
41540	1	Typ	Snapshot Type	enum16			no	4	Signed measurement end, See chapter 17.5
41541	1	St	Snapshot Status	enum16			yes		See Chapter 17.5, Writing 'Update' triggers the creation of a snapshot
41542	2	RCR	Real Energy Imported Since Last Turn-On Sequence	acc32	Wh	Wh_SF	no		
41544	2	TotWhExp	Total Watt-hours Exported	acc32	Wh	Wh_SF	no		
41546	1	Wh_SF		sunssf			no		

41547	1	W	Watts	int16	W	W_SF	no		
41548	1	W_SF		sunssf			no		
41549	8	MA1	Meter Address 1	string			no		
41557	2	RCnt	Response Counter	uint32			no		
41559	2	OS	Operation-Seconds Counter	uint32	s		no		
41561	2	Epoch	Current Epoch Time	uint32	s		no		
41563	1	TZO	Timezone Offset	int16	min		no		
41564	2	EpochSetCnt	Time Set Counter	uint32			no		

41566	2	EpochSetOS	Time Last Set At Operation-Seconds	uint32	s		no		
41568	1	DI	Digital Input State	uint16			no		
41569	1	DO	Digital Output State	uint16			no		
41570	70	Meta1	Metadata 1	string			no		Metadata included when taking and signing a snapshot
41640	50	Meta2	Metadata 2	string			no		Metadata that is included when taking and signing a snapshot
41690	50	Meta3	Metadata 3	string			no		Metadata included when taking and signing a snapshot

41740	2	Evt	Events	bitfield32			no		See chapter 17.5, Event flags of critical events of counter and communication module. A problem exists if this value is different from zero.
41742	1	NSig	Number Of Signature Registers	uint16			no		Number of repeating blocks Sig of the signature
41743	1	BSig	Number Of Signature Bytes	uint16			no		Actual number of bytes of the signature
41744	1	Sig	Digital Signature	uint16			no		Repeating block with binary data of the signature in DER format

OCMF Signed Current Snapshot

In this model instance, a signed momentary state is provided as OCMF for further use by the S.A.F.E. transparency software.

Data Model Address	Register	ID	Label	Type	Unit	Writable	Default Value	Description
41792	1	ID	Model ID	uint16		no	64903	Model OCMF data
41793	1	L	Model Payload Length	uint16		no	372	Without the fields 'Model ID' and 'Length of payload.

41794	1	Typ	Snapshot Type	enum16		no	0	Signed snapshot status, see chapter 17.5
41795	1	St	Snapshot Status	enum16		no		See chapter 17.5, write to the Status field of the corresponding snapshot to create it.
41796	496	O	OCMF	string		no		OCMF representation of the snapshot “Signed Current Snapshot”, the metadata field 1 is used as OCMF identity

OCMF Signed Turn-On Snapshot

When executing "Turn-on switch measurement coordination", the switching operation takes place after the already described switch measurement coordination. From a signed snapshot the OCMF format is created and provided here.

Data Model Address	Register	ID	Label	Type	Unit	Writable	Default Value	Description
42292	1	ID	Model ID	uint16		no	64903	Model OCMF data
42293	1	L	Model Payload Length	uint16		no	372	Without the fields 'Model ID' and 'Length payload.
42294	1	Typ	Snapshot Type	enum16		no	1	Signed switch-measurement coordination turn-on, See chapter 17.5.

42295	1	St	Snapshot Status	enum16		no		See chapter 17.5, write to the Status field of the corresponding snapshot to create it
42296	496	O	OCMF	string		no		OCMF representation of the snapshot for signed switch-measurement coordination turn-on, metadata field 1 is used as OCMF identity

OCMF Signed Turn-Off Snapshot

When executing "Turn-off switch measurement coordination", the switching operation takes place after the already described switch measurement coordination. From a signed snapshot the OCMF format is created and provided here.

Data Model Address	Register	ID	Label	Type	Unit	Writable	Default Value	Description
42792	1	ID	Model ID	uint16		no	64903	Model OCMF data
42793	1	L	Model Payload Length	uint16		no	372	Without the fields 'Model ID' and 'Length payload.
42794	1	Typ	Snapshot Type	enum16		no	2	Signed switch-measurement coordination turn-off, See chapter 17.5.

