GSH01 product manual

Single phase DC meter

DZG Metering GmbH, Heidelberger Str. 32, D-16515 Oranienburg

2022-12-08

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File History:

15.04.2020	Initial Version of Documentation
05.11.2020	Updating Documentation: - Reworked Display State Machine - Added Register Description - Reworked Status Word - Updated general Properties of the GSH - Updated and reworked overall formatting of the Documentation
13.01.2021	- Reworked and added more content to the display state machine - Reworked the Register Definitions by simplifying and augmenting its content - Updated description of the Operation Modes - Updated content of the Status Word - Updated content of the Eichlog - Added missing information
20.01.2021	- Updated Charging Process
25.01.2021	- Minor Text changes - Changed Figure Display State Machine
02.02.2021	- Updated illustration regarding the import energy flow
05.02.2021	- Additional nameplate description in German language - Wiring picture at installation section
19.02.2021	- New PIN out picture (Fig. 5) - New type code
24.02.2021	- Small additions to the document regarding the displayed digits - Added mbed TLS version - Added calculation of the Charging Session Values - Updated OCMF Register Lists
25.02.2021	- New nameplate, drawing of meter side - Humidity, power consumption current circuit - Updated CAD Model Figures
04.03.2021	- new dimensioned constructional drawing of the housing
16.03.2021	- small adjustments of the text
24.03.2021	- adjust the Status word regarding the meter communication error - added the max peak over voltage and over current ratings to the installation and safety tap
31.03.2021	- updated OCMF Examples
09.04.2021	- updated firmware description
12.05.2021	- nameplate with Kl. B (EN50470)
14.09.2021	- updated description of "Show Public Key" at 11.1.2.4
27.10.2021	- updated Statusword and register description

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17.01.2022	- updated:
	    • display states and display symbols
	    • OCMF description for Export
	    • Behavior of the metrological led
	    • register list for Export
	    • EichLog book
	    • status word
	    • overall logical addresses and registers

21.01.2022	- updated:
	    • accuracy Class of the meter
	    • meter type description

24.01.2022	- updated status word
27.01.2022	- updated status word

28.01.2022	- updated:
	    • displayed registers (for Import, Export and combined Mode)
	    • OCMF registers and readings for start and stop

23.02.2022	- updated:
	    • application firmware version and checksum
	    • LCD symbols
	    • accuracy test minimum measurement time and minimum amount of energy
	    • updated nameplate

30.05.2022	- updated:
	    • Changed configuration structure
	    • changed read OCMF commands
	    • new Display item option
	    • restriction setting RTC
	    • public key display update
	    • new backlight setting

04.08.2022	- updated:
	    • Status Metering Load Active Description in Status Word
	    • Removed incompatible features with current metering firmware (export, pulse led source)

12.08.2022	- removed legacy configuration option: display rotation

16.09.2022	- updated:
	    • removed not available option to change the pulse led energy source in metering firmware version 1.22
	    • added display message when Eichlog or Eichrecht memories are full

11.11.2022	• updated firmware version • added Baumusterprüfbescheinigung: Messrichtigkeitshinweise
21.11.2022	• updated contrast voltage configuration statement • fixed typo in firmware version
08.12.2022	• updated nameplate

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Content

1   Properties

1.1   Common

The GSH01 is a DC meter for direct installation in e-mobility charging stations. It provides the measurement data records with timestamp, loading process data and digital signature, thereby enabling charging processes to be billed in accordance with the legal requirements. Furthermore, all charging processes are persistently stored in the internal data storage of the meter.
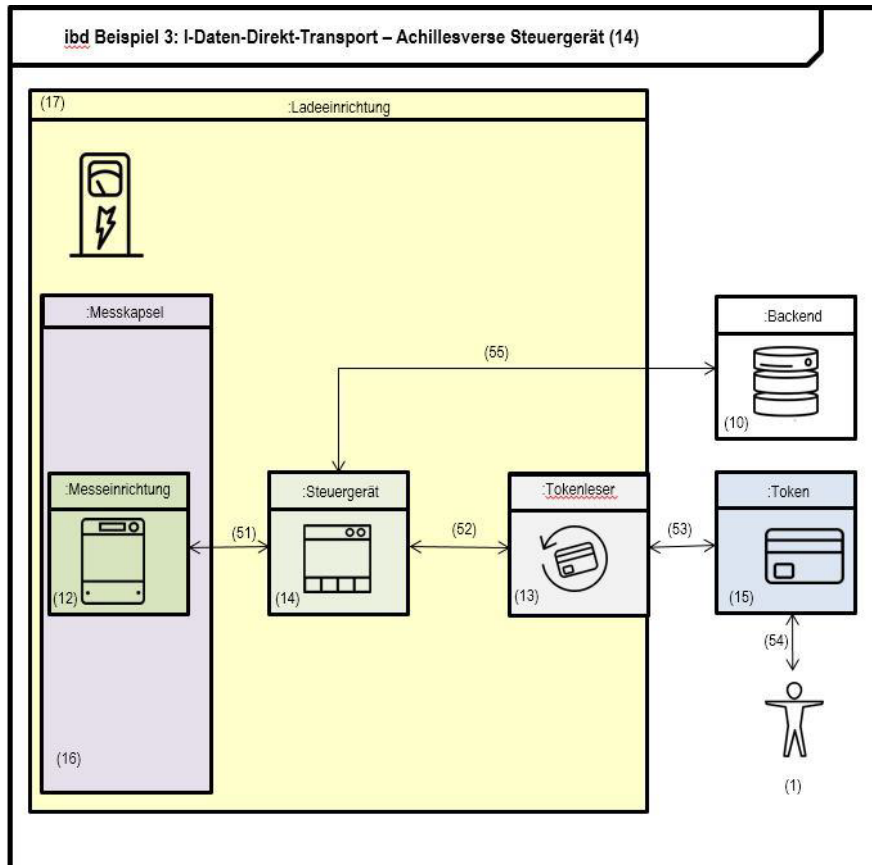
Figure 1: Schematic representation of the charging point structure.

According to Figure 1 the GSH01 acquires meter data, stores meter data and acts as meter data signer as part of the "Messkapsel". The connection between the main controller of the charging station and the GHS01 is realized by a RS485 interface. All signed, OCMF-formatted datasets have to be forwarded unchanged by the station controller. Thereby signature and datasets are always transmitted together. The user authentication process should be performed according to the OCMF specification subsection 4.3.4 [7]. After completing a charging session, the user has access to all session related data sets by the communication interfaces. By means of a transparency software application the signed data sets can be verified for billing purposes. All start and stop values of each individual charging session are persistently stored within the internal flash storage of the meter. All data sets obtained by the meter, contain a second index and a timestamp set by the charging station controller. The mentioned timestamp is a so called "Info-Uhr". This excludes a time-based tariffing. Charge process data sets are visualized after the charging process on the display of the meter.

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Through a transparency software application [10], the customer can check each charging processes invoiced individually. Furthermore, such an application visualizes the datasets of the charging processes during a billing period and shows the status of the signature verification and the amount of energy consumed.

1.2   Appropriate Use and Correctness of Measurements

The electricity meter GSH01 is designed for measuring electrical energy only. All other meter readings are non-verified functions and are for information purposes only. They may not be used for billing purposes.

Extract from Baumusterprüfbescheinigung:

Eine bestimmungsgemäße Verwendung ist nur bei Betrieb in einer mess- und eichrechtkonformen Ladeeinrichtung (REA Geräteart 6.8) nicht ausgeschlossen.

Nach Auftreten von Strömen über 15 600 A ist ein eichrechtskonformer Betrieb dauerhaft ausgeschlossen.

Bei Verwendung der RS485 Schnittstelle zur Ausgabe der Messwerte dürfen nur signierte Datentupel für den geschäftlichen oder amtlichen Verkehr verwendet werden, die nach Abschluss des Lademodus ausgegeben werden.

1.3 Properties

Type	GSH01	
Voltage		
U_{max}	1000 V	
U_{min}	150 V	
Current		
Starting current I_{st}	0.52 A	
Minimum current I_{min}	6.5 A	
Current I_{tr}	13 A	
Normal current I_{Ref}	130 A	
Maximum current I_{max}	650 A	
Accuracy		
Class	Class B, Class A	
Measuring Active Energy		
One Energy Direction	+A	
Energy Register		
Total Mains Import Energy	+A	
Total Device Import Energy		
Meter constant		
LED-Output	1000 Imp/kWh, Total Mains Energy	
Display		
LCD	Dot Matrix Display with 7.2 digits	
Life cycle	> 12 years	
External Display (Option)		
Communication port	All RJ12 ports	
RS485- Data Interface 1 and 2		
Connector	RJ12 ports	
Parameter	115200 bps, 8N1 (configurable)	
RS485- Data Interface 3		
Connector	RJ12 port	
Parameter	115200 bps, 8N1 (configurable)	
Power Consumption		
Voltage circuit	< 0.5 W at U_n	
Current circuit	< 0.12 W at I_{max}	
Auxiliary power supply	< 5 W	

Temperature Range	
Typical Operation	-40°C to +80°C
Storage	-40°C to +85°C
Humidity	
	max. 97,5 %, not condensing EN60068-2-30:1999
Environmental conditions	
Mechanical environmental conditions	M1
Electromagnetic environmental conditions	E2
Housing	
Dimension	DIN-Rail 115.6 mm(L) x 107.2 mm(W) x 70.9 mm(H)
Material	fiber-glass reinforced Polycarbonate
Storage	
Capacity for Start- and Stop-Charge Records > 225000	
Capacity of Logbook	> 2500

Table 1: Electrical and mechanical specifications.

Type	GSH01
Metering Firmware	
Version	V 1.22
Checksum	3A23
Application Firmware	
Version	v233
Checksum	1770
Hash	A61BFA275DF9E4CB0EF8222BB2C30A0C695088AAA6CD28B0BC4AD013F59DA971

Table 2: Firmware Properties.

1.4 Technical Standards

[1] EN50470-1: " *Allgemeine Anforderungen, Prüfungen und Prüfbedingungen - Messeinrichtungen (Genauigkeitsklassen A, B und C)*", Revision date

[2] EN50470-3:" *Besondere Anforderungen - Elektronische Wirkverbrauchszähler der Genauigkeitsklasse A, B und C*", Revision date June 2007

[3] IEC62052-41: "Electricity metering equipment (AC) – General requirements, tests and test conditions", Revision date February 2003

[4] DIN EN62052-11: „*Wechselstrom – Elektrizitätszähler Allgemeine Anforderungen, Prüfungen und Prüfbedingungen Teil 11: Messeinrichtungen*", Revision date November 2003

[5] VDE-AR-E 2418-3-100: „*Elektromobilität – Messsysteme für Versorgungseinrichtungen*", Revision date 29.08.2019

[6] EN 62053-41: "*Electrical Energy Measurement and Control*", Revision date 17.04.2020

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[7]   OCMF1.0: "Open Charge Metering Format", Revision date 21.02.2019

[8]   PTB – A 20.1: " *Messgeräte für Elektrizität: Elektrizitätszähler und deren Zusatzeinrichtungen*", Revision date December 2003

[9]   PTB – A 50.7: " *Anforderungen an elektronische und softwaregesteuerte Messgeräte und Zusatzeinrichtungen für Elektrizität, Gas, Wasser und Wärme*", Revision date April 2002

1.5   Additional Documents and Tools

[10]   Transparenzsoftware of the S.A.F.E Initiative, Version 1.01
https://www.safe-ev.de/global/downloads/transparenzsoftware_v1.01.jar
Hash: f40410bee007ec6cb9189f11c7d871d537955e25289dfb60a300f700db58fe6b

[11]   DC-Meter-Communication-Description: CommunicationDocumentation.pdf

[12]   DC-Meter-View
https://download.dzg-metering.de/apps/DZG.DC-Meter.View/DZG.DC-Meter.View.Setup_2.30.8.exe
SHA256: 03496B63A72AFD5BD879E9EC7263DF2D5 603A45091DC1D630DC95F4289D7C98F

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2 Safety

2.1 Responsibility

The owner or provider is responsible for the proper use of the device. The installation, putting into operation and reinstallation of the meter is only allowed to be done by electrically skilled persons, which got knowledge about the contents of this user manual.

2.2 Common safety instructions

For installation, setting into operation and de-installation of the device the local requirements for safety requirements have to be observed.

Danger
Inappropriate use of parts under high voltage may lead to grave injuries and accidents, which may be fatal.
The conductors which are connected to the device have to be disconnected to the mains during assembling and installation. It also has to be used a prevention for being switched on accidentally.

The device is not allowed to be used out of specifications.

2.3 Disposal (product end of life information)

This meter was designed and built by DZG to provide many years of service and is backed by our commitment to provide high quality support. When it eventually reaches the end of its serviceable life, it should be disposed of in accordance with local or national legislation.

2.4 Environment

This meter is designed for indoor use or in a cabinet environment only (avoiding extreme weather conditions) in accordance with IEC 62052-11 and IEC 62053-21, with the terminal cover fitted.

2.5 Service and warranty

This meter product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period DZG will at its option, either repair or replace products which prove to be defective. For warranty service or repair, this product has to be returned to a service facility designated by DZG. DZG does not warrant that the operation of the meter or firmware will be uninterrupted or error free. Damaged devices cannot be repaired. The warranty and liability will be terminated with opening the device. The same applies to damages caused by external influences. For the device, no servicing is required.

3   Type code

1	2	3	.	4	.	5	
							For direct Connection
	GSH						DC Meter for DIN Rail use
		01					Meter Series Number
				1			one energy direction (A+) with reverse locking
				2			two energy directions (A+) and (A-)
						A	has accuracy Class A
						B	has accuracy Class B

Figure 2: Type Code of the GSH01.

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4 Assembling and Installation

The DC meter can be used as a stand-alone meter without any additional equipment. This ensures a full range of functions with a compact design.

Overvoltage Protection
The isolated DC EV (Electric Vehicle) charging station has to reduce overvoltage to the meter and the EV to the rated impulse voltage of 2.5 kV.

Requirements for the connected charging station controller and the charging station as a whole
The public key and the Server ID of the GSH01 have to be attached to the charging station so that it is visible from the outside for each charging point.

Requirements for the transparency software
Transparency software has to be used to display the invoiced data in compliance with the legal requirements, which enables signature verification of the measurement data records for invoice control.

