

LoRa Module

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1 Document notes

All information in this manual, including product data, diagrams, charts, etc. represents information on products at the time of publication, and is subject to change without prior notice due to product improvements or other reasons. It is recommended that customers contact Engelmann Sensor GmbH for the latest product information before purchasing a control and monitoring interface product.

The documentation and product are provided on an “as is” basis only and may contain deficiencies or inadequacies. Engelmann Sensor GmbH takes no responsibility for damages, liabilities, or other losses by using this product.

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2 Important usage and safety information

The following safety precautions must be observed during all phases of the operation, usage, service or repair of any control and monitoring interface product. Users of the product are advised to convey the information to users and operating personnel and to incorporate these guidelines into all manuals supplied with the product.

Failure to comply with these precautions violates safety standards of design, manufacture and intended use of the product. Engelmann Sensor GmbH assumes no liability for customer's failure to comply with these precautions.

The **LoRa Module** receives and transmits radio frequency energy while switched on. Remember that interference can occur if the product is used close to TV sets, radios, computers, or inadequately shielded equipment. Follow any special regulations and always switch off the product wherever forbidden, or when you suspect that it may cause interference or danger.

3 Using this manual

3.1 Purpose and audience

This manual provides all information needed to mount, deploy, and configure the **LoRa Module** and targets installers and system integrators.

3.2 Online resources

To download the latest version of this user's manual, or to find information in other languages, please contact info@engelmann.de.

3.3 Symbols

The following symbols are used throughout the manual to emphasize important information and useful tips:



The Note symbol is used to mark information that is important to take into consideration for safety reasons or to assure correct operation of the meter connectivity module.



The Tip symbol is used to mark information intended to help you get the most out of your product. It might for example be used to highlight a possible customization option related to the current section.

Table 1 provides information on how the product should be used.



Symbol	Description
	Waste electrical products should not be disposed of with household waste. Please recycle where facilities exist. Contact your Local Authority for recycling advice.
	Electrostatic-sensitive device. Please observe the necessary ESD protective measures when installing the module.

Table 1: Usage information

4 Introduction

4.1 Purpose

This chapter provides a general description of the LoRa Module. In the next-coming sections you will learn more about possible applications for the product and how the LoRa Module can be combined with other products to build versatile solutions.

4.2 Application description

The **LoRa Module** is a meter connectivity module for an Engelmann SensoStar S3/S3C heating/cooling meter to deliver meter data to a receiving (application) server over a LoRaWAN network. Meter data is securely transmitted, using LoRaWAN end-to-end security scheme.

4.3 Product features

The **LoRa Module** offers a combination of battery operation with long lifetime and a versatile application through its many configuration options. Key features of the module include:

- **Extensive battery lifetime**
The module's EcoMode feature enables the module to achieve a battery-lifetime of 6+1 or 10+1 years with a new internal meter battery ("+1" refer to 1 year of storage)
- **Easy start-up**
As soon as the meter connectivity module is mounted in the meter and activated, it will join the LoRaWAN network.
- **Easy and secure commissioning**
With Elvaco's One-Touch Commissioning (OTC), deployment, configuration and key transferring can be performed in a secure and flexible way.
- **Unique and flexible message formats**
The **LoRa Module** has several different message formats, this makes it easy to customize the payload to the unique demands of each application.

4.4 Meter Compatibility

The **LoRa Module** is compatible with Engelmann SensoStar meters with a compatible firmware version. If the LoRa Module is mounted in an incompatible meter, this is indicated in the OTC App. Table 2 shows the minimum firmware versions required.

The meter's firmware version can be shown in the meter's display, for further information please refer to the meter's manual.

Meter	Minimum firmware version
Engelmann SensoStar S3	1.03/0.14
Engelmann SensoStar S3C	1.00/0.05

Table 2: LoRa Module - Meter firmware compatibility

5 Getting started

5.1 Purpose

This chapter provides instructions on how to get started with the **LoRa Module**. After reading and carefully following each step of this chapter, your meter connectivity module should be mounted and connected to the LoRaWAN network.

5.2 Product specification

- (1) Green LED
- (2) Red LED
- (3) Interface Connector
- (4) Push Button
- (5) Pulse Input
- (6) LoRaWAN Antenna

Note: The NFC antenna is integrated in the edge of the PCB.

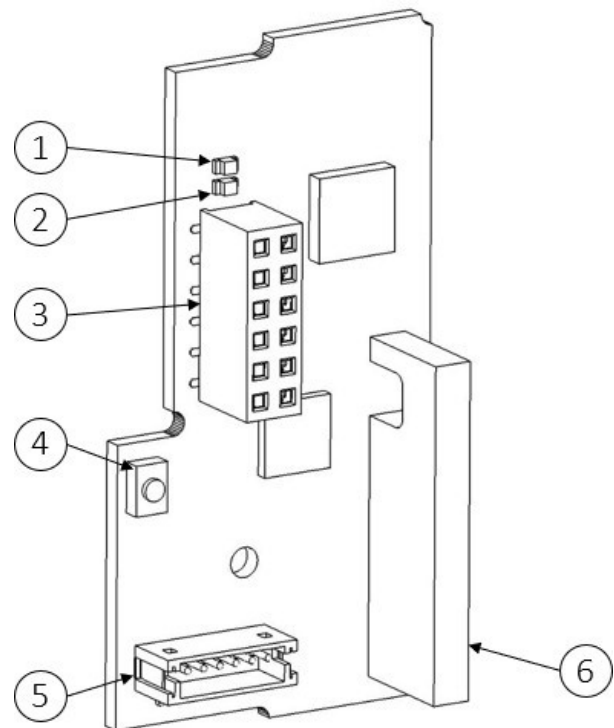


Figure 1. LoRa Module Product Specification

5.3 Mount and start-up the device

5.3.1 Mounting

Mount the **LoRa Module** in the module slot of Engelmann, see Figure 2 below.

- Please make sure that the module's push button (2) is facing upwards.
- Please make sure that Interface connector of the meter (1) fits the Interface connector of the module (3).

