

Flow Computer enCore FC1



Manual Instructions for Use in Legal Metrology

Disclaimer

The information contained in this document is the property of Honeywell. The following information is to be used exclusively for the intended purpose. This document or its contents may not be reproduced, published or made available to a third party in whole or in part without the express permission of Elster GmbH.

All information and descriptions in this Operating Instructions have been compiled after careful examination. Nevertheless, errors cannot be completely excluded. Honeywell therefore does not guarantee the completeness or correctness of the content. The manual cannot be understood as a guarantee of product properties. It also describes properties that are only available as an option.

Honeywell is in no case liable to third parties for direct, special or consequential damages. The information in this document is subject to change without notice.

With regard to extended product liability, the data and material properties listed may only be regarded as guidelines and must always be checked and, if necessary, corrected on a case-by-case basis. This is particularly true where safety aspects are concerned.

Further support is available from your local office or representative. The address can be found on the Internet or at Honeywell.

The passing on and reproduction of this manual or parts thereof is only permitted with the written permission of Honeywell.

If the product described herein is improperly handled, repaired or modified by unauthorized persons or if Honeywell spare parts other than original spare parts are used, the warranty will be void.

This product may contain or be derived from third party material, including software. Third party material may be subject to license terms, notices, restrictions and obligations of the Licensor. The licenses, notices, restrictions and obligations, if any, may be found in the materials accompanying the Product, in the documents or files containing the material of third parties, in a file called third_party_licenses on the media containing the Product, or at www.honeywell.com/ps/thirdpartylicenses.

Copyright © 2017 Elster GmbH, D-55252 Mainz-Kastel. All rights reserved.

Dortmund, October 2017

Contents

1	General Information	5
1.1	The enCore/enSuite Concept	5
1.2	Honeywell (Elster GmbH) Contact Information	6
2	About this Technical Documentation	7
2.1	About the Documentation on Hand	7
2.2	The enCore FC1 Manual at a Glance	8
3	General Legal Information	10
3.1	Legally Relevant Information at the Device Itself	10
3.2	Additional Static Information	10
3.3	Additional Variable Information	11
4	FC1: General Information	12
4.1	FC1: General Device Description	12
4.2	FC1: Hardware	14
4.3	FC1: Software	15
4.3.1	The enCore Software Concept	15
4.3.2	FC1: Legally Relevant Software (for Use in Legal Metrology)	16
4.3.3	FC1: Non-Legally Relevant AFBs	17
4.3.4	FC1: AFB Structure for Common Applications	18
4.3.5	FC1: AFB Structure for Special Applications	22
5	FC1: Operation for Legally Relevant Functionalities	23
5.1	Operating Controls	23
5.1.1	Keys	24
5.1.2	Touch Screen	24
5.1.3	Security Switch	24
5.2	LEDs	25
5.2.1	Power LED	25
5.2.2	Status LED	25
5.3	Display and Navigation	26
5.3.1	Display Test	26

5.3.2	Different Types of Device Displays	27
5.3.3	Navigation via Touch Screen	28
5.3.4	Navigation via Keys	29
5.3.5	Indication of Physical Quantities: Symbols	29
5.4	Displays Showing Legally Relevant Data	29
5.4.1	Flow Conversion AFB	29
5.4.2	Gas Quality AFB	36
5.4.3	Table Z AFB	39
5.4.4	Error List and Logbook	40
5.4.5	Software Identification/List of Fiscal Parameters	42
5.4.6	Fiscal Audit Trail	43
5.5	USB Port for PC Connection	45
5.6	Parameterization	45
5.7	Software Download	47
6	FC1: Legally Relevant Functionalities	48
6.1	Basic System	48
6.2	Gas Quality AFB	49
6.3	Flow Conversion AFB	51
6.4	Table Z AFB	54
7	FC1: Technical Data	55
7.1	General	55
7.2	Inputs	56
7.3	Outputs	57
7.4	Interfaces for Digital Communication	57
8	References	58
9	Index	59
10	Appendix	61

1 General Information

1.1 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.

1.2 Honeywell (Elster GmbH) Contact Information

You can contact our sales and service department at:

Elster GmbH (manufacturer)
Steinern Straße 19-21
55252 Mainz-Kastel/Germany

Phone: +49 6134 605-0
Email: info@elster.com
Website: www.elster-instromet.com

You can reach our Technical Assistance Center (TAC) at:

Phone: +49 231 937110-88
Email: ElsterSupport@Honeywell.com
Website: www.elster-instromet.com

2 About this Technical Documentation

2.1 About the Documentation on Hand

This technical documentation is part of the enCore FC1 manual; 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 the EU type examination certificate and other 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.

In the following, the short name 'FC1' is mostly used for the term 'enCore FC1'.



All safety information is contained in the "Operating Instructions" volume of the FC1 manual).

The documentation on 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" volumes of the manual 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 manual.

2.2 The enCore FC1 Manual at a Glance

The FC1 manual has a modular structure; it is made up of several volumes. Apart from the documentation on hand, all other single volumes of the manual cover *all* devices of the enCore FC series; they are therefore independent of the device type.

The manual consists of the following volumes:

- “Instructions for Use in Legal Metrology” (*document on hand*)
This volume describes the legally relevant functions and properties of the FC1 flow computer in brief.
- “Operating Instructions”
This volume describes the assembly, installation, commissioning and maintenance of the enCore FC devices.
- “Configuration of Device Software”
This volume describes parameterizing the enCore FC devices with the software system enSuite, the software download and further services.
- “Basic System with SFBs”
This volume describes the basic system, which provides all basic functions of the device software. The basic system e.g. manages the system resources, the I/O boards or the connection to other devices via digital protocols.
- **Functionality of individual Application Function Blocks**
Each volume describes the parameterization, function and operation of an individual AFB. These volumes always describe the full range of functions of the respective AFBs.¹

¹ Depending on the device type, some AFBs may not be available for this device software.



Delivery form of the individual manual volumes

The "Instructions for Use in Legal Metrology" (this volume) and the "Operating Instructions" ([4]) 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.

You can download all other volumes of the manual in PDF format from our Docuthek (www.docuthek.com). In addition, the "Instructions for Use in Legal Metrology" and the "Operating Instructions" are also available in digital form here. The documents are updated regularly.

3 General 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 may be divided in several parts; its exact appearance depends on the Type examination certificate to be applied. Please refer to the Appendix for official documents, if applicable.

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

Information	Location
CE mark and other legally required markings (such as number of the EU-type examination certificate and Identification of the Notified Body)	Type plate
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

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

3.2 Additional Static Information

MPE at reference conditions (including AD conversion)	0.5%
Extreme temperatures of the environmental class	Ambient temperature range -10 °C to +55 °C

Battery life time	Not applicable (external power source)
IP protection class	IP20
European standard	EN 12405-1

Table 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 (please refer to Chapter 5.4.5 for further information).
Base pressure and base temperature	<p>Apart from the base pressure, all here mentioned settings are subject to parameterization.</p> <p>The base pressure is fixed $p_b = 1.01325$ bar, according to European standards.</p> <p>During runtime, all legally relevant parameters (including the parameters listed here) can be checked at the device's display (displays for fiscal parameters, please refer to Chapter 5.4.5).</p>
Upper and lower limits of the transmitters	
Parameters for gas meter error correction curve	
Pulse value	
Compression factor calculation algorithm	
Gas properties	

Table 3: Additional variable information

4 FC1: General Information

4.1 FC1: 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 to be 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 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: 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

The FC1 flow computer supports the following European calculation standards:

Value to be calculated	Selectable calculation standards
Compressibility factors at measurement and base conditions (Z_m , Z_b) ²	<ul style="list-style-type: none"> • AGA8-92 DC (ISO 12213-2) • SGERG-88 (ISO 12213-3) • 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 • ISO 6976
Heating values, Wobbe indices	<ul style="list-style-type: none"> • ISO 6976

Table 5: Supported calculation standards

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).

² When selecting the calculation standard, the regulations of the EU type-examination certificate must be observed.

4.2 FC1: 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 6 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: In case of a device with a housing width of 1/3, only one MSER4 or ESER4 board can be mounted in slot 4. A device with a housing width of 1/2 can contain up to two boards of MSER4 or ESER4 type (in slot 6 and slot 7).