The transparency software is ready for download at:

- https://www.safe-ev.de/de/transparenzsoftware.php

4.1 Housing

The meter is constructed for assembling on DIN-rail TH 35-7.5 according to IEC 60715.
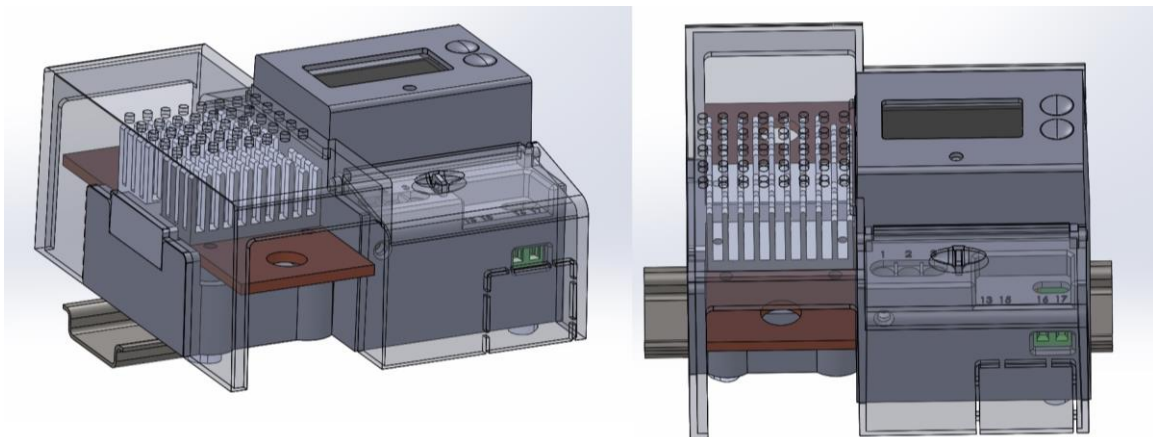
Figure 3: 3D CAD printing of the housing.

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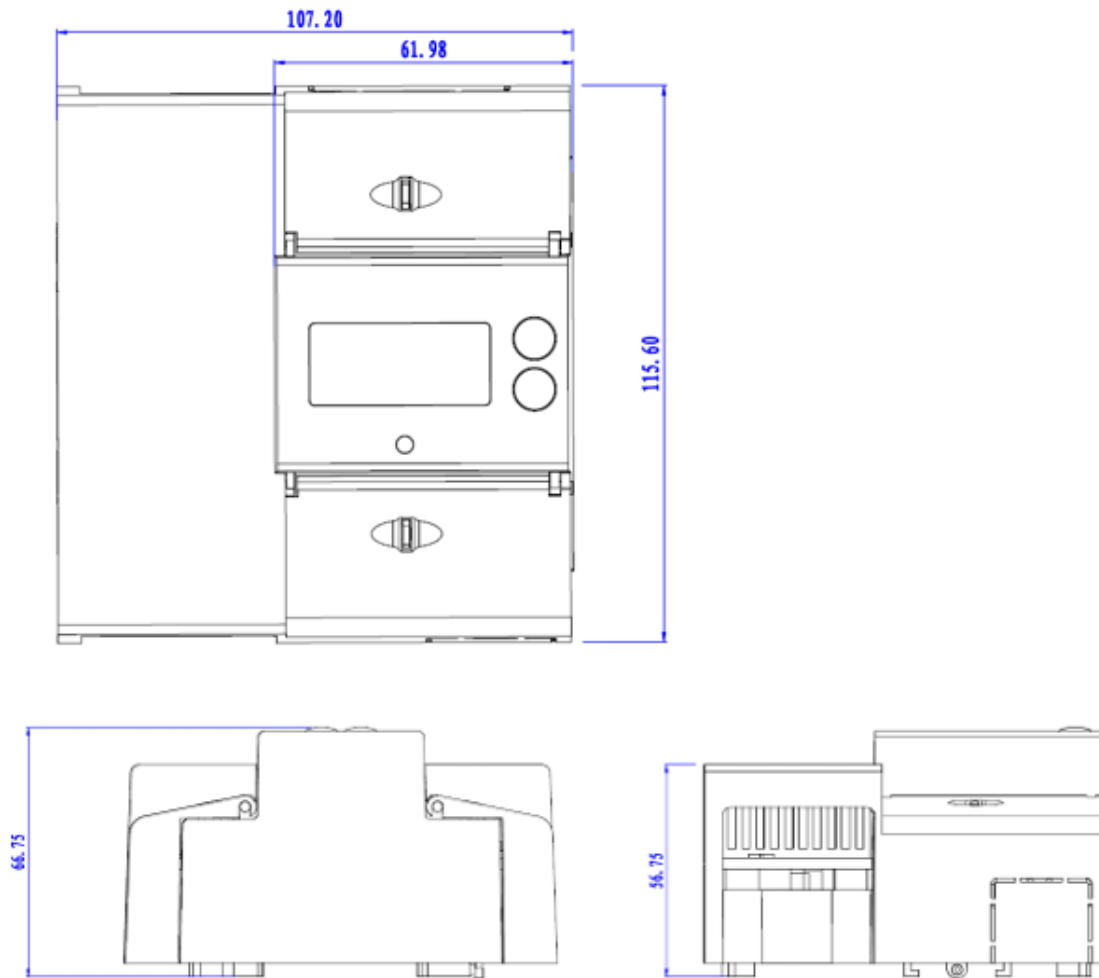
Figure 4: Dimensioned constructional drawing of the housing (unit: mm).

4.2   Installation and Safety

- The meter and all associated components may only be installed in compliance with all safety regulations. Ignoring these instructions may endanger life and the manufacturer will not take any responsibility.

- It is always mandatory to ensure the maximum peak voltage and maximum peak current of the desired application do not exceed the maximum peak values of the meter. Otherwise the meter gets damages due to overvoltage and or overcurrent. These peak values are 1000VDC (Max Voltage) + 3102V overvoltage margin and 650 A (Max Current) and 15 kA overcurrent margin.

- In order to ensure smooth operation of the meter, the manufacturer's seal of approval has to be obtained before installation. If this has expired or is missing, the meter has to be sent back to the manufacturer for a new test.

- The meter should be installed in dry and well-ventilated area. The meter should be installed on a top-hat rail away from flammable or vibrating components. During installation, the meter has to be ensured to operate properly. Possible damage to the

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meter has to be prevented by protective measures such as enclosures or protective caps.

- The connection has to be made according to Figure 5. The current-carrying lines are connected to the shunt of the meter using M8 or M10 nut screws. In order to prevent damage or corrosion due to a bad connection, a tightening torque of 17.5 to 20 Nm has to be applied.

- A torque of 0.5 to 0.6 Nm has to be applied to the voltage terminal (V+).

- If additional modules are used in conjunction with the meter, a communication link between these two devices can be established via one of the three RJ12 interfaces.

- After installation of the meter, it is mandatory to change the operating mode from assembling mode to normal mode. The manufacturer is not responsible for any damage caused by disregarding this instruction.
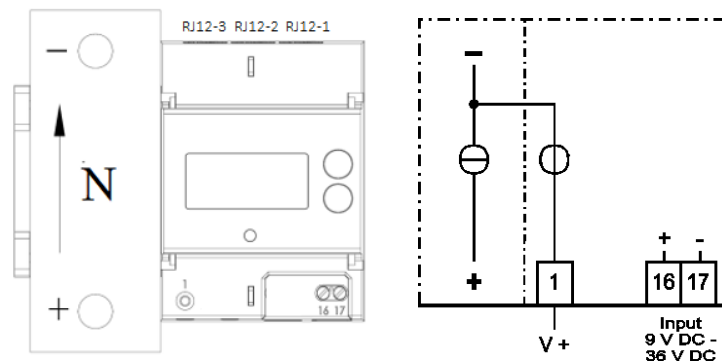
Figure 5: Pinout of the GSH01.
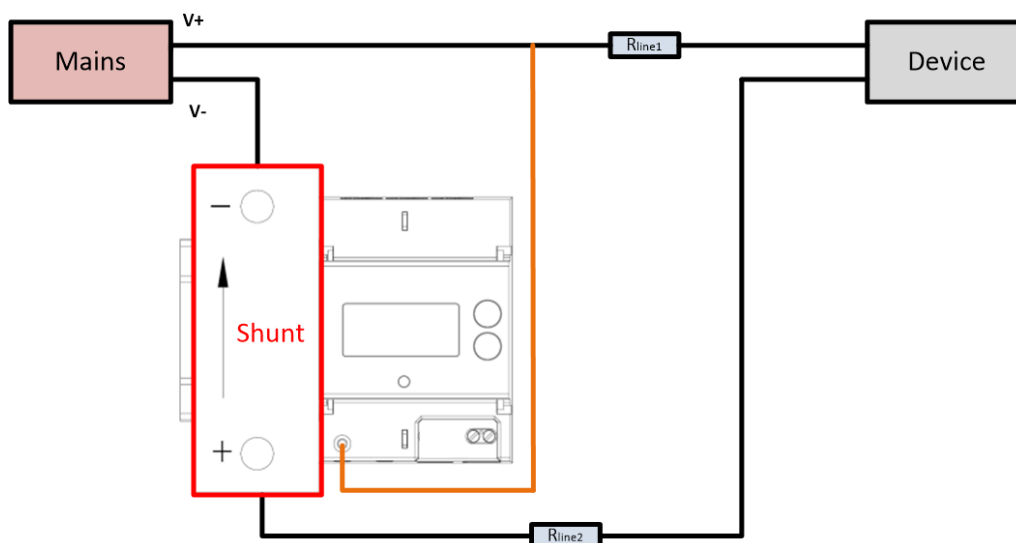
Figure 6: Wiring of the GSH01.

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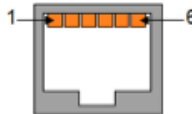
Item	Description	Notes
Current terminals	M10 screws	Terminals "+" and "- "on the Copper Shunt
Voltage terminals	#1: V+ AWG16-20	Upper Current Terminal: common ground (V-)
DC Power supply terminals	#16 (+), #17(-): MU1.5H5.08	9~36V
Communication interfaces	RJ12-1/2: Communication interface for a SMGW RJ12-3: Communication interface for a charger station controller	 PIN 1: RS485 A PIN 2: 12V PIN 3: GND PIN 6: RS485 B

Table 3: Physical Interfaces of the GSH01.

4.3   Protection housing

The meter cover is closed with screws and sealed with a security label.

Figure 7: Sealing of the meter.

5   Nameplate
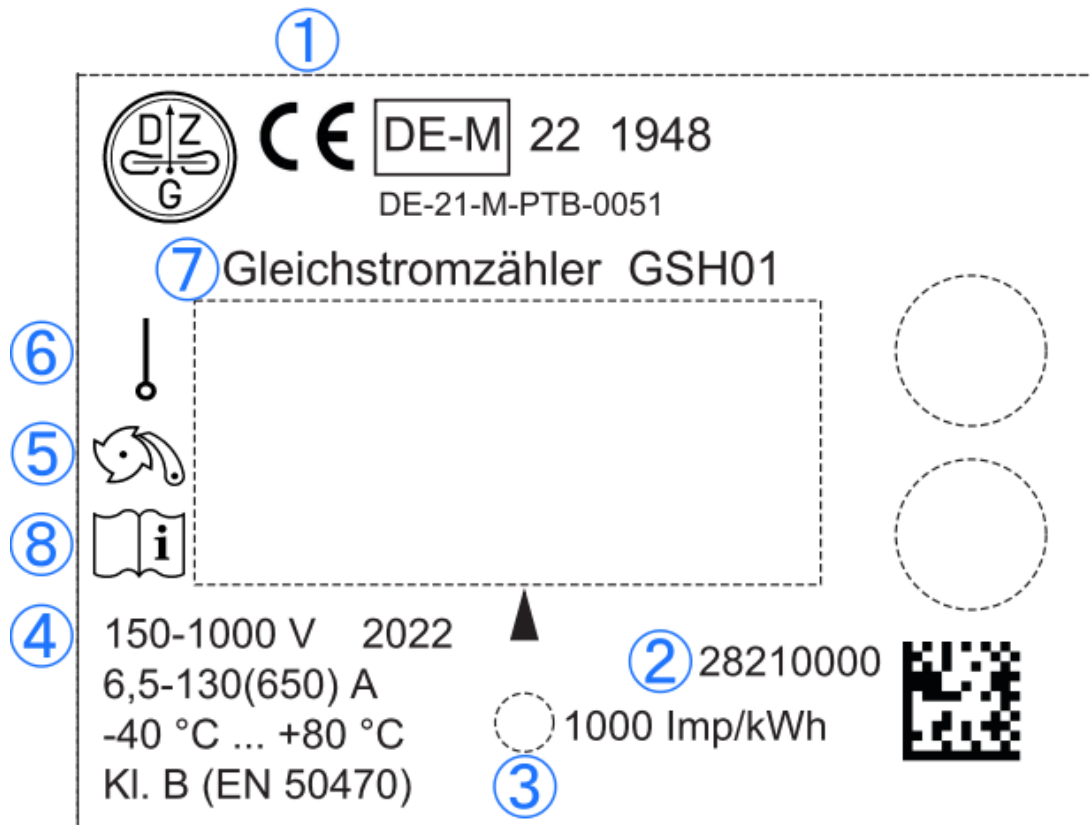
Figure 8: Nameplate

No.	Element	Function
1	information of certification	CE sign, year of certification, named body for approval
2	meter number	
3	Metrological LED	1000 Imp/kWh
4	technical nominal data	
5	energy directions	Import (+A) energy measurement
6	single phase	
7	type code	
8	documents attached	

Table 4: Description of the elements of the nameplate.

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Nr. Element	Erläuterung
1 Zulassungsinformationen	CE Zeichen mit nationaler Kennzeichnung, Jahreszahl, benannte Stelle und Nummer Baumusterprüfbescheinigung
2 Zählernummer	
3 Prüf-LED	1000 Imp/kWh
4 Techn.Nenndaten	
5 Rücklaufsperre	Energierichtung Bezug (+A)
6 Phasenanzahl	Einphasiger Betrieb
7 Zählertyp	

Table 5: Beschreibung Elemente Leistungsschild.
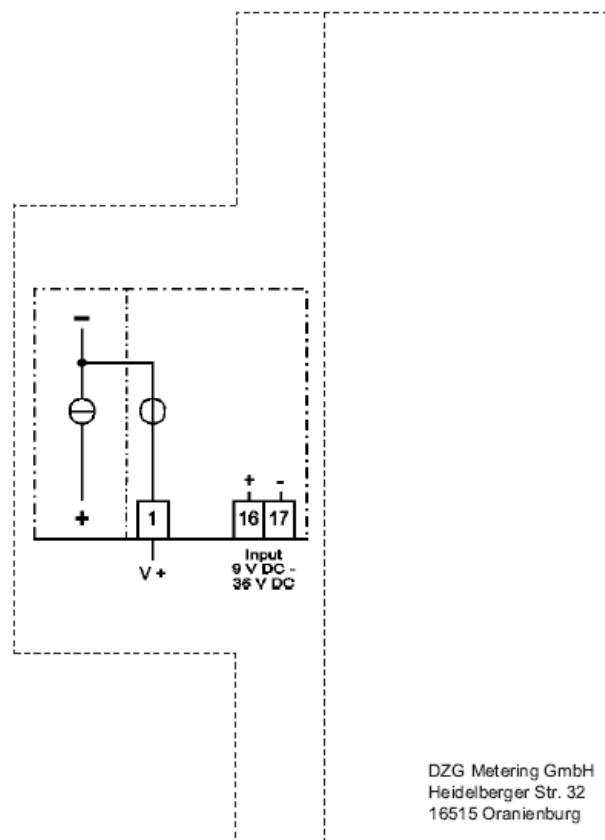
Figure 9: printing of meter side

6 Dot-Matrix-Display

The LCD is dot matrix type with the format 37.5 mm × 17 mm.
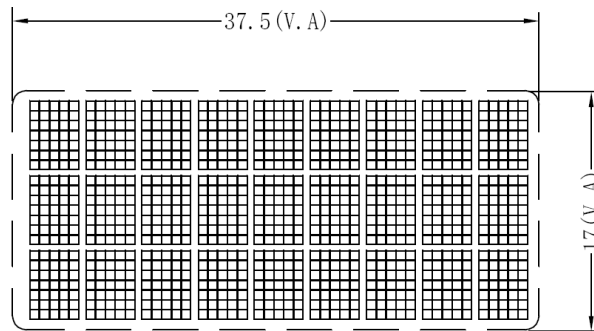
Figure 10: Schematic of the Dot Matrix LC Display (unit: mm).