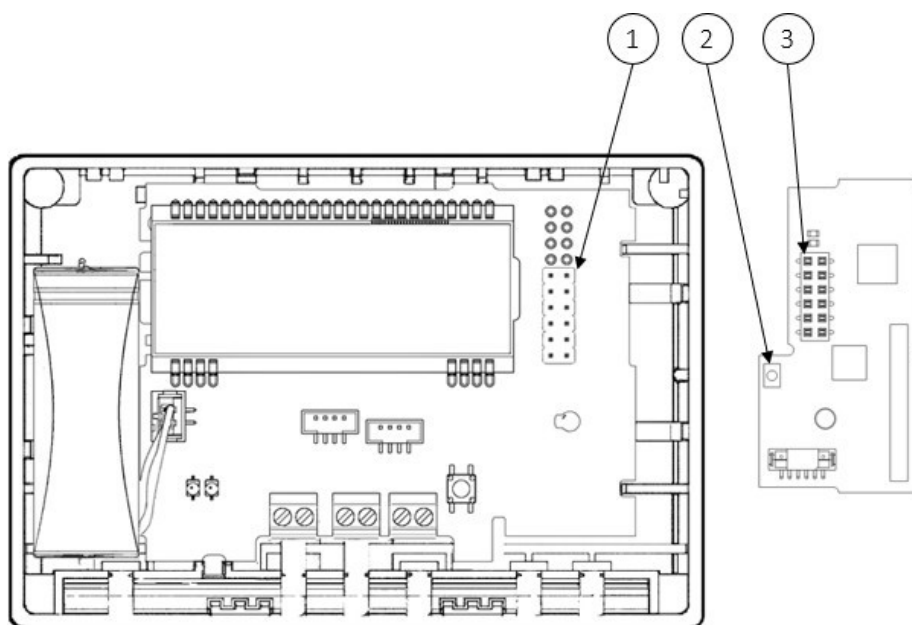


Figure 2: Engelmann SensoStar S3 meter (left) and LoRa module (right)

5.3.2 Network preparation

For the module to connect to the LoRaWAN network, it needs to be registered in the network server. The following information needs to be added in the network server, depending on activation type:

Over-the-air activation (OTAA): Device EUI, Application key and Join EUI

Activation by personality (ABP): Application Session key, Network Session key and Device address



Engelmann Sensor strongly recommends using Over-the-air activation (OTAA) to facilitate deployment and minimize the risk of duplicated keys.

5.3.3 Activation and LED indications

Module activation

By default, the **LoRa Module** is set to passive mode, which means no messages will be transmitted from the module until it is activated. The module can be activated in one of the following ways:

- By using the **Elvaco OTC App**: Open the Elvaco OTC app, which is available in Google Play.

1. Scan the module, make sure NFC is activated on the phone.
2. In Elvaco OTC App, go to the "APPLY" tab,
3. Set "Power mode" to "Active"
4. Click "APPLY" in the bottom of the screen
5. Scan the module to apply new settings.

To verify that the module has been activated, go to the "INSPECT" tab, scan the module, and make sure that "Power mode" is set to "Active".

Note that it is possible to create a configuration profile to apply a preconfigured setting to multiple devices, for further information please refer to the OTC app documentation, available on the Elvaco website.

- b) By using the **module push button**: Press down the push button of the module for at least five seconds until the green LED lights up.
- c) By using the **Engelmann optical interface configuration tool "Device Monitor"**. For further information please refer to Engelmann documentation.
- d) By using the **meter menu**. For further information please refer to Engelmann documentation.

Network join

When activated, the **LoRa Module** will attempt to join the LoRaWAN network by the following sequence:

1. Red LED – One flash
2. Green and Red LED – Lights simultaneously up for 1 second
3. Green LED – Several flashes while trying to connect to the LoRaWAN network
4. Green LED – Lights up for 8 seconds when module succeeds in joining the LoRaWAN network

The network join sequence is illustrated in Figure 3.

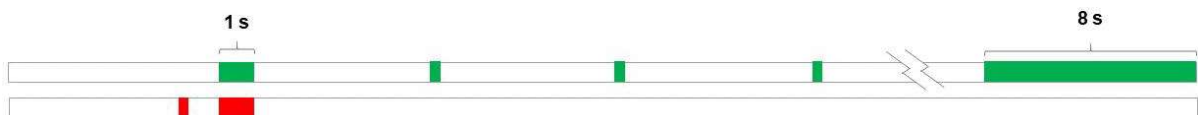


Figure 3: Network join sequence, Green and red LED indication

The time for the **LoRa Module** to join the LoRaWAN network join may differ depending on network conditions.

If the module fails to join the LoRaWAN network, it will retry until it succeeds. The time between each attempt will increase successively, to a minimum of once every day. A new join attempt cycle can be manually started at any time by rebooting the module (see section 5.3.4 Reboot/Switch off module) or by deactivating and activating the module using the Elvaco OTC App.

Once the module has joined the LoRaWAN network, meter data will initially be transmitted from the module every minute (regardless of transmit interval settings) to set the right data rate. After three minutes of calibration, the module will start to deliver meter data using its configured settings.

Follow below steps to verify that the module is communicating with the meter and is connected to the LoRaWAN network:

1. Open the Elvaco OTC App and go to "INSPECT" tab
2. Scan the module
3. Check if "Meter com" is set to "OK" and "Network joined" is set to "Yes"

5.3.4 Reboot/Switch off module

Reboot

Press and hold the push button (2) for 5-15 seconds. Release the button when the green LED is lit.

Switch Off

Press and hold the push button (2) for 15-20 seconds. Make sure to release the button when the red LED is lit. If releasing the push button after more than 20 seconds, the module will not switch off.

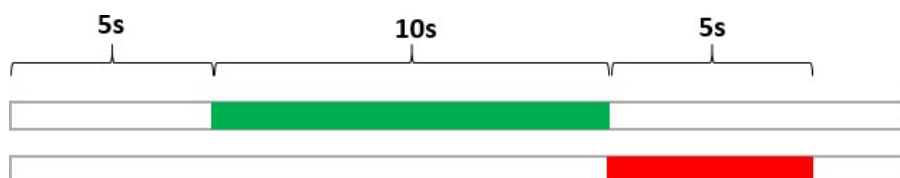


Figure 4: Reboot/switch off module

6 Administration reference

6.1 Purpose

This chapter contains detailed information about configuring options and the different message formats of the **LoRa Module**.

6.2 Security and access control

The **LoRa Module** has a “configuration lock” feature, which prevents unauthorized access to the module. When “configuration lock” has been enabled, a Product Access Key will be needed to configure the device. For more information about security and access control, please refer to the One-touch commissioning (OTC) documentation, available on the Elvaco website.