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.
* for legally and non-legally relevant purposes		
** for non-legally relevant purposes only, non-interacting regarding the legally relevant functionalities		

Table 6: enCore I/O boards

Please refer to Chapter 7 for further technical details.

4.3 FC1: Software

4.3.1 The enCore Software Concept

The device software of each enCore product consists of:

- a Basic System, containing several basic functionalities (SFBs) and
- a number of 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. In principle, the device can use each AFB

once, twice or more times, depending on the individual requirements. Generally, the AFB configuration is limited by the device resources.

4.3.2 FC1: 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, namely the **Gas Quality AFB**, the **Flow Conversion AFB**, and the **Table Z AFB**:

The **Gas Quality 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.

The **Flow Conversion 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 and the counter administration due to error handling and – if applicable – the flow direction switching.

The **Table Z 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 FC1: Non-Legally Relevant AFBs

Additional non-legally relevant AFBs can be added without affecting the legally relevant software.

Examples:

AFB	Function
DSfG	<p>DSfG is a well-established digital protocol standard in Germany for connecting gas measuring devices.³</p> <p>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.</p> <p>In particular, gas quality measurement devices can be connected via DSfG for providing gas quality measurements as input values for the Gas Quality AFB.</p> <p>Additionally, some other DSfG specific features can be used, for example:</p> <ul style="list-style-type: none">• The DSfG AFB can map the device-internal Flow Conversions 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 Conversions.
Postprocessing	Generation of new event-oriented values derived

³ The DSfG specification is issued by DVGW Deutscher Verein des Gas- und Wasserfachs ("DVGW-Arbeitsblatt" G 485, „Technische Spezifikation für DSfG-Realisierungen, Gas-Information Nr. 7").

	from existing values (such as actual values, differential values, averages, or drag indicators)
User archives	Data logging
Modbus	Modbus communication for a single Modbus communication line
Notification	Sending of warning and alarm messages via email and TCP/IP protocol to a selectable set of email addresses

Table 7: Examples for non-legally relevant AFBs

4.3.4 FC1: 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.

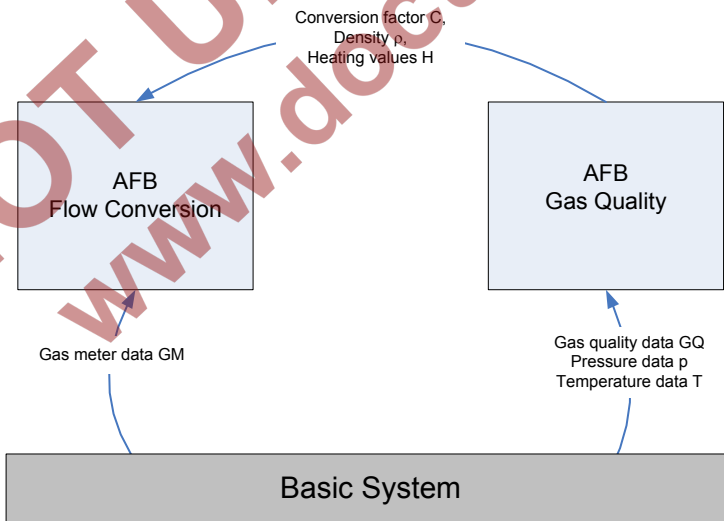


Figure 1: Data flow for a basic “one stream, one flow direction” application

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 Flow Conversion AFBs 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.

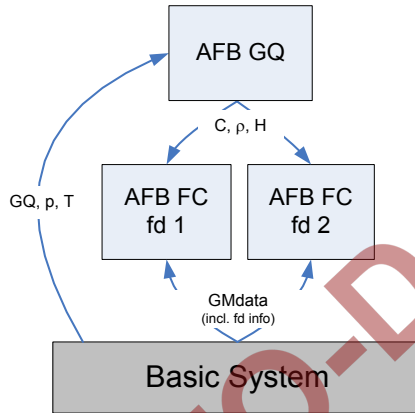


Figure 2: Data flow for 1 stream, 2 flow directions

2 streams

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

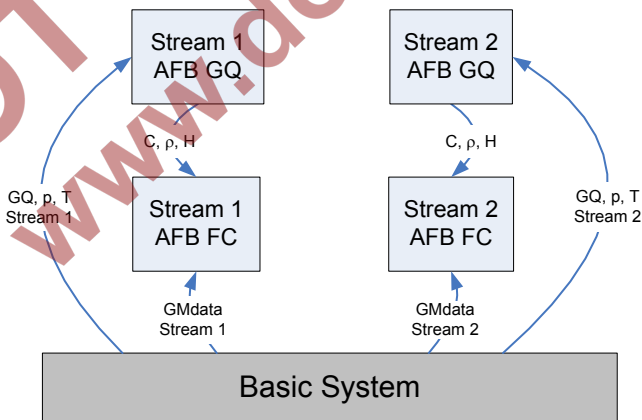


Figure 3: Data flow for 2 streams, 1 flow direction each

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

Figure 4 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 Flow Conversion AFBs and one Gas Quality AFB and one block containing one Flow Conversion and one Gas Quality AFB are needed.

That sums up to three Flow Conversion AFBs and two Gas Quality AFBs 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.

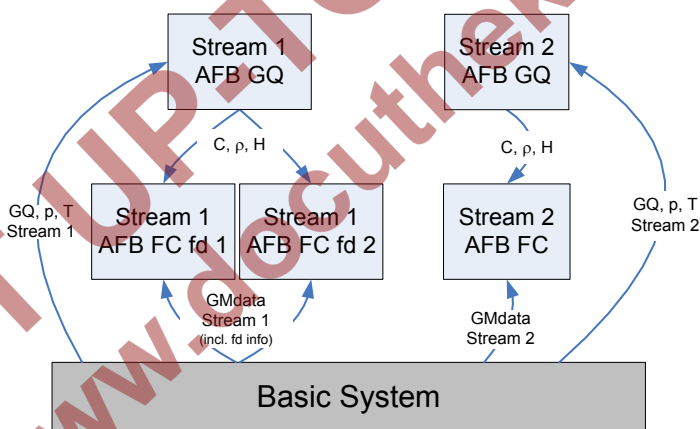


Figure 4: Data flow for 2 streams (dual/single fd)

4.3.5 FC1: AFB Structure for Special Applications

In a standard AFB composition as described in 4.3.4, 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 FC1: Operation for Legally Relevant Functionalities

5.1 Operating Controls



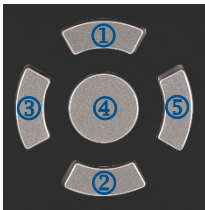
Figure 5: FC1 operating controls

- 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.



- ① up
- ② down
- ③ left
- ④ right
- ⑤ enter

Figure 6: 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).

Note: There are legally relevant parameters that can be changed by a user even if the security switch is closed. In that case, the action is recorded in the Fiscal Audit Trail (cf. page 43).

Note: For devices used in legal metrology, official documents may exist prescribing how the security switch has to be sealed. Please refer to the Appendix, 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 8: 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. An alarm is an error event affecting the legally relevant functionalities severely; the calculation of the fiscal results is stopped.

In case of a warning, a minor error has occurred but the calculation of the fiscal 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 9: 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, you have to 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 according to applicable standards.

For an FC1 flow computer, the `Flow Conversion AFB` provides a fiscal display that shows the volume at base conditions (Vb) 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, if no user-defined name has been parameterized, the default name.

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.

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 according 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 (please refer to Chapter 5.1.1, Figure 6). 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 Flow Conversion AFB

The `Flow Conversion AFBs` are responsible for generating the fiscal 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 preferentially indicated.

That means that the Vb counter is highlighted, marked with a preceding special icon  and displayed using a larger font size (cf. Figure 7).

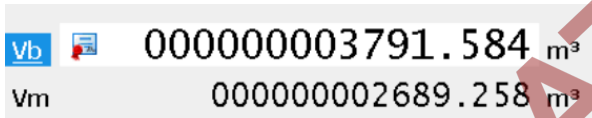



Figure 7: Display indication of Vb (fiscal display)

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, you have to 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.

Figure 8 shows an example of a Flow Conversion fiscal display; Table 10 lists the target displays of the available hyperlinks as well as the values and results included.

