



enCore Device Series

Flow Computer enCore FC1

**Manual
Instructions for Use in Legal
Metrology**

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1 The enCore/enSuite concept

enCore is the name of an Elster product platform for advanced measurement devices. All enCore devices are based on the same hardware components and software concepts. Both the hardware and software of enCore devices have a modular design; the configuration of the process board equipment is variable, just like the arrangement of software components. On one hand, the software components consist of basic functionalities which are provided by the **Basic System** with its **System Function Blocks** (abbreviated as: SFBs) and on the other hand it consists of application-related functionalities which provide the various **Application Function Blocks** (abbreviated as: AFBs). Owing to this modular design principle, each device can be optimally adapted to individual requirements.

The enCore FC1 belongs to the enCore Flow Computer device series (in short: enCore FC). This series comprises several different device types that are used as industrial process computers for special tasks for measuring gas and liquids. It depends on the individual device type which functions a device supports in detail.

enSuite is the name of the PC software supporting all enCore devices along with a number of other Elster devices. The enSuite software provides tools for configuration, parameterization, diagnosis, software downloads and other services.



Parameterization in enSuite, transfer to the device

Changes that you have made in enSuite to the parameterization only become active in the device when you execute the action **Transfer parameterization to device** and after the enCore FC device has been automatically restarted.

⇨ enCore manual “Configuring the Device with enSuite”

2 About this manual

This manual is part of the enCore FC1 user documentation; it briefly describes the properties of the enCore FC1 flow computer being relevant for the use of the device in legal metrology.

It comprises the general device description, technical data, display and operation of the device as well as a brief description of basic functions and the essential AFBs. The appendix contains legally relevant documents.

Thus, the documentation on hand is not only an introductory summary for all users but also intended for all interested parties such as approval authorities and Notified Bodies.

Generally, the user documentation of enCore FC device series has a modular structure. Apart from the manual on hand, the other relevant manuals cover *all* devices of the enCore FC series; they are therefore independent of the device type. References to all available documents ⇨ [8.2 enCore FC manuals at a glance](#) (p. 67).



Abbreviated spellings

- In the following, the short name “FC1” is mostly used for the term “enCore FC1”.
- Both in device displays and in the parameterization software, the term “fiscal” is often used as an abbreviation or synonym for “legally relevant” or “official”.



All safety information is contained in the ⇨ enCore manual “Operating Instructions“

The documentation at hand (“Instructions for Use in Legal Metrology”) does not include any safety information.



Please read the “Instructions for Use in Legal Metrology” and the “Operating Instructions” manuals carefully and completely before starting to work with the FC1, especially prior to installation.

The manufacturer does not assume any liability for damage and failures caused by disregard of the manuals.



Delivery form of the individual manuals

The “Instructions for Use in Legal Metrology” (this manual) and the ⇄ enCore manual “Operating Instructions” are product components and supplied in printed form with the device. These documents must always be kept in the immediate vicinity of the FC1, easily accessible for the installation, operational, maintenance and cleaning personnel.

3 Legal information

3.1 Legally relevant information at the device itself

The device's type plate reveals the most important legal information at first glance. The type plate is divided in several parts; its exact appearance depends on the Type examination certificate to be applied. For details refer to the "FC1: Markings and Sealings" document ↔ [10 Appendix](#) (p. 72).

The following table lists the legally relevant information that can be found at the device itself:

Information	Location
Number of the EU-type examination certificate, CE mark, metrological marking, identification of the Notified Body	Type plate
Marking acc. to WEEE directive	Type plate or separate label
Identification of the manufacturer	Manufacturer's identification mark, printed on front panel
Serial number	Type plate
Year of manufacture	Type plate
Manufacturer's address	Label or printed on front panel
Reference to EN 12405-1 *	Type plate
MPE at reference conditions *	Type plate
IP code *	Type plate
Ambient temperature range *	Type plate

* This information is indicated at the device by a third type plate part for devices placed on the market from the date of issue of the EU-type examination certificate T10434 revision 11 onwards. Previously, this information was given in this manual.

Table 3-1: Legally relevant information at the FC1 front/rear panel

3.2 Additional static information

Information	Values
Battery life time	Not applicable (external power source)
Mechanical class	M1
Electromagnetic environmental class	E2

Table 3-2: Additional static information

3.3 Additional variable information

Software versions and checksums

An information display can be evoked by activating the  **Info** button in the device's home display. The information display contains a [Software status](#) hyperlink leading to the software identification display (⇒ [5.4.6 Software identification/list of fiscal parameters](#), p. 42).

Legally relevant parameters

During runtime, all legally relevant parameters can be checked at the device's display (displays for secured parameters, ⇒ [5.4.6 Software identification/list of fiscal parameters](#), p. 42).

This includes in particular the following legally relevant information:

- Base pressure and base temperature
- Upper and lower limits of the transmitters
- Parameters for gas meter error correction curve
- Pulse value (if applicable)
- Compression factor calculation algorithm
- Gas properties, in case of fixed values¹

¹ Tip: The gas properties used for calculations are indicated comfortably in the Gas Quality AFB displays. For switching to the related main display, activate the  <Gas Quality AFB> button in the device's home display. Hyperlinks are leading to subordinate displays. For example, the [Gas components](#) hyperlink activates a display for gas components and their values used for calculation.

4 General information

4.1 General device description

The enCore FC1 flow computer is an electronic conversion device for measuring and calculating the flow of natural gas or, in special applications, industrial gas or gases with a fixed composition. Different measurement devices are connected to the flow computer (gas meters, pressure transmitters, temperature transmitters and, optionally, gas quality measurement devices). Depending on the type of the individual measurement device, the FC1 provides different connection and interfacing options:

Device type	Connection options
Gas meters	<ul style="list-style-type: none">• Pulse interface for turbine, rotary or other pulse generating gas meters• Serial or LAN interface for Ultrasonic gas meters (digital protocol)• Interface for gas meters equipped with an encoder index
Pressure transmitters	<ul style="list-style-type: none">• 4 ... 20 mA input• HART protocol interface
Temperature transmitters	<ul style="list-style-type: none">• Resistance input (Pt100)• HART protocol interface
Gas quality measurement devices	<ul style="list-style-type: none">• Serial interface• LAN interface

Table 4-1: Connection of measurement devices

Number of streams/number of flow directions

Due to the expandable hardware and software concept, the maximum number of streams and flow directions is variable. It depends on the amount of available device resources, the individual hardware settings and the software configuration.

European Standards and calculation methods

The FC1 flow computer supports the following European calculation standards and calculation methods:

Value to be calculated	Selectable standards/calculation methods
Compressibility factors at measurement and base conditions (z_m, z_b) ¹	<ul style="list-style-type: none"> • AGA8-92 DC (ISO 12213-2) • AGA8 2017 • SGERG-88 (ISO 12213-3) • SGERG-mod-H2 (DVGW G 685-6 (A), August 2022) • AGA-NX19 mod • AGA-NX19 mod BR.KOR.3H • AGA-NX19 GOST • GOST 30319-2 • GOST 30319-3 • ISO 6976 (for z_b) • $z_m/z_b = \text{constant}$ • z_m via compressibility factor table
Density, relative density	<ul style="list-style-type: none"> • AGA8-92 DC • AGA8 2017 • ISO 6976/GPA 2172
Heating values, Wobbe indices	<ul style="list-style-type: none"> • ISO 6976/GPA 2172

Table 4-2: Supported standards and calculation methods

¹ Available options in most recent Gas Quality AFBs version; not all of these standards and calculation methods may be supported and offered in former versions. When selecting a calculation standard or method for an FC1 used in legal metrology, the regulations of the EU type-examination certificate must be observed.

Uncertainties

For a single stream, the measuring system consists of a pressure transmitter, a temperature transmitter and the computing unit.

Influencing factor	Uncertainty
Pressure transmitter	<ul style="list-style-type: none"> • 0.1 %
Temperature transmitter	<ul style="list-style-type: none"> • 0.035 %
Analog-to-digital converter	<ul style="list-style-type: none"> • 0.05 %
Numerical errors of the computing unit	<ul style="list-style-type: none"> • negligible, due to 64 bit floating point calculations
Compressibility calculation method SGERG-88	<ul style="list-style-type: none"> • 0.1 %
Compressibility calculation method AGA-8-92 DC	<ul style="list-style-type: none"> • 0.1 % for application range 1 (temperature between -10 °C and +65 °C, absolute pressure up to 100 bar, Pipeline Quality Gas) • 0.2 % for application range 2 (temperature between -10 °C and +65 °C, absolute pressure up to 120 bar, Pipeline Quality Gas) • 0.3% for application range 3 (temperature between -48 °C und +65 °C, absolute pressure up to 650 bar, Wider Range of Application)

Table 4-3: Uncertainties

Since the uncertainties of the individual influencing factors are independent of each other, the total assumed uncertainty of the measurement system equals the square root of the square sums. If pressure and temperature transmitters are connected via digital HART protocol, the two AD conversions are omitted, and the uncertainty is reduced.

EXAMPLE(S)

- Analog pressure and temperature transmitters, compressibility calculation method with 0.1% uncertainty, then the total uncertainty of the measurement system is 0.162%.

$$\sqrt{0.1^2 + 0.035^2 + 2 \cdot 0.05^2 + 0.1^2} = 0.162$$

- Pressure and temperature transmitters via HART, compressibility calculation method with 0.1% uncertainty, then the total uncertainty of the measurement system is 0.146 %.
- Analog pressure and temperature transmitters, compressibility calculation method with 0.3% uncertainty (i.e., AGA-8-92 DC in application range 3), then the total uncertainty of the measurement system is 0.326 %.

Parameterization

The FC1 flow computer is configured by using the parameterization software that is included in the enSuite software collection and runs on a PC or laptop (Windows).

4.2 Hardware

The FC1 flow computer consists of a rack-mountable card cage with an operation panel on the front side.

At the rear side, the compulsory CPU board additionally offers one network LAN interface and two serial RS232/RS422/RS485 interfaces (COM ports). These interfaces are typically intended for the connection of gas quality measurement devices or other devices equipped with a protocol interface.

Several different I/O boards can be mounted from the rear side. The FC1 device is available in two housing widths, i.e., with a housing width of 1/3 for up to four process boards or a housing width of 1/2 for up to seven process boards. The I/O board configuration is variable; ⇔ [Table 4-4: enCore I/O boards](#) (p. 16) shows an overview of all available I/O boards.

In principle, all board types can be mounted in any slot. There is a restriction for MSER4 and ESER4 boards only: A maximum of 2 of the available slots can be used for MSER4 or ESER4 type boards.

I/O boards	Description
ExMFE5 *	Input board providing 3 NAMUR inputs for status, LF or HF pulses or encoder index; 1 analog/HART input; 1 Pt100 input. All inputs are intrinsically safe. Intended for the connection of gas meters (via pulses or encoder index), pressure transmitters (4 ... 20 mA or HART), temperature transmitters (resistance input or HART).
MFE7 *	Input board providing 3 inputs (24 V DC) for status, LF or HF pulses or encoder index; 2 analog/HART inputs; 1 Pt100 input, 1 RS485 serial interface. Intended for the connection of gas meters (via pulses or encoder index), ultrasonic gas meters (RS485 serial interface), pressure transmitters (4 ... 20 mA or HART), temperature transmitters (resistance input or HART).
MSER4 *	Communication board providing 4 serial interfaces (RS232/RS422/RS485). Typically intended for the connection of gas quality measurement devices or ultrasonic gas meters.
ESER4 *	Communication board providing 3 serial interfaces (RS232/RS422/RS485), typically intended for the connection of gas quality measurement devices or ultrasonic gas meters. Additionally, there is one network LAN interface.
MFA8 **	Output board providing 4 digital outputs for status, LF pulses or frequency; 4 analog outputs.
<p>* for legally and non-legally relevant purposes</p> <p>** for non-legally relevant purposes only, non-interacting regarding the legally relevant functionalities</p>	

Table 4-4: enCore I/O boards

⇨ [7 Technical data](#) (p. 59) for further technical details.

4.3 Software

4.3.1 The enCore software concept

The software of each enCore device has a modular structure and consists of:

- the Basic System, containing several basic functionalities (SFBs), and
- several so-called Application Function Blocks (AFBs)

As the Basic System is responsible for all basic functionalities (such as I/O interface connection, protocol interface connection), it is an integral part of each device's software.

An AFB is a single application-driven functionality that can be added or removed by parameterization. Some AFBs can be used more than one time, depending on the individual application. Generally, the AFB configuration is limited by the device resources.

4.3.2 Legally relevant software (for use in legal metrology)

The Basic System with its basic functionalities is always legally relevant.

There are three types of AFBs that are legally relevant:

-  Gas Quality AFB
This AFB calculates the conversion factor C , density, and heating values by using pressure, temperature, and gas quality measurement data, taking the selected calculation standards and the base conditions to be applied into consideration.
-  Flow Conversion AFB
This AFB generates counters for volumes at base and measurement conditions as well as mass and energy by using the gas meter measurement data and the results of the Gas Quality AFB. It performs the gas meter correction (optional) and the counter administration due to error handling and – if applicable – the flow direction switching.

-  Table Z AFB

This AFB is intended for special applications; it calculates the conversion factor C by using a parameterized compressibility factor table depending on pressure and temperature.

4.3.3 Non-legally relevant AFBs

Additional non-legally relevant AFBs can be added as long as the resources in the device are sufficient. Some of these AFBs are subject to a charge.