6.3 Configuration options

The **LoRa Module** is configured via the Elvaco OTC app. It uses NFC to transfer settings to the module. Downlink may also be used to for some configurations, see section 6.3.1 Downlink for more information.

The **LoRa Module** can also be configured using Engelmann optical interface configuration tool “Device Monitor”, for further information please refer to Engelmann documentation.



Please note that the Elvaco OTC App is compatible with Android phones with Android 5.0 or later.

Table 3 provides a summary of all **LoRa Module** parameters and settings.

Field name (Abbr.)	Description	Default value	Elvaco OTC App Locked device & correct Product Access Key <i>or</i> Open device	Elvaco OTC App No Product Access Key	Downlink
Device Settings					
Meter ID	Meter identification number of the meter. Not configurable.	N/A	Readable	Readable	N/A
Power mode	Used to activate/deactivate the module.	Passive	Readable / Writeable	Readable	N/A
EcoMode	When activated, a minimum battery-life of 6+1 or 10+1 years depending on the configuration) can be achieved by the module.	10 years	Readable / Writeable	Readable	Writeable
Message format	The message format determines the meter data included in the telegram from the module.	0x24 (Standard)	Readable / Writeable	Readable	Writeable
Transmit interval	Sets the number of minutes between each transmission from the module.	60 minutes	Readable / Writeable	Readable	Writeable
Date & Time	Date and time of the meter.	N/A	Readable / Writeable	Readable	N/A
Set Time Relative	Adjusts the time of the meter relative to the current time.	N/A	N/A	N/A	Writeable
Set absolute time	Sets the time of the meter	Writeable	N/A	N/A	N/A
Configuration Lock	Locks the module to prevent unauthorized access.	Open	Readable / Writeable	Readable	Writeable
Pulse input selection	Select which of the three pulse inputs to include when using the Engelmann message format. One or more can be selected.	0x00 (None)	Readable / Writeable	Readable	Writeable
LoRaWAN Settings					
Device EUI	Unique module identification number. Not configurable.	Device-unique 64-bit number	Readable	Readable	N/A
Activation type	Sets the way the device joins the LoRaWAN network.	OTAA	Readable / Writeable	Readable	Writeable

Network join	Used to display whether the module has joined the LoRaWAN network	N/A	Readable	Readable	N/A
Join EUI	Application identifier that determines where data ends up.	94193A030C000001	Readable / Writeable	Readable	Writeable
Device address	32-bit address used by the device to identify itself on the LoRaWAN network.	N/A	Readable / Writeable	Readable	Writeable
Current data rate	The current data rate used for the module.	N/A	Readable	Readable	N/A

Table 3: Configuration options

6.3.1 Downlink

The **LoRa Module** supports configuration via downlink, i.e. sending commands to an end-device via the LoRaWAN network. **Note that this feature should only be used sparingly due to bandwidth consideration.** Communication via downlink can only be made in a short window after an uplink transmission from module to server. Therefore, time-critical communication should not be performed over downlink.

Downlink are sent on **port 2**, structured according to the following format: "0x00" "TLV" "Number of bytes in configuration" "Configuration". For a complete description of all available downlink commands, see Table 4.

Field name	TLV	Number of bytes in configuration	Configuration	Example
Configuration lock	0x05	0x01	0x00 = Locked 0x01 = Open	0x00050101 (Enables configuration lock)
Transmit interval	0x06	0x02	0xNumber of minutes between transmission (lsByte -> msByte)	0x0006021E00 (Sets the Tx interval to 30 minutes)
Message format	0x07	0x01	0x24 = Standard 0x25 = Compact 0x26 = JSON 0x27 = Scheduled-daily redundant 0x28 = Scheduled - Extended 0x29 = Combined heat/cooling 0x2C = Engelmann	0x0007010XX (Sets the message format to compact)
EcoMode	0x0F	0x01	0x00 = Disable EcoMode 0x01 = Enable EcoMode, 10 years 0x02 = Enable EcoMode, 6 years	0x000F0100 (Disables EcoMode)

Set Time Relative	0x13	0x02	0xNumber of minutes* (lsByte -> msByte) *Negative numbers supported.	0x0013020F00 (Adds 15 minutes to the current time) 0x0013020F80 (Subtracts 15 minutes from the current time)
UTC offset	0x17	0x02	0xNumber of minutes* (lsByte -> msByte) *Negative numbers supported.	0x0017023C00 (Sets the UTC offset to +60 minutes) 0x0017023C80 (Sets the UTC offset to -60 minutes)
Reboot	0x22	0x02	0x9E75 is used to reboot device	0x0022029E75 (Reboots the device)
Pulse input selection	0x1D	0x01	Bit flags for selecting which pulse inputs are to be included in the Engelmann message format.	0x001D0101 (Only input 1) 0x001D0107 (Input 1, 2 & 3)
			0 = disabled, 1 = enabled Bit 0: Input 1 Bit 1: Input 2 Bit 2: Input 3 Bits 3-7 are reserved and shall be set to 0.	

Table 4: Downlink commands

6.4 Adaptive data rate (ADR)

The **LoRa Module** uses Adaptive Data Rate (ADR), part of the LoRaWAN standard, where the network server determines the optimal rate of communication for the module based on current signal conditions. In best case, the module will use its highest data rate (DR5) in order to be as energy efficient as possible. When signal conditions are poor, the network server will incrementally lower the data rate until it is able to receive the message. When the data rate is low, the energy consumption per telegram will increase.

6.5 Transmit interval

The transmit interval is used to set how frequently the module should transmit data on the LoRaWAN network. The parameter can be set to a value between 5 and 1440 minutes (i.e. 5-minute to daily values).

6.5.1 EcoMode

When EcoMode is active, the module has a battery lifetime of 6+1 or 10+1 years, depending on what EcoMode alternative is set. EcoMode setting is ignored when PSU (external power supply Engelmann) is connected. The module can achieve battery life of 6+1 or 10+1 years by using a table of allowed transmit intervals settings for each data rate.

When radio conditions are poor (and data rate is low), the module will send data less frequently to conserve battery-life. When signal conditions are good, the module will send data more frequently. When EcoMode is enabled, the module will continuously check if the set transmit interval is “allowed” by the EcoMode table. If a lower transmit interval is needed for the specific data rate to achieve 6+1 or 10+1 years of battery life, the module will adjust the parameter accordingly. See Table 5 and Table 6 for the transmit interval allowed in each data rate.

