Smart Metering System

eMUCs – S1

extended Multi-Utility Companion Specification for the Consumer Interface S1

V1.0

Change summary

This document is continuously improved and revised if needed. To keep track, the version numbers are increased at every change in following way:

The version number is formatted X.Y where:

- X reflects a major version change: expl. HW change possibly not backwards compatible
- Y reflects a minor version change: expl. Extra data-objects, telegram change with backwards compatibility

The version number is also part of the S1 telegram. In section 3.3.1 is described how this version number is built in the S1-telegram

Technical changes against previous version are highlighted to make them more clear.

Version	Change	Publishing date
1.0(beta)	• First Edition	26/04/2018
1.0	• Major textual clean up based on field experience • No technical changes since (unofficial) 1.3 beta (version number unchanged)	01/04/2020

In annex A you can find an overview of meters and corresponding version history.

Application

The version of this specification is applicable to following DSO's:

fluvius.	ORES	resa	Sibelga
X	X	X	X

In annex A you can find an overview of meters and corresponding version history.

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1 Introduction

1.1 Scope

This document is part of a set of companion specification documents for a smart meter system for electricity and gas.

The goal of this companion specification is to reach an open, standardized protocol implementation related to the communication between several types of electricity meters and other smart metering systems and devices.

This document describes the protocol and the data model of S1 interface. The S1 interface is a high speed communication port intended to provide measurement data at a high frequency.

The interface periodically provide measurement data to one or more customer applications. These applications can be used to store, monitor, analyse and display the provided data or use it as trigger for home automation systems to control other devices in home. The objects (internal in the electricity meter) to configure and manage this interface by the DSO are out of scope of this document, but are described in e-MUCs M_{DLMS}. The functionalities of the customer applications that can be connected to these interfaces are also out of scope of this document.

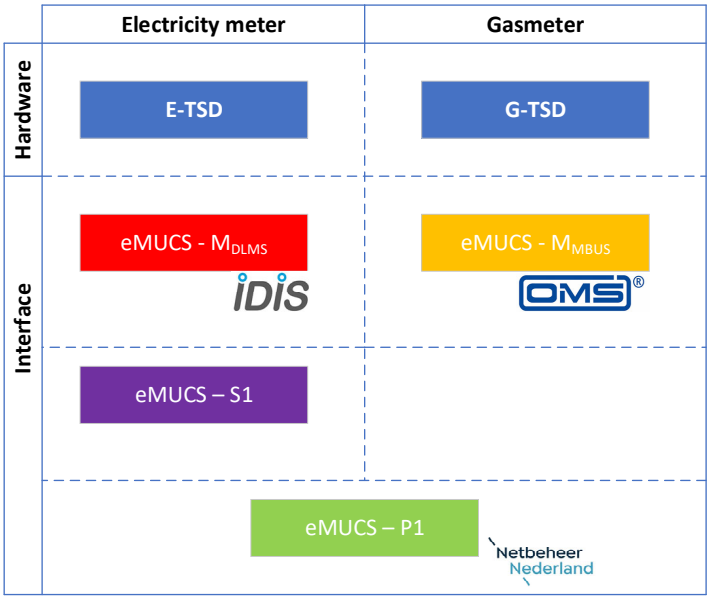

Figure 1 'Set of Requirements' structure of the Smart Metering Solution

1.2 Related Documents

The following standards are referred to in this companion specification.

- For undated references the latest edition applies.
- If a corrigendum for one of these documents is issued, then it is also applicable.

Reference	Document Title	Editor	Version
e-MUCS M_{DLMS}	Companion Specification for I3 Interface	Fluvius / ORES / Resa / Sibelga	
IDIS Pack3	Package 3, IP Profile	IDIS association	Ed. 1.0
IEC 61010	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use	IEC	Ed 3.0
DIN 43863-5	Identification number for measuring devices applying for all manufacturers	DIN	2012-04
TIA/EIA-422	Electrical Characteristics of Balanced Voltage Digital Interface Circuits	TIA	rev B 1994
IEC 13239	Telecommunications and information exchange between systems -- High-level data link control (HDLC) procedures		