42795	1	St	Snapshot Status	enum16		no		See chapter 17.5, write to the Status field of the corresponding snapshot to create it
42796	496	O	OCMF	string		no		OCMF representation of the snapshot for signed switch-measure coordination turn-off, metadata field 1 is used as OCMF identity

OCMF Signed Turn-On Snapshot

From a signed snapshot of the start of a charging process (without switching) the OCMF format is created and provided here.

Data Model Address	Register	ID	Label	Type	Unit	Writable	Default Value	Description
43292	1	ID	Model ID	uint16		no	64903	Model OCMF data
43293	1	L	Model Payload Length	uint16		no	372	Without the fields 'Model ID' and 'Length payload'.
43294	1	Typ	Snapshot Type	enum16		no	3	Signed measurement start, See chapter 17.5

43295	1	St	Snapshot Status	enum16		no		See Chapter 17.5, write to the Status field of the associated snapshot to create it.
43296	496	O	OCMF	string		no		OCMF representation of the snapshot for signed switching measurement coordination turn-on, metadata field 1 is used as OCMF identity

OCMF Signed Turn-Off Snapshot

From a signed snapshot of finishing a charging process (without switching) the OCMF format is created and provided here.

Data Model Address	Register	ID	Label	Type	Unit	Writable	Default Value	Description
43792	1	ID	Model ID	uint16		no	64903	Model OCMF data
43793	1	L	Model Payload Length	uint16		no	372	Without the fields 'Model ID' and 'Length payload'.
43794	1	Typ	Snapshot Type	enum16		no	4	Signed measurement end, See chapter
43795	1	St	Snapshot Status	enum16		no		See chapter 17.5, write to the Status field of the

								corresponding snapshot to create it
43796	496	O	OCMF	string		no		OCMF representation of the snapshot for signed switching measurement coordination turn-off, metadata field 1 is used as OCMF identity

End

These registers mark the end of the data blocks according to SunSpec.

Data Model Address	Register	Label	Type	Default Value	Description
44292	1	Model ID	uint16	65535	
44293	1	Model Payload Length	uint16	0	

17.4. Register with write access

From all registers listed before the following ones are writeable.

With the help of suitable Modbus telegrams, the registers listed below can be changed at any time.

Data Model Address	Register	ID	Label	Type	Unit	Default Value	Description
40069	1	DA	Device Address	uint16		42	Modbus address is set
40083	2	Rte	Rate	uint32	bps		Baud rate can be set
40261	2	Epoch	Current Epoch Time	uint32	s		Setting the time for first operation and for time tracking
40263	1	TZO	Time zone Offset	int16	min		Setting the time zone
40269	1	DO	Digital Output State	uint16			Writing the least significant bit Register switches the output (safety function)
40280	70	Meta1	Metadata 1	string			Metadata included in snapshots, identification data for OCMF.
40350	50	Meta2	Metadata 2	string			Metadata included in snapshots
40400	50	Meta3	Metadata 3	string			Metadata included in snapshots

40525	1	St	Snapshot Status	enum16			See Chapter 17.5, Writing 'Update' triggers the creation of a snapshot
40779	1	St	Snapshot Status	enum16			See Chapter 17.5, Writing 'Update' triggers the creation of a snapshot
41033	1	St	Snapshot Status	enum16			See Chapter 17.5, Writing 'Update' triggers the creation of a snapshot
41287	1	St	Snapshot Status	enum16			See Chapter 17.5, Writing 'Update' triggers the creation of a snapshot
41541	1	St	Snapshot Status	enum16			See Chapter 17.5, Writing 'Update' triggers the creation of a snapshot

17.5. Enumerations

Some register values are of the enumeration type, which can be interpreted according to the tables below.

Status of an interface

Value	Meaning	Note
0	Inactive	
1	Active	
2	Error	

Events of the meter

The bit field for the events of the meter from the model AC meter and snapshots provides the bits described below. If any bit in this bit field is set, the device is not ready for operation.

Bit	Meaning	Note
16	Fatal error of the counter module	
17	Initialization signature module failed	
18	Check firmware hash signature module failed	
19	Signature module in development mode	

Type of binary data

The model for binary data (BLOBs) is universal. This enumeration type describes the provided data.