The non-legally relevant AFBs do not affect the legally relevant functionalities and AFBs.

Examples for non-legally relevant AFBs¹ :

-  DSfG AFB

DSfG is a well-established digital protocol standard in Germany for connecting gas measuring devices.²

The DSfG AFB realizes a DSfG implementation for enCore devices. That way, it is possible to retrieve data from devices that are externally connected to the enCore device via DSfG protocol interface.

In particular, gas quality measurement devices can be connected via DSfG for providing gas quality measurements as input values for the Gas Quality AFB.

Additionally, some other DSfG specific features can be used, for example:

- The DSfG AFB can map the device-internal Flow Conversion AFBs to DSfG entities so that their data can be retrieved via DSfG protocol.
- The DSfG AFB can perform a data logging acc. to DSfG standards, e.g., for counters and measurements of the internal Flow Conversion AFBs.

¹ Not all of these AFBs are available for all Basic System versions.

² The DSfG specification is issued by DVGW Deutscher Verein des Gas- und Wasserfachs in DVGW-Arbeitsblatt G 485, Digitale Schnittstelle für Gasmessgeräte (DSfG) and Technische Spezifikation für DSfG-Realisierungen, Gas-Information Nr. 7, available via www.wvgw.de (German version only).

-  Postprocessing AFB
Generation of new event-oriented values derived from existing values (such as actual values, differential values, averages, or drag indicators)
-  User Archives AFB
Data logging
-  Modbus AFB
Modbus communication for a single Modbus communication line
-  Notification AFB
Sending of warning and alarm messages via email and TCP/IP protocol to a selectable set of email addresses
-  IEC60870 AFB
Implementation of a TCP server in a telecontrol system using standard transport profiles according to IEC 60870-5-104 international standard for data exchange with up to 4 control stations (chargeable AFB)
-  Event Administration AFB
For summarizing individual events in groups, creates special group events for further processing and forwarding (chargeable AFB)

4.3.4 AFB structure for common applications

The device software of a basic FC1 flow computer consists of the Basic System, one Flow Conversion AFB and one Gas Quality AFB. This configuration implements a typical one stream, one flow direction application.

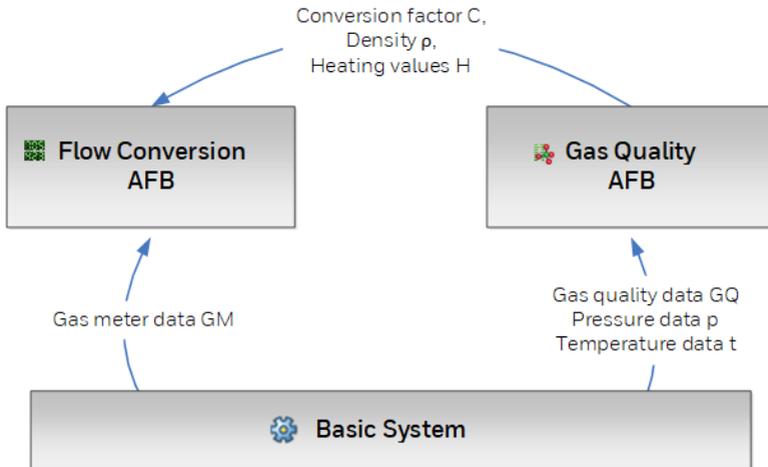


Fig. 4-1: Data flow for a basic one stream, one flow direction application

For other applications, i.e., with more than one stream and/or more than one flow direction, more AFBs of the Flow Conversion and Gas Quality type are used.

General rules:

- One Flow Conversion AFB is necessary for each stream and for each flow direction.
- One Gas Quality AFB is necessary for each C calculation working with different measurement data (pressure/temperature and/or gas quality) or based on different calculation rules (as to calculation standards and/or base conditions).

The Flow Conversion and Gas Quality AFBs working with the same measurement data are linked via parameterization. The parameterization

supports the grouping of AFBs in user-defined structures. This way, it is easy to identify which AFBs belong together in both, the parameterization user interface and the device screen.

Examples of typical applications:

1 stream, 2 flow directions, 1 gas quality measurement

For a flow computer application with one stream and two flow directions (fd 1 and fd 2), there have to be two sets of counters (one for each flow direction) whereas the pressure, temperature, and gas quality measurement has to be performed only once. This means that two entities of Flow Conversion AFB (one for each flow direction) and one Gas Quality AFB are necessary, provided that the same GQ calculation standards and the same base conditions are to be applied to both flow directions.

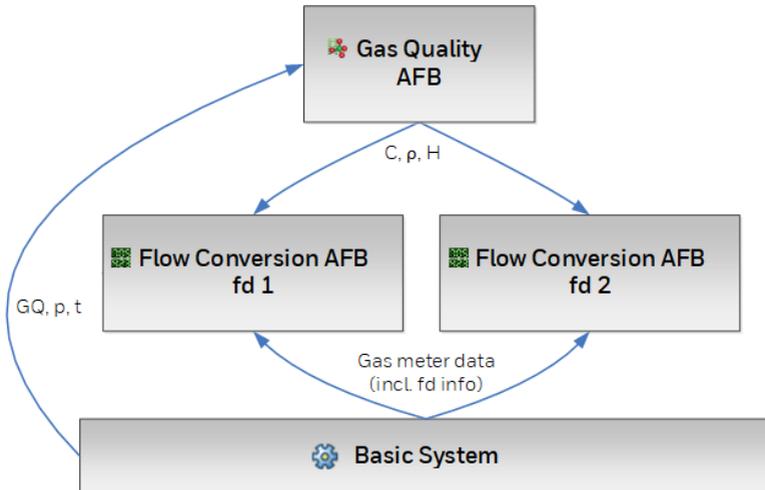


Fig. 4-2: Data flow for 1 stream, 2 flow directions

2 streams

For a flow computer application with two streams, two Flow Conversion AFBs and two Gas Quality AFBs are necessary.

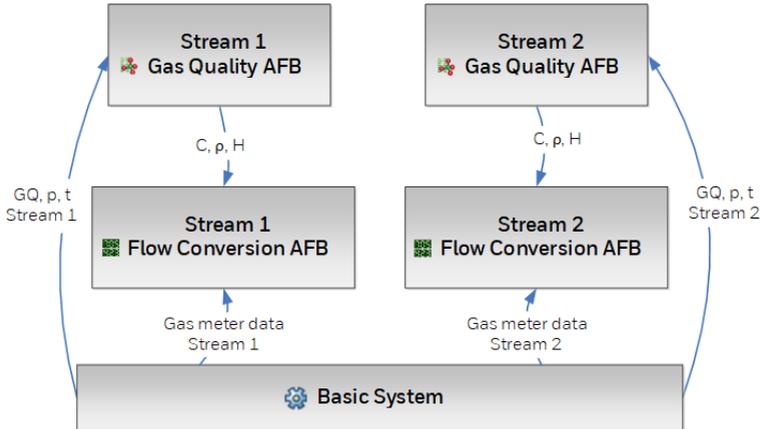


Fig. 4-3: Data flow for 2 streams, 1 flow direction each

2 streams: the first one with 2 flow directions and 1 gas quality measurement, the second one with 1 flow direction

The next figure shows a flow computer application handling two streams, one with two flow directions (fd 1 and fd 2) and one with one flow direction. In that case, one block containing two entities of Flow Conversion AFB and one Gas Quality AFB and one block containing one Flow Conversion AFB and one Gas Quality AFB are needed. That sums up to three entities of Flow Conversion AFB and two entities of Gas Quality AFB altogether – provided that for both flow directions of the first stream the same GQ calculation standard and the same base conditions are to be applied.

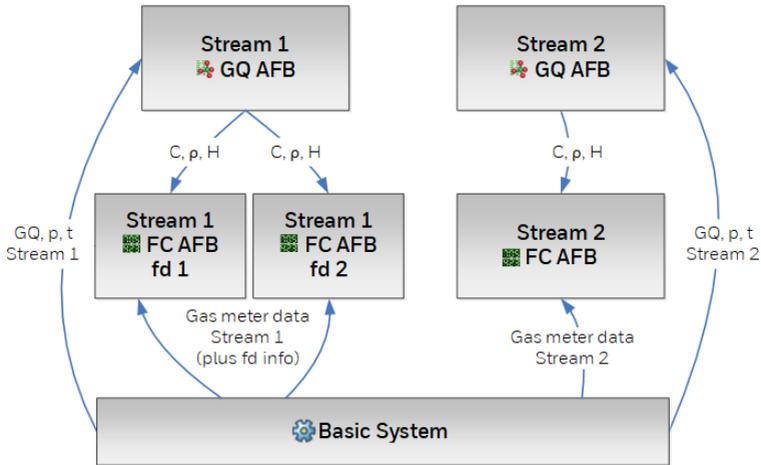


Fig. 4-4: Data flow for 2 streams (dual/single fd)

4.3.5 AFB structure for special applications

In a standard AFB composition as described in [↔ 4.3.4 AFB structure for common applications](#) (p. 20), the Gas Quality AFB is responsible for providing the gas characteristics needed by the Flow Conversion AFB. The Gas Quality AFB calculates the compressibility factors according to European standards for natural gases, e.g., AGA8-92 DC or SGERG-88.

For special applications where industrial gas or gas with a fixed composition is measured, a Table Z AFB can be used instead of a Gas Quality AFB. The Table Z AFB calculates the compressibility factor z_m at measurement conditions (p, t) by using a compressibility factor table.

5 Operation for legally relevant functionalities

5.1 Operating controls



Fig. 5-1: FC1 operating controls

- 1 Navigation keys
- 2 Function keys
- 3 Touch screen
- 4 Security switch (sealable)
- 5 Power LED
- 6 Status LED
- 7 USB port for PC connection

5.1.1 Keys

There are 2 function keys located directly below the touch screen. Pressing one of these keys activates the corresponding display button that is indicated directly above.

The navigation buttons (up, down, left, right, enter) are intended for navigation within the device software's menu as an alternative to an operation via the touch screen.



Fig. 5-2: Navigation keys

5.1.2 Touch screen

All key operations can alternatively be executed from the touch screen. An acoustic signal indicates that an operating action has taken place.

5.1.3 Security switch

The security switch is a sealable rotary switch, which is located on the front panel. It is closed by turning it clockwise as far as it will go.

The security switch is part of the enCore user rights limitation concept. A closed security switch prevents certain user actions that affect the legally relevant functions of the device (e.g., modifications of legally relevant parameters or download of legally relevant software).



There are legally relevant parameters that can be changed by an authorized logged-in user even if the security switch is closed. In that case, the action is recorded in the so-called **Fiscal Audit Trail** (↔ [5.4.7 Fiscal audit trail](#), p. 43).



For devices used in legal metrology, official documents may exist prescribing how the security switch has to be sealed. Refer to the ↔ [10 Appendix](#) (p. 72), if applicable.

5.2 LEDs

There are two multicolor LEDs on the front panel, the Power LED and the Status LED.

5.2.1 Power LED

LED status	Meaning
Off	Power off; no USB connection
Red	Power off, USB connection detected
Green	Power on, no USB connection
Orange	Power on, USB connection active

Table 5-1: Power LED

5.2.2 Status LED

This paragraph describes the behavior of the status LED for devices used in legal metrology (e.g., according to MID/EU Type Examination Certificate).

The status LED indicates whether an error affecting the legally relevant functionalities, i.e., an alarm or a warning, is pending or has been pending.¹

¹ For devices used in legal metrology, the EN12405-1 prescribes that a resetting of cleared alarms shall be possible only if the cause of the alarm has been eliminated. To comply with that requirement, the parameter **Acceptance procedure** in branch **Basic System – System – Error list** must be set to **Inactive errors can be accepted only**.

An alarm is an error event affecting the legally relevant functionalities severely; the calculation of the legally relevant results is stopped. In case of a warning, a minor error has occurred but the calculation of the legally relevant results is continued.

The status LED signals the error state as follows (in order of priority):

LED status	Meaning
Off	Power off
Green, flashing	A green flashing light appears during the startup phase after a power failure.
Green, permanently illuminated	The device's legally relevant functionalities are running error-free, i.e., there are no pending or not accepted alarms or warnings.
Red, flashing	An alarm is pending.
Yellow, flashing	A warning is pending.
Red, permanently illuminated	There is no pending error. At least one alarm that has already ended is not yet accepted. The user has to accept such errors at the device before the color of the status LED turns back to green.
Yellow, permanently illuminated	There is no pending error. At least one warning that has already ended is not yet accepted. The user has to accept such errors at the device before the color of the status LED turns back to green.

Table 5-2: Status LED

5.3 Display and navigation

5.3.1 Display test

The enCore FC1 provides a display test functionality to check that the display functions correctly.

For starting the display test, activate the  button in the device's home display at first. The information display is evoked. The display test can be started by activating the [Display test](#) hyperlink. You quit the test by pressing the  back or  home key.

5.3.2 Different types of device displays

The main purpose of a *Fiscal display* is the indication of legally relevant results. For an FC1 flow computer, the Flow Conversion AFB provides a fiscal display that shows the volume at base conditions (v_b) in a preferential way. Additionally, some other important values are displayed in the regular way.

Main display is the name for a display of an AFB or Basic System functionality, which includes a composition of the most important results of that functionality.

Where appropriate, there are further subordinate displays belonging to the same AFB or functionality.

The *basic display* is the display that is invoked directly after starting the device. For an FC1 flow computer, the fiscal display of the first Flow Conversion AFB is chosen as basic display.