Element	Number of digits
Energy	7.2
Line loss resistance	5.4
Instantaneous value	8.1

Table 6: Number of digits.

6.1 Internal Display State Machine

The control of the internal display consists of a state machine which changes the current display state according to the present meter data. Figure 11 shows the complete display state machine with all transitions and their corresponding conditions.

The contrast voltage may be configured during production at DZG within limits.
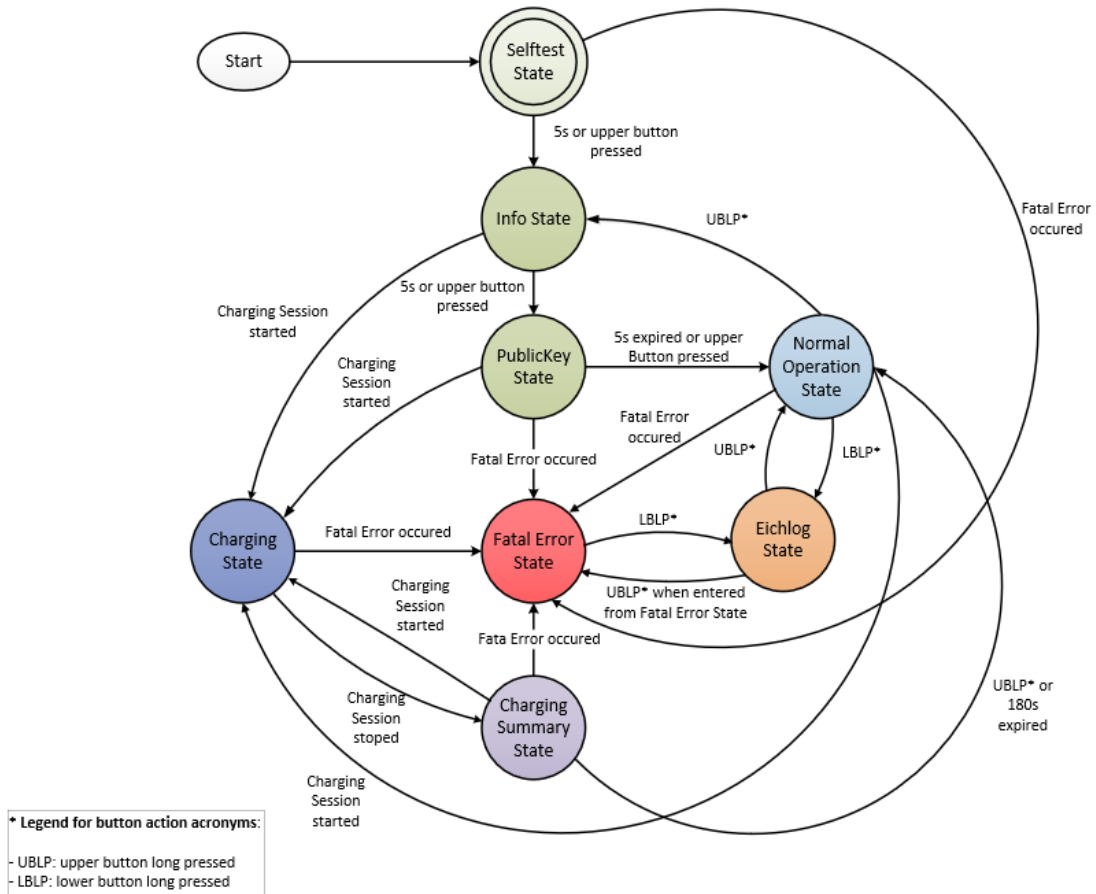
Figure 11: Schematic of the internal display state machine.

6.2 Display State Description

6.2.1 Display Selftest State

6.2.1.1 General Overview

In the Display Selftest State, the meter performs a test sequence on the display to ensure all pixels are fully functional. During this test sequence, a black bar is shown alternately in the lower and upper half of the screen, as shown exemplary in Figure 12. The bar is visible for 1 second at a time. The change between the lower and upper half of the display is carried out 3 times. The total duration of this state is therefore about 7 seconds. To facilitate the detection of faulty pixels during this display test, the backlight is continuously active.

Figure 12: Display Selftest State.

6.2.1.2 State Transition Conditions

This state transmits directly to the Display Init State without further intervention. The test can be skipped by pressing the upper button in order to enter the Display Init State immediately.

Furthermore, this state can be reached at any time during the Normal Operation Display State by holding the upper button element as shown in Figure 11.

If a fatal error occurs within this self-test state, the display and the entire meter will enter the Meter Fatal Error State.

6.2.1.3 Available Button Actions

- **Upper Button Short Press:** Skip the Display Selftest State and enter the Display Init State immediately.
- **Remaining Button Actions:** No effect.

6.2.2 Display Init State

6.2.2.1 General Overview

Within the Display Init State, the checksums and version numbers of the application- and the metering firmware are displayed, as shown in Figure 13. The displayed information can be assigned as follows:

1. Type designation of the meter
2. Server ID of the Meter
3. Application Firmware Version
4. Application Firmware Checksum
5. Metering Firmware Version
6. Metering Firmware Checksum
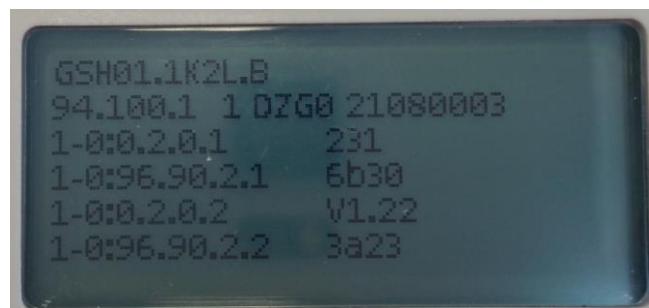
Figure 13: Display Init State.

6.2.2.2 State Transition Conditions

After 5 seconds, the meter changes into the Display State Public Key.
This transition can also be initiated by pressing the upper button shortly.

If a fatal error occurs within the Display Init State, the display as well as the entire meter will enter the Meter Fatal Error State.

If a charging session is started during the Init State, the display as well as the entire meter will enter the Charging State.

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6.2.2.3   Available Button Actions

- **Upper Button Short Press:** Skip the Display Init State and enter the Display Public Key State immediately.
- **Remaining Button Actions:** No effect.

6.2.3   Display Public Key State

6.2.3.1   General Overview

During the Display Public Key State is the public key accessible and humanly readable.

6.2.3.2   State Transition Conditions

After 5 seconds, the meter changes into the Display State Normal Operation.
This transition can also be initiated by pressing the upper button shortly.

If a fatal error occurs within the Display Public Key State, the display as well as the entire meter will enter the Meter Fatal Error State.

If a charging session is started during the Public Key State, the display as well as the entire meter will enter the Charging State.

6.2.3.3   Available Button Actions

- **Upper Button Short Press:** Skip the Display Public Key State and enter the Display Normal Operation State immediately.
- **Remaining Button Actions:** No effect.

6.2.4   Display Normal Operation State

6.2.4.1   General Overview

During the Normal Operation Mode, all meter readings obtained from the meter in general outside of a charging process as well as general information of the meter are displayed as shown in Figure 14. The values to be displayed (marked in yellow) are rotated according to a configured interval. All values relevant to calibration law are displayed in the upper line and all informative values in the lower line.
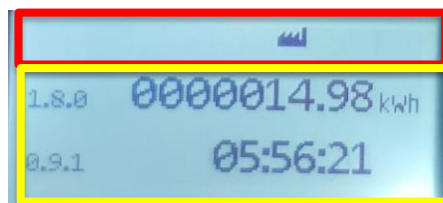
Figure 14: Display State Normal Operation.

The standard setting for the rotation interval of the display values is 5 seconds. Table 7 shows all displayed values, including their relevance. The listed registers are written to the meter during production. The registers in the bottom line (informative registers) can be altered by the customer at any time. This is NOT possible for the registers of the upper line, which are used for billing purposes.

Upper Line Content (Billing Relevant)		
Obis Code	**Name**	**Relevant for billing**
1-0:1.8.0*255	Total Import Mains Energy	yes
1-0:140.7.0*255	Line Loss Impedance	yes
1-0:152.8.0*255	Total Transaction Import Device Energy	yes
Lower Line Content (Informative)		
1-0:32.7.0*255	Phase L1 Voltage	no (informative)
1-0:31.7.0*255	Phase L1 Current	no (informative)
1-0:16.7.0*255	Total Mains Power	no (informative)
1-0:156.7.0*255	Import Device Power	no (informative)
1-0:0.9.1*255	Device Time	no (informative)
1-0:0.9.2*255	Device Date	no (informative)
1-0:154.8.0*255	Total Import Line Loss Energy	no (informative)
1-0:156.8.0*255	Total Import Device Energy	no (informative)
1-0:94.49.0*2	Public Key	no (informative)

Table 7: Visible content of the Display State Normal Operation.

OCMF Content (Informative)	
Obis Code	**Name**
1-1:98.128.0*255	FV (Format-Version)
1-1:98.128.1*255	GI (Gateway-Identification)
1-1:98.128.2*255	GS (Gateway-Serial)
1-1:98.128.3*255	GV (Gateway-Version)
1-1:98.128.8*255	PG (Pagination)
1-1:98.128.16*255	MV (Meter-Vendor)
1-1:98.128.17*255	MM (Meter-Model)
1-1:98.128.18*255	MS (Meter-Serial)
1-1:98.128.19*255	MF (Meter-Firmware)
1-1:98.128.24*255	IS (Identification-Status)*
1-1:98.128.27*255	IT (Identification-Type)*
1-1:98.128.28*255	ID (Identification-Data)*
1-1:98.128.32*255	CT (Charge-Point-Identification-Type)
1-1:98.128.33*255	CI (Charge-Point-Identification)

*Available after first charge process after power cycle.

Table 8: OCMF display content: normal operation (refer to https://github.com/SAFE-eV/OCMF-Open-Charge-Metering-Format/blob/master/OCMF-de.md)

The general information of the meter is displayed with symbols in the upper part of the screen (marked red). An explanation of the displayed symbols can be found in chapter 6.3.

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6.2.4.2 State Transition Conditions

Starting a Charging Session during the Display Normal Operation State, results in a transition to the Charging State. If a fatal error occurs within this state, the display as well as the entire meter will enter the Meter Fatal Error State. All remaining transitions are caused by a button event. These are discussed in more detail in the next subsection. If neither the above conditions nor a button event that can cause a change of state occurs, the display and the meter remain in the Normal Operation display state.

6.2.4.3 Available Button Actions

- **Upper Button Short Press**: Show the next meter value for the top and bottom line according to prior mentioned value List.

- **Upper Button Long Press**: Transit into the Display Selftest State

- **Lower Button Short Press**: Show the previous meter value for the top and bottom line according to prior mentioned value List.

- **Lower Button Long Press:** Transit into the Eichlog State

All button actions default activate the backlight for the configured time period, which is set to 5 seconds by default.

6.2.4.4 Eichlog Memory Full

In case the Eichlog is full an informational message "Logbook full" message is shown on the display. This is illustrated on Figure 15 (marked red).
In addition no charge process can be started anymore.
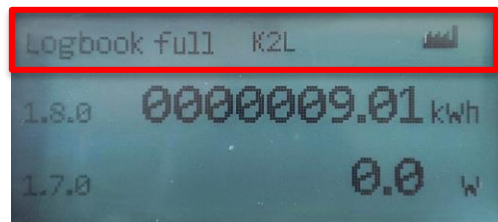
Figure 15: Eichlog Full Status Message

6.2.4.5 Eichrecht Memory Full

In case the Eichrecht is full an informational message "Logbook full" message is shown on the display. This is illustrated on Figure 16 (marked red).
In addition no charge process can be started anymore.
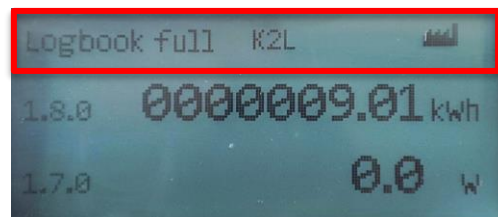
Figure 16: Eichrecht Full Status Message

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6.2.5 Display Charging State

6.2.5.1 General Overview

Within the Charging State, all meter values relevant for billing and Eichrecht are shown on the display as illustrated at Figure 17. The same system used for the normal operation mode is used here as well, that means the values rotate by time period (marked yellow). Analogous to the normal operation mode, all Eichrecht relevant and therefore important for billing meter values are displayed in the upper line and all informative values in the lower line. Due to the strong similarities between the Display Normal Operation State and the Display Charging State, "Charging" is displayed in the left half of the headline block (marked red). All other shown symbols are described in more detail in chapter 6.3.
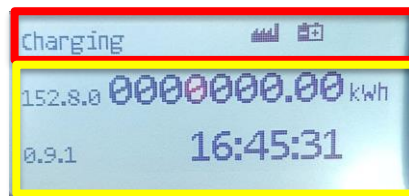
Figure 17: Display State Charging.

The standard setting for the rotation period of the display values is 5 seconds. Table 9 shows all displayed values, including their relevance. The listed registers are written to the meter during production. The registers in the bottom line (informative registers) can be altered by the customer at any time. This is NOT possible for the registers of the upper line, which are used for billing purposes.

Upper Line Content (Billing Relevant)		
Obis Code	**Name**	**Relevant for billing**
1-0:1.8.0*255	Total Import Mains Energy	yes
1-0:140.7.0*255	Line Loss Impedance	yes
1-0:152.8.0*255	Total Transaction Import Device Energy	yes
Lower Line Content (Informative)		
1-0:94.49.0*2	Public Key	no (informative)
1-0:158.8.0*255	Total Transaction Import Mains Energy	no (informative)
1-0:150.8.0*255	Total Transaction Import Line Loss Energy	no (informative)
1.0:156.7.0*255	Import Device Power	no (informative)
1.0:154.7.0*255	Import Line Loss Power	no (informative)
1-0:16.7.0*255	Total Mains Power	no (informative)
1-0:0.9.1*255	Informative Local Device Time	no (informative)
1-0:0.8.6*255	Total Transaction Charge Duration	no (informative)

Table 9: Visible content of the Display State Charging.