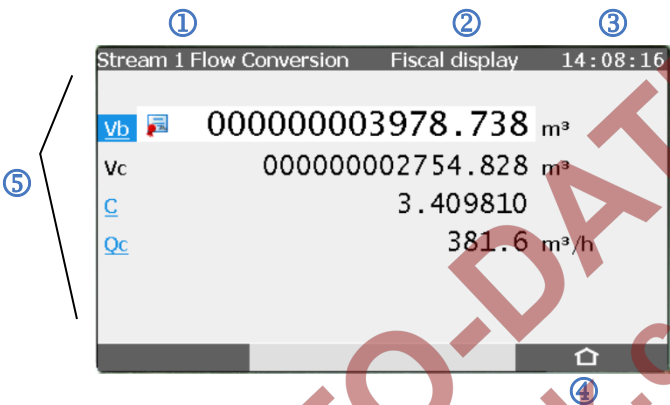


Figure 8: Flow Conversion: Fiscal display (example)

- ① AFB name
- ② Display name
- ③ Time
- ④ Home button
- ⑤ Display area

Hyperlink/ value	Target display	Values shown in target display
Vb	Flow Conversion AFB (main display)	Cf. Table 11.
Vm or Vc ⁴	-	-

⁴ Vm is displayed here in case that no gas meter correction is parameterized. In case that a gas meter correction is activated via parameterization, the corrected volume Vc is shown instead.

C	Gas Quality AFB (main display) ⁵	Cf. Table 12.
Qc ⁶	Flow rates	QE Energy flow rate QM Mass flow rate Qb Base volume flow rate Qc Corrected volume flow rate Qm Flow rate for volume at measurement conditions Cf Correction factor

Table 10: Contents of the Flow Conversion's fiscal display

The labels for all counters and additional measurements that are shown in the Flow Conversion's main display are hyperlinks.

Figure 9 shows a typical example of a Flow Conversion main display; Table 11 lists the target displays of the hyperlinks as well as the values and measurements included.

⁵ If the Flow Conversion AFB is linked to a Table Z AFB instead of a Gas Quality AFB, the link leads to the main display of the corresponding Table Z AFB, cf. 5.4.3.

⁶ If no gas meter correction is parameterized, the flow rate Qm (uncorrected flow rate at measurement conditions) is displayed instead of Qc. Within the target display, the lines for Qc and the correction factor are omitted in that case.

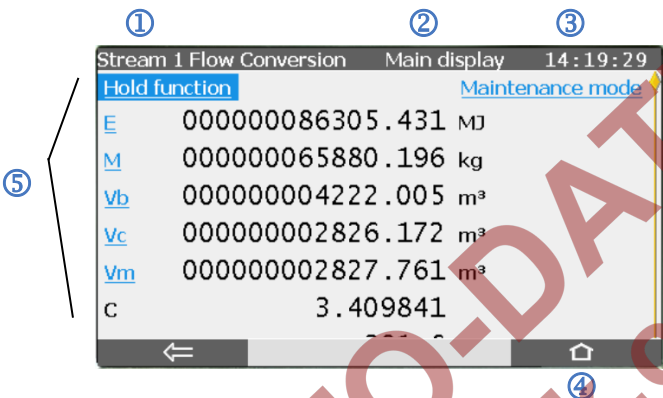


Figure 9: Flow Conversion: Main display (example)

- ① AFB name
- ② Display name
- ③ Time
- ④ Home button
- ⑤ Display area

Hyperlink	Target display	Values shown in target display
Hold function	Hold function	The Hold function 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.
Maintenance mode	Maintenance	The maintenance mode is intended for testing purposes; its activation requires a user login. In maintenance mode, a constant value for the flow rate Qm can be

		<p>entered via operation panel 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 also shown in the Maintenance display:</p> <p>Ee Energy error counter Me Mass error counter Vbe Base volume error counter Vme Volume at measurement conditions, error counter</p> <p>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.⁷</p>
<u>E</u>	Energy	<p>E Energy main counter Ee Energy error counter Eu Energy unhaltable counter HVol Volume-based heating value HMass Mass-based heating value</p>

⁷ In addition to activating the maintenance mode via the control panel described here, a message input (parameterizable) can be used to trigger the maintenance mode. For detailed information refer to [8] or the related online help topic in enSuite.

M	Mass	M	Mass main counter
		Me	Mass error counter
		Mu	Mass unhaltable counter
		ρ_b	Base density
		ρ_m	Density at measurement conditions
Vb	Base volume	Vb	Base volume main counter
		Vbe	Base volume error counter
		Vbu	Base volume unhaltable counter
Vc ⁸	Corrected volume	Vc	Corrected volume main counter
		Vce	Corrected volume error counter
		Vcu	Corrected volume unhaltable counter
		Cf	Correction factor
Vm	Measured volume	Vo ⁹	Original counter (optional)
		Vm	Volume at measurement conditions, main counter
		Vme	Volume at measurement conditions, error counter
		Vmu	Volume at measurement conditions, unhaltable counter
C	-	-	-

⁸ The line for the corrected volume Vc is omitted in case that no gas meter correction is parameterized.

⁹ Vo (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 Vo counter repeats the original counter of the gas meter that is transferred via digital Encoder protocol.

Qc ¹⁰	Flow rates	QE	Energy flow rate
		QM	Mass flow rate
		Qb	Base volume flow rate
		Qc	Corrected volume flow rate
		Qm	Flow rate for volume at measurement conditions
		Cf	Correction factor

Table 11: Hyperlinks in Flow Conversion's main display

5.4.2 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 Table 10, 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's** main display are designed as hyperlinks, too.

Figure 10 shows a typical example of a **Gas Quality** main display; Table 12 lists the target displays of the hyperlinks as well as the values and measurements included.

¹⁰ Qc is replaced by Qm if no gas meter correction is parameterized.

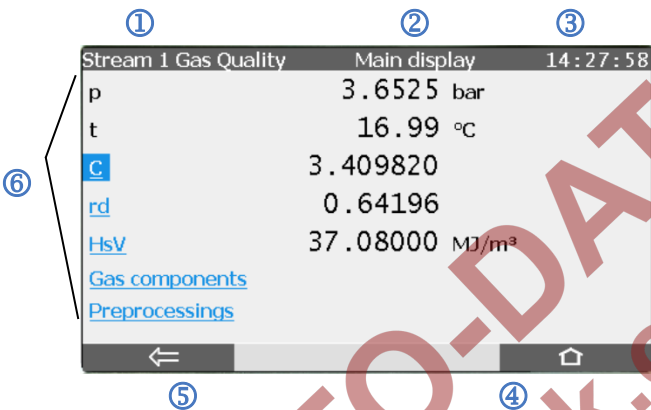


Figure 10: Gas Quality: Main display

- ① AFB name
- ② Display name
- ③ Time
- ④ Home button
- ⑤ Back button
- ⑥ Display area

Hyperlink/value	Target display	Values shown in target display
Pressure p	-	-
Temperature t	-	-
c	Compressibility	<p>p Pressure</p> <p>t Temperature</p> <p>pb Pressure at base conditions</p> <p>tb Temperature at base conditions</p> <p>C Conversion factor</p> <p>Zm Compressibility factor at measurement conditions</p>

		Zb Compressibility factor at base conditions K K factor Zb air Compressibility factor of air at base conditions (acc. to ISO 6976)
rd	Density	Measurements and calculated values for density and relative density
HsV	Heating values	Heating values and Wobbe indices
Gas components	Gas components	Gas composition (as far as available)
Preprocessings	Preprocessings	Display for all preprocessing operations (more details below)

Table 12: Contents of the Gas Quality's main display

Preprocessing display

A preprocessing operation defines a multi-level substitution strategy for measured input values, e.g. for pressure and temperature. An additional limit monitoring is optional.

