CMi4170

User manual

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1.3 Edition
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Table of Contents

1. About this manual **4**
1.1. Symbols 4
1.2. Terms and abbreviations 4
2. Safety **5**
3. Product **6**
3.1. Application description 6
3.2. Features 6
3.3. Compatibility 6
3.4. Parts overview 7
4. Installation **8**
4.1. Mounting the module 8
4.2. Activating the module 8
4.3. Joining the LoRaWAN network 9
5. Operation **10**
5.1. Server configuration 10
5.2. Configuration 10
5.3. Transmit interval 11
5.3.1. Transmit interval in EcoMode 11
5.4. Time handling 12
5.5. Adaptive data rate (ADR) 12
5.6. Message encoding 12
5.7. Security and access control 13
5.8. Meter communication error messages 13
5.9. Reset procedures 13
5.9.1. Rebooting the module 13
5.9.2. Switching off the module 13
6. Configuration options **14**
6.1. Elvaco OTC app configuration options 14
6.2. Downlink configuration options 15
6.3. Message formats 16
6.3.1. Unscheduled message formats 16
6.3.2. Scheduled message formats 19
7. Technical specifications **28**
8. Simplified Declaration of Conformity **30**
9. Document history **31**

1. About this manual

This manual covers information needed to mount, install, configure, and use the product. It is intended for installers and system integrators.

To download the latest version of this User manual, visit the Elvaco website, https://www.elvaco.com. There you will also find information about Elvaco's other products and services.

1.1. Symbols

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

WARNING
Indicates a potentially dangerous situation that could result in severe injuries or serious equipment damage.

CAUTION
Indicates a potentially dangerous situation that could result in minor injuries or equipment damage.

NOTE
Indicates information that is important to take into consideration for safety reasons or to assure correct operation of the product.

TIP
Indicates information intended to help you get the most out of your product. It can for example be used to highlight a possible customization option related to the current section.

1.2. Terms and abbreviations

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

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 the prefix 0b, i.e. 0b00001010 (ten)

European standards

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

2. Safety

The following safety precautions must be observed during all phases of the operation, usage, service, or repair of the product. Users of the product are advised to convey the following safety 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. Elvaco AB assumes no liability for customer's failure to comply with these precautions.

CAUTION

Electrostatic-sensitive product. Observe the necessary ESD protective measures when installing the product.

NOTE

The product 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.

NOTE

Waste electrical products should not be disposed of with household waste. Please recycle where facilities exist. Contact your Local Authority for recycling advise.

3. Product

3.1. Application description

CMi4170 is a meter communication module mounted inside a Engelmann Sensostar S3/S3C to deliver meter data to a receiving server via a LoRaWAN network. The module is energy-efficient and has eleven years battery life. It can be retrofitted into deployed meters and is ideal for applications where long range is required. CMi4170 is easily configured through Elvaco OTC mobile app. With CMi4170, Elvaco offers a meter communication module designed for customers that require a user-friendly and cost-effective solution.

3.2. Features

CMi4170 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**
  CMi4170 has several different message formats, this makes it easy to customize the payload to the unique demands of each application.

3.3. Compatibility

CMi4170 is compatible with Engelmann Sensostar meters with a compatible firmware version. Once the module is mounted and starts up, a compatibility check is made to ensure that it is compatible with the meter firmware. If the module is mounted in an incompatible meter, this is indicated in the OTC App.