Home is a special display visualizing the software structure of the individual device.

Single software parts (such as AFBs) and selected other functionalities that have to be reached easily (e.g., clock settings, language switching) are shown as icons. These icons are labeled with the name of the corresponding functionality.

In case of an AFB, the label shows the user-defined name for this AFB or the default name, if no user-defined name has been parameterized.

The parameterization supports the grouping of AFBs in user-defined structures. If an AFB has been assigned to a structuring folder in this way, the name of the related folder appears as a hint when selecting the corresponding button on the screen.



Remote operation panel

The enSuite software offers the option of operating the device remotely from the PC during an existing data connection. Once the **Remote operation panel** action is called up, enSuite displays a copy of the local operating panel on the computer screen. During an active remote operation panel connection, the display at the device may show a masked screen preventing the usual operation via keys or touch screen. This way, general data security requirements are met to ensure the confidentiality of sensitive user data.

The on-site user can disconnect the remote operation panel connection at any time and return to the usual device display. The device display shows information on how to do this.

5.3.3 Navigation via touch screen

General

There are two buttons at the lower edge of the touch screen. Depending on the actual context, they are mostly labeled with following icons:

 back and  home

or

 back and  basic display

Touching a button labeled  (home) or  (basic display) invokes the corresponding display. The basic display can always be reached in at most two steps – either by touching the buttons  and  consecutively or by touching  solely, when directly available.

The button labeled  (back) always leads you to the display that has been invoked most recently.

If the buttons are labeled  (OK) and  (Cancel), a user action has been carried out that requires confirmation, e.g., a calendar time adjustment. User actions can be accepted by  (OK) or discarded by  (Cancel).

Navigation options in home display

Touching a folder in the home display opens it and shows the AFBs being included.

Touching the icons of the AFBs or other selected functionalities invokes the corresponding fiscal or main displays.

Navigation options in other displays

Most displays show measurement results, status information or settings.

An underlined text element always represents a hyperlink, e.g., a reference to another display showing further details. Actions are also marked as hyperlinks in the FC1 display.

By touching a hyperlink leading to another display, the corresponding display is invoked automatically. By touching a hyperlink for an action, a specific functionality is carried out.

If a display contains more rows than can be shown at once, a yellow scroll bar appears along the right edge of the display. You can scroll the contents of the display up or down by moving the finger over the display area.

5.3.4 Navigation via keys

The buttons (labeled  and  or /, respectively) at the lower edge of the touch screen can be activated alternatively by pressing the corresponding keys located directly below them.

The operating elements (hyperlinks) located in the upper part of the touch screen can be selected by using the up/down/left/right keys and activated by pressing the enter key (↵ [5.1.1 Keys](#), p. 25). The display contents can be scrolled by using the up/down keys.

5.3.5 Indication of physical quantities: symbols

If English has been chosen as device language, all symbols used for physical quantities are according to EN12405-1. Where necessary, the documentation at hand refers to these symbols as well.

After switching the device language setting to German (Deutsch) via the corresponding button in the home display, the device replaces these symbols by symbols that are commonly used in Germany. Localized symbols may also appear after switching to a language other than German.

5.4 Displays showing legally relevant data

5.4.1 General structure of device displays

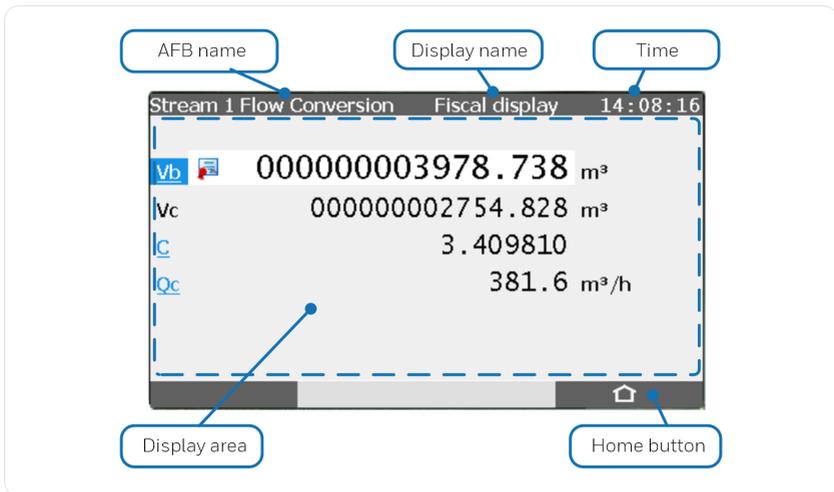


Fig. 5-3: General structure of AFB displays - example

5.4.2 Flow Conversion AFB

The Flow Conversion AFBs are responsible for generating the counters. Each single Flow Conversion AFB administrates the counters of a distinct stream and flow direction.

Each Flow Conversion AFB provides a so-called fiscal display wherein the main counter for volume at base conditions is displayed in a special way to indicate its official relevance: The v_b counter is highlighted, marked with a preceding special icon  and displayed using a larger font size:

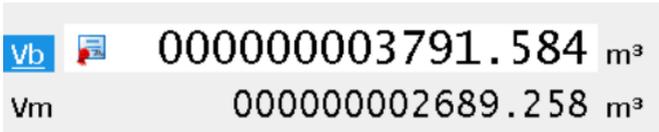


Fig. 5-4: Display indication of v_b (fiscal display)

After starting the FC1 device, the basic display, i.e., the fiscal display of the first Flow Conversion AFB, is invoked. For activating the fiscal display of any other Flow Conversion AFB, navigate to the home display at first. Once in the home display, activate the button  that represents the Flow Conversion AFB you are interested in. For switching back to the basic display, you may either activate the corresponding AFB button or the button labeled .

In most FC1 displays, there are labels that are designed as hyperlinks. Hyperlinks are underlined and displayed in blue color. Using these hyperlinks is the most intuitive way for switching to subordinate displays showing further values and results.

The next figure shows an example of a Flow Conversion fiscal display with its values and hyperlinks to other displays:

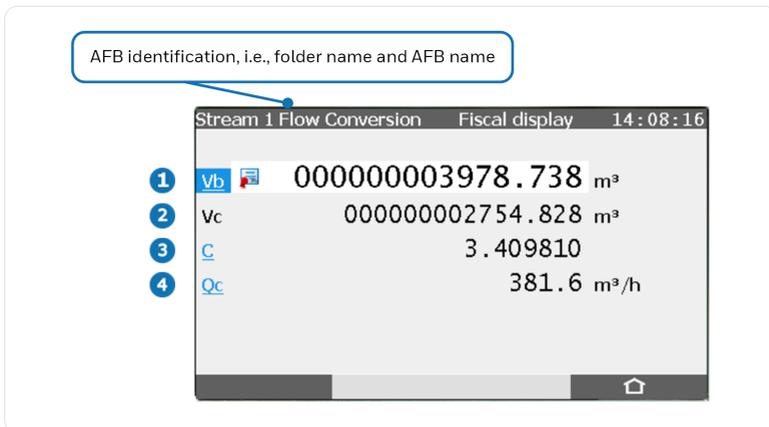


Fig. 5-5: Flow Conversion: Fiscal display - example

- 1 [vb](#) denotes the base volume main counter. The hyperlink switches to Flow Conversion AFB's main display (⇨ [Fig. 5-6: Flow Conversion: Main display - example](#), p. 34).
- 2 In case that no gas meter correction is parameterized in Flow Conversion AFB, the main counter for volume at measurement conditions V_m is displayed in this line. If gas meter correction is activated, the corresponding main counter for corrected volume V_c is shown instead.
- 3 [c](#) is the conversion factor, the hyperlink leads to Gas Quality AFB's main display ⇨ [Fig. 5-7: Gas quality: Main display \(example\)](#) (p. 37)
- 4 In case that no gas meter correction is parameterized in Flow Conversion AFB, the flow rate at measurement conditions [Qm](#) is displayed here. If gas meter correction is activated, the corresponding corrected flow rate [Qc](#) is shown instead. In both cases, the hyperlink leads to the **Flow rates** display showing the following values:

QE	Energy flow rate
QM	Mass flow rate
Q_b	Base volume flow rate
Q_c	Corrected volume flow rate (if gas meter correction is parameterized only)
Q_m	Flow rate at measurement conditions
C_f	Current correction factor (if gas meter correction is parameterized only)

The next figure shows a typical example of a Flow Conversion AFB's main display with its values and hyperlinks to other displays.

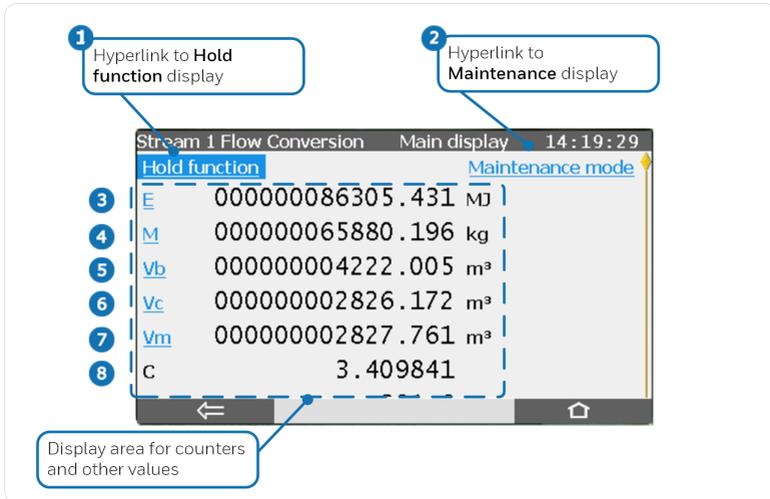


Fig. 5-6: Flow Conversion: Main display - example

1 **Hold function**

Hyperlink to **Hold function** display. The associated display is updated each time when the **Hold** button is activated. On activation, a snapshot is made of the most important counters and measurements. These held values are displayed together with the related time stamp.

2 **Maintenance mode**

Hyperlink to **Maintenance** display. The maintenance mode is intended for testing purposes; its activation requires a user login. Once you are logged in, the Maintenance mode can be set to **on** via display. After that, you can enter via operation panel a constant value for the flow rate Q_m that replaces the actual input value. During maintenance mode, the warning **Maintenance active** is generated; all flow rate-related messages are suppressed. All main counters are stopped, and the error counters are activated instead. These error counters are shown in the **Maintenance** display as well:

Ee Energy error counter

Me	Mass error counter
V_be	Base volume error counter
V_ce	Corrected volume error counter (if gas meter correction is parameterized only)
V_me	Volume at measurement conditions, error counter

You can quit the maintenance mode via display by resetting the maintenance mode to **off**. Maintenance mode is stopped automatically if the user is logged out. ¹

- 3 [E](#) energy main counter; the hyperlink leads to **Energy** display with the following energy-related values:

E	energy main counter
Ee	energy error counter
Eu	energy unhaltable counter
HVol	volume-based heating value
HMass	mass-based heating value

- 4 [M](#) is the mass main counter; the hyperlink leads to **Mass** display with the following mass-related values:

M	mass main counter
Me	mass error counter
Mu	mass unhaltable counter
ρ_b	base density
ρ_m	density at measurement conditions

- 5 [V_b](#) denotes the base volume main counter; the hyperlink leads to **Base volume** display showing following counters:

¹ Since Flow Conversion AFB V03-10-C, a message input (parameterizable) can be used to trigger the maintenance mode, in addition to activating the maintenance mode via operating panel. For detailed information refer to Flow Conversion AFB manual or the related online help topic in enSuite.

V_b	base volume main counter
V_{be}	base volume error counter
V_{bu}	base volume unhaltable counter

- 6 [Vc](#) denotes the main counter for corrected volume at measurement conditions. This line is omitted in case that no gas meter correction is parameterized in Flow Conversion AFB. If available, the hyperlink leads to **Corrected volume** display showing following values:

V_c	corrected volume main counter
V_{ce}	corrected volume error counter
V_{cu}	corrected volume unhaltable counter
C_f	correction factor

- 7 [Vm](#) denotes the main counter for volume at measurement conditions; the hyperlink leads to **Measured volume** display showing following counters:

V_o	original counter (optional) ¹
V_m	volume at measurement conditions, main counter
V_{me}	volume at measurement conditions, error counter
V_{mu}	volume at measurement conditions, unhaltable counter

- 8 **C** conversion factor

- 8 [Qm](#) is the flow rate for volume at measurement conditions; in case that gas meter correction is parameterized, this line is replaced by [Qc](#) (corrected flow rate). In both cases, the hyperlink leads to **Flow rates** display with the following values:

¹ v_o (original counter) is only available and shown in the display if the gas meter is connected via Encoder index and the corresponding value is explicitly parameterized for displaying in Flow Conversion AFB. The v_o counter repeats the original counter of the gas meter that is transferred via digital Encoder protocol.

QE	energy flow rate
QM	mass flow rate
Q_b	base volume flow rate
Q_c	corrected volume flow rate (if gas meter correction is parameterized only)
Q_m	flow rate at measurement conditions
C_f	correction factor (if gas meter correction is parameterized only)

5.4.3 Gas Quality AFB

For most applications, the calculation of the conversion factor is performed by the Gas Quality AFB. The measurements used for this calculation are indicated in the main display of the responsible Gas Quality AFB. As shown in ⇨ 5.4.2 [Flow Conversion AFB](#) (p. 31), this display can be activated by using the [C](#) conversion factor hyperlink in the  **<Flow Conversion AFB>** (fiscal display). Alternatively, the main display of the  **<Gas Quality AFB>** can be invoked by using the corresponding button in the home display as usual.