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

- The status **A** indicates that the respective level is causing a preprocessing alarm. The 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	Out Of Use
OOS	Out Of Service
INT	INi Tialization

OOO	Out Of Order
OOC	Out Of Calculation
OLL	Out of Lower Limit (alarm limit violation)
OUL	Out of Upper Limit (alarm limit violation)

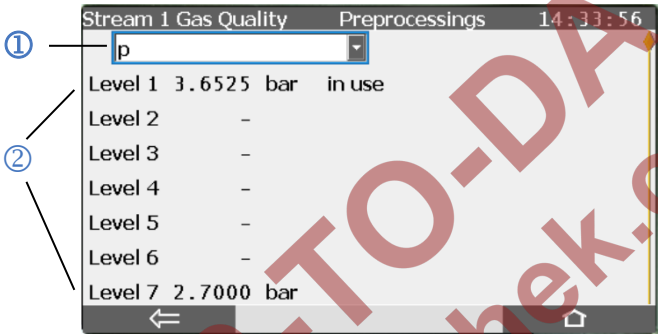


Figure 11: Preprocessing display (example)

- ① Selection of preprocessing to be displayed
- ② Display area for all levels 1 to 7:
Level no., if available: actual value/unit/status

5.4.3 Table Z AFB

In case that the calculation of the conversion factor 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's main display shows following values and measurements:

- pressure p
- temperature t
- conversion factor C
- Zm, compressibility factor at measurement conditions (p, t)

- Zb, compressibility factor at base conditions (pb, tb)
- K factor

The [Base conditions](#) hyperlink leads to a display showing the base conditions (pb, tb) 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. 5.4.3).

5.4.4 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.

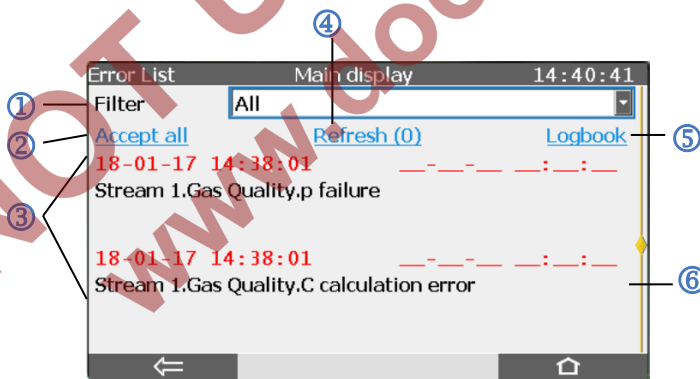


Figure 12: Error List display (example)

- ① Filter selection
- ② **Accept all** button
- ③ Area for displaying errors (scrollable if more than 2 errors are contained in the error list)
- ④ **Refresh** button for refreshing the display
- ⑤ Link to Logbook display
- ⑥ Link to preprocessing display (for errors generated by preprocessing operations only)

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.

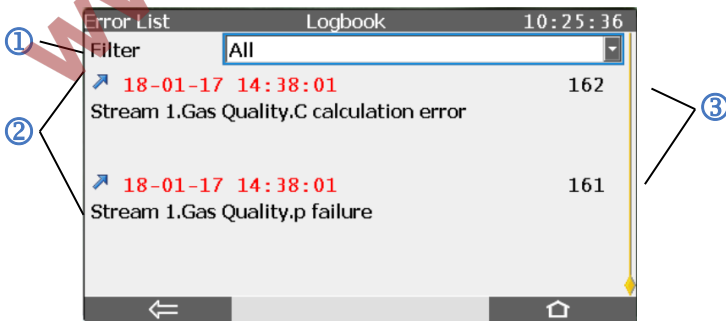


Figure 13: Logbook display (example)

- ① Filter selection (same as in error list display)
- ② Area for displaying errors (scrollable if more than 2 entries are contained in the logbook)
- ③ Sequence number of logbook entry

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 10000 records; if the logbook is full, the next entry overwrites the oldest record.


5.4.5 Software Identification/List of Fiscal Parameters

During runtime, an information display can be evoked 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 (cf. chapter 5.6).

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.

5.4.6 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 1000 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:

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

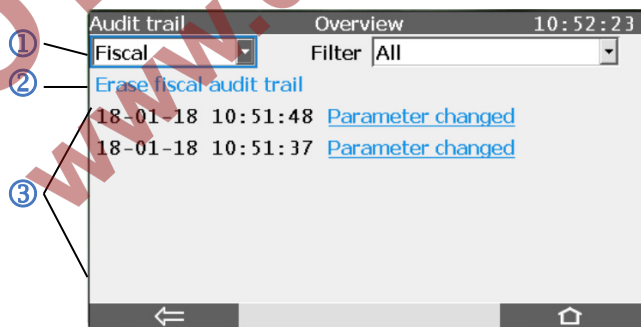


Figure 14: Audit trail display (example)

- ① Selection of audit trail type
- ② **Erase fiscal audit trail** button
- ③ List of parameter changes, sorted by date

The **Erase fiscal audit trail** button 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 change** hyperlink, the corresponding audit trail entry is displayed in detail (cf. Figure 15).

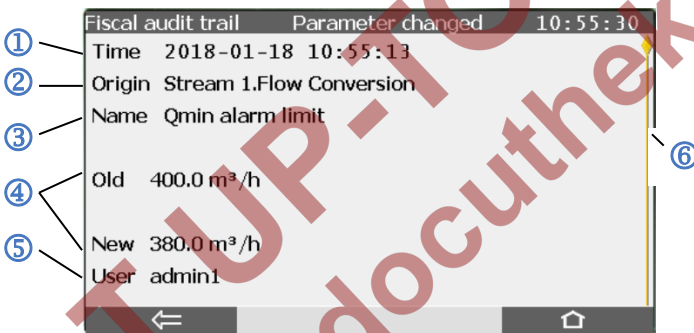


Figure 15: Fiscal audit trail – detailed display (example)

- ① Date and time of the parameter change
- ② Origin of the parameter (AFB or SFB name)
- ③ Identifying string of the parameter
- ④ Old value/new value of the parameter
- ⑤ Logged-in user that has executed the parameter change
- ⑥ Scroll bar (only if more than one entry is available)

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 (cf. Chapter 5.1) 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.


5.6 Parameterization

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



Please refer to the related volume of the enCore FC manual (“Configuration of Device Software”) or the enSuite online help for further details.

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 1000 entries. As soon as the fiscal audit trail is full, no 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.

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.

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

- **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 calibration switch is open, the **<user name>** is sufficient for logging on to the device. This procedure makes it easier, for example, to work in the test centre or before commissioning, as the password is not required.

It depends on the particular fiscal application (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 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 (cf. Chapter 5.4.5) 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.

Please refer to the related chapter in the volume "Configuration of Device Software" of the enCore FC1 manual or the enSuite online help for further details.

6 FC1: 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 meters, 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.

In detail:

Data source	Legally relevant data processed by the Basic System
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 13: Legally relevant measurement data

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), SGERG-88 (ISO 12213-3), AGA-NX19 mod, AGA-NX19 mod BR.KOR.3H or AGA-NX19 GOST, alternatively $Z_m/Z_b = \text{constant}$ ¹¹

¹¹ Depending on the software version, the Gas Quality AFB may offer additional 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.

- Calculation of density at base/measurement conditions and relative density, according to AGA8-92 DC or ISO 6976
- Calculation of heating values and Wobbe indices according to ISO 6976

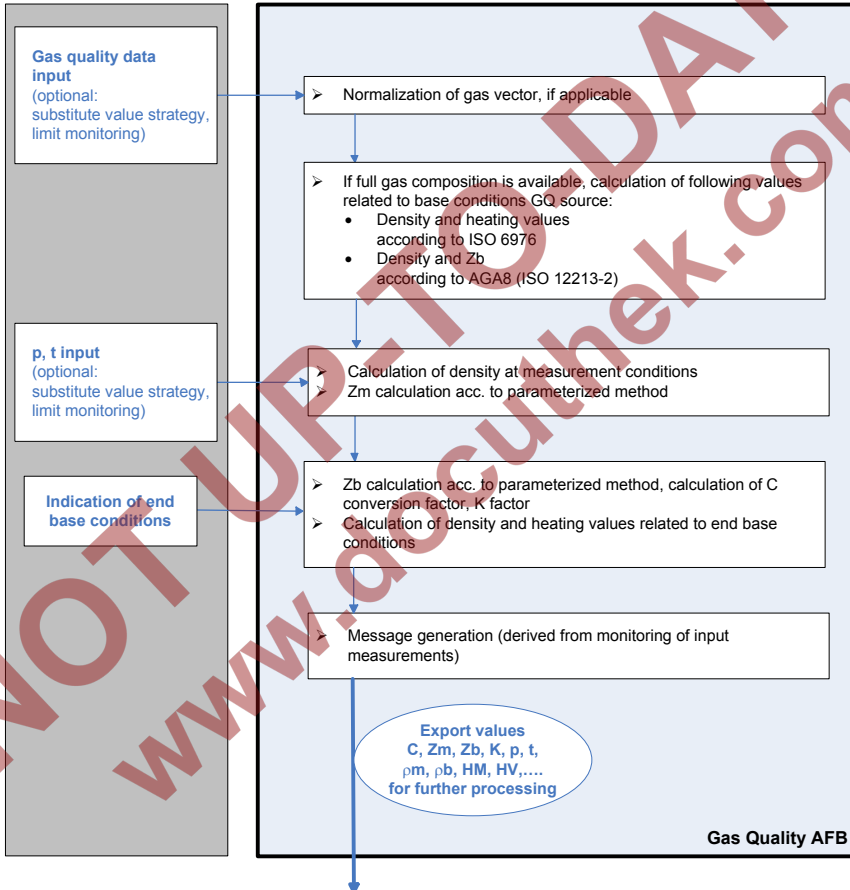


Figure 16: Data flow for Gas Quality AFB

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.