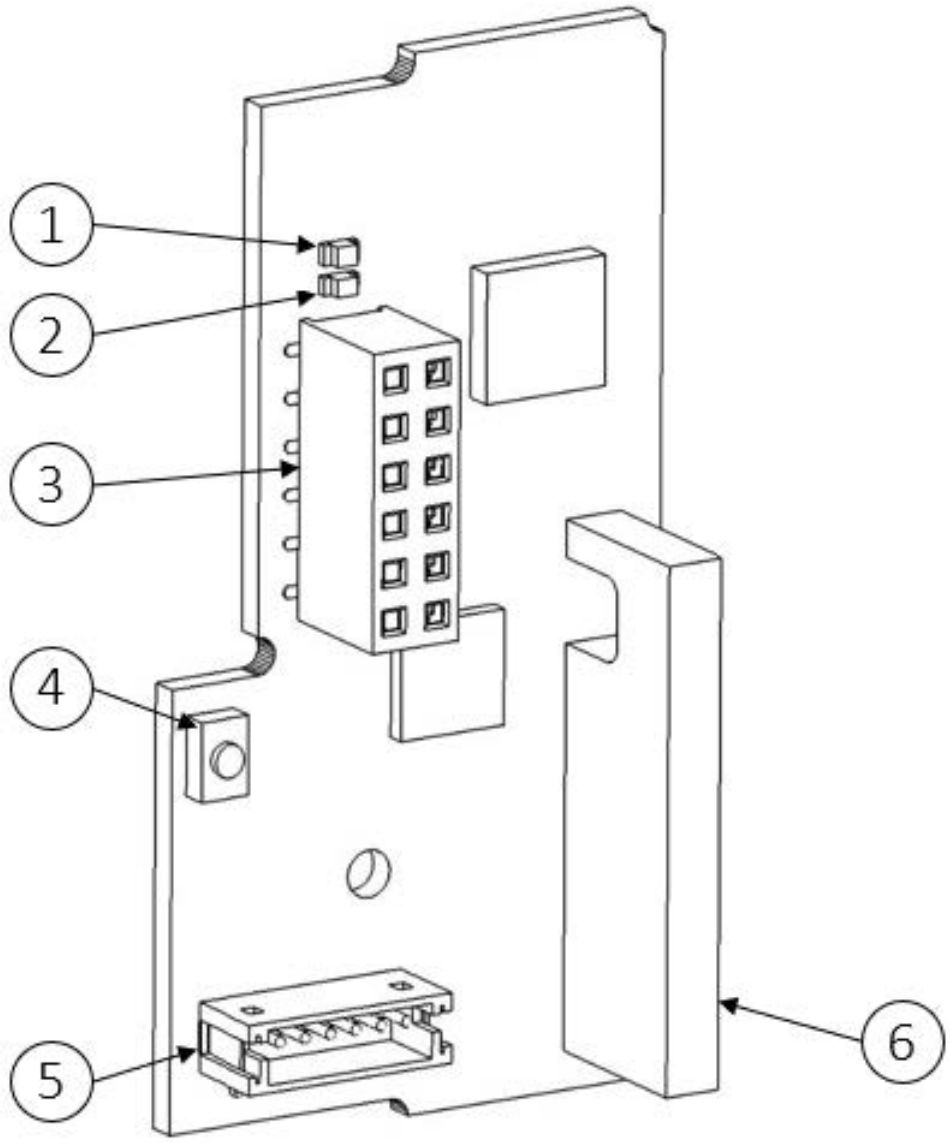
The meter's firmware version can be shown in the meter's display, for further information, refer to the meter's manual.

The following table shows the minimum firmware versions required.

Table 1. CMi4170 - Meter firmware compatibility

Meter	Minimum firmware version
Engelmann SensoStar S3	103/14
Engelmann SensoStar S3C	100/5