OCMF Content (Informative)	
Obis Code	**Name**
1-1:98.128.0*255	FV (Format-Version)
1-1:98.128.1*255	GI (Gateway-Identification)
1-1:98.128.2*255	GS (Gateway-Serial)
1-1:98.128.3*255	GV (Gateway-Version)
1-1:98.128.8*255	PG (Pagination)
1-1:98.128.16*255	MV (Meter-Vendor)
1-1:98.128.17*255	MM (Meter-Model)
1-1:98.128.18*255	MS (Meter-Serial)
1-1:98.128.19*255	MF (Meter-Firmware)
1-1:98.128.24*255	IS (Identification-Status)*
1-1:98.128.27*255	IT (Identification-Type)*
1-1:98.128.28*255	ID (Identification-Data)*
1-1:98.128.32*255	CT (Charge-Point-Identification-Type)
1-1:98.128.33*255	CI (Charge-Point-Identification)

*Available after first charge process after power cycle.

Table 10: OCMF display content: charging (refer to https://github.com/SAFE-eV/OCMF-Open-Charge-Metering-Format/blob/master/OCMF-de.md)

6.2.5.2 State Transition Conditions

If a fatal error occurs within this state, the display as well as the entire meter will enter the Meter Fatal Error State. After stopping the charging session, the Meter as well as the Display transits into the Charging Summary State. If none of the above conditions occur, the meter and thus the display will remain in the State Charging.

6.2.5.3 Available Button Actions

- **Upper Button short press**: Shows the next meter value for the top and bottom line according to prior mentioned value List.

- **Lower Button short press**: Shows the previous meter value for the top and bottom line according to prior mentioned value List.

- Long presses of the upper button as well as the lower button do not cause any reaction.

All button actions default activate the backlight for the configured time period. The default setting is 5 seconds.

6.2.6 Display Charging Summary State

6.2.6.1 General Overview

The Display Charging Summary State is basically a summary of the charging process that has just been carried out. All meter values necessary for a complete billing procedure should be shown to the customer as shown in Figure 18. Analogous to the Display Normal Operation State or the Display Charging State, all values are also displayed in rotation. All billing relevant

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values are shown in the upper line of the display whereas all informative values are displayed in the lower line (highlighted in yellow). In order to ensure better differentiation within this state, "Summary" is displayed in the left half of the headline block (marked red), analogous to the Charging State. All other symbols are described in chapter 6.3 in more detail.
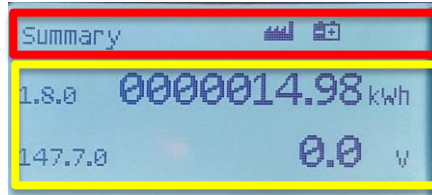
Figure 18: Display State Charging Summary.

The rotation period of the displayed values is set to 10 seconds by default. This value cannot be altered by any means. Table 11 shows all displayed values, including their relevance. The listed registers are written to the meter during production, where the registers in the bottom line (informative registers) can be altered by the customer at any time. This is not possible for the registers of the upper line, which are used for billing purposes.

Upper Line Content (Billing Relevant)		
Obis Code	**Name**	**Relevant for billing**
1-0:1.8.0*255	Total Import Mains Energy	yes
1-0:140.7.0*255	Line Loss Impedance	yes
1-0:152.8.0*255	Total Transaction Import Device Energy	yes
Lower Line Content (Informative)		
1-0:94.49.0*2	Public Key	no (informative)
1-0:158.8.0*255	Total Transaction Import Mains Energy	no (informative)
1-0:150.8.0*255	Total Transaction Import Line Loss Energy	no (informative)
1.0:156.7.0*255	Import Device Power	no (informative)
1.0:154.7.0*255	Import Line Loss Power	no (informative)
1-0:16.7.0*255	Total Mains Power	no (informative)
1-0:0.9.1*255	Informative Local Device Time	no (informative)
1-0:0.8.6*255	Total Transaction Charge Duration	no (informative)

Table 11: Visible content of the Display State Charging.

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OCMF Content (Informative)	
Obis Code	**Name**
1-1:98.128.0*255	FV (Format-Version)
1-1:98.128.1*255	GI (Gateway-Identification)
1-1:98.128.2*255	GS (Gateway-Serial)
1-1:98.128.3*255	GV (Gateway-Version)
1-1:98.128.8*255	PG (Pagination)
1-1:98.128.16*255	MV (Meter-Vendor)
1-1:98.128.17*255	MM (Meter-Model)
1-1:98.128.18*255	MS (Meter-Serial)
1-1:98.128.19*255	MF (Meter-Firmware)
1-1:98.128.24*255	IS (Identification-Status)*
1-1:98.128.27*255	IT (Identification-Type)*
1-1:98.128.28*255	ID (Identification-Data)*
1-1:98.128.32*255	CT (Charge-Point-Identification-Type)
1-1:98.128.33*255	CI (Charge-Point-Identification)

*Available after first charge process after power cycle.

Table 12: OCMF display content: charging summary (refer to https://github.com/SAFE-eV/OCMF-Open-Charge-Metering-Format/blob/master/OCMF-de.md)

If a fatal error occurs within this state, the display as well as the entire meter will enter the Meter Fatal Error State. The Display Charging Summary State can be skipped by long pressing the upper button in order to immediately enter the Display Normal Operation State. If none of the above conditions occur, the meter and thus the display will repeat the rotation for 18 times; iteration takes 10 seconds.

6.2.6.2 Available Button Actions

- **Upper Button Short Press**: Show the next meter value for the top and bottom line according to prior mentioned value List.

- **Upper Button Long Press**: Transit into the Display State Normal Operation

- **Lower Button Short Press**: Show the previous meter value for the top and bottom line according to prior mentioned value List.

All button actions default activate the backlight for the configured time period, which is set to 5 seconds by default.

6.2.7 Display Eichlog State

6.2.7.1 General Overview

The Display Eichlog State is a list of all entries that are stored within the Eichrecht relevant logbook. The values of the entry, its timestamp and its local time offset are displayed as illustrated in Figure 19. Displaying the entries does not influence the underlying logbook. The selection of the entry to be displayed is made exclusively by pressing the meter buttons. It is

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not possible to switch back or forward independently of the user. The sequence of the displayed entries is identical to that in the logbook. The Display Eichlog State is available at application firmware version v228.
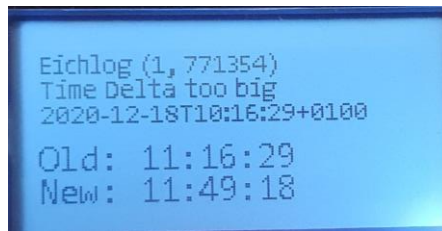
Figure 19: Display State Eichlog.

The items of the in Figure 19 shown items are the following:
1. Line: Eichlog (Number of the entry in the logbook, internal timestamp)
2. Line: Type of the Entry
3. Line: Informative Timestamp
4. Line: Value before the entry creating event
5. Line: Value after the entry creating event

6.2.7.2 State Transition Conditions

If a fatal error occurs within this state, the display as well as the entire meter will enter the Meter Fatal Error State. It is possible, to switch back to this state again by long pressing the lower button, which changes only the display state and not the meter state. Once a fatal error is detected the meter remains in its Meter Fatal Error State. The possibility to change the Display state allows the user a better debugging experience.

By pressing the upper button for a long time, you can leave the Eichlog display state and change to the Normal operation display state. If the Eichlog state was entered from the Meter Fatal Error State, the display also returns to this state by pressing and holding the upper button. If none of the above conditions occur the Display remains in this State

6.2.7.3 Available Button Actions

- **Upper Button Short Press:** Show the next logbook entry on the display.

- **Upper Button Long Press:** Transit into the Display Normal Operation State.

- **Lower Button Short Press:** Show the previous logbook entry on the display.

- **Lower Button Long Press:** No effect.

All button actions default activate the backlight for the configured time period, which is set to 5 seconds by default.

6.2.8 Display Fatal Error State

6.2.8.1 General Overview

If a fatal error occurs during operation, the meter and the display change to the Meter Fatal Error State as illustrated in Figure 20. The meter remains in this state for the rest of its operating time. Within this state, the meter shows its general billing relevant values rotating in the top value line (marked yellow). The corresponding status word of the meter is now persistently shown in the bottom value line (marked green). Once the meter is in this state, no charging

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process can be started. If a fatal failure is detected, the meter has to be exchanged by an authorized person. In order to clearly separate the Meter Fatal Error State from the other states "Fatal Failure" is displayed in the left half of the headline block (marked red).
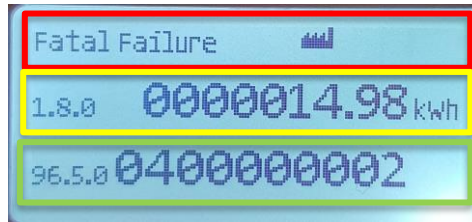
Figure 20: Display Meter Fatal Error State.

The values displayed in the upper line are based on the register values of the Display Normal Operation State, which are listed at Table 13. The contents of the lower display line are omitted.

Upper Line Content (Billing Relevant)		
Obis Code	Name	Relevant for billing
1-0:1.8.0*255	Total Import Mains Energy	yes
1-0:140.7.0*255	Line Loss Impedance	yes
1-0:152.8.0*255	Total Transaction Import Device Energy	yes

Table 13: Visible content of the Display Meter Fatal Error State.

6.2.8.2 State Transition Conditions

As already mentioned, the Meter Fatal Error State cannot be left once it has been entered. By pressing the lower button for a long time, it is possible to switch to the Eichlog state for further debugging purposes, but this leads back to the Meter Fatal Error State.

6.2.8.3 Available Button Actions

- **Upper Button Short Press:** Show the next meter value for the top line according to prior mentioned value List.

- **Upper Button Long Press:** No effect.

- **Lower Button Short Press:** Show the previous meter value for the top line according to prior mentioned value List.

- **Lower Button Long Press:** Transit into the Eichlog State.

All button actions default activate the backlight for the configured time period, which is set to 5 seconds, by default.

6.3 Explanation of display symbols

During Normal Operation-, Charging and Charging Summary State some symbols can be visible. These symbols extend the displayed information by meter status information. The following symbols are possible:

6.3.1 Production mode active symbol

Figure 21: Production mode symbol.

Figure 21 shows the symbol, which indicates a currently active production mode of the meter. This Mode is only available during production of the meter. The symbol remains visible as long as the production mode is active.

6.3.2 Assembling mode active symbol

Figure 22: Assembling mode symbol.

Figure 22 shows the symbol, which indicates a currently active assembling mode of the meter. This mode is only available during assembly of the charging point. The symbol remains visible as long as the assembling mode is active.

6.3.3 Charging transaction symbol

Figure 23: Charging transaction symbol.

During the Charging State, the symbol shown at Figure 23 is continuously blinking and indicates an ongoing charging session. On the contrary the symbol remains permanently (no blinking animation) during charging summary state.

6.3.4 Measurement mode symbol
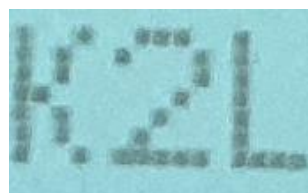
Figure 24: Measurement mode symbol.

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The symbol illustrated in Figure 24 indicates that the currently active line loss energy measurement mode of the Meter is "K2L", which means that the meter calculates the line losses according to a given line impedance.

6.3.5 Start current reached symbol
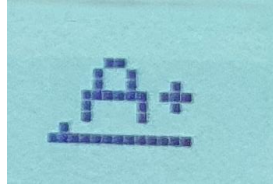
Figure 25: Starting current reached symbol for A+

The symbol illustrated in Figure 25 indicates that the by the meter currently measured current reached the starting threshold. At this point the meters starts measuring.

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7 User Buttons
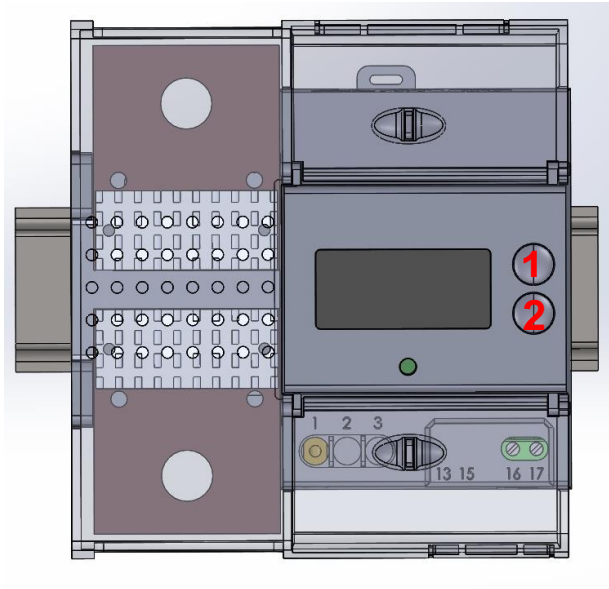
Figure 26: User Buttons

No.	Element	Function
1	Button "Up"	Depending on the press duration, tapping to the next display item, or changing the current display state (e.g.: 6.2)
2	Button "Down"	Depending on the press duration, tapping to the previous display item, or controlling the display backlight (e.g.:6.2).

Table 14: Button events of the GSH01.

The buttons only control the display sequence. They do not influence the metrological part of the meter.

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8   Communication Interface

8.1   RS485 Interfaces

There are three RS485 interfaces of type RJ12.

- RJ12-1 and 2 used for future communication with SMGW (Smart Meter Gateway) modules.
  The two jacks are connected internally and can be used for daisy-chain connection of several meters on a metrological network.

- RJ12-3 is designed for the communication with the charge station.

Currently there is no firmware support for a SMGW, therefore the meter provides its standard communication interface also on these jacks. On all ports the communication protocol described in 8.2 is available.

1 RS485 Bus(-)
2 power supply input 12V/DC
3 GND
4 not used
5 not used
6 RS485 Bus(+)
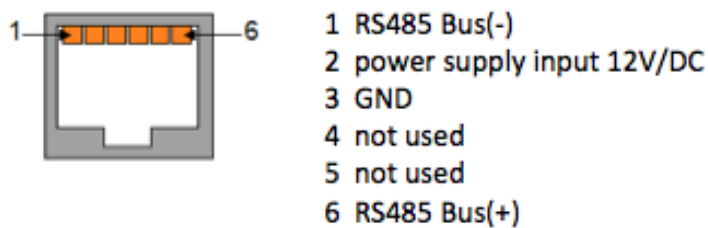
Figure 27: Pinout of the RS485 interface.

8.2   Communication Protocol

The GSH01 uses SLIP for Data Link Layer. The higher layers are described in the Communication Protocol Description [11] in more detail. The network layer allows using multiple meters on a single bus. Individual data items can be accessed by their logical register addresses (ports). The logical addresses are listed in the register description below. Individual meter readings as well as combinations of different meter readings - including signed meter readings in OCMF format - can be retrieved form the meter.

To get a better understanding of the communication protocol, two examples are provided. The first example shows the request of a single meter reading and its resulting response. The second example illustrates the response of a signed reading in OCMF format.

The Communication Protocol Description [11] describes additional commands, such as starting and stopping a charging process, reading historic charge entries, or reading the logbook entries, setting time etc.