1.3 Definitions and abbreviations

3W	3-wire electricity system (Delta)
4W	4-wire electricity system (Star)
AMM	Automatic Meter Management system
ASCII	American Standard Code for Information Interchange
CEMS	Consumer Energy Management System
CRC	Cyclic Redundancy Check
DIN	Deutsches Institut für Normung
DLMS	Device Language Message Specification
DSMR	Dutch Smart Meter Requirements
DSO	Distribution System Operator
EIA	Electronic Industries Alliance
FCS	Frame Check Sequence
e-MUCs	extended Multi-Utility Companion Specification
E-TSD	Electricity meter Technical Specification Document
G-TSD	Gas meter Technical Specification Document
GND	Ground
HES	Head-End System

IEC	International Electrotechnical Commission
IDIS	Interoperability Device Interface Specification
IHD	In Home Display
LSB	Lowest Significant Byte/Bit
M-bus	Meter bus
Mbps	Megabits per second
MSB	Most Significant Byte/Bit
NC	Not Connected
OMS	Open Meter Specification
SI	Système International (d' unites)
TIA	Telecommunications Industry Association
UCC	Unbalanced Connectionless

2 Architecture and interfaces

The system architecture follows the interface mentioned in Figure 2. This document describes the S1 interface and is defined as the interface between a Electricity Meter and customer applications, in example an In-Home Display (IHD) or a CEMS device, as used in home automation systems.

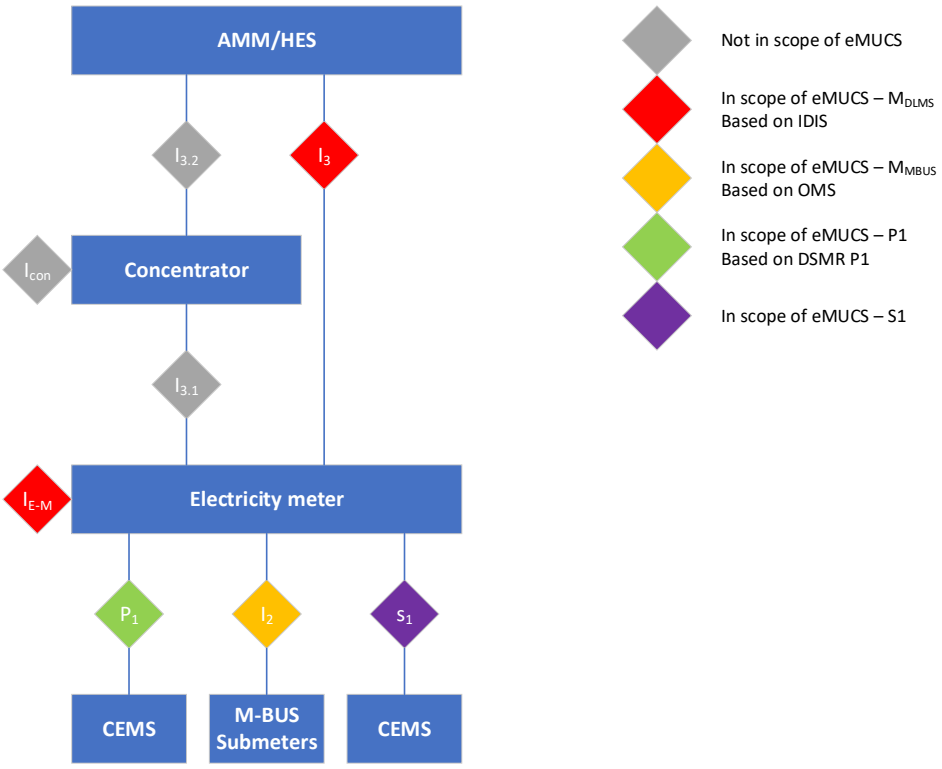

Figure 2: Communication interfaces

Remark 1: The E-meter acts as a concentrator for up to four M-bus devices (e.g. gas meters) via the I2 interface, therefore the data of these M-bus devices can also be provided to the customer via the Belgian P1 interface.

Remark 2: The S1 interface only provides electricity related data from the primary electricity meter (blue block in figure 2). MBUS-related data, even if this device is an secondary electricity meter, is not in scope for the S1 interface.

3 S1 interface description

This section specifies the main characteristics of the S1. The S1 interface provides raw digital samples coming from the measurement system that can be used for reconstructing several electricity related SI units like the voltage and current patterns.

The sample frequency for this interface can vary between 2 and 4 kHz.