3.4. Parts overview



1. Green LED
2. Red LED
3. Interface connector
4. Push button
5. Pulse input
6. LoRaWAN antenna

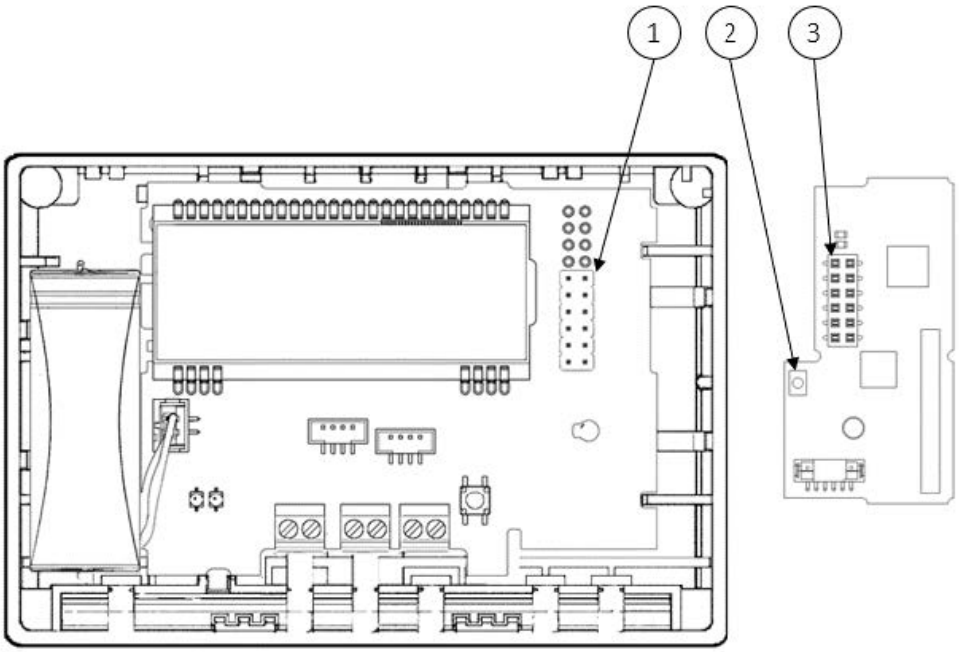
NOTE
The NFC antenna is integrated in the edge of the PCB.

4. Installation

4.1. Mounting the module

CMi4170 is mounted in an Engelmann Sensostar S3/S3C meter.

1. Grab the device by the outer edges.
2. Gently press it into postition in the module slot.
   - Make sure that the module's push button (2) is facing upwards.
   - Make sure that interface connector of the meter (1) fits the interface connector of the module (3).



Engelmann Sensostar (left), CMi4170 (right)

4.2. Activating the module

Upon delivery, CMi4170 is set to passive mode, which means no messages will be transmitted from the module. The module can be activated in one of the following ways:

Via the module push button

1. Press down the push button of the module for at least five seconds.
2. Release when the green LED lights up.
3. Wait for one to eleven seconds.

The module indicates start-up by flashing red and green LEDs for one second.

Via Elvaco OTC app

1. Open Elvaco OTC app (downloadable via Google Play).
2. Scan the module (make sure NFC is activated on the phone).
3. Go to **Apply mode**.
4. Set the power mode to “Active”.
5. Select **Apply settings**.
6. Scan the module to apply new settings.
   To verify that the module has been activated, go to the **Inspect**, scan the module, and make sure that power mode is set to “Active”.

TIP
The NFC field is easiest accessible if placing the phone in the middle part of the front.

Via device monitor

Device monitor refers to Engelmann's optical configuration tool. For more information see Engelmann documentation.

Via meter menu

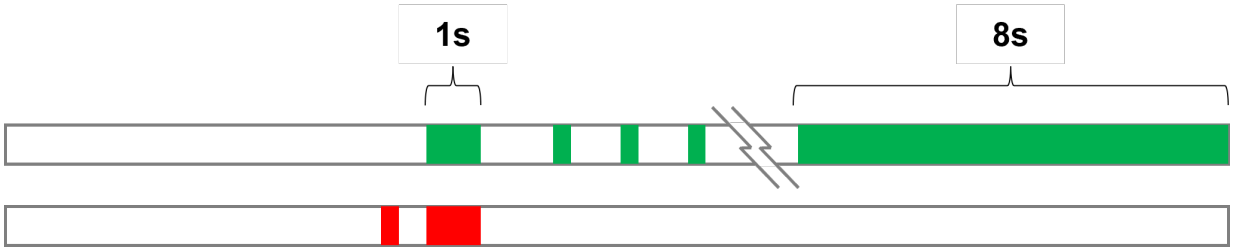
Refer to Engelmann documentation.

4.3. Joining the LoRaWAN network

When activated, the product 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 the figure below:



Network join LED indication

If the module fails to join the LoRaWAN network, it will perform retries until it succeeds. The time between each attempt will increase for every attempt until it is performed once every day. A new join attempt cycle can be manually started anytime by using the push button to reboot the module or by deactivating and activating the module using the Elvaco OTC App.