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Request Meter Reading (Obis: 1.8.0, Total Active Import Mains Energy)

- Complete request
```
Slip:          c0 ff 10 01 05 00 00 a1 cd c0
Frame:         ff 10 01 05 00 00 a1 cd
Frame Element: 10 01 05 00 00
```

- Transmitted data frame
```
ff:              Address (Broadcast)
10 01 05 00 00:  Payload
a1 cd:           Checksum
```

- Data frame element description
```
10 01:  Logical Address: 0x0110: TotalActiveImportMainsEnergy
05 00:  Frame Element Length L = 5
00:     StatusCode::OK
:       Payload (No Value)
```

Corresponding Response Meter Reading

- Complete response
```
Slip:          c0 00 10 01 0d 00 00 00 00 00 00 00 00 00 00 41 3e c0
Frame:         00 10 01 0d 00 00 00 00 00 00 00 00 00 00 41 3e
Frame Element: 10 01 0d 00 00 00 00 00 00 00 00 00 00
```

- Data Frame:
```
00: Address (actual device address)
10 01 0d 00 00 00 00 00 00 00 00 00 00: Payload
41 3e:  Checksum
```

- Frame Element Description:
```
10 01            Logical Address: 0x0110: TotalActiveImportMainsEnergy
0d 00            Frame Element Length L = 13
00               StatusCode::OK
00 00 00 00 00 00 00 00: Payload (Value)
```

8.3   Behavior of external interfaces

All interfaces of the GSH01 are designed to guarantee proper operation of the meter, without any side reactions, caused by an external device. They are non-reactive.

8.4   OCMF Dataset

The meter readings that are written to the OCMF load log are similar to the values displayed on the meter display. They depend on the configuration settings, which provide four different templates (hereafter referred to as ContentTemplate 1 to 4). In the standard case (ContentTemplate 1) the values listed in Table 15 are available.

The following values are separated in Eichrecht relevant (listed under RD) and optional configurable registers (listed under U).

Note: All Energy Values of the following chapters are parsed into the OCMF file with 3 decimal counts. Internally the GSH01 calculates all of these values with 4 decimal counts. Therefore the last decimal count of the parsed value can deviate from the calculated value.

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8.4.1   Start Readings for Import Direction

Obis Code	Name
Start Reading List RD	
1-0:152.8.0*255	Total Transaction Import Device Energy
Start Reading List U	
1-0:156.8.0*255	Total Import Device Energy
1-0:140.7.0*255	Line loss Impedance

Table 15: List of all OCMF Start Reading in Import Direction

Example: Response Frame Payload of a signed Start Meter Reading in OCMF format for the Import Direction

The corresponding request and the frame structure of the response can be found in the **Communication Protocol Description [11]**. The OCMF formatted reading can be verified by the **transparency software**.

```
OCMF|
{
  "FV": "1.0",
  "GI": "DZG-GSH01.1K2L.B",
  "GS": "1DZG0022222222",
  "GV": "231",
  "PG": "T1",
  "MV": "DZG",
  "MM": "GSH01.1K2L.B",
  "MS": "1DZG0022222222",
  "MF": "231",
  "IS": true,
  "IT": "ISO14443",
  "ID": "TestUser",
  "CT": "EVSEID",
  "CI": "",
  "RD": [
    {
      "TM": "2022-01-28T15:33:09,000+0100 I",
      "TX": "B",
      "RV": "0.000",
      "RI": "01-00:98.08.00.FF",
      "RU": "kWh",
      "RT": "DC",
      "EF": "",
```

```
      "ST": "G"
    }
  ],
  "U": [
    {
      "TM": "2022-01-28T15:33:09,000+0100 I",
      "TX": "B",
      "RV": "0.000",
      "RI": "01-00:9C.08.00.FF",
      "RU": "kWh",
      "RT": "DC",
      "EF": "",
      "ST": "G"
    },
    {
      "TM": "2022-01-28T15:33:09,000+0100 I",
      "TX": "B",
      "RV": "0.1000",
      "RI": "01-00:8C.07.00.FF",
      "RU": "Ohm",
      "RT": "DC",
      "EF": "",
      "ST": "G"
    }
  ]
}|
{
  "SA": "ECDSA-secp256k1-SHA256",
  "SD":
"3046022100D2466016DBAE27AD8BAC8B215B6F8B31FAD0663083E0EA3149857D5F08CA
4F2F022100A33460F637B62DBBF5EFA3256EF7E31DD035FE1B2987C450AC2EFAF29E0AA
8F1"
}
```

8.4.2 Stop Readings for Import Direction

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Stop Reading List RD	
1-0:152.8.0*255	Total Transaction Import Device Energy (start)
1-0:152.8.0*255	Total Transaction Import Device Energy (stop)
Stop Reading List U	
1-0:0.8.6*255	Total Transaction Charge Duration
1-0:156.8.0*255	Total Import Device Energy (start)
1-0:156.8.0*255	Total Import Device Energy (stop)
1-0:140.7.0*255	Line loss Impedance

Table: List of all OCMF Stop Readings for Import Direction

Example: Response Frame Payload of a signed Stop Meter Reading in OCMF format for Import Direction

The corresponding request and the frame structure of the response can be found in the Communication **Protocol Description [11]**. The OCMF formatted reading can be verified by the **transparency software**.

```
OCMF|
{
  "FV": "1.0",
  "GI": "DZG-GSH01.1K2L.B",
  "GS": "1DZG0022222222",
  "GV": "231b",
  "PG": "T2",
  "MV": "DZG",
  "MM": "GSH01.1K2L.B",
  "MS": "1DZG0022222222",
  "MF": "231b",
  "IS": true,
  "IT": "ISO14443",
  "ID": "TestUser",
  "CT": "EVSEID",
  "CI": "",
  "RD": [
    {
      "TM": "2022-01-28T15:33:09,000+0100 I",
      "TX": "B",
      "RV": "0.000",
      "RI": "01-00:98.08.00.FF",
      "RU": "kWh",
      "RT": "DC",
      "EF": "",
      "ST": "G"
```

_____

```
    },
    {
      "TM": "2022-01-28T15:38:56,000+0100 I",
      "TX": "E",
      "RV": "0.000",
      "RI": "01-00:98.08.00.FF",
      "RU": "kWh",
      "RT": "DC",
      "EF": "",
      "ST": "G"
    }
  ],
  "U": [
    {
      "TM": "2022-01-28T15:33:09,000+0100 I",
      "TX": "B",
      "RV": "0.000",
      "RI": "01-00:9C.08.00.FF",
      "RU": "kWh",
      "RT": "DC",
      "EF": "",
      "ST": "G"
    },
    {
      "TM": "2022-01-28T15:38:56,000+0100 I",
      "TX": "E",
      "RV": "0.000",
      "RI": "01-00:9C.08.00.FF",
      "RU": "kWh",
      "RT": "DC",
      "EF": "",
      "ST": "G"
    },
    {
      "TM": "2022-01-28T15:33:09,000+0100 I",
      "TX": "B",
      "RV": "0.1000",
      "RI": "01-00:8C.07.00.FF",
      "RU": "Ohm",
```

_____

```
        "RT": "DC",
        "EF": "",
        "ST": "G"
      },
      {
        "TM": "2022-01-28T15:38:56,000+0100 I",
        "TX": "E",
        "RV": "347",
        "RI": "01-00:00.08.06.FF",
        "RU": "s",
        "RT": "DC",
        "EF": "",
        "ST": "G"
      }
    ]
}|
{
  "SA": "ECDSA-secp256k1-SHA256",
  "SD":
"3046022100E90CA19D0006214B8AD91F212A2E3404010B37731A0DD1F3AF97683E38AD
770F022100DF5F492B405A0C707CD48203010180B9218D23C9D91292471857F0ED04936
9AC"
}
```

9 System Architecture

9.1 Overview

The meter consists of two independent components: A metering part and an application part. Both parts communicate via a non-reactive serial interface.
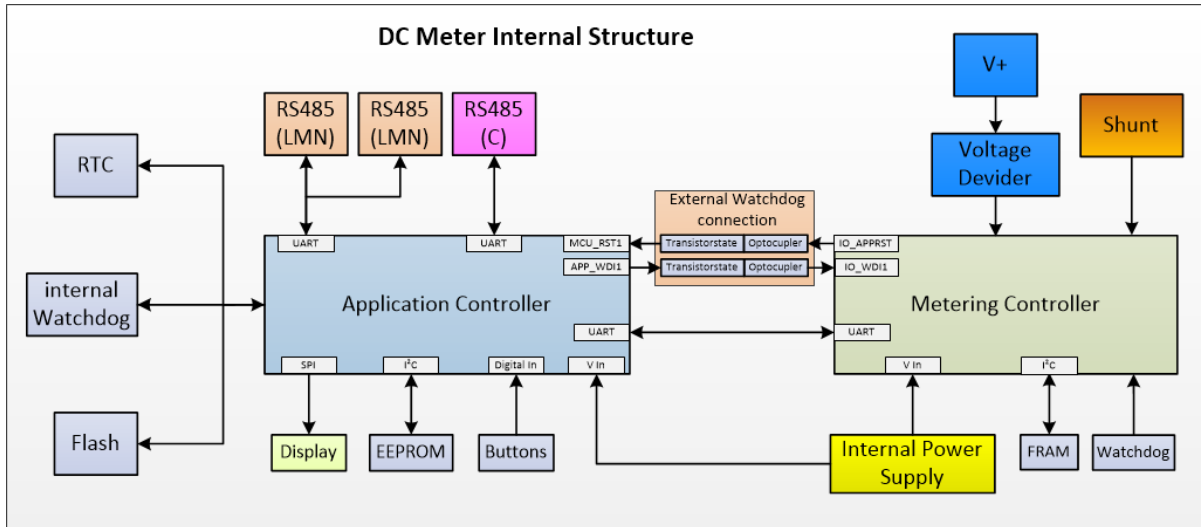
Figure 28: Simplified block diagram of the GSH01.

9.2 Measurement Part

The voltage sampling is implemented by a resistor divider network. Current sampling is implemented by a 20uΩ manganin shunt. The DC voltage is filtered by a RC-network. The metering chip (V9911) integrates the voltage and current measurement in a SoC, to obtain power and other instantaneous value. Power and energy values are computed and stored inside the metering part.

9.3 Application Part

The application part is designed to control the local user interface – the buttons and the DOT Matrix Display – as well as the two serial communication interfaces. The RTC is integrated in the application part, the storage of charge process data and logbook is controlled by the application controller.

9.4 Metrological LED

The meter has one pulse LED, which is capable of displaying the active mains energy with 1000 Imp/kWh. In idle state (no load) the LED is on. The LED is controlled by the metering part.

10 Functional Description

10.1 Line Loss Measurement

The GSH01 can calculate the line loss energy. For that reason, the impedance (R_{line}) has to be configured. The impedance can only be changed in assembling mode. A change of the impedance is recorded in the logbook. The line loss power and its resulting energy are calculated by the metering controller. The line loss energy is counted in the line loss registers. If the impedance is set to 0, the line loss measurement is deactivated, the corresponding status flag is cleared, and the display symbol is switched off.
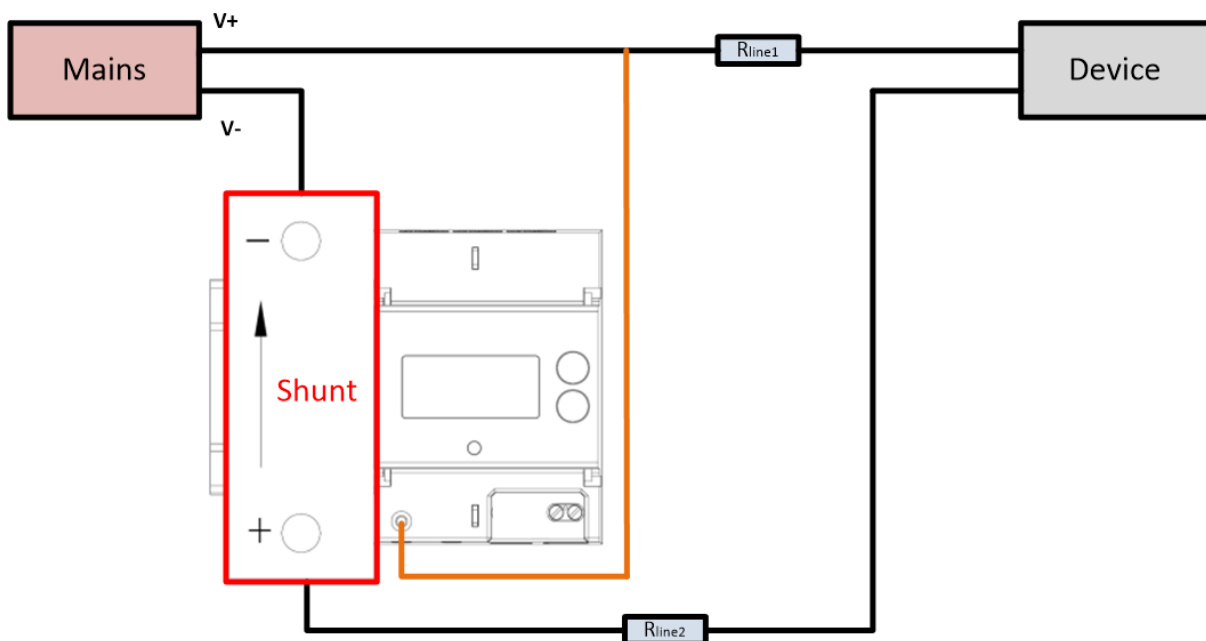
Figure 29: GSH01 Wiring Illustration.

As shown in Figure 29 the overall line loss impedance is a result of the impedance of the wire between the positive terminal of the Mains supply and the device itself **R_{line1}** and of the impedance of the wire between the second terminal of the device to the positive terminal of the meters shunt **R_{line2}**. Therefore the overall line loss impedance can be calculated as sum of both wire impedance.

The calculation is described with the following:

$$Line\ Loss\ Impedance = R_{lineLoss} = R_{line1} + R_{line2}$$

Remark: In this document the line loss impedance is mentioned several times. This refers to the overall line loss impedance. The same applies for the configurable line loss impedance.

In the two-wire line loss measurement mode (K2L), the line loss energy is calculated as:

$$Line\ Loss\ Power = P_{lineLoss}(t) = I_{shunt}^2(t) \cdot R_{line}$$

$$Line\ Loss\ Energy = \int_0^t P_{lineLoss}(t)\,dt$$

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Note: The Value for I_{shunt} refreshes with a maximal period of 1500ms. The same value is applied for the integration constant for the line loss energy. The energy integration cycle is synchronized with the line loss power cycle.

10.2 Meter Energy Registers and Line Loss Measurement

10.2.1 Import

For Import Energy Mode the register values for every point in time are given by:

$$Total\ Import\ Mains\ Energy = Total\ Import\ Device\ Energy + Total\ Import\ Line\ Loss\ Energy,$$

with $R_{line} = (R_{line1} + R_{line2}) > 0,$ which is illustrated in Figure 30.