Please note that anticipated battery lifetime cannot be assured if:



- EcoMode is disabled (Even if EcoMode is activated later)
- Changing from 6+1 to 10+1 years battery lifetime in EcoMode



When using the “Engelmann” message format the transmit interval is doubled to compensate for the additional telegrams transmitted in this message format, with the exception of DR0 in 10+1 year EcoMode where the transmit interval is capped at 1440 minutes (corresponding to once every 24 hours).

Data rate	Transmit interval (minutes)	Transmit interval, Engelmann message format (minutes)
DR0	180	360
DR1	120	240
DR2	60	120
DR3	30	60
DR4	15	30
DR5	15	30

Table 5: EcoMode transmit interval settings, EcoMode (6+1 years)

Data rate	Transmit interval (minutes)	Transmit interval, Engelmann message format (minutes)
DR0	1440	1440
DR1	360	720
DR2	180	360
DR3	120	240
DR4	90	180
DR5	60	120

Table 6: EcoMode transmit interval settings, EcoMode (10+1 years)

6.6 Message formats

The **LoRa Module** has several different message formats. Each one will be described in detail in this section.

6.6.1 Message structure

Message formats *Standard*, *Compact*, *Scheduled – Daily redundant*, *Scheduled Extended*, *Combined heat/cooling* and *Engelmann* are encoded in M-Bus format (M-Bus standard EN 13757-3:2013). Message format JSON is encoded in JSON format.

All messages begin with one byte specifying the message format used. All M-Bus encoded messages begin with one byte specifying the message format used. Then follows a sequence of data information blocks (DIBs), each one containing a data information field (DIF), a value information field (VIF) and a data field (DATA). The structure of the telegram is illustrated in Figure 5.

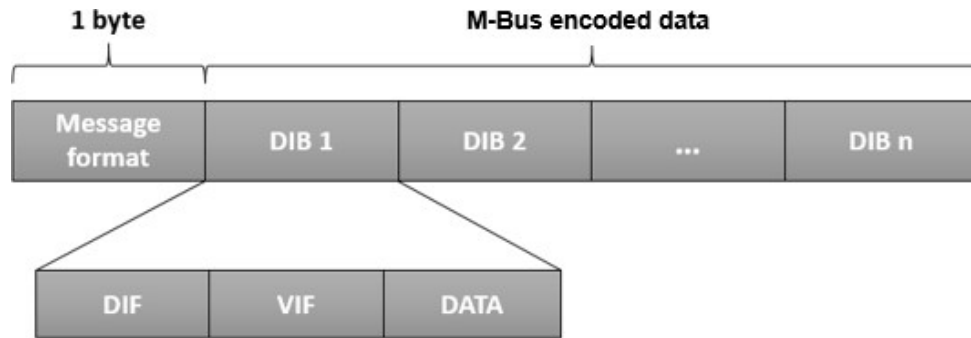


Figure 5: LoRa Module M-Bus message structure

For message type *JSON*, the data is presented as plain text.

Field	Size	Description
Message format	1 byte	0x24 = Standard 0x25 = Compact 0x26 = JSON 0x27 = Scheduled – daily redundant 0x28 = Scheduled - Extended 0x29 = Combined heat/cooling 0x2C = Engelmann telegram 1 0x2D = Engelmann telegram 2*

Table 7: LoRa Module Message formats

*Engelmann telegram 2 cannot be selected as a telegram type. It is the ID of the second telegram when using message format Engelmann.

6.6.2 Structure and payload

In this section, a detailed description of each message format payload is provided. All numbers in the payload are given in hexadecimal unless otherwise stated.

6.6.2.1 Standard

Table 8 provides a detailed description of the payload of message format *Standard*.

DIB	Field	Size	Data type	Description
0	Message format	1 byte	-	0x24 (= Standard)
1	Energy	6-7 bytes	INT32	Energy consumption (Wh, J, Cal, MBTU) 0400xxxxxxxx = xxxxxxxx,xxx Wh 0401xxxxxxxx = xxxxxxxx,xx Wh 0402xxxxxxxx = xxxxxxxx,x Wh 0403xxxxxxxx = xxxxxxxx Wh 0404xxxxxxxx = xxxxxxxx * 10 Wh 0405xxxxxxxx = xxxxxxxx * 100 Wh 0406xxxxxxxx = xxxxxxxx kWh 0407xxxxxxxx = xxxxxxxx * 10 kWh 040Exxxxxxxxx = xxxxxxxx MJ 040Fxxxxxxxx = xxxxxxxx * 10 MJ 04FB0Dxxxxxxxx = xxxxxxxx MCal

				04FB0Exxxxxxxx = xxxxxxxx * 10 MCal 04FB0Fxxxxxxx = xxxxxxxx * 100 MCal
2	Volume	6 bytes	INT32	Volume (m ³) 0411xxxxxxx = xxxxxxxx * 0.00001 m ³ 0412xxxxxxx = xxxxxxxx * 0.0001 m ³ 0413xxxxxxx = xxxxxxxx * 0.001 m ³ 0414xxxxxxx = xxxxxxxx * 0.01 m ³ 0415xxxxxxx = xxxxxxxx * 0.1 m ³ 0416xxxxxxx = xxxxxxxx m ³ 0417xxxxxxx = xxxxxxxx * 10 m ³
3	Power	4 bytes	INT16	Power (W) 022Bxxxx = xxxx W 022Cxxxx = xxxx * 10 W 022Dxxxx = xxxx * 100 W 022Exxxx = xxxx kW 022Fxxxx = xxxx * 10 kW
4	Flow	4 bytes	INT16	Flow (m ³ /h) 023Bxxxx = xxxx * 0.001 m ³ /h 023Cxxxx = xxxx * 0.01 m ³ /h 023Dxxxx = xxxx * 0.1 m ³ /h 023Exxxx = xxxx m ³ /h 023Fxxxx = xxxx * 10 m ³ /h
5	Fw temp	4 bytes	INT16	Forward temperature (°C) 0258xxxx = xxxx * 0.001 °C 0259xxxx = xxxx * 0.01 °C 025Axxxx = xxxx * 0.1 °C 025Bxxxx = xxxx °C
6	Rt temp	4 bytes	INT16	Return temperature (°C) 025Cxxxx = xxxx * 0.001 °C 025Dxxxx = xxxx * 0.01 °C 025Exxxx = xxxx * 0.1 °C 025Fxxxx = xxxx °C
7	Meter ID	6 bytes	According to M-Bus EN13757-3 identification field	Meter ID 0C78xxxxxxx
8	Error flags	4 bytes	INT8	Error and warning flags 01FD17xx

Table 8: Payload, message format Standard

6.6.2.2 Compact

Table 9 provides a detailed description of message format *Compact*.