When the module has joined the LoRaWAN network, it will perform three quick transmissions (regardless of transmit interval settings) before starting to use its configured transmit interval settings. By using the Elvaco OTC App, you can easily verify that the module is successfully communicating with the meter (“Meter communication”) and is connected to the LoRaWAN network (“Network joined”).

5. Operation

5.1. Server configuration

There are two different activation types for LoRaWAN - Over-the-air activation (OTAA) and Activation by personalization (ABP). Elvaco strongly recommends using OTAA, where all network keys are generated each time the module joins the LoRaWAN network. In contrast, for ABP, all keys are set manually and stay constant over time.

In OTAA mode

Before the module is able to transmit messages via the LoRaWAN network, device information needs to be added to the network server. More specifically, the following parameters needs to be registered in order to enable the network server to receive messages from the module:

Device EUI

The device EUI is a 16 digit module unique identification number. It is not configurable.

Application key

The application key of each device is generated by Elvaco and used in OTAA mode to generate network keys when the module joins the LoRaWAN network. Keys are managed in a secure way using Elvaco's OTC (One Touch Commissioning) solution which includes the mobile application for configuration.

Join EUI

The Join EUI sets the identification number of the application server where data from the module shall be delivered. The identification number is set to a default value in all devices. The default value is presented in Elvaco OTC configuration options.

In ABP mode

If the activation mode is set to ABP, the application key does not need to be added to the network server. Instead the following information will be needed:

- Network session key
- Application session key
- Device address

5.2. Configuration

Via Elvaco OTC app

The module is configured via the Elvaco OTC app. The app uses NFC to transfer settings to the module. It is compatible with iPhone or Android phones with Android 5.0 or later. The OTC app can be downloaded from Google Play for Android and App Store for iOS.

It is possible to create a configuration profile to apply preconfigured settings to multiple devices. For further information, refer to the OTC app documentation, available on the Elvaco website.

1. Open the Elvaco OTC app on your smartphone.
2. Place your smartphone close to the device and press SCAN.
3. After a successful scan, the current settings will be displayed on the INSPECT tab.
4. To change settings, go to the APPLY tab. Use the toggle button to activate an option, and make your changes.
5. When done with changes press APPLY at the bottom of the screen, then Apply settings. Repeat step 2 to change the settings in the device.

A successful change is acknowledged by a vibration.

TIP
The NFC field is easiest accessible if placing the phone in the middle part of the front.

Via downlink

The product supports configuration via downlink, i.e. sending commands to an end-device via the LoRaWAN network. Communication via downlink is sent on LoRa port 2 and 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 commands are structured according to the following format: *“0x00” "TLV" "Number of bytes in configuration" "Configuration"*.

NOTE
This feature should only be used sparingly due to bandwidth consideration.

5.3. 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. between 5-minute and daily values).

5.3.1. Transmit interval in 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 the following tables for the transmit interval allowed in each data rate.

CAUTION
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

NOTE
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 year EcoMode where the transmit interval is capped at 1440 minutes (corresponding to once every 24 hours).

Table 2. EcoMode transmit interval settings, EcoMode (6 years)

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

Data rate	Transmit interval (minutes)	Transmit interval, Engelmann message format (minutes)
DR4	15	30
DR5	15	30

Table 3. EcoMode transmit interval settings, EcoMode (10 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

5.4. Time handling

The module relies on the meter's clock for keeping time. Time in the meter is assumed to be in standard local time (no DST). When synchronizing time in the meter using the OTC App, local standard time is always used, even if DST is in effect. The timestamped meter data sent from the module can be adjusted to be sent in UTC by specifying the "UTC offset" configuration parameter. The UTC offset will be subtracted from the timestamp prior to transmission. If the meter is in Sweden, which uses CET (Central European Time), it should have UTC offset set to +60 (+1h). In this case at time 12.00 a telegram is sent with timestamp 11.00 as this is the corresponding UTC time. A meter in New York (USA) should have a UTC offset of -300 (-5h) etc. A UTC offset of 0 means the meter time is used as-is.