The labels of some of the measurements that are shown in the Gas Quality AFB's main display are designed as hyperlinks, too.

The next figure shows a typical example of a Gas Quality AFB's main display with its measurements, values, and hyperlinks to other displays:

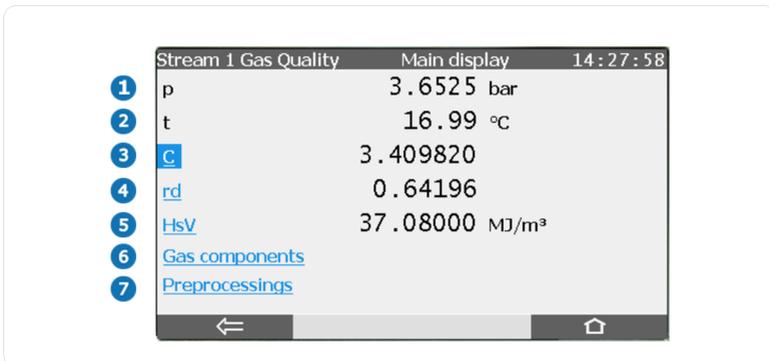


Fig. 5-7: Gas quality: Main display (example)

- ① pressure **p**
- ② temperature **t**
- ③ **c** is the conversion factor: the hyperlink leads to **Compressibility** display showing the following values:

p	pressure
t	temperature
p_b	pressure at base conditions
t_b	temperature at base conditions
C	conversion factor
Z_m	compressibility factor at measurement conditions
Z_b	compressibility factor at base conditions
K	K factor
Z_{b(air)}	compressibility factor of air at base conditions (acc. to ISO 6976)

- ④ **rd** relative density, the hyperlink leads to **Density** display showing measured and calculated values for density and relative density.
- ⑤ **HsV** denotes the superior heating value (volume-based). The hyperlink leads to **Heating values** display showing heating values and Wobbe indices.
- ⑥ **Gas components** is a hyperlink leading to a display showing the gas composition (as far as available).
- ⑦ **Preprocessings** is a hyperlink to leading to the display for all pre-processing operations.

Preprocessing display

A preprocessing operation defines a multi-level substitution strategy for measured input values, e.g., for pressure and temperature. In addition, the preprocessing operations perform the monitoring of measurements for upper and lower alarm limits as well as warning limits (optional).

Within the preprocessing display, the actual values of all levels for the selected preprocessing are shown, including status information:

- Status **A** indicates that the respective level is causing a pre-processing alarm. Status **W** signalizes a preprocessing warning.
- The status **in use** indicates the level that is currently used as result.
- The acronyms with three letters (**OOU**, **OOS**, **INT**, **OOO**, **OOC**, **OLL**, and **OUL**) denote the actual reason why a level cannot be used.

Error status	Meaning
OOU	O ut O f U se
OOS	O ut O f S ervice
INT	I n I tialization
OOO	O ut O f O der
OOC	O ut O f C alculation
OLL	O ut of L ower L imit (alarm limit violation)
OUL	O ut of U pper L imit (alarm limit violation)

Table 5-3: Preprocessing: Error status indication

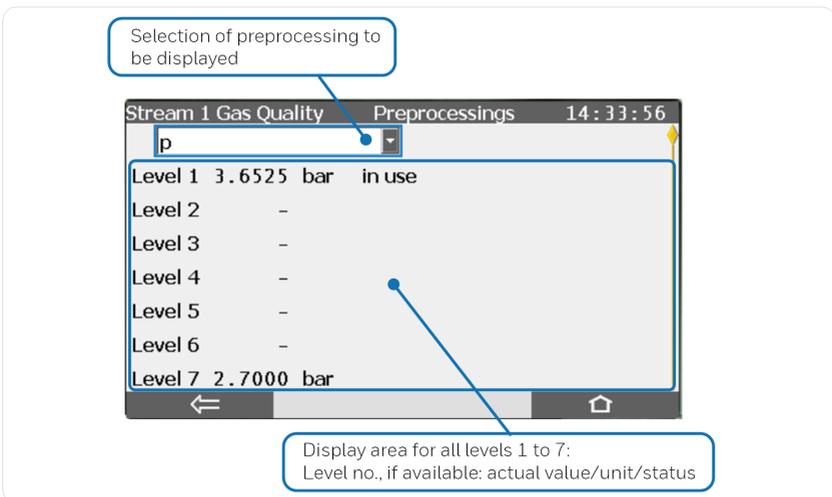


Fig. 5-8: Preprocessing display - example

5.4.4 Table Z AFB

In case that the calculation of the conversion factor C is performed by the Table Z AFB, the input measurements for C calculation as well as the results are indicated in the main display of the responsible Table Z AFB. This display can be activated by using the [c](#) hyperlink in the Flow Conversion AFB (fiscal and main display). Alternatively, the main display of the Table Z AFB can be invoked by using the corresponding button in the home display as usual.

The  <Table Z AFB>'s main display shows following values and measurements:

p	pressure
t	temperature
C	conversion factor
Z_m	compressibility factor at measurement conditions (p , t)
Z_b	compressibility factor at base conditions (p_b , t_b)
K	K factor

The [Base conditions](#) hyperlink leads to a display showing the base conditions (p_b , t_b) as well as optional constants for density or heating values.

The [Preprocessings](#) hyperlink leads to a display for preprocessing operations that can optionally be defined for pressure and temperature (cf. [Preprocessing display](#), p. 38).

5.4.5 Error list and logbook

The administration of events and errors is a functionality provided by the Basic System. Its main display, the **Error List**, can be evoked by activating the button labeled [**Error List**] in the device's home display.

At first, the **Error List** display shows all errors, i.e., all alarms and warnings that are currently pending or waiting for acceptance. There is a filter option for displaying errors of single function blocks only or of function blocks that are grouped by parameterization.

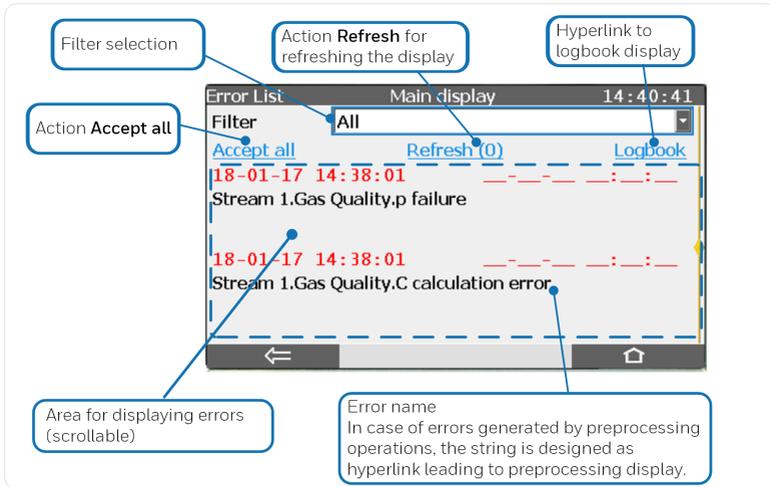


Fig. 5-9: **Error List** display - example

For each displayed error, the time and date shown at the left side indicate when the error has become active; date and time at the right indicate when the error has ended (if applicable). Time and date are highlighted in red for errors of alarm type; yellow is used to indicate warnings.

By activating the button labeled **Accept all**, all errors that have already ended are accepted at once. If a filtered view has been chosen, the errors of the currently used filtered view are affected only. Accepted errors are removed from the error list. The accepting of errors may require a user login and/or an opened security switch (parameterizable).

The **Logbook** display can be evoked by activating the related button within the **Error List** display. Whenever an error becomes active or ends, its state change is recorded in the logbook.

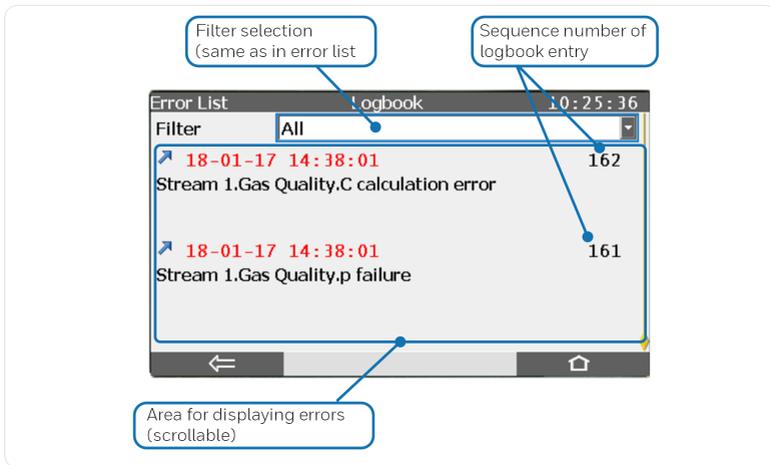


Fig. 5-10: **Logbook** display - example

If a logbook entry indicates that an error becomes active, it is marked with an upward arrow. An ending error is marked with a downward arrow. If the error is of alarm type, time and date are highlighted in red; yellow is used to indicate a warning.

The logbook can contain up to 10,000 records; if the logbook is full, the next entry overwrites the oldest record.

5.4.6 Software identification/list of fiscal parameters

During runtime, you can evoke an information display by activating the ⓘ button in the device's home display.

The subordinate menu **Software status** leads to a display showing the identification data of all legally and non-legally relevant software parts that are included in the device. These identification data consist of the name of the respective software part, its version number and the checksum.

A special software part is the approval file, which is contained within the device's software. The identifying abbreviation of the approval file is highlighted in red if the access rights of the parameterization are not consistent with the approval file (↔ [5.6 Parameterization](#), p. 45).

The names of the software parts are designed as hyperlinks leading to displays that contain further information about the respective software part. For the Basic System and all legally relevant AFBs, a list of all related fiscal parameters can be evoked in these displays (via [CRC param. secured](#) hyperlink). These displays enable the user to check all legally relevant settings directly at the device.

For better identification, the checksums of all legally relevant software parts are highlighted and marked with a special preceding icon .

During operation, the actual checksums are calculated and compared with the respective reference values. If a checksum is highlighted in red, the last check has failed, i.e., a deviation has been detected. An alarm is generated in that case.

5.4.7 Fiscal audit trail

The fiscal audit trail is a log file for legal purposes. There are legally relevant parameters that can be changed even if the security switch is closed. In that case, the action is recorded in the fiscal audit trail.

The fiscal audit trail can contain up to 1,000 entries. If the fiscal audit trail is full, no further entry can be written, i.e., no further legally relevant change of the parameterization is possible without opening the security switch.

The fiscal audit trail can be deleted, provided that the security switch is open and an authorized user is logged in.

The display of the fiscal audit trail can be evoked as follows:

- 01 Activate the **System** button in the home display.
- 02 Activate the button labeled **Audit trail**.
- 03 Select **Fiscal** in the drop-down list at the left.

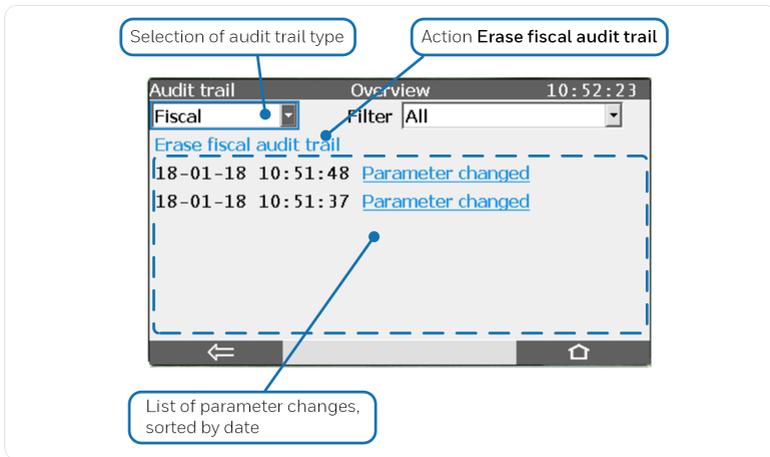


Fig. 5-11: Audit trail display - example

The **Erase fiscal audit trail** action can only be activated if the security switch is open; a user login is required additionally. If both conditions are fulfilled, the text **Erase fiscal audit trail** is designed as a hyperlink.

By activating a **Parameter changed** hyperlink, the corresponding audit trail entry is displayed in detail:

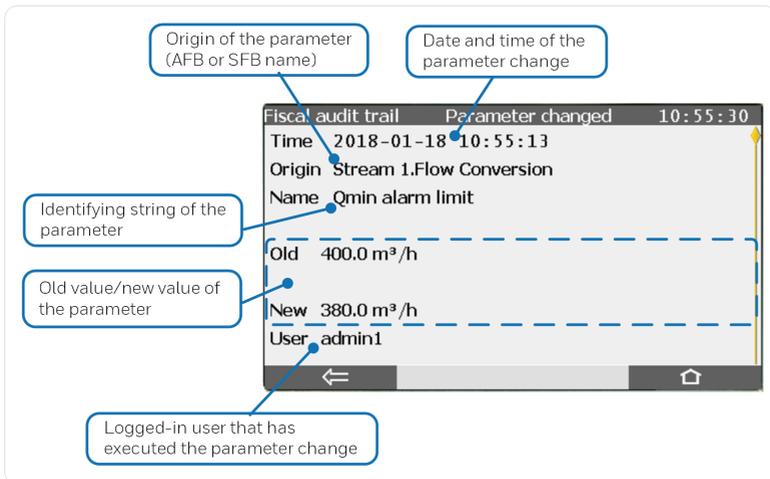


Fig. 5-12: Fiscal audit trail – detailed display - example

If the fiscal audit trail contains more than one entry, it is also possible to use the navigation keys to page through the audit trail entries.