DIB	Field	Size	Data type	Description
0	Message format	1 byte	-	0x25 (= Compact)

1	Energy	6-7 bytes	INT32	Energy consumption (Wh, J, Cal, MBTU) 0400xxxxxxxx = xxxxxxxx,xxx Wh 0401xxxxxxxx = xxxxxxxx,xx Wh 0402xxxxxxxx = xxxxxxxx,x Wh 0403xxxxxxxx = xxxxxxxx Wh 0404xxxxxxxx = xxxxxxxx * 10 Wh 0405xxxxxxxx = xxxxxxxx * 100 Wh 0406xxxxxxxx = xxxxxxxx kWh 0407xxxxxxxx = xxxxxxxx * 10 kWh 040Exxxxxxxxx = xxxxxxxx MJ 040Fxxxxxxxx = xxxxxxxx * 10 MJ 04FB0Dxxxxxxxx = xxxxxxxx MCal 04FB0Exxxxxxxxx = xxxxxxxx * 10 MCal 04FB0Fxxxxxxxx = xxxxxxxx * 100 MCal
2	Meter ID	6 bytes	According to M-Bus EN13757-3 identification field	Meter ID 0C78xxxxxxxx
3	Error flags	4 bytes	INT8	Error and warning flags 01FD17xx

Table 9: Payload, message format Compact

6.6.2.3 JSON

In message format *JSON*, data is presented on a plain text format. Table 10 provides a description of all fields included in the telegram.

Field	Description
Energy	Energy consumption (Wh, J, Cal)
Unit	Unit of energy consumption
Meter ID	Identification number of the meter in which the module is mounted.

Table 10: Message format JSON

In Figure 6, an example of a telegram for message format *JSON* is presented.

{"E": "12345.678", "U": "MWh", "ID": 87654321}

Figure 6: JSON message example

6.6.2.4 Scheduled mode

For message formats of type "Scheduled" (Scheduled – Daily redundant and Scheduled – Extended), two types of messages will be transmitted from the module - a clock message and a data message. The difference between the two is described in Table 11. A detailed description of the payload of the clock message is provided in Table 12.

Message	Time interval	Description
Clock message	Once per day	The clock message presents the current time of the meter. It can be used to verify that the clock is correct and has not drifted more than accepted.
Data message	Determined by transmit interval settings.	The actual meter data collected from the meter. For more information.

Table 11: Clock and data message

DIB	Field	Size	Data type	Description
0	Message format identifier	1 byte	-	0xFA (=Clock message)
1	Date/time	6 bytes	32 bit binary integer M-Bus type F	046Dxxxxxxx = Valid date/time message 346Dxxxxxxx = Invalid date/time message

Table 12: Payload, clock message

The clock message will be transmitted once every day and the data message at least (regulated by transmit interval parameter) once every day. The transmit interval can only be set the values listed in Table 10. Note that although the meter readout will occur on top-of-the-hour, the data message will not necessarily be transmitted at that exact time. The LoRa transmission will occur after a random delay of 1- 30 minutes. The meter readout for the clock message occurs at a random hour (00:00-23:00) at a random minute in the 35-45 interval. The clock message will be transmitted immediately after readout.



When using message format *Scheduled*, the transmit interval cannot not be set to higher than 1440 minutes (24 hours).

Parameter	Values	Unit
Transmit interval	60, 120, 180, 240, 360, 480, 720, 1440	Minutes

Table 13: Transmit interval values in *Scheduled* mode

6.6.2.5 Daily redundant

The data message of *Scheduled mode – Daily redundant* contains an accumulated daily energy field, which is updated at 24:00 each day. Depending on transmit interval settings and data rate, the field will be included in between 1-24 data messages per day. This will increase the probability of the value being received. For example, if the transmit interval is set to “12”, the accumulated energy read at 24:00 will be transmitted 12 times during the 24 next coming hours.

Table 14 provides a detailed description of message format *Scheduled – Daily redundant*.

DIB	Field	Size	Data type	Description
0	Message format	1 byte	-	0x27 (= Scheduled – Daily redundant)
1	Heat energy E1 / Cooling energy E3	6-7 bytes	INT32	Energy consumption (Wh, J, Cal, MBTU) 0400xxxxxxx = xxxxxxxx,xxx Wh 0401xxxxxxx = xxxxxxxx,xx Wh 0402xxxxxxx = xxxxxxxx,x Wh 0403xxxxxxx = xxxxxxxx Wh 0404xxxxxxx = xxxxxxxx * 10 Wh 0405xxxxxxx = xxxxxxxx * 100 Wh 0406xxxxxxx = xxxxxxxx kWh 0407xxxxxxx = xxxxxxxx * 10 kWh 040Exxxxxxx = xxxxxxxx MJ 040Fxxxxxxx = xxxxxxxx * 10 MJ 04FB0Dxxxxxxx = xxxxxxxx MCal 04FB0Exxxxxxx = xxxxxxxx * 10 MCal 04FB0Fxxxxxxx = xxxxxxxx * 100 MCal
2	Volume	6 bytes	INT32	Volume (m ³) 0411xxxxxxx = xxxxxxxx * 0.00001 m ³ 0412xxxxxxx = xxxxxxxx * 0.0001 m ³ 0413xxxxxxx = xxxxxxxx * 0.001 m ³ 0414xxxxxxx = xxxxxxxx * 0.01 m ³