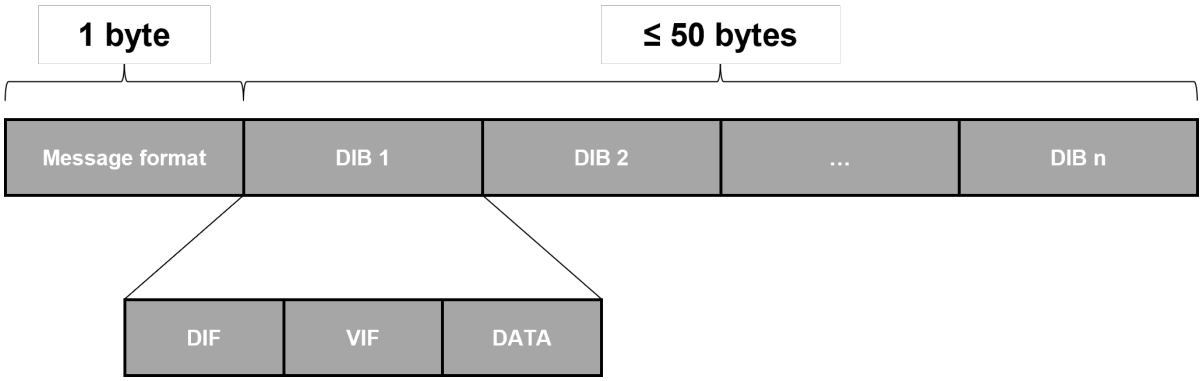
If the meter is set to used DST this is ignored by the module and the standard time is used. Thus, the time on the meter's display may not match the time in the telegram or in the OTC App.

5.5. Adaptive data rate (ADR)

ADR is part of the LoRaWAN standard where the network server determines the optimal rate of communication for the module based on current signal conditions. In the best radio conditions, 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.

5.6. Message encoding

All message formats encoded to M-bus standard will have the following structure. Each telegram begins with one byte specifying the message format. Then follows a sequence of data information blocks (DIBs). The data and structure of the DIBs depends on the message type set. Each DIB contains a data information field (DIF), a value information field (VIF) and a data field (DATA), where the actual payload is stored.



M-Bus message structure

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

5.7. Security and access control

The product has a configuration lock feature, which prevents unauthorized access to the module. When configuration lock has been enabled, a device-specific Product Access Key (PAK) will be needed to access the device. Keys are managed in a secure way using Elvaco's OTC solution which includes the mobile application for configuration.

> **NOTE**
> For more information about security and access control for the product, refer to the One-touch commissioning (OTC) documentation, available on the Elvaco website.

5.8. Meter communication error messages

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 error state". 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.

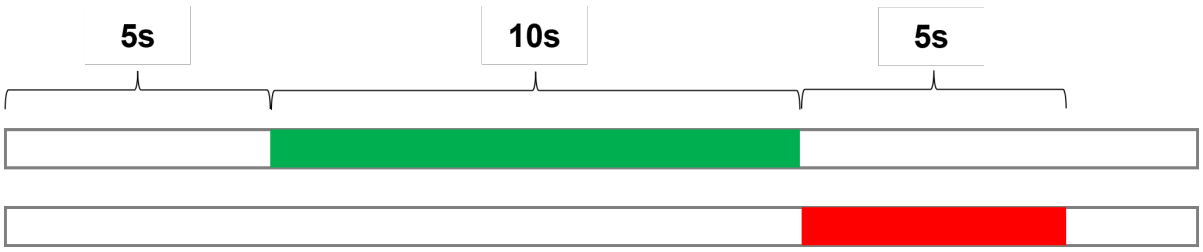
Example 1. Example

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.