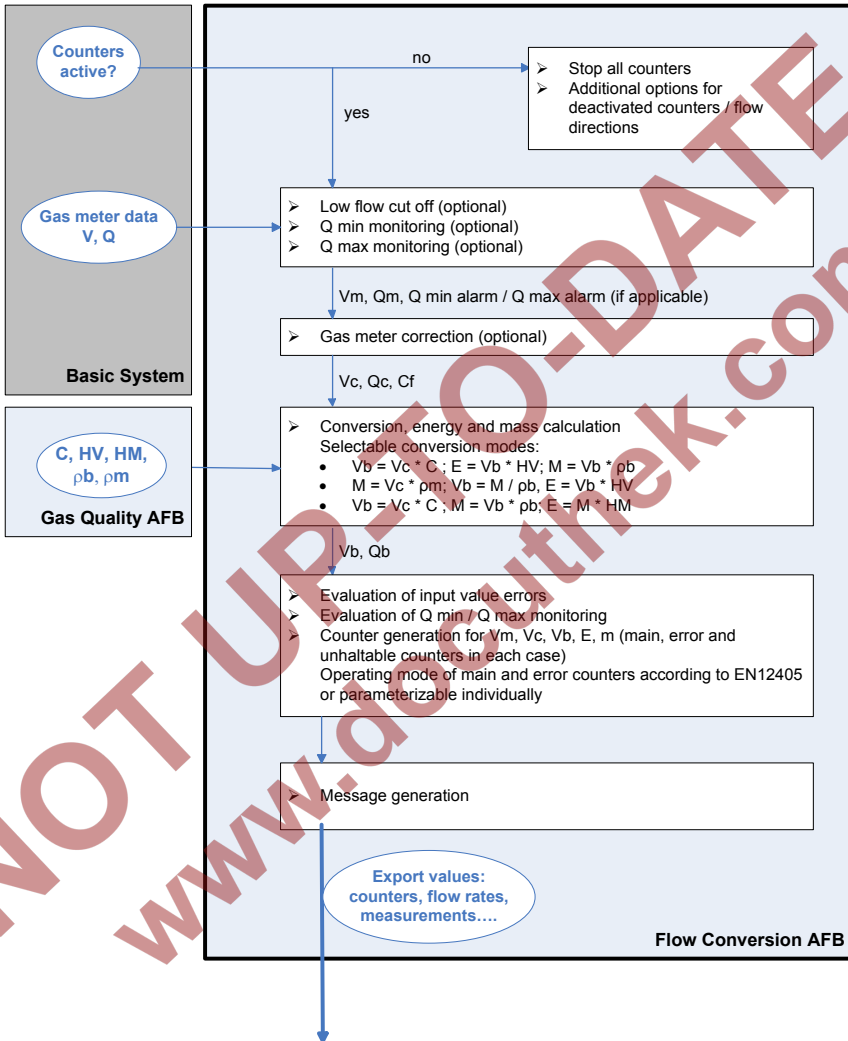


Figure 17: Data flow for Flow Conversion AFB

Gas meter correction (optional)

The optional gas meter correction of the Flow Conversion AFB uses up to 10 calibration points, each of them consisting of the flow rate in m³/h and the related error in percent (%).

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:

$$V_c = V_m * C_f$$

$$Q_c = Q_m * C_f$$

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 lying 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).

7 FC1: Technical Data

7.1 General

Dimensions/housing	<p>Plug-in unit in 19" design, 3 height units (3HU), 1/2 or 1/3 width</p> <p>Overall depth without plugs approximately 170 mm, with plugs approximately 220 mm</p> <p>Process interfacing at the rear, operation panel at the front</p>
Ambient conditions	<p>Ambient temperature range -10 °C to +55 °C</p> <p>Humidity < 90%, non-condensing</p> <p>Installation outside Ex zones 0, 1, 2 only</p>
IP protection class	IP20
Storage temperature	-25°C to +60°C
Weight	<p>(fully equipped)</p> <ul style="list-style-type: none">• 1/3 device width: approx. 1.3 kg• 1/2 device width: approx. 2.1 kg
Power supply	<p>Power supply 24 V DC +/- 20%, power consumption up to 12 W (typically 5 W)</p> <p>Optional: 230 V AC via external power supply</p>
Display/Operation panel	<p>4.3" TFT color display with touch screen, 480 × 272 × 3 pixels, LED background lighting</p> <p>4 navigation and 2 function keys</p> <p>2 multicolor LEDs for power and status indication</p> <p>Sealable security switch</p>

Table 14: General technical data

7.2 Inputs

ExMFE5 input board	<ul style="list-style-type: none"> • 3 NAMUR inputs [Ex ib] IIC for LF pulses (max. 2 Hz, min. pulse length 200 ms)) or HF pulses (max. 5 kHz) or messages One of these inputs can be used alternatively for connecting an encoder index. • Analog input for a transmitter with 4 ... 20 mA interface [Ex ib] IIC, alternatively suitable for connecting transmitters with HART interface (1 transmitter in burst mode or up to 4 transmitters in multidrop mode) • Pt100 temperature sensor input (4-wire technology), [Ex ib] IIC
MFE7 input board	<ul style="list-style-type: none"> • 3 inputs (24 V DC) for LF pulses (max. 8 Hz, min. pulse length 50 ms) or HF pulses (max. 5 kHz) 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 up to 4 transmitters with HART interface (1 transmitter in burst mode or up to 4 transmitters in multidrop mode) • input for a Pt100 temperature sensor in 4-wire technology

Table 15: Inputs: Technical specifications

7.3 Outputs

MFA8 output board	<ul style="list-style-type: none"> • 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
-------------------	---

Table 16: Outputs: Technical specifications

7.4 Interfaces for Digital Communication

CPU	<ul style="list-style-type: none"> • LAN interface (Ethernet 10/100MBit) • 2 serial ports (supported standards: RS485/RS422/RS232), the first port can be used as DSfG protocol interface
MSER4	<ul style="list-style-type: none"> • 4 serial ports, electrically isolated (supported standards: RS485/RS422/RS232)
ESER4	<ul style="list-style-type: none"> • 3 serial ports, electrically isolated (supported standards: RS485/RS422/RS232) • LAN interface (Ethernet 10/100MBit)
MFE7	<ul style="list-style-type: none"> • 1 serial RS485 interface
USB port	<ul style="list-style-type: none"> • USB interface for PC or laptop connection for parameterization and service purposes
Ethernet communication	<ul style="list-style-type: none"> • NTP, Modbus TCP, FTP, HTTP
Serial communication	<ul style="list-style-type: none"> • Modbus (ASCII, RTU), UNIFORM

Table 17: Communication interfaces: Technical specifications

8 References

- [1] DSfG document „DVGW-Arbeitsblatt G 485, Digitale Schnittstelle für Gasmessgeräte (DSfG)“, DVGW
available via <http://www.wvgw.de> (German version only)
- [2] DSfG document „Technische Spezifikation für DSfG-Realisierungen, Gas-Information Nr. 7“, DVGW
available via <http://www.wvgw.de> (German version only)
- [3] DIN EN 12405-1:2011-04: Gas meters – Conversion devices - Part 1:
Volume conversion (includes Amendment A2:2010)
- [4] Manual „Flow Computer, Device series enCore FC – Operating Instructions“
included in scope of FC1 delivery, additionally available for download at www.docuthek.com
- [5] Manual „Flow Computer, Device series enCore FC – Configuration of Device Software“
available for download at www.docuthek.com
- [6] Manual „Flow Computer, Device series enCore FC – Basic System with SFBs“
available for download at www.docuthek.com
- [7] Manual „Flow Computer enCore FC1 – Gas Quality AFB“
available for download at www.docuthek.com
- [8] Manual „Flow Computer enCore FC1 – Flow Conversion AFB“
available for download at www.docuthek.com