				0415xxxxxxxx = xxxxxxxx * 0.1 m ³ 0416xxxxxxxx = xxxxxxxx m ³ 0417xxxxxxxx = xxxxxxxx * 10 m ³
3	Meter ID	6 bytes	According to M- Bus EN13757-3 identification field	Meter ID 0C78xxxxxxxx
4	Error flags	4 bytes	INT8	Error and warning flags 01FD17xx
5	Meter date/time	6 bytes	INT32	Meter date and time (YY-MM-DD HH:MM) 046Dxxxxxxxx Bit 31-28 = Year-high* Bit 27-24 = Month Bit 23-21 = Year-low* Bit 20-16 = Day Bit 15 = Summer time flag** Bit 14-13 = Century Bit 12-8 = Hour Bit 7 = Error flag Bit 6 = Reserved for future use*** Bit 5-0 = Minute *The year is read by combining the year-high and year- low field. For example, year-high = 0010 and year-low = 010 => year = 0010010 **0 = standard time, 1= daylight-saving time ***0 = timestamp is valid, 1 = timestamp is not valid
6	Accumulated energy at 24:00	6-7 bytes	INT32	Energy consumption (Wh, J) 4406xxxxxxxx = MWh, 3 decimals = kWh 440Exxxxxxxxx = GJ, 3 decimals 44FB0Dxxxxxxxx = Gcal, 3 decimals 44863Dxxxxxxxx = MMBTU, 3 decimals Note: Before a midnight reading has been performed the Function field of the DIF is set to "value during error state" to indicate that the value is not valid. Example: The following table contains a detailed description of the payload of message format <i>Scheduled – Daily redundant</i>

Table 14: Message format Scheduled – Daily redundant

6.6.2.6 Scheduled – Extended

The data message of *Scheduled mode – Extended* contains all the data fields from message format *Standard* with an additional meter timestamp. Like all *Scheduled* message formats, the meter is read at full hour.

A detailed description of the payload in the message format is presented in Table 15.

DIB	Field	Size	Data type	Description
0	Message format identifier	1 byte	-	0x28 (Scheduled – Extended)
1	Heat energy E1 / Cooling energy E3	6-7 bytes	INT32	Energy consumption (Wh, J, Cal, MBTU) 0400xxxxxxxx = xxxxxxxx,xxx Wh 0401xxxxxxxx = xxxxxxxx,xx Wh 0402xxxxxxxx = xxxxxxxx,x Wh 0403xxxxxxxx = xxxxxxxx Wh 0404xxxxxxxx = xxxxxxxx * 10 Wh 0405xxxxxxxx = xxxxxxxx * 100 Wh 0406xxxxxxxx = xxxxxxxx kWh 0407xxxxxxxx = xxxxxxxx * 10 kWh 040Exxxxxxxxx = xxxxxxxx MJ 040Fxxxxxxxx = xxxxxxxx * 10 MJ 04FB0Dxxxxxxxx = xxxxxxxx MCal 04FB0Exxxxxxxxx = xxxxxxxx * 10 MCal 04FB0Fxxxxxxxx = xxxxxxxx * 100 MCal
2	Volume	6 bytes	INT32	Volume (m ³) 0411xxxxxxxx = xxxxxxxx * 0.00001 m ³ 0412xxxxxxxx = xxxxxxxx * 0.0001 m ³ 0413xxxxxxxx = xxxxxxxx * 0.001 m ³ 0414xxxxxxxx = xxxxxxxx * 0.01 m ³ 0415xxxxxxxx = xxxxxxxx * 0.1 m ³ 0416xxxxxxxx = xxxxxxxx m ³ 0417xxxxxxxx = xxxxxxxx * 10 m ³
3	Power /Flow / Fw temp / Rt temp	12 bytes	INT64	Byte 0-2 = DIF/VIF codes, 0x07FFA0 Byte 3 = Scaling of Power/Flow -Bit 6.4 (n), 10 ⁿ⁻³ W, n = 0..7 -Bit 2..0 (m), 10 ^{m-3} m ³ /h, m = 0..7 Byte 4-5 = Fw temp (lsByte -> msByte), °C, 2 decimals Byte 6-7 = Rt temp (lsByte -> msByte), °C, 2 decimals Byte 8-9 = Flow (lsByte -> msByte), 10 ^{m-6} m ³ /h Byte 10-11 = Power (lsByte -> msByte), 10 ⁿ⁻³ W
4	Meter ID / Info bits	9 bytes	INT48	06FF21xxxxxxxxxxxx xxxx = Info bits (lsByte -> msByte) yyyyyyyy = Meter ID (lsByte -> msByte)* *Sent in binary format

5	Meter date/time	6 bytes	INT32	<p>Meter date and time (YY-MM-DD HH:MM)</p> <p>046Dxxxxxxxx</p> <p>Bit 31-28 = Year-high*</p> <p>Bit 27-24 = Month</p> <p>Bit 23-21 = Year-low*</p> <p>Bit 20-16 = Day</p> <p>Bit 15 = Summertime flag**</p> <p>Bit 12-8 = Hour</p> <p>Bit 7 = Error flag***</p> <p>Bit 6 = Reserved for future use***</p> <p>Bit 5-0 = Minute</p> <p>*The year is read by combining the year-high and year-low field. For example, year-high = 0010 and year-low = 010 => year = 0010010</p> <p>**0 = standard time, 1= daylight-saving time</p> <p>***0 = timestamp is valid, 1 = timestamp is not valid</p>
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Table 15: Message format Scheduled – Extended

6.6.2.7 Combined heat/cooling

Message format *Combined heat/cooling* is made to be used in meters that measures both heating and cooling energy.

Table 13 lists the indexes included in this message format.

DIB	Field	Size	Data type	Description
0	Message format	1 byte	-	0x29 (Combined heat/cooling)
1	Heat Energy E1	6-7 bytes	INT32	<p>Energy consumption (Wh, J, Cal, MBTU)</p> <p>Energy consumption (Wh, J, Cal)</p> <p>0400xxxxxxxx = xxxxxxxx,xxx Wh</p> <p>0401xxxxxxxx = xxxxxxxx,xx Wh</p> <p>0402xxxxxxxx = xxxxxxxx,x Wh</p> <p>0403xxxxxxxx = xxxxxxxx Wh</p> <p>0404xxxxxxxx = xxxxxxxx * 10 Wh</p> <p>0405xxxxxxxx = xxxxxxxx * 100 Wh</p> <p>0406xxxxxxxx = xxxxxxxx kWh</p> <p>0407xxxxxxxx = xxxxxxxx * 10 kWh</p> <p>040Exxxxxxxxx = xxxxxxxx MJ</p> <p>040Fxxxxxxxx = xxxxxxxx * 10 MJ</p> <p>04FB0Dxxxxxxxx = xxxxxxxx MCal</p> <p>04FB0Exxxxxxxxx = xxxxxxxx * 10 MCal</p> <p>04FB0Fxxxxxxxx = xxxxxxxx * 100 MCal</p>
2	Cooling Energy E3	7-8 bytes	INT32	<p>Energy consumption (Wh, J, Cal, MBTU)</p> <p>841006xxxxxxxx = MWh, 3 decimals = kWh</p> <p>84100Exxxxxxxxx = GJ, 3 decimals</p> <p>8410FB0Dxxxxxxxx = Gcal, 3 decimals</p> <p>8410863Dxxxxxxxx = MMBTu, 3 decimals</p>