The exact calculation is given by:

$$Total\ Import\ Mains\ Power = P_{ImportMains}(t) = I_{shunt}(t) \cdot U_{terminal}(t)$$

$$Total\ Import\ Device\ Power = P_{ImportDevice}(t) = P_{ImportMains}(t) - P_{lineLoss}(t)$$

$$Total\ Import\ Mains\ Energy = \int_0^t P_{ImportMains}(t)\ \mathrm{d}t.$$

$$Total\ Import\ Device\ Energy = \int_0^t P_{ImportDevice}(t)\ \mathrm{d}t.$$

As prior mentioned the refreshment cycle of the base values for the respective power calculation and integration cycle of the resulting energy are synchronized.
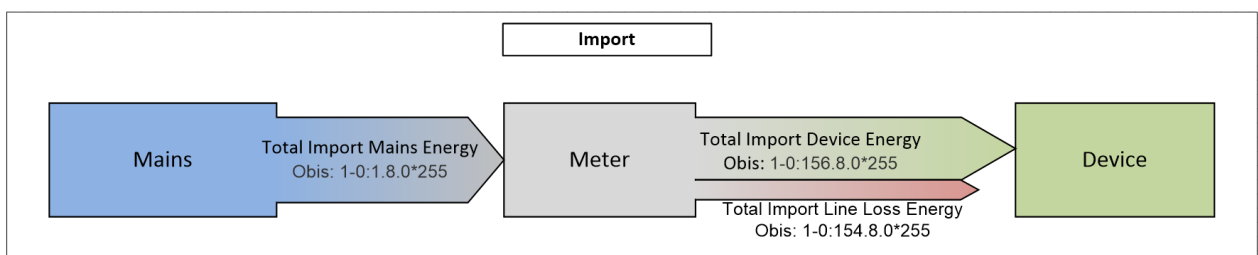
Figure 30: Sankey diagram of the import energy flow.

10.3 Operation Modes

The GSH operates within three operating modes that allow the user different access rights to the meter. These three modes are Normal Operation Mode, Assembling Mode and Production Mode. In the following, these modes are described in more. A change of the operating mode is always accompanied by an entry in the Eichrecht relevant logbook.

10.3.1 Normal Operation Mode

10.3.1.1 General Information

The GSH is shipped in normal operating mode. Within this operating the access to the meters registers is according to the table shown at chapter 13.5. This means that all billing-relevant data can be read but not altered.

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10.3.1.2 Alterable Meter Settings within Normal Operation Mode

This operation mode only allows alterations to settings of the meter that are not relevant for billing. This is a software safety measure to ensure complete data integrity. The following values can be changed within the normal operating mode:

- Setting and or alteration of the device bus address.

- Setting of the information time of the meter. An alteration of this value is only allowed, if currently no charging session is ongoing.

- Setting of informative displayable Meter Values.

Note: Charging is only permitted in this operation mode.

10.3.1.3 Transition conditions

The normal operating mode can be entered at any time without any additional physical intervention by sending the corresponding control command via one of the serial interfaces of the GSH. A list of all command sets can be found at section 13.1.

10.3.2 Assembling Mode

10.3.2.1 General Information

The assembling operation mode is intended exclusively for customers who install the GSH in an existing product and resell it to the end user in the assembled state. Within the assembling operation mode, the user is granted further access rights to alter settings of the GSH. This makes it possible to adapt billing-relevant settings to the corresponding conditions of the installation location.

10.3.2.2 Alterable Meter Settings within Assembling Operation Mode

Within this operation mode, the access rights already available from the normal operation mode are extended by the following billing-relevant setting options:

- Setting of Line Loss Impedance. Only values up to a maximum of 0.1 Ohm are allowed for the line loss impedance.

- Setting of Charge Point Identification.

- Adding new content to the OCMF output. The mandatory registers shown at 8.2 cannot be removed.

10.3.2.3 Transition conditions

The assembling operation mode can be reached without further physical intervention of the user by sending the corresponding control command via one of the serial interfaces of the GSH. A list of all possible control commands is given in chapter 13.1.

Note: In order to ensure data integrity, it is not possible to switch to the assembling operating mode during a charging process.

10.3.3 Production Mode

10.3.3.1 General Information

The production operating mode is only active during the production of the GSH. Full access to the meter is possible within this operating mode.

10.3.3.2 Alterable Meter Settings within this Operation Mode

All registers shown in chapter 13.5 can be written.

10.3.3.3 Transition conditions

The production operation mode can be reached by sending the corresponding control command via one of the serial interfaces of the GSH, if and only if additional a hardware jumper within the housing of the GSH is set.

10.4 Charging Process

This chapter describes the charging process by an example of authenticating a user by a smart card. The components ChargeStationController, Backend and RFID Reader are shown to provide a system overview.

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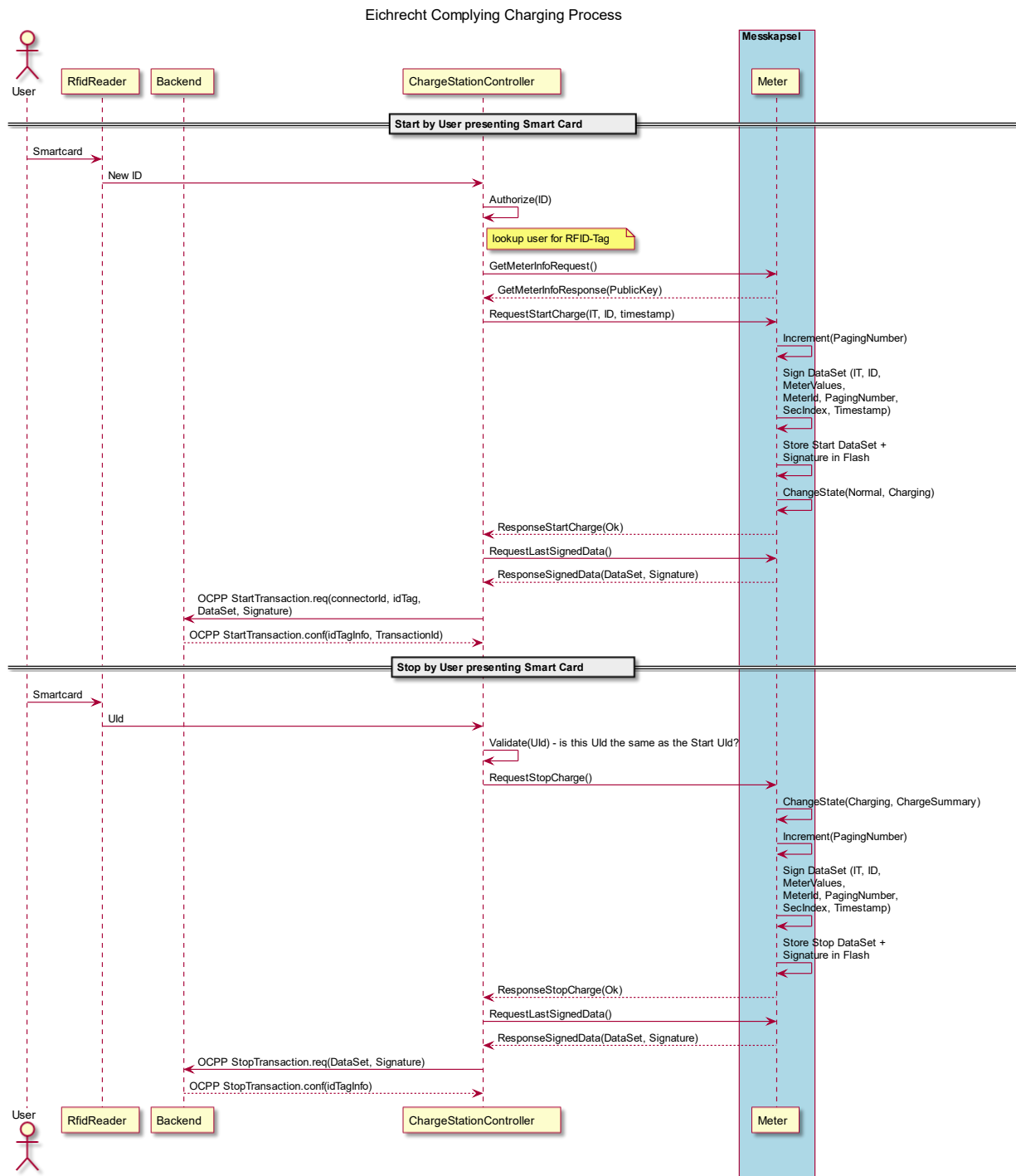
Figure 31: Example of a charging process imitated by a user presenting a smart card.

Before the start of a charging process, the current user is authorized by the ChargeStationController via the U_{Id} of the smart card (e.g. RFID).

When a charging process is started, the ChargeStationController uses the RequestStartCharge command to write the user data (ID, IT, see OCMF [7]) and the current system local timestamp to the meter. The meter assembles a data set, containing user data, the timestamp, the current meter readings (mandatory energy registers, status word) and ChargeStationController-Identification. This data set is hashed (SHA256) and signed by a secp256k1 signature.

The ChargeStationController can retrieve the singed data set in OCMF format. The OCMF output is compliant to OCMF 1.0. The output can directly be used as an input for the transparency software.

The content of the mandatory registers for OCMF and display can be configured in Production and Assembling mode. The timestamp within the OCMF data set is marked as informative.

Start

A charging process can only be started, if the status word indicates no error, if the time delta of the internal RTC time and the current time is less than 300s and if the capacity of the logbook and the charge process storage is not exhausted.

After starting a charging process, the signed charge process data can be requested in OCMF format.

Stop

A charging process can only be stop, if the status word indicates no error and if the capacity of the logbook and the charge process storage is not exhausted.

After stopping a charging process, the signed charge process data can be requested in OCMF format.
The stop charge process reading includes the Start-, Stop- and Delta Readings of the Charging Process. The OCMF content can be configured in Assembling Mode to include Mains-, Device- and Loss-Energy. The device energy is a mandatory register.

Stop after power failure

If the meter experiences a power failure while a charging session is in process, the meter will not go back into the charging mode by itself but will set the "Status Session Not Completed" bit within the status word.
While this bit is set, it is possible to start a new charging session, by sending the regular start-charge command as explained above. In the case the aborted charging process has no further effect. Another option is to send the regular stop-charge command as explained above. This will restore the pending charging session readings and imminently stop this session. Within the OCMF output of this charging process the stop meter readings will have the status "A", for a cancelled charging process. In any case each start data tuple is stored in the internal memory and is uniquely identifiable by its paging number.

10.5 Charge Process Storage

All charging processes are recorded in the internal storage. The historic processes can be read securely (signed) via the communication interface. The secured communication is realized with the TLS library version 2.6.1 of mbed. Entries are never overridden. Charging processes can only be started if there is capacity in the storage.
The capacity of the charge process storage is sufficiently dimensioned for a lifetime of 12 years (25 Charging Processes per day).

The individual charge process records are stored with a unique strictly monotonically increasing identification number (Paginierung).

A check at the beginning of each charging session ensures that there is at least enough space for one more charging session (Start and Stop entry) in the storage left.

In case of an error during a charging process, no billing relevant dataset is generated.

10.6 Info Clock

The time is represented as local time. If the drift of the internal RTC is too big (five minutes), the corresponding event and its related values are traced in the logbook.

The following rules apply:

1. If a time is set with a delta greater than 300 seconds, no charging session may be started for 60 seconds.

2. If the time delta is greater than 300 seconds on starting a charge session, the command will be rejected and the time will be set. Previous rules apply.

3. The time can only be set every 60 seconds.

4. During an ongoing charging process, setting the time is not allowed.

10.7 Logbook

A logbook is implemented, that records every event that can influence the metrological readings. The logbook can be accessed via the communication interface. The communication is secured by the usage of ECDSA signatures. The authentication is provided by including the device identification into the signed responses. The logbook is safely and chronologically stored in the internal storage of the meter. The logbook cannot be overridden. If the capacity is exhausted no further charging processes are allowed. Therefore the meter has to be changed by an authorized person.

For a detailed description of the reading of the signed logbook entries, see Communication Protocol Description [11]. Table 16 describes the overall structure of an Eichlog Entry and Table 17 all available events that cause a new logbook entry. The logbook can be accessed via the display of the meter.

Size in byte	Description	Value Type
1	Eichlog Type	Enum
4	Second Index	uint32_t
4	UTC Time	uint32_t
1	Local Time Offset	int8_t
N	Old Value	Depends on Type
N	New Value	Depends on Type
10	Server ID	byte [10]
64	Signature	byte [64]

Table 16: Structure of an Eichlog Entry.

Name	Event	Number of Bytes per value	Value Type	Value Meaning	Comment
Line Loss Measurement Mode Changed	1	1	Enum	Line Loss Measurement Mode: 0x00 = disabled 0x02 = K2L By Impedance	This value is set within the assembly config
Impedance Changed	2	4	uint32_t	Impedance [Ohm]	Scaler -4
Operation Mode Changed	3	1	byte	Operation Mode: 0x00 = Normal, 0x01 = Assembling, 0x02 = Production	
Assembling Config Changed	4	2	uint16_t	Assembling Configuration CRC	
Fatal Error Event	5	4	uint64_t	Status word	Has only first value
Time Delta Too Big Event	6	1	bool	value == true	Has only first value
Charge Point Identification Changed	7	10	byte [10]	Charge Point Identification	
External Display Paired	8	1	bool	External Display Paired	Optional
External Display Failure Occurred	9	1	bool	External Display Failure occurred	Optional
Charge Data Collector out of memory	10	1	bool	Charge Data Collector out of memory	
Eichlog Data Collector out of memory	11	1	bool	Charge Data Collector out of memory	
Firmware Version changed	12	9	byte [9]	Firmware version	

Table 17: Eichlog Events and description.

10.8 Optional External Display

An external display can be connected via the communication ports. The communication is secured by a secp256k1 elliptic curve signature. If the external display option is activated, a charging process can only be started, if the display is connected and functional. Therefore, certain timing requirements must be met. The display must respond to periodic watchdog requests. A deviation of this timing indicates a malfunction of the display and is tracked in the Eichlog and as well as in the status word. A detailed description can be found at [11] chapter 12.

11 Description for Application and Assembling Configuration

To provide a better usability and customizability the GSH01 offers some configurable options for the operator. This option can be configured within the application and the assembling configuration. The production configuration can, as its name implies, only be written during production. For simplicity only the application and the assembling configuration are subject of this chapter. In the following both chapters both available configuration sets are described regarding their possible settings and their default pre-set.

11.1 Application Configuration

The first part of the Application Configuration contains all settings for both serial interfaces. Every block is separated with ","

11.1.1 AppConfig Serial Interfaces

1. **Serial Charge Controller Interface**
- Baudrate (default Value : 115200)
- Data Bits (default Value : 8)
- Parity (default Value : 0 [none])
- Stop Bits (default Value : 1)

2. **Serial LMN Interface**
- Baudrate (default Value : 115200)
- Data Bits (default Value : 8)
- Parity (default Value : 0 [none])
- Stop Bits (default Value : 1)

11.1.2 AppConfig Display Configuration

The second part of the application configuration contains all configurations regarding the internal display content. That means, which obis numbers are visible in which line (upper/lower) in which state (Normal Operation, Charging, Charging Summary).