3.1 Physical interface

For the physical interface a solution based on the TIA/EIA-422 specification is specified. The physical connector is carried out as a female RJ-12 connector with following pin assignment.

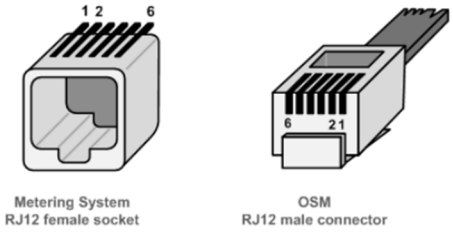

Figure 3: S1 Physical connector

Pin	Signal name	Description	Remark
1	NC	Not connected	
2	NC	Not connected	
3	GND	Data ground	
4	Tx-	Dataline (+)	
5	Tx+	Dataline (-)	
6	NC	Not Connected	

Table 1: S1 physical connector pin assignment

Note 1: The S1 interface can be deactivated by the DSO.

Note 2: The S1 interface is an integral part of the entire metering system and has to fulfil the requirements for Installation category IV, meaning impulse withstand voltages of 6000V as described in IEC 61010.

Note 3: The S1 interface is designed in a way that its function is separated from other functions of the meter in that sense that it's not possible to break the meter itself when a consumer makes improper use of the S1 interface. This can be met by galvanic insolation of the S1-interface.

Note 4: The S1 interface is and unidirectional interface (meter to CEMS) and the data output lines are driven continuously by the meter if the S1 interface is activated. The data output lines (Tx- and Tx+) comply to TIA/EIA-422 and signal levels described in this standard are respected by the S1-interface. To ensure reliable data transmission, the cable used to connect the CEMS to the S1 interface is a twisted pair and the CEMS is responsible for termination of the line.

Note 5: The S1 interface does not provide power supply to the CEMS. Only the Ground line of the S1 interface is provided on the connector and it's mandatory that the CEMS and S1 interface share the same ground reference to make the data transmission reliable.

The S1 interface transfers data with following settings:

Parameter	Setting
Data rate (fixed)	2 Mbps
Startbits	1
Databits	8
Parity	none
Stopbit	1

Table 2: S1 interface port settings

3.2 Protocol description

The data is sent as telegrams according IEC 13239 over the TIA/EIA-422 interface. IEC 13239 leaves some options open. For the S1 interface, following options apply:

Parameter/option	Setting
Station type	Primary station
Procedure class	Unbalanced connectionless (UCC)
UI frames	Yes (option 4)
FCS	16 bit only (option 14.2)
Transmission type	Start/stop (option 15.1)
Format field present?	Yes, type 1 (option 22)
Transparency mechanism	Disabled (option 24)

Table 3: S1 interface IEC 13239 option settings

The S1 interface uses following telegram format:

Description	Number of bytes	Description/setting
Opening Flag	1 byte	Standard HDLC opening delimiter = 0x7E
Frame Type	1 byte	Frame type = 0x08
Frame length	1 byte	Frame length = 0x2B (fixed)
Address field	1 byte	Broadcast to all stations = 0xFF
Control field	1 byte	UI frame, P/F bit 0 = 0x03
Data field	37 byte	See 3.3
CRC	2 bytes	HDLC polynomial CRC
Closing Flag	1 byte	Standard HDLC closing delimiter = 0x7E

Table 4: S1 interface telegram format

3.3 Data representation

The field of the telegram always consists out of 37 bytes independent from the meter type (monofase meter or polyphase meter). The data field of each telegram contains the following data:

- Relevant information to help in the interpretation of the provided measurement values
- Instantaneous measurement values of voltages (for each phase)
- Instantaneous measurement values of currents (for each phase and for the neutral)

It is to be noted here that the voltage and current values provided within the same telegram must be synchronous with each other (values measured at the same sampling time) and that the telegram must be output within 10ms from the actual sampling time of the contained samples.