9 Index

A

Accepting errors 41
AFB 5, 15
AFB structure
 Examples 18
Ambient conditions 55
Application Function Block 5

B

Basic display 27
Basic System 15, 48

C

Connection options 12
CPU interfaces 57

D

Display and navigation 26
Display test 26
Display types 27
DSfG AFB 17

E

enCore 5
enSuite 5
Error list 40
ESER4 15, 57
Ethernet 57
EU Type Examination Certificate
 Appendix
European standards 13

ExMFE5 14, 56

F

Fiscal audit trail 43
Fiscal display 27, 29
Flow Conversion AFB 51
 Fiscal display 30
 Main display 32

G

Gas meter correction 53
Gas Quality AFB 49
 Main display 36

H

Hardware 14
Home display 27

I

I/O boards 14
IP protection class 11, 55

K

Keys 24

L

LEDs 25
List of fiscal parameters 42
Logbook 41

M

Main display 27
Markings and Sealings
 Appendix
MFA8 15, 57
MFE7 14, 56, 57
MPE 10
MSER4 15, 57

N

Navigation
 via keys 29
 via touch screen 28

O

Operating controls 23

P

Parameterization 13, 45
Physical quantities
 Symbols 29
Power LED 25
Power supply 55
Preprocessing display 38

S

Safety information 7
Security switch 24
SFB 5, 15
Software
 legally relevant 16
 non-legally relevant 17
Software concept 15
Software download 47
Software identification 42
Status LED 25
Storage temperature 55
System Function Block 5

T

Table Z AFB 54
 Display 39
Technical data 55
Touch screen 24
Type plate 10

U

USB port 45, 57

10 Appendix

- EU Type Examination Certificate (NMI)
- FC1: Markings and Device Sealing

NOT UP-TO-DATE
www.docuthek.com

NOT UP-TO-DATE
www.docuthek.com



EU-type examination Certificate

Number **T10434** revision 5
Project number **1902124**
Page 1 of 1

Issued by NMI Certin B.V.,
designated and notified by the Netherlands to perform tasks with respect to
conformity modules mentioned in article 17 of Directive 2014/32/EU, after
having established that the Measuring instrument meets the applicable
requirements of Directive 2014/32/EU, to:

Manufacturer Elster GmbH
Steinernstrasse 19-21
D-55252 Mainz-Kastel
Germany

Measuring instrument An **electronic gas-volume conversion device (EVCD)**, intended to be
used for gas volume conversion as a sub-assembly (according to article 4 of
the MID) of a gas meter.

Type : enCore FC1

Conversion principle : PT or PTZ

Device type : 2 (separate component)

Ambient temperature range : -10 °C / +55 °C

Designed for : non-condensing humidity

Environment classes : M2 / E2

The intended location for the instrument is closed.

Further properties are described in the annexes:
– Description T10434 revision 5;
– Documentation folder T10434-5.

Valid until 25 June 2022

Remarks This revision replaces the earlier versions, including its documentation
folder.

Issuing Authority

NMI Certin B.V., Notified Body number 0122
9 March 2018


C. Oosterman
Head Certification Board

NMI Certin B.V.
Hugo de Grootplein 1
3314 EG Dordrecht
The Netherlands
T +31 78 6332332
certin@nmi.nl
www.nmi.nl

This document is issued under the provision
that no liability is accepted and that the
manufacturer shall indemnify third-party
liability.

The designation of NMI Certin B.V. as
Notified Body can be verified at
[http://ec.europa.eu/growth/tools-
databases/mandate/](http://ec.europa.eu/growth/tools-databases/mandate/)

Reproduction of the complete
document only is permitted.



1 General information about the electronic gas-volume conversion device

All properties of the EVCD, whether mentioned or not, shall not be in conflict with the legislation.

The EVCD is a so-called type 2 device, with external separate transducers for pressure and temperature.

1.1 Essential parts

The electronic gas volume conversion device is composed of the following parts:

Part	Document	Remarks
CPU base	10434/0-04; 10434/0-05	-
CPU core	10434/0-06; 10434/0-07	-
ExMFE5 input board	10434/0-08; 10434/0-09	Optional
MFE7 input board	10434/0-10; 10434/0-11	Optional
Display module	10434/0-12; 10434/0-13	-

1.2 Essential characteristics

1.2.1 Software specification (refer to WELMEC guide 7.2):

- Software type P;
- Risk Class C;
- Extension T, S and I;

while the extensions L and D are not applicable or excluded.

Software part	Version	Checksum
ExMFE5 input board - firmware	2.0.7	E4289B65
MFE7 input board - firmware	1.0.7	2D311E1F
	1.0.8	81B50CFE
	1.0.9	6A251F79
	1.2.0	6D456065
	1.2.1	0A0DC244
MSER4 serial communication board - firmware	1.0.3	49F5E5EA
	1.0.4	C6A536B0
ESER4 communication board	1.0.4	D7DE3088
Basic system	01-00-C	2670647A
	02-02-B	75881213
	02-11-B	81D0356E
	03-02-A	3CA9EDA0
	03-22-A	84060E4D
	03-28-A	FEB06D27

Software part	Version	Checksum
Gas Quality Application Function Block	01-00-C	620D285C
	02-00-E	F65E6ED5
	02-06-B	77A2051C
	03-00-C	B9CADD5D
	03-08-A	DCEAC7C0
	03-12-B	2A8E492E
Table Z Application Function Block	03-00-A	FF48B3BB
	03-03-A	70406B20
	03-06-B	3C966F95
Flow Conversion Application Function Block	01-00-C	05D6A298
	02-01-C	DF5B7846
	02-05-D	848E39FD
	03-00-C	7F8AEA5F
	03-07-A	F706E911
	03-10-C	E80B09B2

The software versions and checksums can be read on the information display by activating the "i"-button in the device's home display, followed by the "Software status" hyperlink.

1.2.2 Conversion

The conversion is performed according to the following formula as stated below:

$$V_b = V_{(m \text{ or } c)} \times \frac{p_{abs}}{p_b} \times \frac{273,15+t_b}{273,15+t} \times \frac{Z_b}{Z}$$

Symbol	Represented quantity	Unity
V_b	volume at base conditions	m ³
V_m	volume at measurement conditions	m ³
V_c	volume at measurement conditions meter error corrected (optional)	m ³
p_{abs}	absolute pressure at measurement conditions	bar
p_b	absolute pressure at base conditions	bar
t	gas temperature at measurement conditions	°C
t_b	temperature at base conditions	°C
Z_b	compression factor at base conditions	-
Z	compression factor at measurement conditions	-

1.2.3 Compression

The compression factor Z/Z_b can be programmed in the EVCD as a fixed value or is calculated by interpolation from a table which is programmed in the EVCD or it can be calculated on the basis of the following algorithms:

- NEN-EN-ISO 12213-3 – SGERG88 (mol%CO₂, mol%H₂, H₂ and d or ρ_b) or
- NEN-EN-ISO 12213-2 – AGA8 DC92 (detailed composition) or
- AGA-NX19

The required gas properties are programmed in the EVCD as fixed parameters or they come as actual values from a Gas chromatograph or CVDD (see par. 5.4.2 of the Technical documentation no. 10434/5-01).

When using a fixed compression factor (PT conversion), the pressure and temperature range are limited such, that the error of the EVCD remains within the MPE.