11.1.2.1 NormalOperation

- UpperLineContent (visible Content of the Upper Display Line)
  - Registers [default none] (not editable)
- LowerLineContent (visible Content of the Lower Display Line)
  - Registers
    - Obis Phase L1 Current,
    - Obis Phase L1 Voltage,
    - Obis Total Import Mains Power,
    - Obis Local Device Time
    - Obis Public Key
- Number of Display Lines : 2
- Time between each item shown on display : 6000 (6s)
- Show Symbols on Screen : true

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11.1.2.2 Charging

- UpperLineContent (visible Content of the Upper Display Line)
    - Registers [Obis Total Transaction Import Line Loss Energy]
- LowerLineContent (visible Content of the Lower Display Line)
    - Registers
        - Obis Total Import Mains Power,
        - Obis Import Device Power
        - Obis Import Line Loss Power
        - Obis Local Device Time
        - Obis Total Transaction Charge Duration
        - Obis Public Key
- Number of Display Lines : 2
- Time between each item shown on display : 6000 (6s)
- Show Symbols on Screen : true

11.1.2.3 ChargingSummary

- UpperLineContent (visible Content of the Upper Display Line)
    - Registers [Obis Total Transaction Import Line Loss Energy]
- LowerLineContent (visible Content of the Lower Display Line)
    - Registers
        - Obis Local Device Time
        - Obis Total Transaction Charge Duration
        - Obis Public Key
- Number of Display Lines : 2
- Time between each item shown on display : 6000 (6s)
- Show Symbols on Screen : true

11.1.2.4 Display Properties

The last part of the Display Configuration contains the Display configurable properties of the display like:

- BacklightConfiguration: mode of the Backlight
  possible Values:
    - 0: off
    - 1: on
    - 2: on by charge
    - 3: on by button press [default value]
    - 4: on by charge or button press
- BackLightButtonPressTimeoutMs: On time of the display backlight in milliseconds
    - e.g. 5000 -> 5 seconds [default value]
- Show Public Key : Currently without effect. (can be shown on display by OBIS 1-0:94.49.0*2 (see p.24)
  Possible Values:
    - true
    - false

11.1.3 AppConfig Charging Configuration, Feature Configuration

The third part of the Application Configuration contains the Charging Configuration, Feature Configuration and the Exploration Configuration with the following entries:

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11.1.3.1 Charging Configuration

In this part the bus address of the meter is set. The value can vary between 0 and 255 (0x00 – 0xFF).

11.2 Assembling Configuration

11.2.1 AsmConfig Eichrecht Control Configuration

- UseExternalDisplay: usage of an external Display
  possible values:
    - false: no external Display is used
    - true: an external Display is used
- AdditionalExternalDisplayRegisters: Registers shown on the external display
  possible values:
    - if the external display is not in use: no registers are applied
    - if an external display is in use: all registers desired to be visible on the external display
- OcmfConfiguration:
  Each of the following is a list with the length of four, corresponding to ContentTemplate1, ContentTemplate2, ContentTemplate3 or ContentTemplate4 respectively.
    - AdditionalRegistersStart
    - AdditionalRegistersStop
    - AdditionalRegistersVendorSpecificStart
    - AdditionalRegistersVendorSpecificStop

11.2.2 AsmConfig Metrological Configuration

- LineLossEnergyMeasurementMode: selection for the line loss energy measurement mode
  possible values:
    - 2: line loss measurement by impedance

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12   Firmware

The GSH01 is based on a two-controller architecture. Therefore, the firmware of both controllers is independent. The communication is non-reactive. The metrological registers are maintained by the metering firmware.

Furthermore, due to the above-described separation into two independently working parts, the firmware versions including validity check (checksum) are displayed within the Init State as shown in the Figure 32.
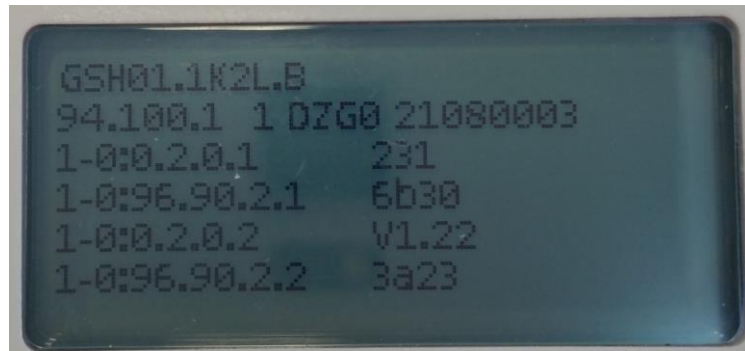
Figure 32: Firmware Version Verification within the Display Init State.

12.1 Metering Firmware structure

The functionality of the meter is periodically processed in the main loop of the application layer. The main loop is interrupted by interrupt service routines based on timer events and asynchronous events. The flow diagram for the metering firmware is shown in Figure 33.

Main functionalities:

- Acquisition of relevant measurement values.
- Loss energy measurement and loss energy compensation.
- Redundant storage of energy registers.
- Continuous and non-reactive communication with the application part.
- Providing a strictly monotonically increasing second index.
- Controlling the metrological LED.
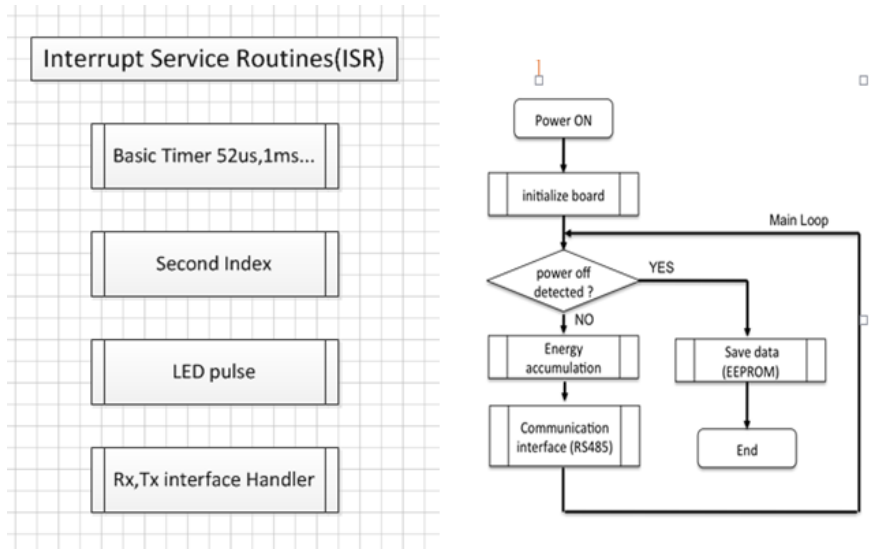
Figure 33: Firmware Flow Diagram Metering Part.

12.2 Application Firmware structure

To give an overview of the structure of the application firmware, it is illustrated as block diagram in Figure 34.
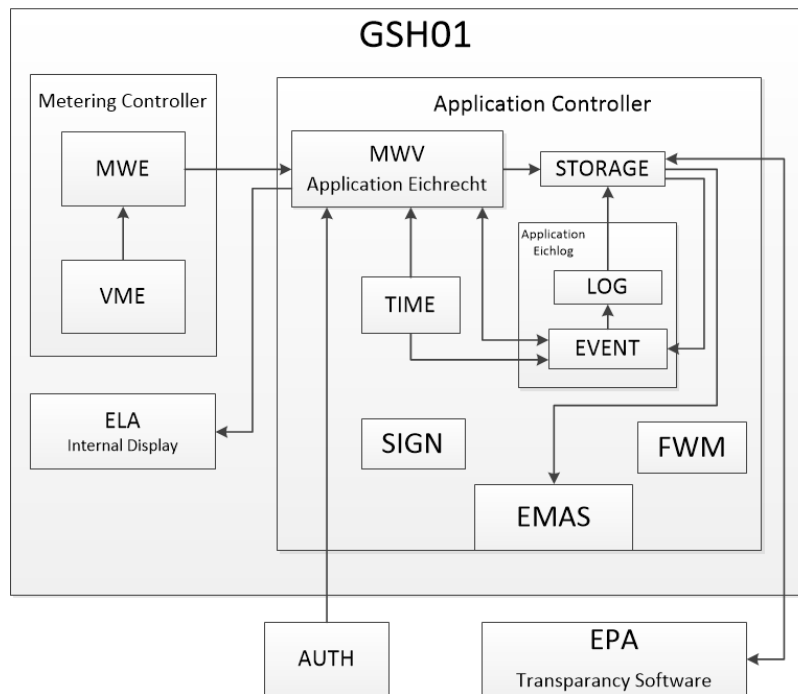
Figure 34: GSH01 Firmware Block Diagram of the Application Controller according to VDE-AR-E 2418-3-100, external components are shown to illustrate the part of the Application Controller within the system architecture.

The functionality of the meter is periodically processed in the main loop of the application layer.

The application firmware is executed in the main loop. Internal interrupts are used to provide timing functionalities. The usage of DMA and controlled memory access for all communication interfaces guarantees the absence of external feedback to the interfaces. Before processing input data, all data is

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verified. The main functionalities and their assignments to function blocks in the reference architecture of VDE-AR-E 2418-3-100 are listed below.

Main functionalities:

- Continuous communication and observation of the metering controller to retrieve meter readings. The communication is safeguarded by means of checksums and timeout monitoring.
  [MWE, VME]

- Displaying metrological and informative meter readings on the display. This includes charge process and charge summary readings. Device Status and operation mode is part of the display module. An external display can optionally be connected.
  [ELA]

- Providing signed meter readings for billing purposes. The signed meter readings are provided in OCMF 1.0 format. The hashing and signing as well as the canonical representation of the data are according to OCMF 1.0.
  [EPA]

- OCMF data and the Charge Process Storage are the base for the market surveillance interface.
  [EMAS]

- The integrity of the firmware is checked continuously by means of a hash check. An invalid hash check of firmware or configuration storage will lead to a fatal error, further operation is prohibited.
  [FWM]

- The safe and secure storage of charge process readings and logbook is implemented in the storage module. All stored data is protected by a checksum and stored persistently. A failed check will cause the corresponding bit in the status word to be set. A logbook entry is generated.
  [STORAGE]

- The Application-part Eichlog is intended to handle all device events and store the events chronologically and safely in the storage module.
  [LOG, EVENT]

- The service of generating signatures provided by the ECDSA-Module. The module hashes the data to be signed and generates a secp256k1 signature. The private key is generated during the production process inside the meter. The software architecture guarantees that the private key cannot be read out. The public key is available via the communication interface. The key pair is used for signing charge process data and the logbook entries.
  [SIGN]

- The RTC is handled by the firmware module time. It includes the monitoring and fault reaction of the RTC. It provides a local timestamp. The RTC is a so called "Info Clock", its reading may not be used for billing purposes. The RTC may not be set during an active charging process. An Eichlog Entry is generated, if the difference of the new set time and the current time is greater than five minutes.
  [TIME]

- The central part of the firmware is the Eichrecht Application module. It is responsible for the proper conduct of a charging process. It is a data hub for all meter readings.

Therefore, this module continuously retrieves and observes incoming data from the metering part and the external interfaces to handle charging processes (start, stop), to trigger the storage of charge process data and logbook entries. It provides data and the system state for the display and links the meter readings to the info clock.
[MWV]

12.3 Security measures

12.3.1 On the Application Controller

Measures against unintentional or intentional changes of the firmware

The application controller runs a system self-check to monitor the internal flash for firmware storage to avoid unintended changes of firmware. This validation is accomplished with a SHA256 hash. The hash is calculated during the creation of the firmware image and patched into it. The application controller calculates the hash and compares the calculated one to the patched one. This check is performed periodically every 10 seconds. A mismatch will cause a fatal error.

Measures against unintentional or intentional changes of the configuration

The configuration sets for the application firmware (Production, Assembling and Application) are secured with an CRC16 and are stored separately in the storage. After loading a new configuration, the application controller calculates the CRC16 and compares it to the embedded CRC16 within the configuration itself. If both CRC16 match, the configuration is accepted.

Measures in case of a crash of the firmware (Fault recovery, Watchdog)

The system has internal watchdog. The application controller has to toggle the input pin watchdog within 1.25s. If the toggle window is missed, the watchdog resets the application controller.

12.3.2 On the Metering Controller

Measures against unintentional or intentional changes of the firmware

The MCU runs a system self-check to monitor the internal flash for firmware storage to avoid the changes for firmware by a CRC16. This value is checked periodically by the application part every 10 seconds. A mismatch will cause a fatal error.

Measures for secure memory of the energy registers (backup facilities)

The metering controller generates backup data for each energy register. The original data as well as the backup data are stored at different locations in the storage of the metering part. Each energy register data has a checksum. The metering controller will validate the main data according to its checksum. If there is any inconsistency, the backup data will be used.

Measures in case of a crash of the firmware (Fault recovery, Watchdog)

System has internal watchdog. Firmware will kick-off watchdog within 1.25s. If it is not executed correctly, the whole system will be reset. A watchdog event is traced in the Meter Fatal Error bit.

Measures against unintended or intended reset of the energy registers

Firmware does not provide the interface to reset the energy registers. If there was a situation that resulted in the current energy registers being reset, the firmware will recognize it by check sum validation; in this case the backup data will be used.

Measures against miss function caused of unintended load of the MCU (dynamic behavior)

System has a timer monitor for each function block. The firmware will monitor each function block, with a timeout definition for each function block. If there is no normal operation for any part more than timeout duration, this part will be reset by system.

12.4 Status Word

If one of the error flags is set, no charging process is allowed. The meter is in the Meter Fatal Errors State, which is also visualized on the display.

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Bit Meaning		meaning of set to "1"	meaning if set to "0"
0	Error Real time clock	Fatal meter error	Real time clock initialized properly
1	Error Configuration Memory	Fatal meter error	Communication with configuration memory works properly
3	Error Signature Module	Fatal meter error	All keys for the signature are present and valid
5	Error Metering Configuration	Fatal meter error	The loaded metering configuration is valid and within working specs
6	Error Meter Communication	An Error occurred in the communication between application and metering controller. This Error can be caused by an missing or delayed response of one of the both controllers	The communication between application and metering controller working properly
7	Error Meter Fatal	Fatal meter error	The meter has none of the prior mentioned errors and runs within its specs
8	Error External Display Not Available	No external display connected	An external display is properly connected to the meter
16	Status Real time clock not in sync	The internal real time clock is not synced with the local time	The internal real time clock is synced with the local time
17	Status Charging	charging session ongoing	No charging session is ongoing
19	Status Compensated Mode Impedance	Uses line impedance for Line Loss Compensation	Uses 4 terminal line loss compensation or no Compensation
20	Status external Display used	The connected external display is in use	The connected external display is not in use
21	Status Is Ready for Charging	Meter is Ready to start a charging Session	Meter is not Ready to start a charging session
22	Status Session Not Completed	A charging process can be resumed	Last Charging process is ongoing or was finished correctly
23	Status Eichlog Is Full	The logbook for Eichrecht relevant events is full	The logbook for Eichrecht relevant events has enough storage left
24	Status Charge Process List is full	The charge process list is full. If set, the meter wont allow any further charging sessions	The charge process list has enough storge left. Starting a charge session is possible
34	Status Word Identification Bit	Always set to 1	
35	Error DC Line Loss Power Abnormal	The DC Line Loss Power seems invalid	No remarkable behaviour detected
36	Status Factory Jumper Set	Factory jumper is set	Factory Jumper is Set

Table 18: Description of the Status Word.