5.5 USB port for PC connection

The USB port for PC connection located on the front panel (⇨ [5.1 Operating controls](#), p. 24) is a standard type B version. It is intended for establishing a local data connection between a PC or laptop and an enCore device by using the enSuite PC software.

The USB driver necessary for the USB communication is part of the enSuite installation. It can be easily installed when connecting an enCore device to a PC or laptop for the first time (⇨ Installation Instructions “enSuite - Installation and Security Measures”).

5.6 Parameterization

The parameterization of enCore devices is carried out by using the enSuite configuration software¹. The data communication between the PC and the device can be established via USB or network TCP.

For further details ⇨ enCore manual “Configuring the Device with enSuite” or refer to the enSuite online help.

The modification of legally relevant parameters is secured by two alternative mechanisms:

- **Security switch**
Parameters that are marked with the symbol  in enSuite can only be changed if the security switch is open.
- **Fiscal audit trail**
Parameters that are marked with the symbol  in enSuite can be changed even if the security switch is closed – in this situation the changes are recorded in the fiscal audit trail. The fiscal audit trail's depth is 1,000 entries. As soon as the fiscal audit trail is full, no

¹ Instructions for installation ⇨ Installation Instructions “enSuite - Installation and Security Measures”

more changes of parameters marked  can be made when the security switch is closed. You can only erase the fiscal audit trail if the security switch is open (⇒ [5.4.7 Fiscal audit trail](#), p. 43).

Such parameters (marked  or ) are called *secured parameters*.



Changing secured and non-secured parameters: User login

In addition to the securing mechanisms for changing legally relevant parameters described here, a user login is necessary for changing parameters.

Since Basic System V03-39-A, such a user login is also necessary for reading a device parameterization.

There are two different modes (parameterizable) for logging in when the security switch is open¹ :

- **Authentication mode: Password (default)**

To log in to the device, you need **< user name >** and **< password >**, regardless of the position of the security switch.

- **Authorization mode: Security switch**

When the security switch is open, the **< user name >** is sufficient for logging on to the device. This procedure makes it easier, for example, to carry out necessary tasks in the test centre or before commissioning, as the password is not required.

Since Basic System V03-39-A, however, it is not possible to read or change sensitive data such as SIM PINs or email credentials in this authorization mode if only the security switch is open. To ensure the confidentiality of such sensitive user data, a proper login with **< user name >** and **< password >** is necessary.

¹ supported since Basic System V03-28-A

It depends on the particular application and the applicable EU type Examination Certificate which parameters are regarded as being legally relevant, and which securing mechanism shall be used in each case. These restrictions are summarized in a special configuration file (approval file) that is part of the individual device's software.

In order to be able to operate in conformity with an official Type Examination Certificate, the device parameterization must contain at least the same securing mechanisms for legally relevant parameters as described in the approval file. To ensure this, you can select which approval file is valid for the device when creating or editing a device parameterization in enSuite as well.

During operation, the enCore device checks whether the device parameterization contains at least the same securing mechanisms as the approval file of the device software. If the FC1 detects that the securing mechanism for at least one parameter in the parameterization is weaker than specified in the approval file of the device software, the identifying string of the approval file shown within the **Software status** display is highlighted in red (↔ [5.4.6 Software identification/list of fiscal parameters](#), p. 42) and the device generates an alarm.

5.7 Software download

The software download for enCore devices is carried out by using a special tool included in the enSuite configuration software. The data communication between the PC and the device can be established via USB or network TCP.

Each part of the device's software (Basic System software, software of individual AFBs, software of individual process boards) can be downloaded individually.

The download process is liable to certain regulations and verification checks. In particular, a download of legally relevant software and the modification of the AFB configuration are prohibited if the device's security switch is closed.

For further details ↔ enCore manual "Configuring the Device with enSuite" or refer to the enSuite online help.

For software download, the device software is provided in separate parts, so-called *containers*. Each container contains a software module, information about its checksum and a signature. Each individual container

can be exchanged for a container with the same software module in a different version independently. The transmission is secured by a signature procedure.

There are containers for the legally relevant Basic System, for all available legally relevant and not legally relevant AFBs as well as for the so-called approval file. The approval file is a non-executable configuration file and defines the security mechanisms¹ for legally relevant parameters.

All approved legally relevant software parts are listed with version and check sum in the latest revision of the EU Type Examination Certificate.

The approval files do not have a version but are identified by their name that refers to the related revision of the EU Type Examination Certificate (e.g., **Approval FC1-MID Rev.7**).

There is also a special signed container that contains the basic setup of the device in the form of a non-executable configuration file. Here, identification data of the device is stored together with information on which additional, non-legally relevant AFBs subject to purchase can be used in the respective device.

A software download not only allows the *exchange* of containers for another version, but in principle it is also possible to *add* containers for further AFBs if the device resources are sufficient.

The download process for an FC1 used in legal metrology is liable to certain regulations and verification checks. In particular, following actions are only possible when the security switch is open:

- Exchange of containers for legally relevant software parts (Basic System, Gas Quality AFB, Flow Conversion AFB, Table Z AFB). Only software versions that are explicitly mentioned in the respective valid EU Type Examination Certificate may be used.
- Exchange of the approval file
- Modification of the AFB configuration (e.g., adding an AFB container). For adding a chargeable AFB, it may also be necessary to replace the configuration file for the basic device settings by another one provided by the manufacturer.

¹ The modification of legally relevant parameters is secured by two alternative mechanisms (security switch or fiscal audit trail), ⇔ [5.6 Parameterization](#) (p. 45).

The software download for enCore devices is carried out by using a special tool included in the enSuite software (**Software Configuration** action). You can activate this tool as soon as the data connection between PC and enCore device via USB or TCP network is established.

For further details:

- ⇒ enCore manual “Update of the Device Software“, or
- ⇒ enCore manual “Configuring the Device with enSuite“

6 Legally relevant functionalities

6.1 Basic System

The main task of the Basic System is the I/O board interfacing and the digital protocol interfacing for intelligent measurement devices like USMs or PGCs. That means that the Basic System collects, monitors, and evaluates all legally relevant input data coming in via process boards and protocol ports. It is able to perform adjustments for pressure and temperature measurements as well as a geometry correction for ultrasonic gas meters¹, if parameterized.

From the fiscal point of view, the Basic System provides all measurement data and status information needed for the volume conversion for the Gas Quality and Flow Conversion AFBs.

Data source	Legally relevant data processed
Gas meter	<ul style="list-style-type: none">• Meter progress• Flow rate• Flow direction information (if applicable)• Status information
Pressure transmitter	<ul style="list-style-type: none">• Measurement, adjusted measurement• Status, error information
Temperature transmitter	<ul style="list-style-type: none">• Measurement, adjusted measurement• Status, error information
Gas quality measurement device	<ul style="list-style-type: none">• Measurements• Status, error information

Table 6-1: Legally relevant measurement data

¹ Geometry correction of ultrasonic gas meters is not permitted for FC1 devices used in legal metrology acc. to EU type examination certificate.

6.2 Gas Quality AFB

The Gas Quality AFB calculates special characteristics of the gas, using gas quality data, pressure, and temperature measurements and taking the base conditions to be applied into consideration.

The gas quality data can be parameterized as constant values.

Besides, the FC1 can use gas quality data that are actually measured on-site by a GQ measurement device (e.g., a gas chromatograph):

- The FC1 supports the connection of some specific GQ measurement devices to a serial interface (COM Port) or LAN interface. The used protocol standard is Modbus, Modbus IP, or a manufacturer-dependent protocol, respectively. The Basic System is responsible for the protocol interfacing and makes the gas quality data available for the Gas Quality AFB.
- In addition, the FC1 supports the connection of GQ measurement devices that are DSfG protocol capable. The FC1 can use the first COM port of the CPU as DSfG interface; the DSfG AFB is responsible for receiving the gas quality data and makes them available for the Gas Quality AFB.

In detail, the Gas Quality AFB performs the following tasks:

- Normalization of the gas component vector, if required
- Calculation of conversion factor C (and the interim results compressibility factors z_m and z_b , K factor) according to AGA8-92 DC (ISO 12213-2), AGA8-2017, SGERG-88 (ISO 12213-3), SGERG-mod-H2 (DVGW G 685-6), AGA-NX19, AGA-NX19 mod BR.KOR.3H or AGA-NX19 GOST, alternatively $z_m/z_b = \text{constant}$ ¹
- Calculation of density at base/measurement conditions and relative density, according to AGA8-92 DC or ISO 6976/GPA 2172 (for information only)
- Calculation of heating values and Wobbe indices according to ISO 6976/GPA 2172 (for information only)

¹ Depending on the software version. The Gas Quality AFB may offer calculation standards that are not admitted for use in legal metrology. When selecting the calculation standard, the regulations of the EU Type Examination Certificate must be observed.

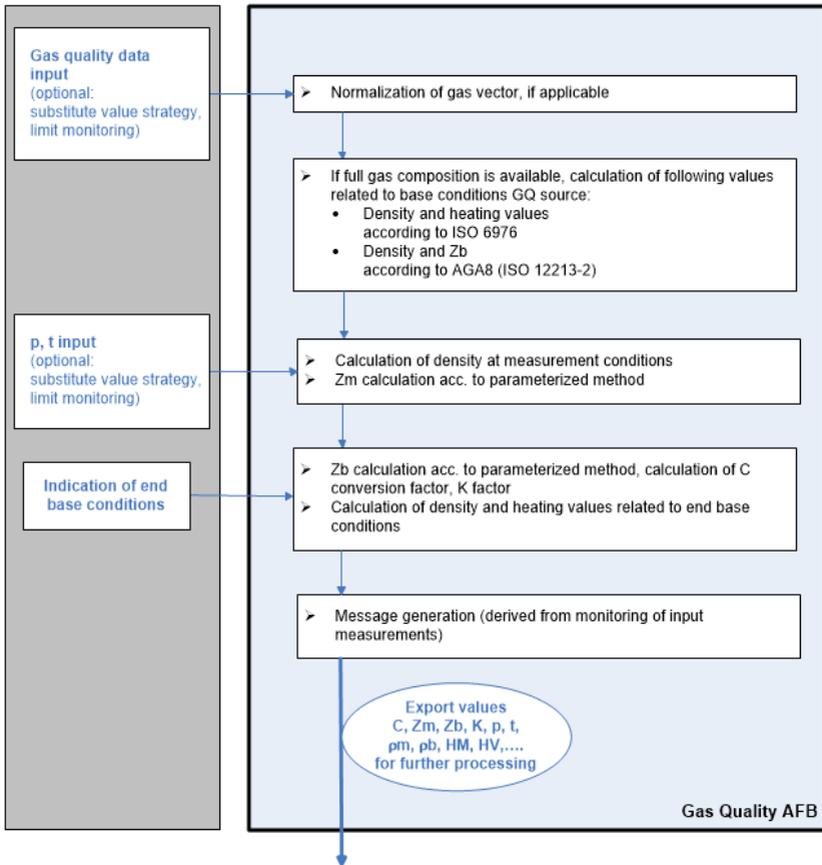


Fig. 6-1: Data flow for Gas Quality AFB, exemplary for measured gas quality

6.3 Flow Conversion AFB

The Flow Conversion AFB generates counters for volume at base and measurement conditions as well as mass and energy by using the gas meter measurement data and the results of the Gas Quality AFB. It performs the meter correction and the counter administration due to error handling and – if applicable – takes the counter activation message (e.g., for flow direction switching) into consideration.

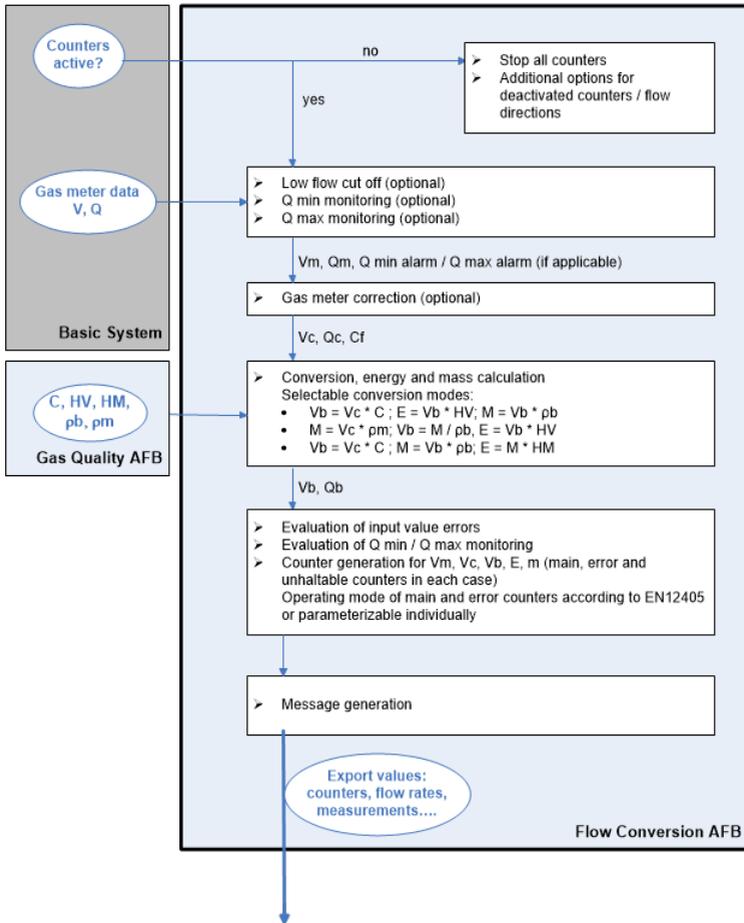


Fig. 6-2: Data flow for Flow Conversion AFB

Gas meter correction (optional)

The optional gas meter correction of the Flow Conversion AFB uses up to 20¹ calibration points, each of them consisting of the flow rate in m³/h and the related error in percent (%).