- 1.2.4 Presentation of legal data**
The legal data is presented in the fiscal display.
The menu structure, keyboard, display and (alarm) indicators are described in chapter 5 of the Technical documentation no. 10434/5-01.
- 1.2.5 Meter error curve correction**
Meter error curve correction (see paragraph 6.3 of the Technical documentation no. 10434/5-01) can be applied if the gas meter produces at least 10 pulses per second at Q_{min} .
The correction is performed by linear interpolation using a maximum of 10 points.
Besides the corrected volume V_c , also the uncorrected volume V_m can be read via the display.
- 1.2.6 Accountable alarms**
The EVCD has to be programmed such that accountable alarms will be generated (only) if extreme values are measured by the EVCD or if otherwise a defect arises (see paragraph 5.3 of Technical documentation no. 10434/5-01).
Accountable alarms cause that the registration of the volume at base conditions in the main totalizer V_b is stopped, while the registration is continued in an alarm totalizer V_{se} .
The alarm indication (status LED – see paragraph 5.2.2 of Technical documentation no. 10434/5-01) can be reset by the error list menu, which can be activated via the device's home display.
It is not possible to clear an alarm as long as the cause of the alarm still is present.

1.3 Essential shapes

- 1.3.1** The nameplate is bearing at least, good legible, the following information:
- CE marking including the supplementary metrological marking (M + last 2 digits of the year in which the instrument has been put into use);
 - Notified Body identification number, following the supplementary metrological marking;
 - EU type-examination Certificate no. T10434;
 - identification mark or name of the manufacturer;
 - serial number of the meter and year of manufacture.

The following information is mentioned on the nameplate or on the display:

- the gas temperature range;
- the gas pressure range;
- the base pressure;
- the base temperature;
- the compression algorithm;
- the gas properties;
- the parameters for gas meter error correction curve (if applicable).

The following information is mentioned in the manual:

- ambient temperature range;
- mechanical environment class;
- electromagnetic environment class.

An example of the markings is shown in document no. 10434/5-02.

1.3.2 Sealing: see chapter 2.

1.4 Conditional parts

1.4.1 Housing

The EVCD has a metal housing, which has sufficient tensile strength. Different housing designs are available. For examples of the housing see documentation no. 10434/5-03
Metrological important parts are only accessible after breaking one or more seals.

1.4.2 Power supply

The EVCD is powered by an external 24 V DC (+/- 20%) power supply.

1.4.3 Printed circuit boards

Besides the essential PCB's (see 1.1) the EVCD can be equipped the following conditional printed circuit board:

- MSER4 communication board (optional) – see documentation no. 10434/0-14
- ESER4 communication board (optional) – see documentation no. 10434/2-02

1.4.4 Serial communication

The EVCD is equipped with in- or outputs for serial communication (RS232 / RS422 / RS485) and Ethernet. The use of these communication ports shall not influence the working of the EVCD.

1.4.5 Pressure transducer

Any absolute pressure transducer may be used provided the following conditions are met:

- there is a respective Parts certificate issued for the pressure transducer by a Notified Body responsible for type examination;
- the output signal has to be according to the HART-protocol or it has to be a standard 4-20 mA signal;
- the pressure range is according to the concerning Parts certificate, besides the following restrictions are valid:
 - maximum measuring range is 1:20 for 4-20 mA transducers;
 - the pressure range has to be within the working range of the used algorithm for correcting the deviation from the ideal gas law.

1.4.6 Temperature transducer

Any temperature transducer may be used provided the following conditions are met:

- when the output signal is according to the HART-protocol there is a respective Parts certificate issued for the temperature transducer by a Notified Body responsible for type examination, when output signal a resistance (PT100, thermistor) the transducer is in accordance with the requirements of EN60751 class A or better;
- the temperature range t may not exceed: $-30\text{ °C} \leq t \leq +80\text{ °C}$. The temperature range may be limited by the respective Parts certificates for HART protocol transducers;

- the temperature range has to be within the working range of the used algorithm for correcting the deviation from the ideal gas law.
- 1.4.7 Gas chromatograph or CVDD (optionally)
Any Gas chromatograph or CVDD may be used provided the following conditions are met:
 - there is a respective Parts certificate issued for the Gas chromatograph or CVDD by a Notified Body responsible for type examination;
 - the communication between the EVCD and the Gas chromatograph or CVDD takes place through a serial (RS485, RS422, RS232) - or TCP/IP (Ethernet 10/100 MBit) interface, different communication protocols can be used, for example Modbus and DSfG ;
 - if the connection between the EVCD and Gas chromatograph or CVDD is broken or if the Gas quality measurement device is defective, this will cause an accountable alarm.

1.5 Conditional characteristics

- 1.5.1 Impulse input gasmeter
The volume impulses generated by the pulser belonging to the gasmeter can have two different types:
 - 1.5.1.1 LF-impulses
The maximum frequency may not exceed 2 Hz (board ExMFE5) or 8 Hz (board MFE7) if the gas meter is running at Q_{max} .
The minimum pulse length is 200 ms (board ExMFE5) or 50 ms (board MFE7).
 - 1.5.1.2 HF-impulses
The maximum frequency is not higher than 5 kHz, if the gas meter is running at Q_{max} .
- 1.5.2 Ultrasonic gas meter
The EVCD is equipped with drivers to communicate with Ultrasonic gas meters as specified by the manufacturer. The communication takes place through a RS232, RS485 or Ethernet interface. If the communication between the EVCD and the gas meter is broken or if the Ultrasonic gas meter is defective, this will cause an accountable alarm.
- 1.5.3 Programming
The parameters which are essential for the conversion can only be changed if the sealable security switch is open or if the changes are recorded by the Fiscal audit trail (see paragraphs 5.1.3 and 5.4.6 of the Technical documentation 10434/5-01).
During normal operation the security switch has to be in the closed position.

1.6 Non-essential parts

- 1.6.1 MFA8 output board (optional) – see documentation no. 10434/0-15.

2 Seals

The following items are sealed:

- the nameplate with the housing; *)
- the front and rear panel of the EVCD;
- the security switch.

*) Removal without destroying the nameplate shall not be possible; otherwise the nameplate shall be sealed to the housing.

An example of the sealing is presented in drawing no. 10434/5-02.

NOT UP-TO-DATE
www.docuthek.com

Honeywell 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 004	REVISION DATE 2018-02-07

FC1: Markings and Device Sealing

Contents

1	FC1 front markings	2
1.1	Front markings for an FC1 with 1/3 housing width, Elster front design	2
1.2	Front markings for an FC1 with 1/3 housing width, Honeywell front design	3
1.3	Type plates	4
1.4	Front markings for an FC1 with 1/2 housing width, Elster or Honeywell front design	5
2	Front Sealing	7
3	Rear Sealing	8
4	Sealing of Process Connectors	10

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 (Elster or Honeywell).

1.1 Front markings for an FC1 with 1/3 housing width, Elster front design

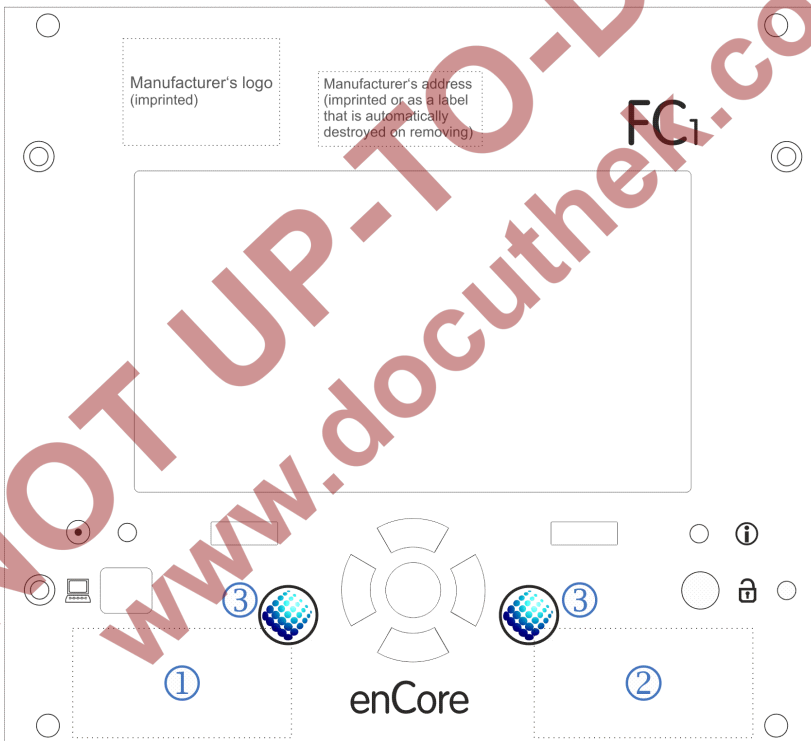


Figure 1: FC1 front view with position of type plates
(1/3 housing width, Elster design)