3	Volume	6 bytes	INT32	Volume (m ³) 0411xxxxxxx = xxxxxx * 0.00001 m ³ 0412xxxxxxx = xxxxxx * 0.0001 m ³ 0413xxxxxxx = xxxxxx * 0.001 m ³ 0414xxxxxxx = xxxxxx * 0.01 m ³ 0415xxxxxxx = xxxxxx * 0.1 m ³ 0416xxxxxxx = xxxxxx m ³ 0417xxxxxxx = xxxxxx * 10 m ³
4	Fw temp	4 bytes	INT16	Forward temperature (°C) 0258xxxx = xxxx * 0.001 °C 0259xxxx = xxxx * 0.01 °C 025Axxxx = xxxx * 0.1 °C 025Bxxxx = xxxx °C
5	Rt temp	4 bytes	INT16	Return temperature (°C) 025Cxxxx = xxxx * 0.001 °C 025Dxxxx = xxxx * 0.01 °C 025Exxxx = xxxx * 0.1 °C 025Fxxxx = xxxx °C
6	Meter ID	6 bytes	According to M-Bus EN13757-3 identification field	Meter ID 0C78xxxxxxx
7	Error flags	4 bytes	INT8	Error and warning flags 01FD17xx

Table 16: Message format, Combined heat/cooling

6.6.2.8 Engelmann

In message format Engelmann, two types of telegrams are transmitted from the module; the first contain information collected from the SensoStar meter and the second information collected from meters connected via the module's pulse inputs. Note that telegram 2 is only transmitted from the module if the pulse inputs are used.

When using the Engelmann message format the transmit interval (see section 6.5) is doubled to compensate for the additional telegrams transmitted in this message format, even if pulse inputs are not used and telegram 2 is not transmitted.

The module configuration parameter "Pulse input configuration" specifies which of the three pulse inputs are connected and whose data shall be read and transmitted by the module. Only the values configured to be included are sent. If no inputs are selected, telegram 2 is not sent.

Note: in case of errors in reading the data from the meter the function field in the DIF is set to indicate "value during error state" (M-Bus standard EN 13757-3:2013). In such cases the VIF and data part should be ignored. Since the unit of the input can be unknown in such cases it is set to dimensionless in the VIF, e.g., B440FD3A00000000 = pulse counter 1, no unit, with "value during error state".

Table 17 and Table 18 list the indexes the information of both telegrams of this message format.

DIB	Field	Size	Data type	Description
0	Message format	1 byte	-	0x2C (Engelmann, telegram 1)
1	Heat energy E1 / Cooling energy E3	6-7 bytes	INT32	<p>Energy consumption (Wh, J, Cal)</p> <p>0400xxxxxxxx = xxxxxxxx,xxx Wh 0401xxxxxxxx = xxxxxxxx,xx Wh 0402xxxxxxxx = xxxxxxxx,x Wh 0403xxxxxxxx = xxxxxxxx Wh 0404xxxxxxxx = xxxxxxxx * 10 Wh 0405xxxxxxxx = xxxxxxxx * 100 Wh 0406xxxxxxxx = xxxxxxxx kWh 0407xxxxxxxx = xxxxxxxx * 10 kWh 040Exxxxxxxxx = xxxxxxxx MJ 040Fxxxxxxxx = xxxxxxxx * 10 MJ 04FB0Dxxxxxxxx = xxxxxxxx MCal 04FB0Exxxxxxxxx = xxxxxxxx * 10 MCal 04FB0Fxxxxxxxx = xxxxxxxx * 100 MCal</p>
2	Cooling energy E3*	7-8 bytes	INT32	<p>Energy consumption (Wh, J, Cal, MBTU)</p> <p>841006xxxxxxxx = MWh, 3 decimals = kWh 84100Exxxxxxxxx = GJ, 3 decimals 8410FB0Dxxxxxxxx = Gcal, 3 decimals 8410863Dxxxxxxxx = MMBTu, 3 decimals</p>
3	Volume	6 bytes	INT32	<p>Volume (m³)</p> <p>0411xxxxxxxx = xxxxxxxx * 0.00001 m³ 0412xxxxxxxx = xxxxxxxx * 0.0001 m³ 0413xxxxxxxx = xxxxxxxx * 0.001 m³ 0414xxxxxxxx = xxxxxxxx * 0.01 m³ 0415xxxxxxxx = xxxxxxxx * 0.1 m³ 0416xxxxxxxx = xxxxxxxx m³ 0417xxxxxxxx = xxxxxxxx * 10 m³</p>
4	Meter date / time	6 bytes	INT32	<p>Meter date and time (YY-MM-DD HH:MM)</p> <p>046Dxxxxxxxx</p> <p>Bit 31-28 = Year-high* Bit 27-24 = Month Bit 23-21 = Year-low* Bit 20-16 = Day Bit 15 = Summer time flag** Bit 14-13 = Century Bit 12-8 = Hour Bit 7 = Error flag Bit 6 = Reserved for future use*** Bit 5-0 = Minute</p> <p>*The year is read by combining the year-high and year- low field. For example, year-high = 0010 and year-low = 010 => year = 0010010</p> <p>**0 = standard time, 1= daylight-saving time</p> <p>***0 = timestamp is valid, 1 = timestamp is not valid</p>

5	Meter ID	6 bytes	According to M-Bus EN13757-3 identification field	Meter ID 0C78xxxxxxx
6	Error flags	4 bytes	INT8	Error and warning flags 01FD17xx

Table 17: Message format Engelmann, heat meter telegram

*Cooling energy E3 field is only valid in a combined heat/cooling meter for message format Engelmann. Else the function field of the DIF is set to "value during error state" to indicate that the value is not valid.