¹ 20 calibration points are available from Flow Conversion AFB V 03-14-A on; in earlier AFB versions the number of calibration points is limited to 10.

The correction factor C_f is calculated for any measured flow rate Q by linear interpolation between the parameterized calibration points. If Q falls below the lowest flow of all calibration points, the correction factor obtained for that flow is retained (no extrapolation). The behavior regarding high flow rates is similar: Above the highest flow rate of all calibration points, the correction factor remains at the value obtained for that flow rate.

The EN12405 standard (§ 4.4) prescribes a special behavior of the gas meter correction below Q_{\min} and above Q_{\max} . Therefore, following additional rules are applied to comply with EN12405:

- below Q_{\min} ($C_f := 1$): no gas meter correction is performed
- above Q_{\max} : the correction factor remains at the value obtained at Q_{\max} .

The calibration points are specified in the gas meter's calibration certificate and have to be parameterized in the related Flow Conversion AFB, as well as the minimum and maximum flow rates Q_{\min} and Q_{\max} .

During operation, for each operating point the gas meter correction is carried out by applying the calculated correction factor C_f as follows:

$$V_c = V_m \cdot C_f$$

$$Q_c = Q_m \cdot C_f$$

where

V_m	volume at measurement conditions
V_c	volume at measurement conditions, gas meter correction applied
Q_m	flow rate at measurement conditions
Q_c	flow rate at measurement conditions, gas meter correction applied
c_f	correction factor

6.4 Table Z AFB

The Table Z AFB calculates the compressibility factor at measurement conditions (p , t) using a compressibility factor table. The entries of the compressibility factor table (related to measurement conditions p , t) are subject to parameterization.

In detail, the Table Z AFB performs the following tasks:

- calculation of compressibility factor Z_m at measurement conditions (p , t) by bilinear interpolation using the compressibility factor table
- Calculation of K factor ($K = Z_m/Z_b$)
- calculation of conversion factor C
- density at base conditions, relative density, heating values, and Wobbe indices can optionally be parameterized as constants

During operation, the Z_m compressibility factor is calculated by bilinear interpolation between the table Z values belonging to the nearest interpolation points for p and t . For the compressibility factor at base conditions Z_b , the functionality either uses a parameterized constant or calculates the value via compressibility factor table.

In case that any of the inputs for pressure p or temperature t are beyond the defined table range, no extrapolation is done. Instead, the value of the outermost interpolation point is used for calculating the respective compressibility factor. In this situation, an alarm is generated and the results Z_m , K and C are marked as being in error. Same holds if p_b and/or t_b are outside the table and Z_b is parameterized to be calculated from table.

To detect a possible transition of the gas to the liquid state, the compressibility factor table shall contain a zero (0) for all pairs (p , t) for which the respective gas is supposed to be liquid. As long as liquid state is detected, an alarm is pending. At the same time, the Z_m , K and C results are marked as being in error and the C result is set to zero (0).

6.5 Mandatory parameter settings

For FC1 devices that are ordered for use in legal metrology, the manufacturer (Elster GmbH) declares the conformity to the respective EU Type Examination Certificate and to the appropriate regulations of the MID Directive, based on quality assurance of the production process (Annex D MID). This includes that the parameterization of the delivered device complies with the FC1 EU Type Examination Certificate. After the FC1 has been placed on the market, all changes of legally relevant parameters are under the responsibility of the Notified Body in charge.

You can check the settings of legally relevant parameters at the device.

↔ [5.4.6 Software identification/list of fiscal parameters](#) (p. 42)

Steps to check the settings of legally relevant parameters

- 01 Activate the  button in the device's home display.
 - 02 Activate the [Software status](#) hyperlink.
 - 03 Activate the hyperlink for the respective software part, e.g., [Basic System](#).
 - 04 Scroll through the list of secured parameters to check the settings.
- The following sections list the legally relevant and secured parameters that are set compliantly on deliverance, sorted by software part.

Basic System

Parameter	Mandatory setting
System.Script supervision mode	CRC error fiscal code
System.Message on CRC error fiscal code	Alarm
System.Message on CRC error fiscal parameterization	Alarm
System.Message on deviation from approval file	Alarm
Error list.Acceptance procedure	Inactive errors can be accepted only

Parameter	Mandatory setting
For ultrasonic gas meters: Intelligent measurement devices.USM <x>.Geometry correction	unused

Gas Quality AFB

Parameter	Mandatory setting
<Stream name>.Gas Quality.t input <Stream name>.Gas Quality.p input	p input, t input via preprocessing: <Stream name>.Gas Quality.<preprocessing name>.value
for p, t preprocessing: <Stream name>.Gas Quality.<preprocessing name>.level1	Reference to respective I/O input value (measured value)
for p, t preprocessing: <Stream name>.Gas Quality.<preprocessing name>.level <x> (for up to 6 levels)	unassigned
for p, t preprocessing: <Stream name>.Gas Quality.<preprocessing name>.lower alarm limit <Stream name>.Gas Quality.<preprocessing name>.upper alarm limit	upper and lower alarm limits are used
for p, t preprocessing: <Stream name>.Gas Quality.<preprocessing name>.alarm behavior	non-sensitive
for p, t preprocessing: <Stream name>.Gas Quality.<preprocessing name>.external level selection	unassigned

Parameter	Mandatory setting
In case of measured gas quality: use 1-level preprocessing group to ensure substitute value strategy, external level selection = unassigned	first levels: reference to measured value
<Stream name>.Gas Quality.Calculation methods.Zm calculation method <Stream name>.Gas Quality.Calculation methods.Zb calculation method	only methods mentioned in EU Type Examination Certificate are permitted, same method must be chosen for both parameters
<Stream name>.Gas Quality.End base conditions.Standard used	ISO combinations of p_b , t_b permitted only

Flow Conversion AFB

Parameter	Mandatory setting
<Stream name>.Flow Conversion.Conversion mode	only modes with $v_b = v_c \times C$ permitted
<Stream name>.Flow Conversion.Stop Vm/Vc counters	never
<Stream name>.Flow Conversion.Start Vme/Vce counters	if affected by alarm
<Stream name>.Flow Conversion.Stop Vb/E/M counters	during any alarm
<Stream name>.Flow Conversion.Start Vbe/Ee/Me counters	during any alarm

7 Technical data

7.1 General

	Technical data
Dimensions/housing	<ul style="list-style-type: none">• plug-in unit in 19" technology, 3 height units (HU), 1/3 or 1/2 housing width• depth without plugs approx. 170 mm, with plugs approx. 220 mm• process interfacing at the rear, operation panel at the front
Ambient conditions	<ul style="list-style-type: none">• ambient temperature range -10 °C up to +55 °C• humidity < 90 %, non-condensing• installation outside Ex zones 0, 1 and 2 only
IP code	<ul style="list-style-type: none">• IP20
Storage temperature	<ul style="list-style-type: none">• -25 °C to +60 °C
Weight	(fully equipped) <ul style="list-style-type: none">• 1/3 device width: approx. 1.3 kg• 1/2 device width: approx. 2.1 kg
Power supply	<ul style="list-style-type: none">• 24 V DC with a tolerance of -15 % and +20 % (i.e., maximum permissible range 20.4 V DC to 28.8 V DC), power consumption up to 12 W (typically 5 W)• optional: 230 V AC via external power supply

	Technical data
	<ul style="list-style-type: none"> • We recommend to operate the process computer in conjunction with a suitable uninterruptible power supply. Its design must comply for direct current; nominal voltage 24 V DC, permitted range 20.4 V DC to 28.8 V DC, switching time not exceeding 10 ms. The external power supply must provide at least 12 W power. With a mains voltage of 100 V up to 230 V for the uninterruptible power supply, the switching time must not be greater than a mains period (50 or 60 Hz), based on the nominal value of the mains frequency.
Display/operation panel	<ul style="list-style-type: none"> • 4.3" TFT color display with touch screen, 480 × 272 pixels RGB, LED background lighting • 4 × navigation and 2 × function keys • 2 × multicolor LEDs for power and status indication • 1 × sealable security switch

Table 7-1: General technical data

7.2 Input channels

ExMFE5

- 3 × NAMUR inputs [Ex ib Gb] IIC for LF pulses (max. 2 Hz, min. pulse length 200 ms) or HF pulses (max. 5 kHz, min. pulse length 110 μs) or messages.
One of these inputs can alternatively be used for connecting an encoder index.
- 1 × analog input for a transmitter with 4 ... 20 mA interface [Ex ib Gb] IIC, alternatively suitable for connecting transmitters with HART interface (1 × transmitter in burst mode¹ or up to 4 × transmitters in multidrop mode)
- 1 × resistance input for a Pt100 temperature transmitter (4-wire technology), [Ex ib Gb] IIC

All inputs are galvanically isolated from the system.

MFE7

- 3 × inputs (24 VDC) for LF pulses (max. 8 Hz, min. pulse length 50 ms) or HF pulses (max. 5 kHz, min. pulse length 20 μs) or messages
One of these inputs can be used alternatively for connecting an encoder index or as frequency input.
- 2 × analog inputs for transmitters with 4 ... 20 mA interface, alternatively suitable for connecting transmitters with HART interface (1 × transmitter in burst mode² or up to 4 × transmitters in multidrop mode), active or passive power supply
- 1 × resistance input for a Pt100 temperature transmitter (4-wire technology)

All inputs are galvanically isolated from the system.

¹ Burst mode is not supported by all transmitters.

² Burst mode is not supported by all transmitters.

7.3 Output channels

MFA8

- 1 × PhotoMos output (NC, max. 28.8 V, 120 mA) for alarm/message signaling
- 3 × PhotoMos outputs (NO, max. 28.8 V DC, 120 mA) for alarm/message or pulse outputs of up to 25 Hz
- 4 × analog outputs 0/4 ... 20 mA for measurements

Alarm/message and pulse outputs are galvanically isolated from each other, from the analog outputs, and from the system. Analog outputs are galvanically isolated in common from the system and the digital outputs.

7.4 Interfaces for digital communication

CPU

- 1 × LAN interface (Ethernet 10/100 Mbit/s)
The interface is galvanically isolated from all other interfaces and from the system.
- 2 × COM ports
The first port can be used as DSfG protocol interface.
The serial interfaces are galvanically isolated from each other and from the system.
Supported standards: RS485, RS422, RS232



Not all enCore device types support all standards.

MSER4

- 4 × serial interfaces
The serial interfaces are galvanically isolated from each other and from the system.
Supported standards: RS485/RS422/RS232

ESER4

- 3 × serial interfaces
The serial interfaces are galvanically isolated from each other and from the system.
Supported standards: RS485/RS422/RS232
- 1 × LAN interface (Ethernet 10/100 Mbit/s)
The interface is galvanically isolated from all other interfaces and from the system.

MFE7

- 1 × serial RS485 interface
The interface is galvanically isolated from all other interfaces and from the system.

USB port

- 1 × USB interface for connecting a PC or laptop for parameterization and service purposes

7.4.1 Supported data protocols

Protocols at a glance



Not every data protocol is supported by every enCore FC device type.

Communication	Supported data protocols
Ethernet	<ul style="list-style-type: none"> • DSfG (class B) • HTTP (<i>only up to Basic System V03-38</i>) • MMS (secured via TLS) • Modbus TCP • IEC 60870-5-104 • NTP • SMTP (unencrypted, SSL/TLS, STARTTLS)
serial (RS232, RS485)	<ul style="list-style-type: none"> • DSfG (class A) • Modbus (ASCII, RTU) • UNIFORM

Table 7-2: Support data protocols



Use secure version of a protocol!

Unencrypted protocols transmit data in plain text, such as Modbus. If possible, use the secure version of a protocol.

8 Notices

8.1 General notices

8.1.1 Third-party trademarks

All used or mentioned brand names are the property of their respective owners. A possible mention of brands is done in good faith and without any intention to derive a claim.

8.1.2 Third-party licenses

This product may contain or be derived from materials, including software, of third parties. The third party materials may be subject to licenses, notices, restrictions and obligations imposed by the licensor.

The licenses, notices, restrictions and obligations, if any, may be found in the materials accompanying the product, in the documents or files accompanying such third party materials, in a file named `Third_Party_Licenses_enCore.pdf` at:

process.honeywell.com/us/en/site/elster-instromet/about-us

8.1.3 Warranty Conditions

You will find our current warranty conditions in the General Terms and Conditions, for example, on our website:

process.honeywell.com/us/en/site/elster-instromet/about-us

8.1.4 Technical support Flow Computers and Gas analyzers

Our support of Elster Gas is available for technical advice as well as repairs.

To find further information visit our support site of Elster Gas:

process.honeywell.com/us/en/site/elster-instromet/support



Use secure communication!