Value	Meaning	Note
0	Firmware-Hash	

Type of a signed snapshot

The three register blocks in which the snapshots are displayed have the same layout. To be able to distinguish them better afterwards, they have the register entry "Type" (example: 40524). The value indicates which type of snapshot is present:

Value	Meaning	Note
0	Signed Current Snapshot	
1	Signed Turn-On Snapshot	
2	Signed Turn-Off Snapshot	
3	Signed Start Snapshot	

4	Signed End Snapshot	

Status of a signed snapshot

Wert	Name	Bemerkung
0	Valid	
1	Invalid	
2	Updating/update	Writing this value triggers an update
3	Failed: general error	
4	Failed: no charge release via DOE	Can occur with switch-measurement coordination turn-on
5	Failed: incorrect feedback from contactor via DI	Can occur during switch-measurement coordination turn-on and turn-off

18. Appendix B: Communication

The Modbus interface is designed as RTU via RS-485 with the following parameters:

- Data lines A/- and B/+
- Transmission rate 2,400-115,200 Baud (default 19,200 Baud)
- Parity even
- 8 data bits
- 1 stop bit

Example: Reading the current energy consumption

The current meter reading of the current active energy consumption can be read off via three registers according to the register overview (Appendix A):

- The numerical value of the meter readings from the holding registers at the Modbus addresses 40137 and 40138
- The exponent of the associated scaling factor at the Modbus address 40145
- The unit of active energy consumption explicitly defined as Wh (watt-hour)

In this example the readout provides the values:

R[40137] = 0x00bc, R[40138] = 0x614e and R[40145] = 0x0000

The numerical value is derived from this: 0xbc614e = 12,345,678

and the scaling factor: 10^0 = 1

combined to 12,345,678 * 1 Wh

and thus the value 12,345,678 Wh or 12,345.678 kWh.

Set the time

The time is set by writing the following registers in the signing meters block.

Address	Register	Name	Type	Unit	Comment
40261	2	Current time UTC	uint32	s	Epoch time, “Unix Time”, seconds since 1.1.1970 00:00
40263	1	Offset local time to UTC	int16	min	

Example:

1574076961 s with offset 60 min. is 18.11.2019, 12:36:01 p.m. CET

1574076961 = 0x5dd28221

60 = 0x3c

Assignments to registries:

R[40261] = 0x5dd2, R[40262] = 0x8221, R[40263] = 0x003c

To achieve the full lifetime of the meter in operating hours, the time must not be readjusted more often than in a 24 h cycle. If a smaller period of time adjustment is permanently selected, the operating hours will be shortened and the warranty period will become invalid. One-time time readjustments beyond the normal cycle are permitted. If there is a larger time deviation after 24 h (>1%), this is a fault condition and must be checked by the manufacturer.

Set metadata for billing

In all blocks that map a snapshot, there are three data points for metadata. These can be freely described with a character string (type: string.) Usually, billing-relevant data for a load flow are recorded here. These should be described before the first snapshot is taken. If desired, these fields can also remain blank without an error message being generated.

As an example of a charging process in the e-mobility, the metadata in the register block “signing meter” can

be described as follows

- Customer-ID badeafea in metadata 1 (register address 40280)
- Type of Customer-ID RFID tag in metadata 2 (register address 40350)
- EVSE ID DE*BDO*E12345*1 in metadata 3 (register address 40400)

When using the signed snapshots (without OCMF), the length of the data points of 140 ASCII characters can be used as desired. For characters outside ASCII, a byte encoding such as UTF-8 or ISO 8559-1 (Latin 1) must be used, which may reduce the number of effectively usable characters.

In OCMF, some characters have a special meaning:

- Control characters (U+0000 up to and including U+001F).
- quotation marks (", U+0022)
- Backslash (\, U+005C)
- Vertical bar (|, U+007C)

If these are used in metadata, a longer replacement representation is resorted to for OCMF output, which reduces the number of characters that can effectively be used.