5.9. Reset procedures

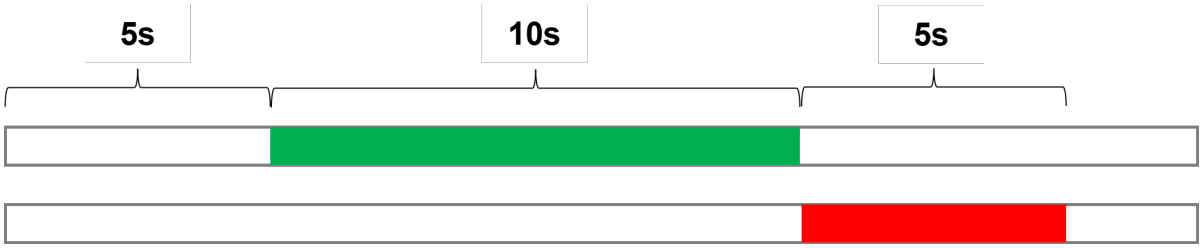
5.9.1. Rebooting the module

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



5.9.2. Switching off the module

1. Press and hold the push button for 15-20 seconds.
2. Release the button when the red LED is lit.



6. Configuration options

6.1. Elvaco OTC app configuration options

Table 4. All configuration options

Field name (Abbr.)	Description	Default value	Locked device & correct Product Access Key or open device	Locked device & no Product Access Key	Downlink
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.	94193A030C0 00001	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

Field name (Abbr.)	Description	Default value	Locked device & correct Product Access Key or open device	Locked device & no Product Access Key	Downlink
Current data rate	The current data rate used for the module.	N/A	Readable	Readable	N/A

6.2. Downlink configuration options

Table 5. Downlink commands

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)

Field name	TLV	Number of bytes in configuration	Configuration	Example
Pulse input selection	0x1D	0x01	Bit flags for selecting which pulse inputs are to be included in the Engelmann message format. 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.	0x001D0101 (Only input 1) 0x001D0107 (Input 1, 2 & 3)

6.3. Message formats

CMi4170 has several different message formats.

Table 6. CMi4170 Message formats

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*

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

6.3.1. Unscheduled message formats

6.3.1.1. Standard

Table 7. Payload, message format Standard [0x24]

DIB	Field	Size	Data type	Description
0	Message format	1 byte	-	0x24 (= Standard)

DIB	Field	Size	Data type	Description
1	Energy	6-7 bytes	INT32	Energy consumption (Wh, J, Cal) 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 040Exxxxxxxx = xxxxxxxx MJ 040Fxxxxxxxx = xxxxxxxx * 10 MJ 04FB0Dxxxxxxxx = xxxxxxxx MCal 04FB0Exxxxxxxx = xxxxxxxx * 10 MCal 04FB0Fxxxxxxxx = xxxxxxxx * 100 MCal
2	Volume	6 bytes	INT32	Volume (m³) 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
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 (m³/h) 023Bxxxx = xxxx * 0.001 m³/h 023Cxxxx = xxxx * 0.01 m³/h 023Dxxxx = xxxx * 0.1 m³/h 023Exxxx = xxxx m³/h 023Fxxxx = xxxx * 10 m³/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

DIB	Field	Size	Data type	Description
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 0C78xxxxxxxx
8	Error flags	4 bytes	INT8	Error and warning flags 01FD17xx

6.3.1.2. Compact

Table 8. Payload, message format Compact [0x25]

DIB	Field	Size	Data type	Description
0	Message format	1 byte	-	0x25 (= Compact)
1	Energy	6-7 bytes	INT32	Energy consumption (Wh, J, Cal) 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 040Exxxxxxxx = xxxxxxxx MJ 040Fxxxxxxxx = xxxxxxxx * 10 MJ 04FB0Dxxxxxxxx = xxxxxxxx MCal 04FB0Exxxxxxxx = 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

6.3.1.3. JSON

In message format JSON, data is presented on a plain text format.

The following table contains a description of all field included in the telegram.

Table 9. Payload, message format JSON [0x26]

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.

Below shows an example of a telegram sent using the JSON message format.

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

6.3.2. Scheduled message formats

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 a clock message and a data message is described in the following table.

Table 10. Clock message and data message

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 parameter	The actual meter data collected from the meter.

The following table contains a detailed description of the payload of the clock message.

Table 11. Payload, clock message

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

The clock message will be transmitted once every day and the data message at least (regulated by transmit interval parameter or EcoMode) once every day. The transmit interval can only be set the values listed in Table 12, “Transmit interval options ” [19].

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 0-15 minutes to decrease the risk of collisions. The readout for the clock message occurs at a random hour (00:00-23:00) at a random minute in the 35-45 interval and will be transmitted immediately after the readout.