Use secure communication, such as email encryption, to send confidential data.

8.1.5 Spare parts and repairs

For spare parts and repairs please write an email to our service.

PMT-Reparatur@Honeywell.com

8.1.6 How to report a security vulnerability

A security vulnerability is defined as an error or weakness in the software that can be exploited to impair the operation or security of the parameterization or device software or to access sensitive data.

Honeywell investigates all reports of security vulnerabilities affecting Honeywell products and services. For details on Honeywell security policy, visit:

www.honeywell.com/us/en/product-security

To report a potential security vulnerability against any Honeywell product, please follow the instructions at:

www.honeywell.com/us/en/product-security#vulnerability-reporting

To view information on current malware threats please visit:

www.honeywell.com/us/en/news

OR

Contact your local Honeywell Process Solutions Customer Contact Center (CCC) or our technical support of Elster Gas.

8.1.7 How to give feedback to user documentation

We are always interested in your comments, corrections or suggestions for improvement regarding the Elster Gas Flow Computers and Gasanalyzers documentation. Please send your feedback to our technical support of Elster Gas.

ElsterSupport@Honeywell.com

Use this email address to provide feedback, or to report errors and omissions in the documentation.

8.1.8 Knowledge base articles on Honeywell Support Portal

Elster Gas provides problem-solving approaches and answers to frequently asked questions, as well as tips and tricks in short articles for various product series in our technical knowledge base.

process.honeywell.com/us/en/services-and-support/support-center/technical-support

The knowledge articles are constantly being expanded.

8.2 enCore FC manuals at a glance

The user documentation of enCore FC has a modular structure. All manuals are available for download in the docuthek. Manuals for which an order number is given in the following tables can be ordered as printed copies from Elster Gas. .



Please note that safety instructions are contained exclusively in the ↔ enCore manual “Operating Instructions“.

8.2.1 For use in legal metrology

The legally relevant functions and features are described for each device type in a separate manual. For use in legal metrology, a printed copy of the corresponding manual is included in the delivery. The order number is indicated in square brackets.

Manual	FC1	MC1
FC1 –Instructions for Use in Legal Metrology ¹ [FC1-ULM-EN]	✓	–

8.2.2 Basic manuals

These manuals document assembly, installation, commissioning, configuration, maintenance, and basic functions.

Manual	FC1	MC1
Operating Instructions ² (included in delivery) [FC1-OI-EN]	✓	✓
Configuring the Device with enSuite ³	✓	✓
Basic System with SFBs ⁴	✓	✓
Update of the Device Software	✓	✓

8.2.3 Single AFBs

For the individual AFBs, parameterization, functionality and operation are described in separate manuals. These manuals always describe the maximum functional range of an AFB. Which AFBs are necessary for a device or which AFBs can be used optionally depends on the individual device type.

An overview of which AFB manuals are available and applicable for which device type is provided in ⇨ enCore manual “Operating Instructions“ in the corresponding section.

¹ as per EU-type examination certificate as electronic gas-volume conversion device (EVCD)

² assembly, installation, commissioning, and maintenance of an enCore FC device

³ parameterization and analysis software enSuite, the download of the device software and further service measures

⁴ Basic System of the device software, which includes all basic functions of the device such as the user administration

8.2.4 Download latest manuals on Docuthek

Elster Gas provides the user documentation such as manuals, certificates, data sheets, technical information for different device types (in different languages) on the Docuthek. The documents are regularly updated.

www.docuthek.com

Use the device type as search term, for example,

enCore FC1



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The target value of the SHA-1 checksum for a PDF can be found on our Docuthek in the details in section **Remarks**, or – if you have downloaded the PDF from Honeywell website – in brackets next to the download link.



Which manuals are relevant for previous product releases?

Only the latest manuals are available on the Docuthek. If you are using an older software version, you can look up these manuals for each version in the software history on the Honeywell website. The software history is available as a PDF file for product releases since 2020 in the download area of the respective device type.

process.honeywell.com/us/en/site/elster-instromet/support#software-downloads

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10 Appendix

- FC1: Markings and Device Sealing

 Elster GmbH Schloßstraße 95a 44357 Dortmund Germany T +49 (0)231 937 110 0 www.elster-instromet.com	DOCUMENT TITLE FC1: MARKINGS AND DEVICE SEALING	
	DOCUMENT NUMBER 08 00 00 01 301	
	DOCUMENT REVISION 007	REVISION DATE 2023-10-25

FC1: Markings and Device Sealing

Contents

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1 FC1 front markings

The FC1 device is available in two housing sizes, i.e. with a housing width of 1/3 for up to four process boards or a housing width of 1/2 for up to seven process boards. The front plate for both housing widths is available in two designs: former Elster design or current Honeywell design.

1.1 1/3 housing width, former Elster front design

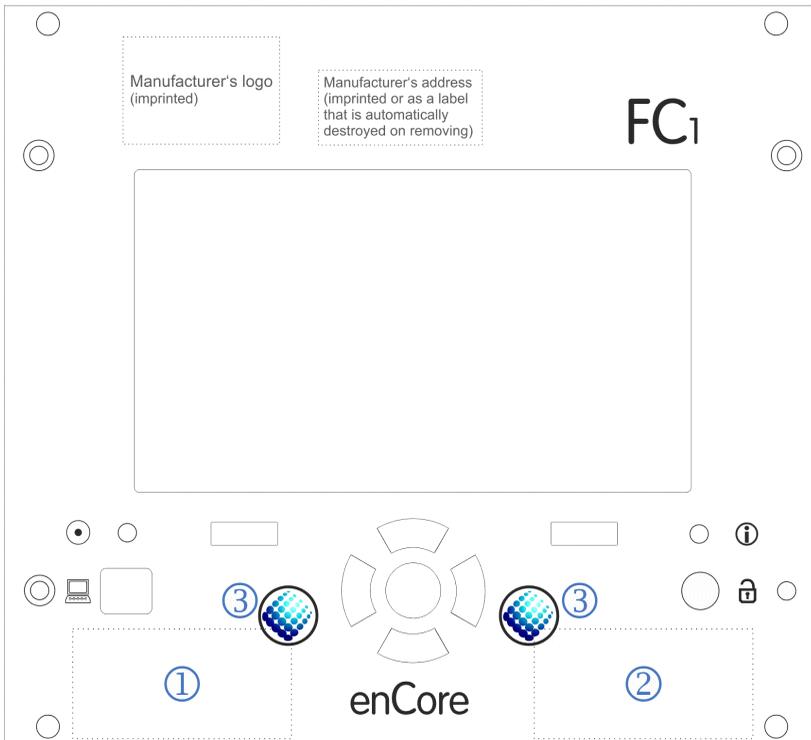


Figure 1: FC1 front view with position of type plates
(1/3 housing width, Elster design)

- ① Location of type plate part 1
- ② Location of type plate part 2
- ③ Securing marks (adhesive labels), example

1.2 1/3 housing width, Honeywell front design

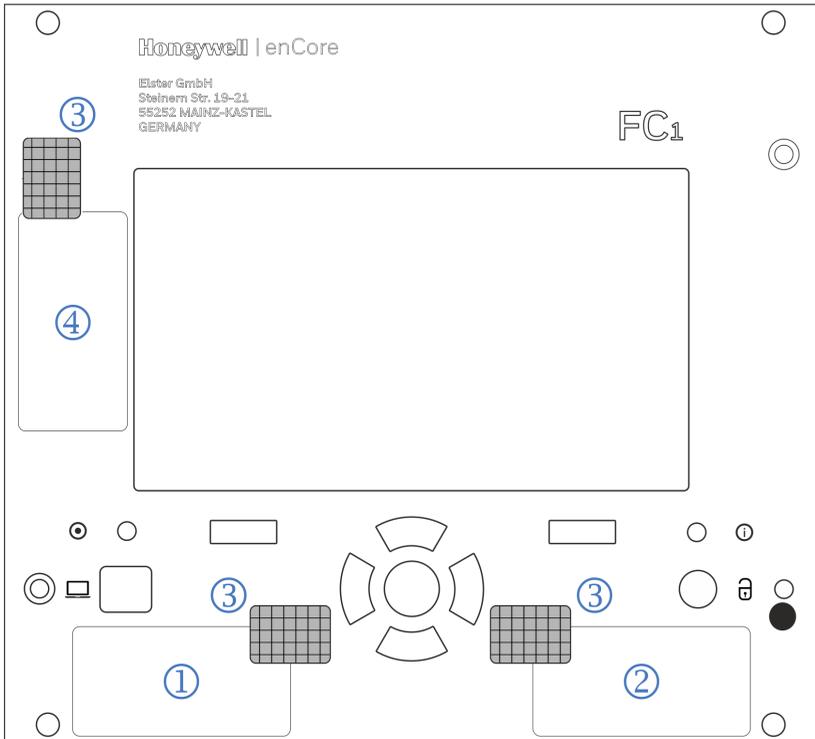


Figure 2: FC1 front view with position of type plates
(1/3 housing width, Honeywell design)

- ① Location of type plate part 1
- ② Location of type plate part 2
- ③ Position of securing marks (adhesive labels)
- ④ Location of type plate part 3

(for devices placed on the market from the date of issue of the EU- type examination certificate T10434 revision 11 onwards)

1.3 Type plates

For the design of the type plates part 1 and 2 there are two alternatives differing slightly in label size and arrangement. Figure 3 shows the first and Figure 4 the second design. In the second design, a 2D code and/or the marking acc. to WEEE directive can optionally be applied on the left part of the type plate.



Figure 3: Type plate parts 1&2 (design 1)

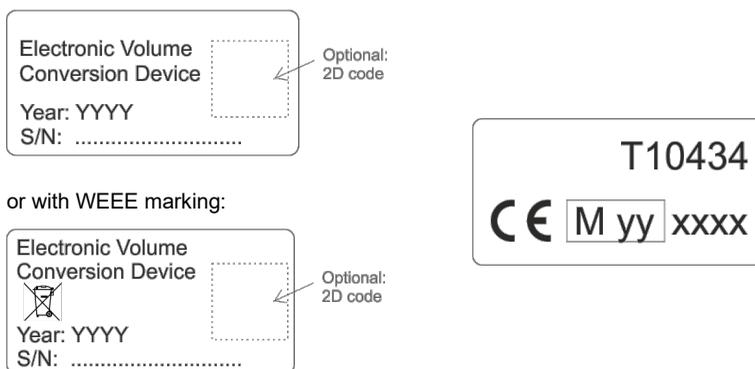


Figure 4: Type plate parts 1&2 (design 2)

For devices placed on the market from the date of issue of the EU- type examination certificate T10434 revision 11 onwards, a third type plate part provides additional information (cf. Figure 5).

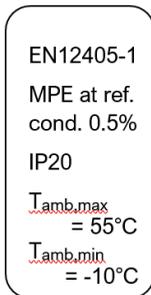


Figure 5: Type plate part 3
(cf. EU-type examination certificate T10434 as of revision 11)

1.4 FC1 with 1/2 housing width, Elster or Honeywell front design

Figure 6 and Figure 7 show the FC1 front markings for both the former Elster and the current Honeywell design in case of a device with a housing width of 1/2.

As there is more free space on the front plate in 1/2 housing width, the exact positioning of the type plates in practice may also differ from Figure 6 or Figure 7. In any case, the type plates must be secured with a securing mark.

For the type plates parts 1 and 2, there are the same two designs as shown in chapter 1.3 in Figure 3 and Figure 4, respectively.