19. Appendix C: Create snapshots

Creating and reading out a snapshot

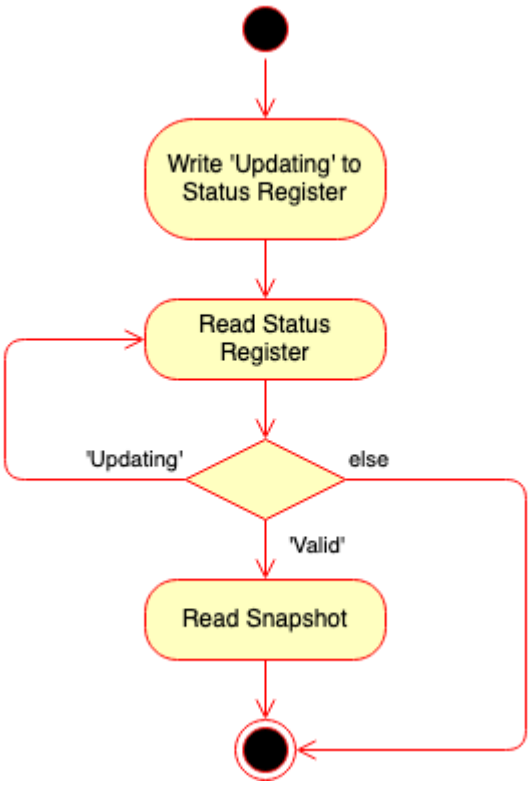
A snapshot is requested by writing “Being updated/update” in the status register of the block.

Example for a signed current snapshot: Set register 40525 to 2

The status register is then polled until it is “valid” or indicates an error. If the creation of the snapshot was successful, the data of the block can be read out.

Example: Register 40525 is set to 0 if valid

Basic procedure:



20. Appendix D: Details about the signing

Public Key

The BSM model provides the public key DER-encoded according to RFC 5480 (https://tools.ietf.org/html/rfc5480) via its repeating block:

- Data point NPK with length of the public key area in registers: Register 40450
- Data point BPK with length of the public key data contained therein in bytes: Register 40451
- Repeating data point PK with public key data contained therein: starting at register 40452

The key data contains information about the signature method, the curve used and the curve point of the public key. The byte order is big-endian.

Example:

- Length of the public-key area (NPK): 48 registers.
- Contents of the public key area:
  3059301306072a8648ce3d020106082a8648ce3d030107034200044bfd02c1d85272ceea9977db26d72cc401d9e5602faeee7ec7b6b62f9c0cce34ad8d345d5ac0e8f65deb5ff0bb402b1b87926bd1b7fc2dbc3a9774e8e70c72540000000000

- Length of the public key (BPK): 91 bytes
- Public-Key as DER:
  3059301306072a8648ce3d020106082a8648ce3d030107034200044bfd02c1d85272ceea9977db26d72cc401d9e5602faeee7ec7b6b62f9c0cce34ad8d345d5ac0e8f65deb5ff0bb402b1b87926bd1b7fc2dbc3a9774e8e70c7254

- Interpretation using OpenSSL's asn1parse (https://www.openssl.org/docs/man1.1.1/man1/openssl-asn1parse.html):

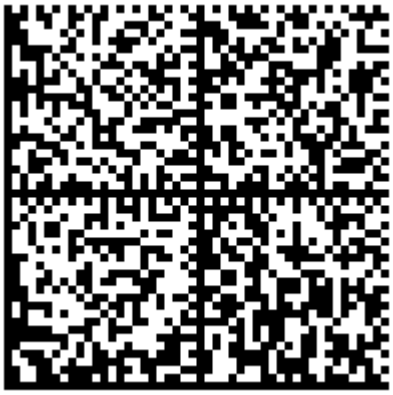
  ```
  $ openssl asn1parse -inform der -in charging-demo-20201111-24-public-key.bin -i -dump
  0:d=0  hl=2 l=  89 cons: SEQUENCE
  2:d=1  hl=2 l=  19 cons:  SEQUENCE
  4:d=2  hl=2 l=   7 prim:   OBJECT           :id-ecPublicKey
  13:d=2  hl=2 l=   8 prim:   OBJECT           :prime256v1
  23:d=1  hl=2 l=  66 prim:  BIT STRING
    0000 - 00 04 4b fd 02 c1 d8 52-72 ce ea 99 77 db 26 d7   ..K….Rr...w.&.
    0010 - 2c c4 01 d9 e5 60 2f ae-ee 7e c7 b6 b6 2f 9c 0c   ,....`/..~.../..
    0020 - ce 34 ad 8d 34 5d 5a c0-e8 f6 5d eb 5f f0 bb 40   .4..4]Z...]._..@
    0030 - 2b 1b 87 92 6b d1 b7 fc-2d bc 3a 97 74 e8 e7 0c   +...k...-.:.t...
    0040 - 72 54
  ```

- The bit string contains the point coordinates according to SEC1 (https://www.secg.org/sec1-v2.pdf):
  Prefix for uncompressed point: 0004

  X: 4bfd02c1d85272ceea9977db26d72cc401d9e5602faeee7ec7b6b62f9c0cce34

  Y: ad8d345d5ac0e8f65deb5ff0bb402b1b87926bd1b7fc2dbc3a9774e8e70c7254

A QR code is printed on the front of the meter, which contains the public key in full format (DER).