DIB	Field	Size	Data type	Description
0	Message format	1 byte	-	0x2D (Engelmann, telegram 2)
1	Pulse input 1	7-8 bytes	INT32	844013xxxxxxx = m ³ , 3 decimals 844014xxxxxxx = m ³ , 2 decimals 844015xxxxxxx = m ³ , 1 decimal 844006xxxxxxx = MWh, 3 decimals 844007xxxxxxx = MWh, 2 decimals 8440FD3Axxxxxxx = No unit
2	Pulse input 2	8-9 bytes	INT32	84804013xxxxxxx = m ³ , 3 decimals 84804014xxxxxxx = m ³ , 2 decimals 84804015xxxxxxx = m ³ , 1 decimal 84804006xxxxxxx = MWh, 3 decimals 84804007xxxxxxx = MWh, 2 decimals 848040FD3Axxxxxxx = No unit
3	Pulse input 3	8-9 bytes	INT32	84C04013xxxxxxx = m ³ , 3 decimals 84C04014xxxxxxx = m ³ , 2 decimals 84C04015xxxxxxx = m ³ , 1 decimal 84C04006xxxxxxx = MWh, 3 decimals 84C04007xxxxxxx = MWh, 2 decimals 84C040FD3Axxxxxxx = No unit
4	Meter date / time	6 bytes	INT32	Meter date and time (YY-MM-DD HH:MM) 046Dxxxxxxx Bit 31-28 = Year-high* Bit 27-24 = Month Bit 23-21 = Year-low* Bit 20-16 = Day Bit 15 = Summer time flag** Bit 14-13 = Century Bit 12-8 = Hour Bit 7 = Error flag Bit 6 = Reserved for future use*** Bit 5-0 = Minute *The year is read by combining the year-high and year- low field. For example, year-high = 0010 and year-low = 010 => year = 0010010 **0 = standard time, 1= daylight-saving time

				***0 = timestamp is valid, 1 = timestamp is not valid
5	Meter ID	6 bytes	According to M-Bus EN13757-3 identification field	Meter ID 0C78xxxxxxxx

Table 18: Message format Engelmann, pulse input telegram

6.6.3 Meter communication error message

The payloads using M-Bus encoded data uses the Function field of the DIF to indicate errors. In this case it is set to "value during error state" (M-Bus standard EN 13757-3:2013) and the value sent should not be used. A typical case for this is when the module is unable to communicate with the meter and retrieve meter values, in which case all the fields in the payload have the DIF indicating "value during errorstate".

In case of erroneous data or if the module is unable to communicate with meter, bit 4-5 of the bit of the DIF code (first byte of each index field) will be set to 11b. For example, a DIF code of 0x02 will be set to 0x32 in case of error. (This applies to all message format except *JSON*.) For message format *JSON*, the actual value will be replaced with "null" in case of error state. If no meter communication is possible at all, all fields have this error indication set.

7 Technical specifications

Type	Value	Unit	Comments
Mechanics			
Dimensions (w x h x d)	29 x 56 x 12	mm	
Weight	9	g	
Mounting	In module slot of Engelmann SensoStar S3/S3C	-	
Electrical connections			
Supply voltage	Internal meter battery or PSU (Engelmann External Power Supply)	-	
Electrical characteristics			
Nominal voltage	3.0	VDC	
Power consumption (max)	50	mA	
Power consumption (sleep mode)	2.5	µA	
Environmental specifications			
Operating temperature	5 - 55	°C	
Operating humidity	0 - 93	% RH	No condensation
Operating altitude (max)	2000	m	
Usage environment	Indoors	-	
Storage temperature	-20 to +60	°C	
Radio characteristics			
Frequency	868	MHz	
Output power	14	dBm	
Receiver sensitivity	-135	dBm	
LoRaWAN characteristics			
Device class	Class A	-	Bi-directional
Activation	OTAA or ABP	-	
Data rate	DR0 - DR5	-	250 – 5470 bit/s
User interface			
Green LED & Red LED	Indication for start-up / reboot / switch-off		
Push button	Start-up / reboot / switch off module		
Configuration	Elvaco OTC app, Downlink or Engelmann optical configuration tool "Device Monitor"	-	

8 Type approvals

The **LoRa Module** is designed to comply with the directives and standards listed below.

Approval	Description
EMC	EN 301 489-1, EN 309 489-3
LoRa Alliance®	LoRaWAN® Certified

9 Document history

9.1 Versions

Version	Date	Description
V1.0	2020-10	Commercial release v1.0
V1.1	2024-02	Adjustments M-Bus decoding

10 References

10.1 Terms and abbreviations

Abbreviation	Description
DIB	Data Information Block
DIF	Data Information Field
VIF	Value Information Field
MCM	Meter Connectivity Module

10.2 Number representation

- Decimal numbers are represented as normal number, i.e. 10 (ten).
- Hexadecimal numbers are represented with prefix 0x, i.e. 0x0A (ten)
- Binary numbers are represented with prefix 0b, i.e. 0b00001010 (ten)
- Payload data follows the M-Bus Standard with the least significant byte (LSB) first

10.3 European Standards

- [1] M-Bus standard EN 13757-3:2013 Communication systems for and remote reading of meters – Part 3: Dedicated application layer

10.4 EU Declaration of Conformity

EU DECLARATION OF CONFORMITY

This declaration of conformity is issued under the sole responsibility of the manufacturer:
Elvaco AB, Kabelgatan 2T, S-434 37 Kungälv, Sweden.

Product	Year of CE-marking
CMI4170	2020

The object(s) of the declaration listed above is in conformity with the relevant Community harmonization legislation:
Radio Equipment Directive (RED) 2014/53/EU
Low Voltage Directive 2014/35/EU
EMC Directive 2014/30/EU
RoHS 2011/65/EU

And are in conformity with the following harmonization standards or other normative documents:

EN 62368-1 2018 (Safety requirements for information and communication technology equipment)
EN 301 489-1 v2.2.3 (EMC standard for radio equipment and services)
EN 301 489-3 v2.1.1 (EMC standard for radio equipment and services)
EN 300220-1 v3.1.1 (SRD Low power radio equipment)
EN 300220-2 v3.2.1 (SRD Low power radio equipment)
EN 55032 CISPR 32 2015 (Radiated emission)
EN 61000-4-2 2008 (Immunity to ESD)
EN 61000-4-3 2006 (Immunity to RF field)
EN 61000-4-4 2012 (Immunity to electrical fast transient/burst)
EN 61000-4-5 2017 (Immunity to surge measurement)
EN 61000-4-6 (Immunity to HF injections)
EN 61000-4-11 (Immunity to voltage dips/short interruptions and variations)

Kungälv, Sweden, 2020-01-13



Håkan Saxmo, Chief Technology Officer