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

Table 12. Transmit interval options

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

6.3.2.1. Scheduled - 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 “120”, the accumulated energy read at 24:00 will be transmitted 12 times during the 24 next coming hours.

Table 13. Payload, message format Scheduled – Daily redundant [0x27]

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) 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 040Exxxxxxxx = xxxxxxxx MJ 040Fxxxxxxxx = xxxxxxxx * 10 MJ 04FB0Dxxxxxxxx = xxxxxxxx MCal 04FB0Exxxxxxxx = xxxxxxxx * 10 MCal 04FB0Fxxxxxxxx = xxxxxxxx * 100 MCal
2	Volume	6 bytes	INT32	Volume (m³) 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
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

DIB	Field	Size	Data type	Description
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 440Exxxxxxxx = 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 *Scheduled - Daily redundant*

6.3.2.2. 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.

Table 14. Payload, message format Scheduled - Extended [0x28]

DIB	Field	Size	Data type	Description
0	Message format identifier	1 byte	-	0x28 (Scheduled-Extended)

DIB	Field	Size	Data type	Description
1	Heat energy E1 / Cooling Energy E3	6-7 bytes	INT32	Energy consumption (Wh, J, Cal) 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 040Exxxxxxxx = xxxxxxxx MJ 040Fxxxxxxxx = xxxxxxxx * 10 MJ 04FB0Dxxxxxxxx = xxxxxxxx MCal 04FB0Exxxxxxxx = xxxxxxxx * 10 MCal 04FB0Fxxxxxxxx = xxxxxxxx * 100 MCal
2	Volume	6 bytes	INT32	Volume (m³) 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
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	06FF21xxxxyyyyyyyy xxxx = Info bits (lsByte -> msByte) yyyyyyyy = Meter ID (lsByte -> msByte)* *Sent in binary format

DIB	Field	Size	Data type	Description
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 = Summertime flag** 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

6.3.2.3. Combined heat/cooling

NOTE
Message format Combined heat/cooling is only meant to be used in combined heat/cooling meters.

Table 15. Payload, message format, Combined heat/cooling [0x29]

DIB	Field	Size	Data type	Description
0	Message format	1 byte	-	0x29 (Combined heat/cooling)
1	Heat Energy E1	6-7 bytes	INT32	Energy consumption (Wh, J, Cal) 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 040Exxxxxxxx = xxxxxxxx MJ 040Fxxxxxxxx = xxxxxxxx * 10 MJ 04FB0Dxxxxxxxx = xxxxxxxx MCal 04FB0Exxxxxxxx = xxxxxxxx * 10 MCal 04FB0Fxxxxxxxx = xxxxxxxx * 100 MCal

DIB	Field	Size	Data type	Description
2	Cooling Energy E3	7-8 bytes	INT32	Energy consumption (Wh, J, Cal, MBTU) 841006xxxxxxxx = MWh, 3 decimals = kWh 84100Exxxxxxxx = GJ, 3 decimals 8410FB0Dxxxxxxxx = Gcal, 3 decimals 8410863Dxxxxxxxx = MMBTu, 3 decimals
3	Volume	6 bytes	INT32	Volume (m³) 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
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 0C78xxxxxxxx
7	Error flags	4 bytes	INT8	Error and warning flags 01FD17xx

6.3.2.4. 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 16. Payload, message format Engelmann, heat meter telegram [0x2C]

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	Energy consumption (Wh, J, Cal) 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 040Exxxxxxxx = xxxxxxxx MJ 040Fxxxxxxxx = xxxxxxxx * 10 MJ 04FB0Dxxxxxxxx = xxxxxxxx MCal 04FB0Exxxxxxxx = xxxxxxxx * 10 MCal 04FB0Fxxxxxxxx = xxxxxxxx * 100 MCal
2	Cooling Energy E3*	7-8 bytes	INT32	Energy consumption (Wh, J, Cal, MBTU) 841006xxxxxxxx = MWh, 3 decimals = kWh 84100Exxxxxxxx = GJ, 3 decimals 8410FB0Dxxxxxxxx = Gcal, 3 decimals 8410863Dxxxxxxxx = MMBTu, 3 decimals
3	Volume	6 bytes	INT32	Volume (m³) 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

DIB	Field	Size	Data type	Description
4	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
5	Meter ID	6 bytes	According to M-Bus EN13757-3 identification field	Meter ID 0C78xxxxxxxx
6	Error flags	4 bytes	INT8	Error and warning flags 01FD17xx

*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.