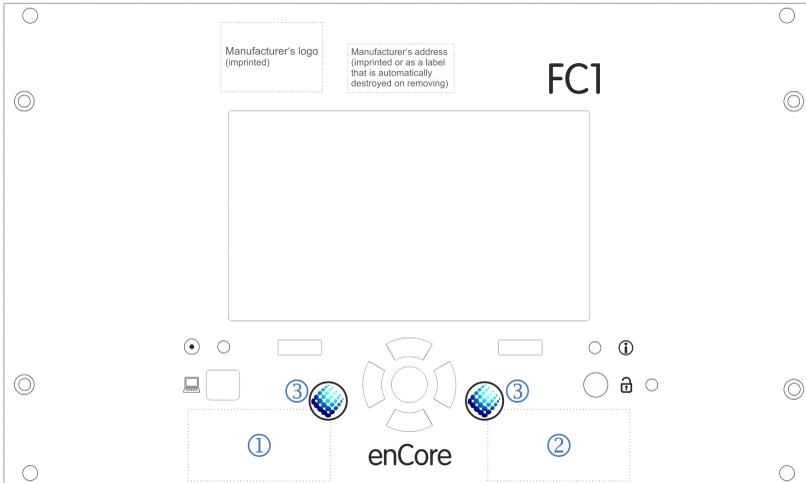


Figure 6: FC1 front view
(1/2 housing width, former Elster design)

- ① Type plate part 1
- ② Type plate part 2
- ③ Securing marks (adhesive labels), example

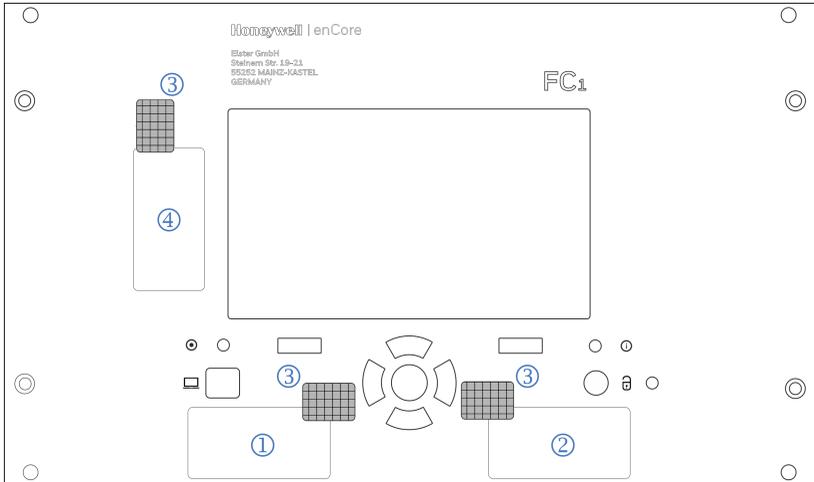


Figure 7: FC1 front view (1/2 housing width, current Honeywell design)

- ① Type plate part 1
- ② Type plate part 2
- ③ Securing marks (adhesive labels)
- ④ Type plate part 3 (for devices placed on the market from the date of issue of the EU- type examination certificate T10434 revision 11 onwards)

2 Front Sealing

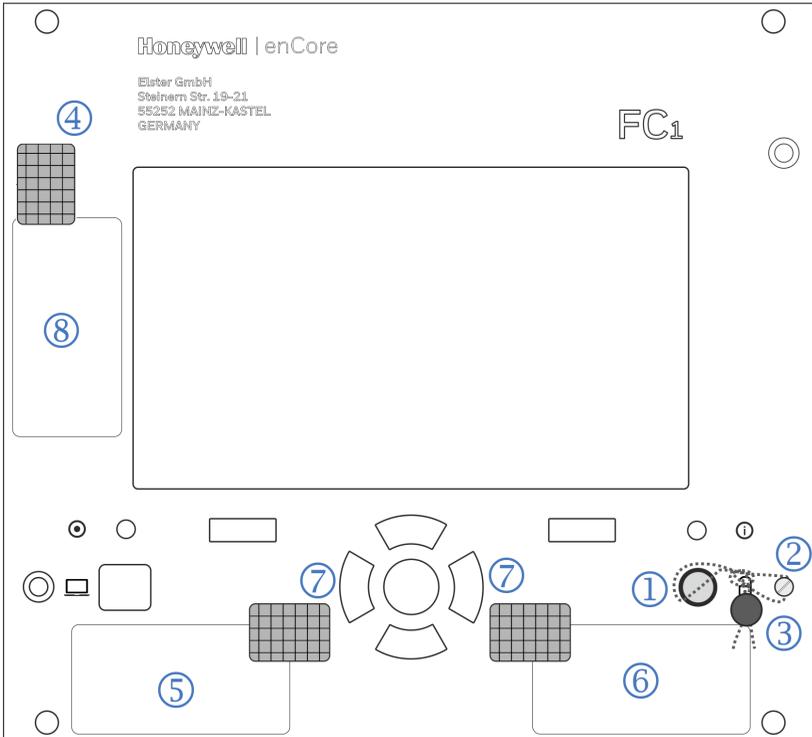


Figure 8: FC1 device sealing, front view (1/3 housing width),
exemplary for Honeywell design

- ① Security switch (sealable)
- ② Seal screw
- ③ Wire and seal (detailed description cf. Figure 9)
- ④ Securing mark (adhesive label), securing a housing screw and type plate part 3, if applicable
- ⑤ Location of type plate part 1
- ⑥ Location of type plate part 2
- ⑦ Securing marks (adhesive labels), securing the type plate parts 1 and 2
- ⑧ Location of type plate part 3 (for devices placed on the market from the date of issue of the EU-type examination certificate T10434 revision 11 onwards)

Close the security switch ① by turning it clockwise until it stops. Secure the closed security switch with sealing wire and seal as shown in Figure 9. Take care to pull the sealing wire tight and to place the seal as close as possible to the knot, so that there is no room to turn the security switch afterwards.

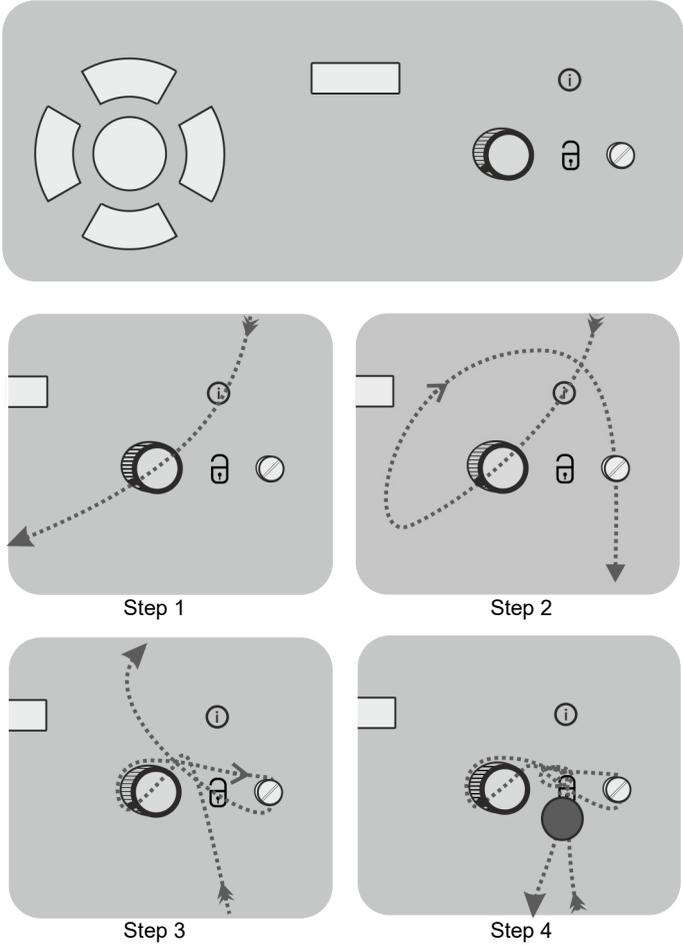


Figure 9: How to seal the security switch

The front sealing of a device with a wide housing (1/2 housing width) is the same (cf. Figure 8): Wire and seal for securing the security switch ① ② ③ (acc. to Figure 9), adhesive label for securing the housing screw in the top left corner of the front ④ and adhesive label for securing the type plates ⑦.

3 Rear Sealing

Figure 10 and Figure 11 show the FC1 rear view for both housing types, the process board configuration being typical examples that may differ from application to application.

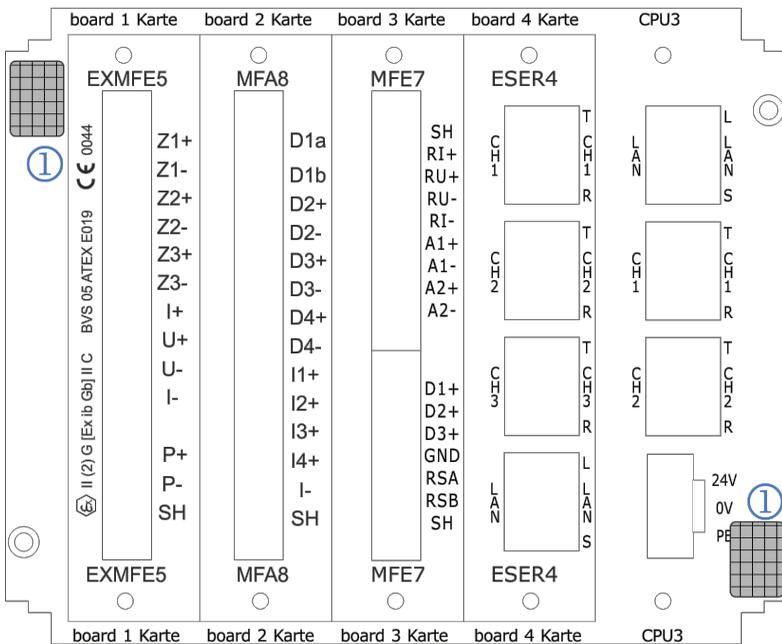


Figure 10: FC1 device sealing, rear view
(1/3 housing width, typical process board configuration)

- ① Securing marks (adhesive labels), securing two of the housing screws at the rear

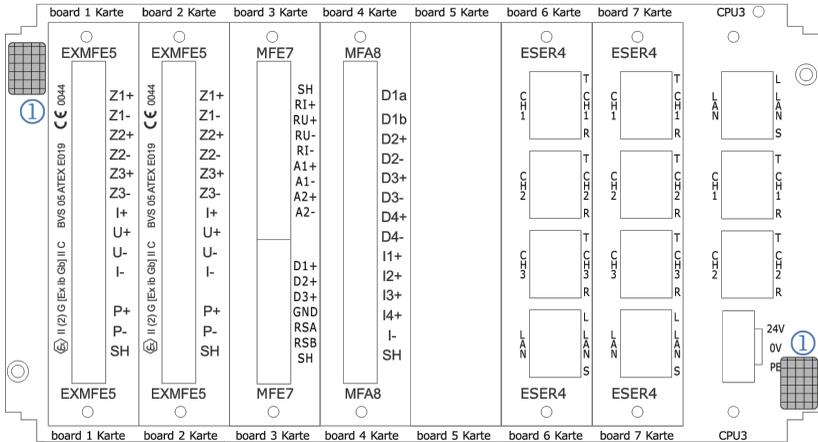


Figure 11: FC1 device sealing, rear view
(1/2 housing width, typical process board configuration)

- ① Securing marks (adhesive labels), securing two of the housing screws at the rear

Deviating from Figure 10 and Figure 11, the cover plate shown in Figure 12 applies to ExMFE5 input boards from firmware Version 3.0.0 onwards.

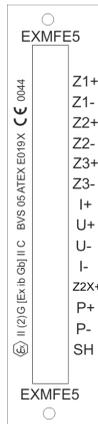


Figure 12: ExMFE5 cover plate from board firmware version 3.0.0

The connectors of the process boards that are applied for legally relevant purposes are to be sealed as described in Chapter 4.

4 Sealing of Process Connectors

For use in legal metrology, the connectors of legally relevant process boards must be officially secured. Plug-in connectors with screws are used for connecting the lines of the ExMFE5 and the MFE7 board.

Sealing of ExMFE5 connectors

In case of an ExMFE5 board, there is only one connector for all lines. In principle, there are two alternatives for securing these connectors. The standard method is to secure the drilled screws fixing the connector with a wire and a seal (cf. Figure 13).

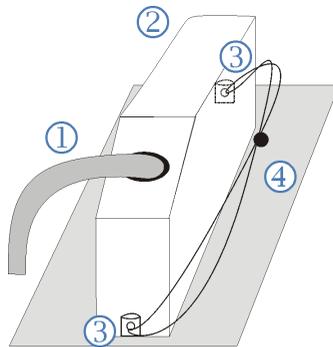


Figure 13 (schematic):

Sealing of ExMFE5 plug-in connectors with wire and seal

- ① Sensor and transmitter lines
- ② Connector housing
- ③ Seal screws
- ④ Wire and seal

If required (depending on the installation situation), the ExMFE5 screw connections can alternatively be secured with two securing marks in the form of adhesive labels (cf. Figure 14).

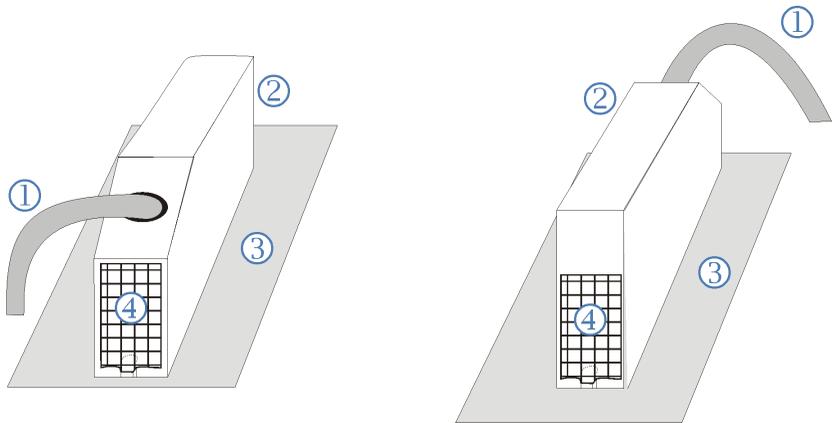


Figure 14 (schematic): Sealing of ExMFE5 plug-in connectors with adhesive labels (view from below and from above, cable feeding from below or from above, depending on installation situation)

- ① Sensor and transmitter lines
- ② Connector housing
- ③ Rear panel
- ④ Securing mark (adhesive labels)

Sealing of MFE7 connectors

In case of an MFE7 board, there are two connectors for connecting all available lines: One connector for two current/HART interfaces and one resistance input, the second one for three pulse or signal inputs and a serial RS485 interface. There are also two alternatives for securing these connectors. The standard method is to secure the drilled screws fixing the connector with a wire and a seal as shown in Figure 13.

If required (depending on the installation situation), the MFE7 screw connections can alternatively be secured by using securing marks in form of adhesive labels. One securing mark per connector is sufficient (to secure the upper OR the lower screw connection, cf. Figure 14) as these connectors are shorter compared to the ExMFE5 connectors.

Sealing of RJ45 connectors

RJ45 connectors for digital interfaces as provided by the CPU board, the MSER4 board and the ESER4 board can be secured by securing marks in form of adhesive labels.