{V1

AA1BZR1520110401

AC3059301306072a8648ce3d020106082a8648ce3d030107034200044bfd02c1d85272ceea9977db26d72cc401d9e5602faeee7ec7b6b62f9c0cce34ad8d345d5ac0e8f65deb5ff0bb402b1b87926bd1b7fc2dbc3a9774e8e70c7254

}

AA = Multi-vendor identification number

AC = Public Key

Signature

The snapshots provide the signature DER-encoded according to RFC 4299 (https://tools.ietf.org/html/rfc4492) analogous to the public key in the BSM model via their repeating block. Example: Turn-on measurement coordination:

- Data point NSig (register 40980) provides the length of the signature area in registers
- Data point BSig (register 40981) provides the length of the signature data in bytes
- The repetition of data point Sig (registers 40982 to 41029) provides the signature

The signature consists of a sequence of the values r and s. The byte sequence is big-endian. Example:

- Length of the signature area (NSig): 48 registers
- Contents of the signature area:
  30450220633af3e89b89747ed105f7b7df02b814ad289dc8d20aed6815c184e4344a0109022100d1e0019af352cadc5aef90687903c54c0e41074a3ede65d8798769ab4495932900000000000000000000000000000000000000000000000000000000000000

- Length of signature data (BSig): 71 bytes
- Signature data
  30450220633af3e89b89747ed105f7b7df02b814ad289dc8d20aed6815c184e4344a0109022100d1e0019af352cadc5aef90687903c54c0e41074a3ede65d8798769ab44959329

- Interpretation of signature data using OpenSSL's asn1parse:

```
$ openssl asn1parse -inform der -in charging-demo-20201111-25-signature.bin -i -dump
0:d=0  hl=2 l=  69 cons: SEQUENCE
2:d=1  hl=2 l=  32 prim:  INTEGER :633AF3E89B89747ED105F7B7DF02B814AD289DC8D20AED6815C184E4344A0109
36:d=1  hl=2 l=  33 prim:  INTEGER   :D1E0019AF352CADC5AEF90687903C54C0E41074A3EDE65D8798769AB44959329
```

- The two integer values in it are r and s of the signature.

The signature can be verified by means of a public key.

Hash (SHA-256)

The hash is an abstract representation of the data over which the hash is formed. All numerical values from it have the following properties:

- Numerical values Big Endian
- Numerical values as scaled value with unit
  - 32-bit numerical value (with or without sign)
  - 8-bit scaling factor (signed, explicitly given or 0)
  - 8-bit scaling factor (unsigned, explicitly or implicitly specified via register overview)
- Character strings as length and data
  - 32-bit length
  - Length data bytes

The following data are included in the hash calculation. The hash is formed via the representation in the column Data in the order of the table:

Label	ID	Format Hash	Sample	Data
Snapshot Type	Typ	SUI32	1	0000000100ff
Total Watt-hours Imported	TotWhImp	SUI32	268 Wh	0000010c001e
Watts	W	SI32	0.0 W	00000000011b
Meter Address 1	MA1	String	001BZR1520200007	00000010303031425a5231353230323030303037
Response Counter	RCnt	SUI32	49	0000003100ff
Operation-Seconds Counter	OS	SUI32	14980 s	00003a840007
Current Epoch Time	Epoch	SUI32	1602145353 s	5f7ecc490007
Timezone Offset	TZO	SI32	120 min	000000780006
Time Set Counter	EpochSetCnt	SUI32	22	0000001600ff