The data field in the telegram is described in the table below:

Description	Byte number	Content
Meter ID (character 1)	1	First digit of the Identification number according DIN 43863-5 ASCII coded
Meter ID (character 2)	2	Second digit of the Identification number according DIN 43863-5 (ASCII coded)
Meter ID (character 3)	3	Thirth digit of the Identification number according DIN 43863-5 (ASCII coded)
Meter ID (character 4)	4	Fourth digit of the Identification number according DIN 43863-5 (ASCII coded)
Meter ID (character 5)	5	Fifth digit of the Identification number according DIN 43863-5 (ASCII coded)
Meter ID (character 6)	6	Sixth digit of the Identification number according DIN 43863-5 (ASCII coded)
Meter ID (character 7)	7	Seventh digit of the Identification number according DIN 43863-5 (ASCII coded)
Meter ID (character 8)	8	Eight digit of the Identification number according DIN 43863-5 (ASCII coded)
Meter ID (character 9)	9	Ninth digit of the Identification number according DIN 43863-5 (ASCII coded)
Meter ID (character 10)	10	Tenth digit of the Identification number according DIN 43863-5 (ASCII coded)
Meter ID (character 11)	11	eleventh digit of the Identification number according DIN 43863-5 (ASCII coded)
Meter ID (character 12)	12	Twelfth digit of the Identification number according DIN 43863-5 (ASCII coded)

Meter ID (character 13)	13	Thirteenth digit of the Identification number according DIN 43863-5 (ASCII coded)
Meter ID (character 14)	14	Fourteenth digit of the Identification number according DIN 43863-5 (ASCII coded)
Additional information	15	See 3.3.1
Sampling frequency	16	Gives the sampling frequency according the method chosen with bit 1 of byte 15 (see 3.3.1 and 3.3.2)
Network frequency (MSB)	17	Gives together with byte 18 the network frequency with 1 mHz resolution
Network frequency (LSB)	18	Gives together with byte 17 the network frequency with 1 mHz resolution
Frame sequence number	19	Counts from 0x00 to 0xFF (than back to 0x00) to detect missed frames
Voltage Phase 1 (MSB)	20	Representation of data see 3.3.3
Voltage Phase 1 (LSB)	21	Representation of data see 3.3.3
Current Phase 1 byte 1 (MSB)	22	Representation of data see 3.3.3
Current Phase 1 byte 2	23	Representation of data see 3.3.3
Current Phase 1 byte 3 (LSB)	24	Representation of data see 3.3.3
Voltage Phase 2 (MSB)	25	Only meaningful when polyphase meter is operating in 4W mode. In this case bit 0 and bit 2 is set in byte 15 (see 3.3.1) Representation of data see 3.3.3
Voltage Phase 2 (LSB)	26	Only meaningful when polyphase meter is operating in 4W mode. In this case bit 0 and bit 2 is set in byte 15 (see 3.3.1) Representation of data see 3.3.3
Current Phase 2 byte 1 (MSB)	27	Only meaningfull when polyphase meter. In this case bit 0 is set in byte 15 (see 3.3.1) Representation of data see 3.3.3
Current Phase 2 byte 2	28	Only meaningfull when polyphase meter. In this case bit 0 is set in byte 15 (see 3.3.1) Representation of data see 3.3.3
Current Phase 2 byte 3 (LSB)	29	Only meaningfull when polyphase meter. In this case bit 0 is set in byte 15 (see 3.3.1) Representation of data see 3.3.3

Voltage Phase 3 (MSB)	30	Only meaningfull when polyphase meter. In this case bit 0 is set in byte 15 (see 3.3.1) Representation of data see 3.3.3
Voltage Phase 3 (LSB)	31	Only meaningfull when polyphase meter. In this case bit 0 is set in byte 15 (see 3.3.1) Representation of data see 3.3.3
Current Phase 3 byte 1 (MSB)	32	Only meaningfull when polyphase meter. In this case bit 0 is set in byte 15 (see 3.3.1) Representation of data see 3.3.3
Current Phase 3 byte 2	33	Only meaningfull when polyphase meter. In this case bit 0 is set in byte 15 (see 3.3.1) Representation of data see 3.3.3
Current Phase 3 byte 3 (LSB)	34	Only meaningfull when polyphase meter. In this case bit 0 is set in byte 15 (see 3.3.1) Representation of data see 3.3.3
Current neutral byte 1 (MSB)	35	Optionally if the hardware allows this bit 0 is set in byte 15 is set to 1 (see 3.3.1) Representation of data see 3.3.3
Current neutral byte 2	36	Optionally if the hardware allows this bit 0 is set in byte 15 is set to 1 (see 3.3.1) Representation of data see 3.3.3
Current neutral byte 3 (LSB)	37	Optionally if the hardware allows this bit 0 is set in byte 15 is set to 1 (see 3.3.1) Representation of data see 3.3.3