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13 Register Description

For the following register tables, it applies (if available):

- Scaler: Accuracy used for internal calculation and communication related to the used unit.
- Displayed Accuracy: Accuracy used for Meter value visualization on the Internal and external Display.
- OCMF Accuracy: Accuracy used for value visualization within the OCMF reading. The number of all integer digits is constantly 8.

13.1 Device Information

Logical Address	Obis Code	Description	Data Type	Unit	Scaler	Remarks
0x4102	---	Application Operation Mode	enum uint8_t	---	---	---
0x4103	---	Transparent Mode Meter	enum uint8_t	---	---	---
0x4110	94:94.94.100.1*1	Server Id	byte [10]	---	---	e.g.: DIN 43863-5
0x4111	1-0:0.0.5*255	Serial Number	uint32_t	---	---	---
0x4112	1-0:96.50.1*4	Hardware Version	String	---	---	---
0x4113	1-0:94.49.1*5	Device Type	string	---	---	---
0x4114	1-0:0.2.0*1	Application Firmware Version	string	---	---	---
0x4115	1-0:96.90.2*1	Application Firmware Checksum	uint16_t	---	---	---
0x4116	1-0:0.2.0*2	Metering Firmware Version	string	---	---	---
0x4117	1-0:96.90.2*2	Metering Firmware Checksum	uint16_t	---	---	---
0x4118	1-0:0.2.0*3	Bootloader Version	string	---	---	---
0x4119	1-0:96.90.2*4	Application Firmware Hash	uint16_t	---	---	---
0x4120	1-1:96.96.4*255	Measurement Mode	enum uint8_t	---	---	---
0x4121	1-0:0.6.0*255	Normal Voltage	uint16_t	V	-2	---
0x4122	1-0:0.6.1*255	Normal Current	uint16_t	A	-3	---
0x4123	1-0:0.6.3*255	Maximum Current	uint16_t	A	-3	---
0x4124	1-0:142.7.0*255	Reverse Mode	uint8_t	---	---	---
0x4125	---	Clear Meter Status	---	---	---	only Command
0x4126	---	Initialize Meter	---	---	---	only Command
0x4130	1-0:140.7.0*255	Line loss impedance	uint16_t	Ohm	-4	changing this value is logged within the Eichlog
0x4131	1-0:141.7.0*255	Line loss Energy Measurement Mode	uint8_t	---	---	---
0x4133	1-1:96.96.15*255	Meter Operation Mode	uint8_t	---	---	---
0x4135	1-0:0.9.1*255	Device Time	uint32_t	s	0	---
0x4137	1-0:96.5.0*255	status word	uint64_t	---	---	---
0x4211	---	Application Configuration Complete	---	---	---	only Command
0x4212	---	Meter Bus Address	uint8_t	---	---	---
0x4221	---	Assembling Configuration Complete	---	---	---	only Command

Table 19: List of all device information registers.

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13.2 Device Control Registers

Note: Table 20 contains only commands to control the meter. Therefore, these registers do not have a corresponding Obis ID.

Logical Address	Description	Functionality	Usability
0x0201	Application Signer ID Reset	only Command	Production Mode
0x0210	Application Signer generate Key Pair	only Command	Production Mode
0x0211	Application Signer get Key Pair	command returns public key as string	every Mode
0x0212	Application Signer get Public Key Base32	command returns public key as string in Base32 format	every Mode
0x0213	Application Signer get Public Key Compressed	command returns compressed public key as string	every Mode
0x0214	Application Signer get Public Key Compressed Base32	command returns compressed public key as string in Base32 format	every Mode
0x1501	Start Charge	only Command	every Mode
0x1502	Stop Charge	only Command	every Mode
0x1510	Reading Statistics	command returns data statistics as int32_t values	every Mode
0x1511	Clearing Statistics	only command	Production Mode
0x1520	Reading OCMF	command returns data based on derived int32_t index and uint8_t ContentTemplate as OCMF String	every Mode
0x1521	Last Reading OCMF	command returns data based on derived and uint8_t ContentTemplate as OCMF String	every Mode
0x1522	Reading OCMF Reverse	command returns data based on derived int32_t index and uint8_t ContentTemplate from behind as OCMF String	every Mode
0x1530	Public Key OCMF	command returns Public Key as OCMF String	every Mode
0x1531	OCMF Charge Point Identification	---	every Mode
0x1710	Eichlog Reading Statistics	command returns data statistics as int32_t values	every Mode
0x1711	Eichlog Clearing Statistics	only command	Production Mode
0x1720	Eichlog Reading Log	command returns Log Entries based on derived int32_t index as shown in [11] Chapter 6	every Mode
0x1721	Eichlog Reading Last Log Entry	command returns last Log Entry as shown in [11] Chapter 6	every Mode
0x1722	Eichlog Reading Log Entry Reverse	command returns Log Entries based on derived int32_t index from behind as shown in [11] Chapter 6	every Mode

Table 20: List of all device control registers.

13.3 Energy and instantaneous Registers

13.3.1 Import Values

Logical Address	Obis	Description	Data Type	Unit	Scaler	Displayed Accuracy	OCMF Accuracy
0x0110	1-0:1.8.0*255	Total Import Mains Energy	int64_t	kWh	-4	2	3
0x0131	1-0:31.7.0*255	Phase L1 Current	int32_t	A	-2	1	---
0x0132	1-0:32.7.0*255	Phase L1 Voltage	int32_t	V	-2	1	---
0x0133	1-0:1.7.0*255	Total Import Mains Power	int32_t	W	-2	1	---
0x0138	1.0:156.7.0*255	Import Device Power	int32_t	W	-2	1	---
0x013A	1.0:154.7.0*255	Import Line Loss Power	int32_t	W	-2	1	---
0x013C	1-0:16.7.0*255	Total Device Power	int64_t	W	-2	1	---
0x0160	1-0:154.8.0*255	Total Import Line Loss Energy	int64_t	kWh	-4	2	3
0x0170	1-0:156.8.0*255	Total Import Device Energy	int64_t	kWh	-4	2	3

Table 21: List of all import related energy registers.

13.4 Charging Session Meter Readings

13.4.1 Transaction Start Values

This Energy Values for a charging process t_c are collected at the start (t_1) of a charging session and are summarized as
$$Values_{start}(t_c) = Values_{total}(t_1).$$

Note: All Energy Values of the following chapters are parsed into the OCMF file with 3 decimal counts. Internally the GSH01 calculates all of this values with 4 decimal counts. Therefore the last decimal count of the parsed value can deviate from the calculated value.

13.4.1.1 Import Direction

The Start Values are therefore generated likewise:

- 1-0:1.8.0*255 (Total Import Mains Energy)(t_1) => 1-0:164.8.0*255 (Total Start Import Mains Energy)(t_c)
- 1-0:156.8.0*255 (Total Import Device Energy)(t_1) => 1-0:162.8.0*255 (Total Start Import Device Energy)(t_c)
- 1-0:154.8.0*255 (Total Import Line Loss Energy)(t_1) => 1-0:160.8.0*255 (Total Start Import Line Loss Energy) (t_c)

Logical Address	Obis	Description	Data Type	Unit	Scaler	Displayed Accuracy	Communication Accuracy
0x1570	1-0:160.8.0*255	Total Start Import Line Loss Energy	int64_t	kWh	-4	2	4
0x1580	1-0:162.8.0*255	Total Start Import Device Energy	int64_t	kWh	-4	2	4
0x1590	1-0:164.8.0*255	Total Start Import Mains Energy	int64_t	kWh	-4	2	4

Table 22: List of all import related transaction start register values.

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13.4.2 Transaction Stop Values

These Energy Values for a charging process t_c are collected at the stop (t_2) of a charging session and are summarized as
$Values_{stop}(t_c) = Values_{total}(t_2).$

13.4.2.1 Import

The Stop Values are therefore generated likewise:

- 1-0:1.8.0*255 (Total Import Mains Energy)(t_2) => 1-0:170.8.0*255 (Total Stop Import Mains Energy)(t_c)
- 1-0:156.8.0*255 (Total Import Device Energy)(t_2) => 1-0:168.8.0*255 (Total Stop Import Device Energy)(t_c)
- 1-0:154.8.0*255 (Total Import Line Loss Energy)(t_2) => 1-0:166.8.0*255 (Total Stop Import Mains Energy) (t_c)

Logical Address	Obis	Description	Data Type	Unit	Scaler	Displayed Accuracy	Communication Accuracy
0x15A0	1-0:166.8.0*255	Total Stop Import Line Loss Energy	int64_t	kWh	-4	2	4
0x15B0	1-0:168.8.0*255	Total Stop Import Device Energy	int64_t	kWh	-4	2	4
0x15C0	1-0:170.8.0*255	Total Stop Import Mains Energy	int64_t	kWh	-4	2	4

Table 23: List of all import related transaction stop register values.

13.4.3 Total Transaction Values

Transaction Values are calculated by the equation

$$Values_{transaction}(t_c) = Values_{stop}(t_c) - Values_{start}(t_c).$$

13.4.3.1 Import

Logical Address	Obis	Description	Data Type	Unit	Scaler	Displayed Accuracy	Communication Accuracy
0x1540	1-0:150.8.0*255	Total Transaction Import Line Loss Energy	int64_t	kWh	-4	2	4
0x1550	1-0:152.8.0*255	Total Transaction Import Device Energy	int64_t	kWh	-4	2	4
0x1560	1-0:158.8.0*255	Total Transaction Import Mains Energy	int64_t	kWh	-4	2	4
0x156A	1-0:0.8.6*255	Total Transaction Charge Duration	int32_t	s	0	---	---

Table 24: List of all total transaction register values.

13.5 Description of all displayed registers

General Description of the entries:

- R: Read access allowed

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- W: Write Access allowed
- P: Only Written during Production
- A: Write access allowed during assembling or production

13.5.1 Device Information

Logical Address	Obis Code	Description	Accessibility	Relevance for billing
0x4102	---	Application Operation Mode	R/P	no
0x4103	---	Transparent Mode Meter	R/P	no
0x4110	94:94.94.100.1*1	Server Id	R/P	yes
0x4111	1-0:0.0.5*255	Serial Number	R/P	yes
0x4112	1-0:96.50.1*4	Hardware Version	R/P	no
0x4113	1-0:94.49.1*5	Device Type	R/P	yes
0x4114	1-0:0.2.0*1	Application Firmware Version	R/P	yes
0x4115	1-0:96.90.2*1	Application Firmware Checksum	R/P	yes
0x4116	1-0:0.2.0*2	Metering Firmware Version	R/P	yes
0x4117	1-0:96.90.2*2	Metering Firmware Checksum	R/P	yes
0x4118	1-0:0.2.0*3	Bootloader Version	R/P	yes
0x4119	1-0:96.90.2*4	Application Firmware Hash	R/P	yes
0x4120	1-1:96.96.4*255	Measurement Mode	R/P	yes
0x4121	1-0:0.6.0*255	Normal Voltage	R/P	No
0x4122	1-0:0.6.1*255	Normal Current	R/P	No
0x4123	1-0:0.6.3*255	Maximum Current	R/P	No
0x4130	1-0:140.7.0*255	Line loss impedance	R/A	Yes
0x4131	1-0:141.7.0*255	Line loss Energy Measurement Mode	R/A	Yes
0x4133	1-1:96.96.15*255	Meter Operation Mode	R/P	no
0x4135	1-0:0.9.1*255	Device Time	R/W	no
0x4137	1-0:96.5.0*255	status word	R	yes
0x4212	---	Meter Bus Address	R/P	no

Table 25: List of all device information registers and their access rights.

13.5.2 Energy and instantaneous Registers

Logical Address	Obis	Description	Accessibility	Relevance for billing
0x0110	1-0:1.8.0*255	Total Import Mains Energy	R/P	yes
0x0131	1-0:31.7.0*255	Phase L1 Current	R/P	no
0x0132	1-0:32.7.0*255	Phase L1 Voltage	R/P	no
0x0133	1-0:1.7.0*255	Total Import Mains Power	R/P	no
0x0135	1.0:145.7.0*255	Positive Device Voltage	R/P	no
0x0136	1.0:146.7.0*255	Negative Device Voltage	R/P	no
0x0137	1.0:147.7.0*255	Total Device Voltage	R/P	no
0x0138	1.0:156.7.0*255	Import Device Power	R/P	no
0x013A	1.0:154.7.0*255	Import Line Loss Power	R/P	no
0x0160	1-0:154.8.0*255	Total Import Line Loss Energy	R/P	yes
0x0170	1-0:156.8.0*255	Total Import Device Energy	R/P	yes
0x0180	1-128:160.160.8*255	Second Index	R/P	no

Table 26: List of all energy and instantaneous registers and their access rights.

13.5.3 Transaction Start Values

Logical Address	Obis	Description	Accessibility	Relevance or billing
0x1570	1-0:160.8.0*255	Total Start Import Line Loss Energy	R/P	no
0x1580	1-0:162.8.0*255	Total Start Import Device Energy	R/P	no
0x1590	1-0:164.8.0*255	Total Start Import Mains Energy	R/P	no

Table 27: List of all transaction start value registers and their access rights.

13.5.4 Transaction Stop Values

Logical Address	Obis	Description	Accessibility	Relevance for billing
0x15A0	1-0:166.8.0*255	Total Stop Import Line Loss Energy	R/P	no
0x15B0	1-0:168.8.0*255	Total Stop Import Device Energy	R/P	no
0x15C0	1-0:170.8.0*255	Total Stop Import Mains Energy	R/P	no

Table 28: List of all transaction stop value registers and their access rights.

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13.5.5 Total Transaction Values

Logical Address	Obis	Description	Accessibility	Relevance for billing
0x1540	1-0:150.8.0*255	Total Transaction Import Line Loss Energy	R/P	no
0x1550	1-0:152.8.0*255	Total Transaction Import Device Energy	R/P	yes
0x1560	1-0:158.8.0*255	Total Transaction Import Mains Energy	R/P	yes
0x156A	1-0:0.8.6*255	Total Transaction Charge Duration	R/P	no

Table 29: List of all transaction value registers and their access rights.

14   Accuracy Test

The accuracy of the meter can be checked with the pulse LEDs. For testing, the following quantity of minimum pulses - dependent on the load - are recommended.

If the meter is checked by reading out the energy register values via the communication interface, a minimum measuring time of 4.5 minutes and a minimum amount of energy of 300 Wh must be observed.

Load	Pulses
I_{max}	10
I_{ref}	5
I_{tr}	5
I_{st}	1

Table 30: Accuracy Table.

15   Manufacturing

The final assembling is done by DZG Oranienburg GmbH. The company is certified according to the quality standard DIN EN ISO 9001.

DZG provides a certified testing centre for electricity meters EBB1.

The processes, controls and documentations are organized according to the quality standard. Each meter will be tested in the certified testing centre (acceptance test).