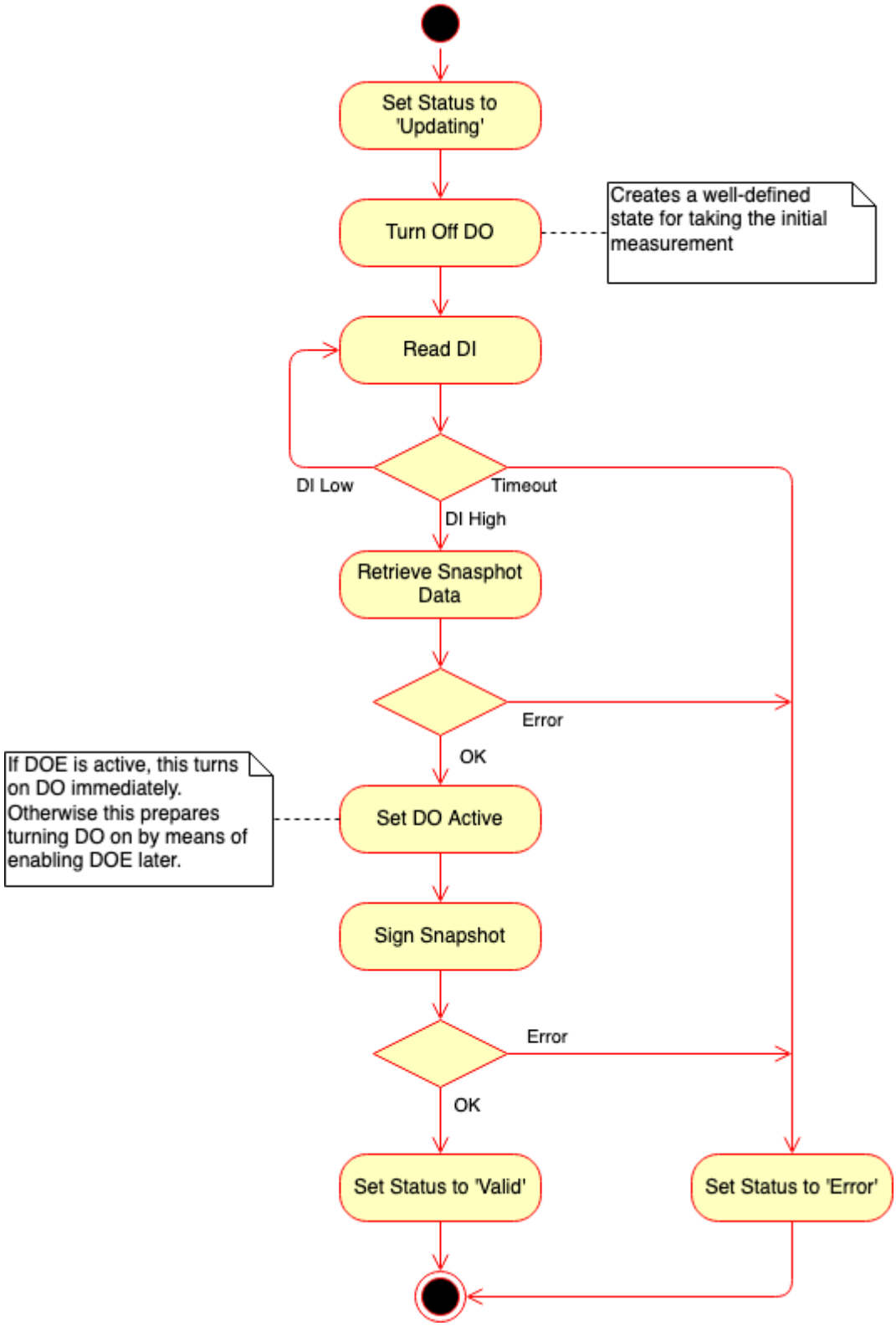
Time Last Set At Operation-Seconds	EpochSetOS	SUI32	14954 s	00003a6a0007
Digital Input State	DI	SUI32	1	0000000100ff
Digital Output State	DO	SUI32	0	0000000000ff
Digital Outputs Last Changed At Operation-Seconds	DIChgOS	SUI32	Not available	ffffffff0007
Digital Inputs Last Changed At Epoch Time	DIChgEpoch	SUI32	Not available	ffffffff0007
Digital Inputs Last Changed Timezone Offset	DIChgTZO	SI32	Not available	ffff80000006
Digital Outputs Last Changed At Operation-Seconds	DOChgOS	SUI32	Not available	ffffffff0007
Digital Outputs Last Changed At Epoch Time	DOChgEpoch	SUI32	Not available	ffffffff0007
Digital Outputs Last Changed Timezone Offset	DOChgTZO	SI32	Not available	ffff80000006
Metadata 1	Meta1	String	chargeIT up 12*4, id: 12345678abcdef	00000024636861726765495420757020313 22a342c2069643a2031323334353637386162636465 66
Metadata 2	Meta2	String	demo data 2	0000000b64656d6f20646174612032
Metadata 3	Meta3	String	Not available	00000000
Events	Evt	SUI32	0	0000000000ff