Table 5: S1 interface data field content

3.3.1 Content of byte “Additional Information”

The “additional information” byte in the frame is used to give context to the measurement data provided in the frame. It’s important that the content of this byte is taken into account when interpreting the measurement data. Following table gives insights in the meaning of the bits

Description	Bit number	Content
Meter type	0	0 = Single Phase 1 = Poly phase
Sampling type	1	0 = Per second fixed sampling (see 3.3.2) 1 = Per period fixed sampling (see 3.3.2)
3W/4W mode	2	0 = 3W (and Single phase) 1 = 4W
Valid Samples	3	0 = One or more samples corrupt 1 = all sample values correct
Neutral Current	4	0 = not measured and/or provided 1 = measured and provided
Data format version [0]	5	Allows version of data formatting
Data format version [1]	6	Allows version of data formatting
Data format version [2]	7	Allows version of data formatting

Table 6: S1 interface "additional information" byte content

Note 1: The data format version reflects the last digit of the eMUCs – S1 version, for example eMUCs – S1 V1.0 will result in Data format version [0] = 0, Data format version [1] = 0, Data format version [2] = 0. Data format version [0] is the LSB.

3.3.2 Sampling frequency

Depending on internal sampling approach, two cases are distinguished and described below. The using of one or the other sampling method must be indicated in the dedicated bit in the “Additional Information” field (see 3.3.1)

Overall, the sample frequency should remain lower than 4200 kHz to not overcome the RS-422 bus speed (2Mbps). If the internal sampling of the meter is greater than the 4200 kHz, the sample rate to the S1 interface is reduced by providing only the odd/even samples to the interface (or less). It’s important that the time between the samples stays equal during the period to be able to reconstruct the patterns in an easy way by the CEMS

Fixed “Per Second” sampling	Fixed “Per period” sampling
In this case, the sampling is performed at a fixed “real time” rate, independently from the actual network frequency. In this case, the “sampling frequency” byte contains the number of samples per second in multiples of 100Hz.	In that case, the sampling is performed at a fixed number of sample per network period, thus the actual “real time” rate varies over time depending on the actual network frequency. When the sampling is performed in that way, this field must contain the number of samples per period

Table 7: S1 interface sampling methods

3.3.3 Data formatting of measurement values

Following table specifies the representation of the current and voltage data in the telegram

Voltages (L1, L2, L3)	Currents (L1, L2, L3, N)
The voltage values are adjusted values, thus already taking into account scaling factors and calibration parameters set in factory.	The current values are adjusted values, thus already taking into account scaling factors and calibration parameters set in factory.
The voltage values are coded on 2 bytes as signed integer types with the LSB coding for a physical resolution of 25mV.	The current values are coded on 3 bytes as signed integer types with the LSB coding for a physical resolution of 1mA.

Note: For single phase meters, voltage values in the fields corresponding to L2 and L3 are irrelevant and should therefore be set to 0x0000.

Note: For single phase meters, values in the fields corresponding to L2 and L3 are irrelevant and should therefore be set to 0x0000.

Note: For meters that do not implement neutral current measurement, the field corresponding to N is irrelevant and should therefore be set to 0x0000.

4 Annex A: Implementation matrix

e-MUCs – S1 is continuously evolving, always with backwards compatibility in mind. This results in several versions of the document but also in several versions implemented in the field. Depending on the evolution, the DSO decides to upgrade or not upgrade meters that are already in the field.

Table 8 gives an overview of the versions that are applicable per DSO and per meter vendor / meter-type.

		Fluvius	ORES	RESA	SIBELGA
Producer / type	Roll-out	S1	S2	S3	S4
Sagemcom S211	2019 - 202x	V1.0	V1.0	V1.0	V1.0
Sagemcom T211	2019 - 202x	V1.0	V1.0	V1.0	V1.0

Table 8: S1 implementation matrix

Note 1: The DSO will put effort in upgrading the meters in the field to the most recent version of the e-MUCs – P1 that is listed in the table per DSO and meter vendor / meter -type but be aware that it's not possible to have a coverage for 100% of the meter park. It can be that some meters are never upgrade to the most recent version for technical reasons.