Table 17. Payload, message format Engelmann, pulse input telegram

DIB	Field	Size	Data type	Description
0	Message format	1 byte	-	0x2D (Engelmann, telegram 2)
1	Pulse input 1	7-8 bytes	INT32	844013xxxxxxxx = m^3, 3 decimals 844014xxxxxxxx = m^3, 2 decimals 844015xxxxxxxx = m^3, 1 decimal 844006xxxxxxxx = MWh, 3 decimals 844007xxxxxxxx = MWh, 2 decimals 8440FD3Axxxxxxxx = No unit

DIB	Field	Size	Data type	Description
2	Pulse input 2	8-9 bytes	INT32	84804013xxxxxxxx = m^3, 3 decimals 84804014xxxxxxxx = m^3, 2 decimals 84804015xxxxxxxx = m^3, 1 decimal 84804006xxxxxxxx = MWh, 3 decimals 84804007xxxxxxxx = MWh, 2 decimals 848040FD3Axxxxxxxx = No unit
3	Pulse input 3	8-9 bytes	INT32	84C04013xxxxxxxx = m^3, 3 decimals 84C04014xxxxxxxx = m^3, 2 decimals 84C04015xxxxxxxx = m^3, 1 decimal 84C04006xxxxxxxx = MWh, 3 decimals 84C04007xxxxxxxx = MWh, 2 decimals 84C040FD3Axxxxxxxx = No unit
4	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
5	Meter ID	6 bytes	According to M-Bus EN13757-3 identification field	Meter ID 0C78xxxxxxxx

7. Technical specifications

Table 18. Mechanics

Type	Value
Dimensions (w x h x d)	29 x 56 x 12 mm
Weight	9 g
Mounting	In module slot of Engelmann Sensostar S3/S3C

Table 19. Electrical connections

Type	Value
Supply voltage	Internal meter battery (life span up to 10+1 years) or PSU (Engelmann external power supply)

Table 20. Electrical characteristics

Type	Value
Nominal voltage	3.0 VDC
Power consumption (max)	50 mA
Power consumption (sleep mode)	2.5 µA

Table 21. Environmental specifications

Type	Value
Operating temperature	+5 - +55 ºC
Operating humidity	0 - 93 % RH, no condensation
Operating altitude	2000 m
Usage environment	Indoors
Storage temperature	-20 - +60 ºC

Table 22. Radio characteristics

Type	Value
Frequency	868 MHz
Output power	14 dBm
Receiver sensitivity	-135 dBm

Table 23. LoRaWAN characteristics

Type	Value
Device class	Class A, bi-directional
LoRa version	1.0.2, rev B
Activation	OTAA or ABP
Data rate	DR0 - DR5 (250 bit/s-5470 bit/s)

Table 24. User interface

Type	Value
Green/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”

Table 25. Approvals

Type	Value
LoRa Alliance®	LoRaWAN® Certified
EMC	EN 301 489-1, EN 301 489-3

8. Simplified Declaration of Conformity

Hereby, Elvaco declares that CMi4170 is in compliance with the following directives:

EU

- 2014/53/EU (RED)
- 2014/30/EU (EMC)
- 2014/35/EU (LVD)
- 2011/65/EU + 2015/863 (RoHS)

See EU Declaration of Conformity for a complete description.

UK

- 2017 No. 1206 (RED)
- 2016 No. 1091 (EMC)
- 2016 No. 1101 (LVD)
- 2012 No. 3032 (RoHS)

See UK Declaration of Conformity for a complete description.

9. Document history

Table 26. Versions

Version	Date	Description
0.1	2019-11	First draft
0.2	2020-05	Second draft
1.0	2020-10	Commercial release v1.0
1.1	2020-10	Commercial release v1.1
1.2	2023-12	Minor layout changes were made.
1.3	2024-02	Adjustments M-Bus decoding