The hash over this sample data:

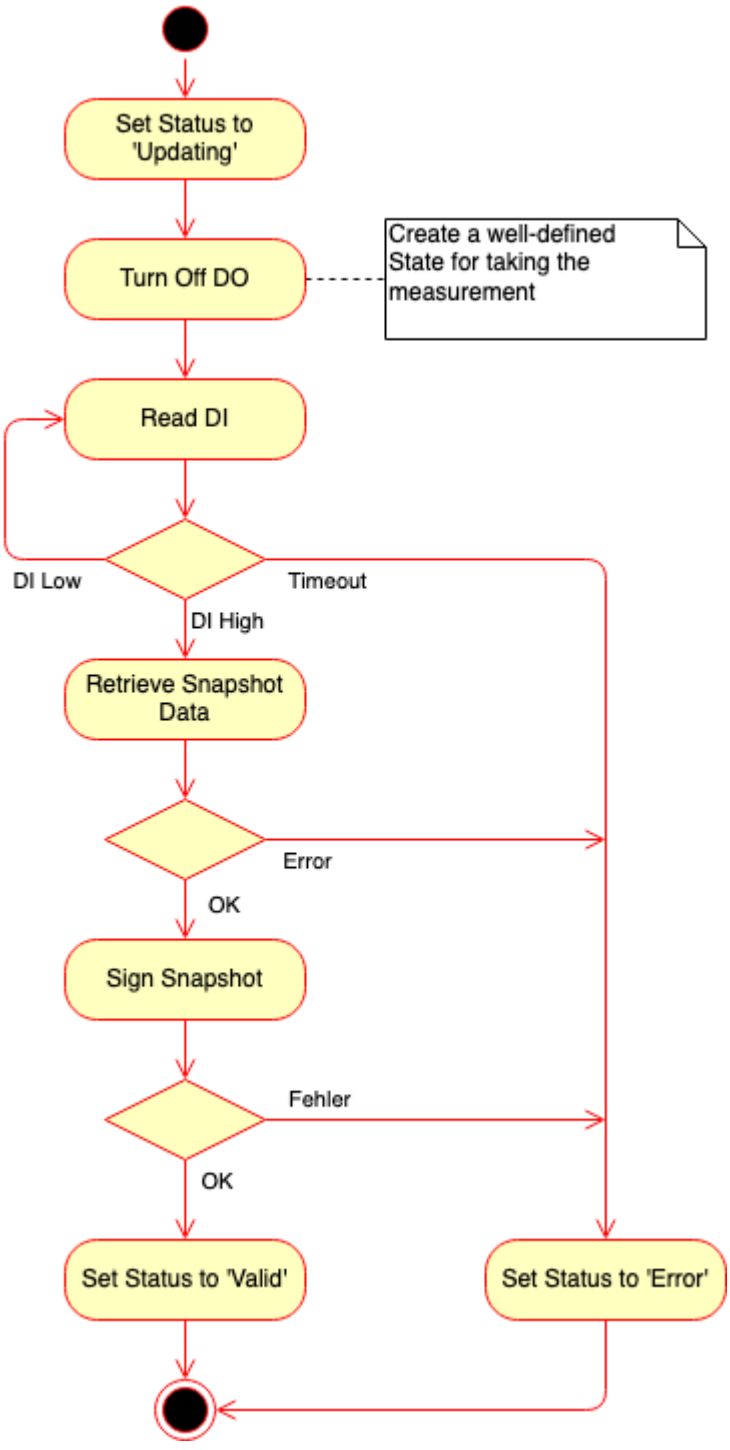
cab351d004e662963ca855717cc7ba55cc84b11a655d0d1db4c705d05796e7

21. Appendix E: Switch-measurement coordination

Principle of turn-on procedure: Register 40779 is set to 2. The following sequence is then automatically controlled by the firmware.



Principle of turn-off procedure: Register 41033 is set to 2. The following sequence is then automatically controlled by the firmware.



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