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

1.2 Front markings for an FC1 with 1/3 housing width, Honeywell front design

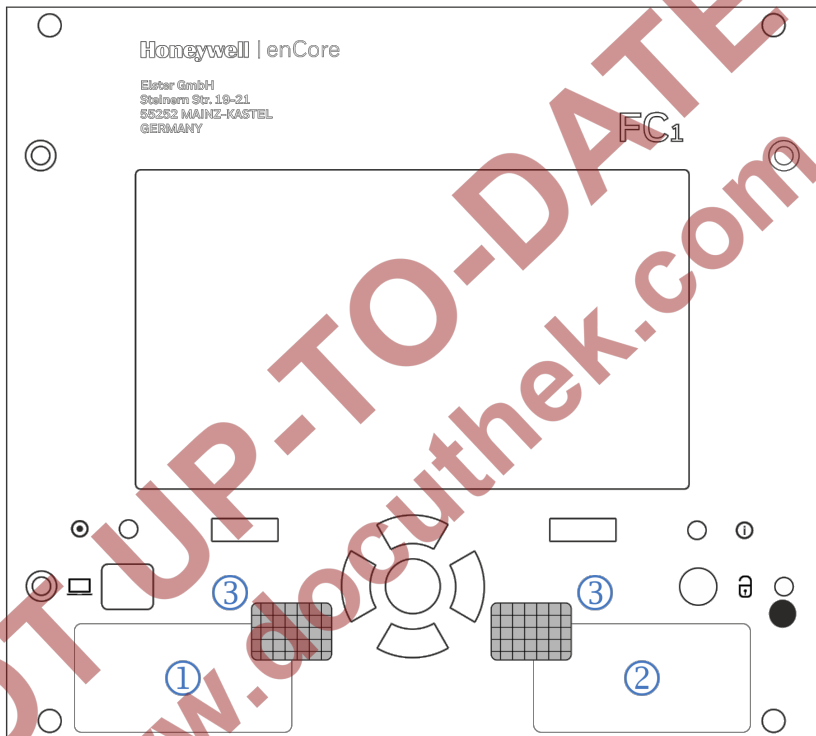


Figure 2: FC1 front view with position of type plates
(1/3 housing width, Honeywell design)

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

1.3 Type plates

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



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



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

1.4 Front markings for an FC1 with 1/2 housing width, Elster or Honeywell front design

Figure 5 and Figure 6 show the FC1 front markings for both Elster and 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 deviate from Figure 5 or Figure 6. In any case, the type plates must be secured with a securing mark.

For the type plates themselves, there are the same two alternatives as shown in chapter 1.3 in Figure 3 and Figure 4, respectively.

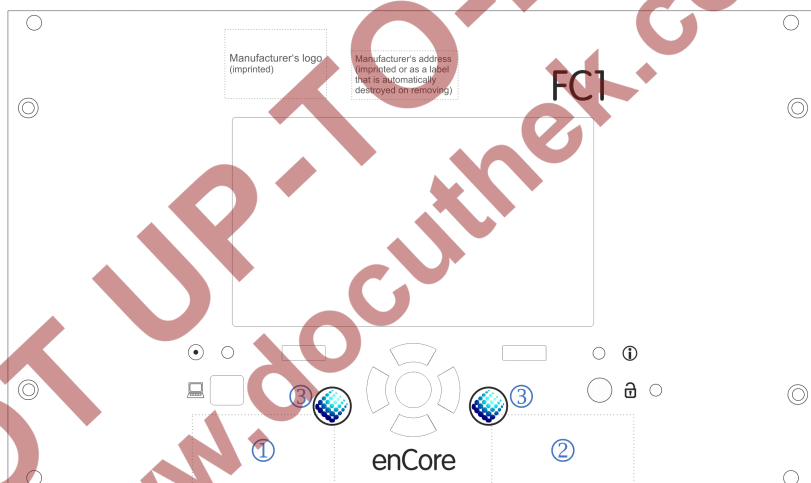


Figure 5: FC1 front view
(1/2 housing width, Elster design)

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

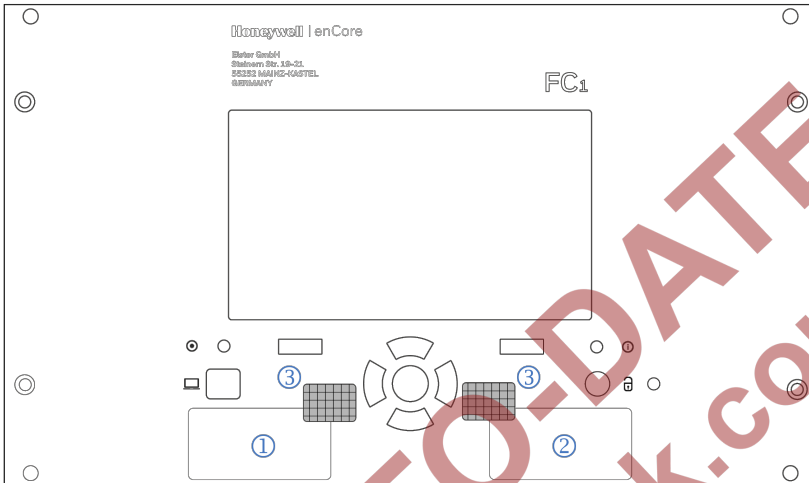


Figure 6: FC1 front view (1/2 housing width, Honeywell design)

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

2 Front Sealing

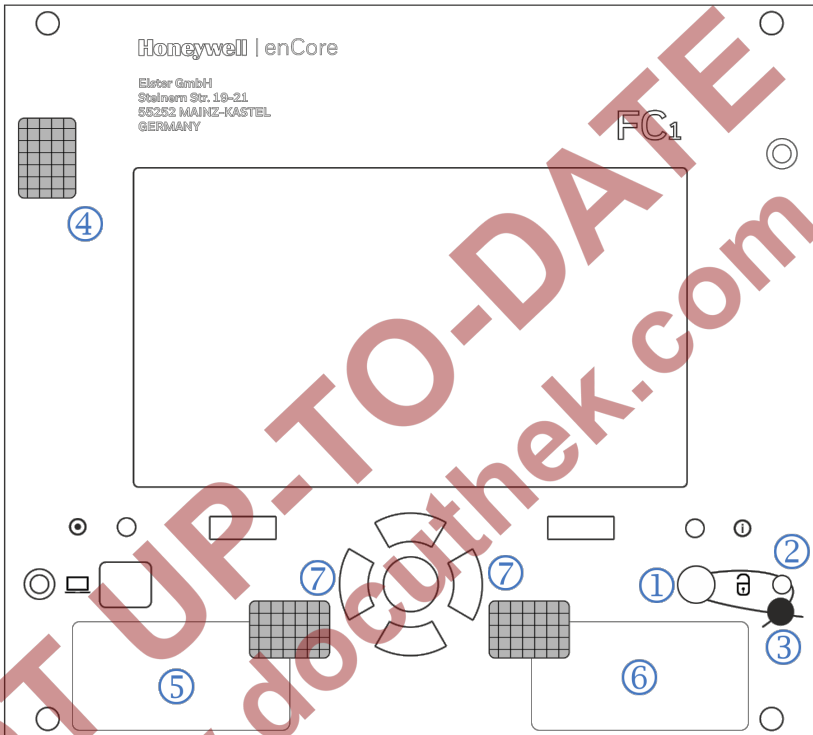


Figure 7: FC1 device sealing, front view (1/3 housing width),
exemplary for Honeywell design (same for Elster design)

- ① Security switch (sealable)
- ② Seal screw
- ③ Wire and seal
- ④ Securing mark (adhesive label), securing a housing screw
- ⑤ Location of type plate part 1
- ⑥ Location of type plate part 2
- ⑦ Securing mark (adhesive label), securing the type plate parts

The front sealing of a device with a wide housing (1/2 housing width) is the same (cf. Figure 7): Wire and seal for securing the security switch ① ② ③ ,

Rear Sealing

Figure 8 and Figure 9 show the FC1 rear view for both housing types, the

Figure 2. *Diagrams illustrating the experimental design.*

board 1 Karte	board 2 Karte	board 3 Karte	board 4 Karte	CPU3
---------------	---------------	---------------	---------------	------

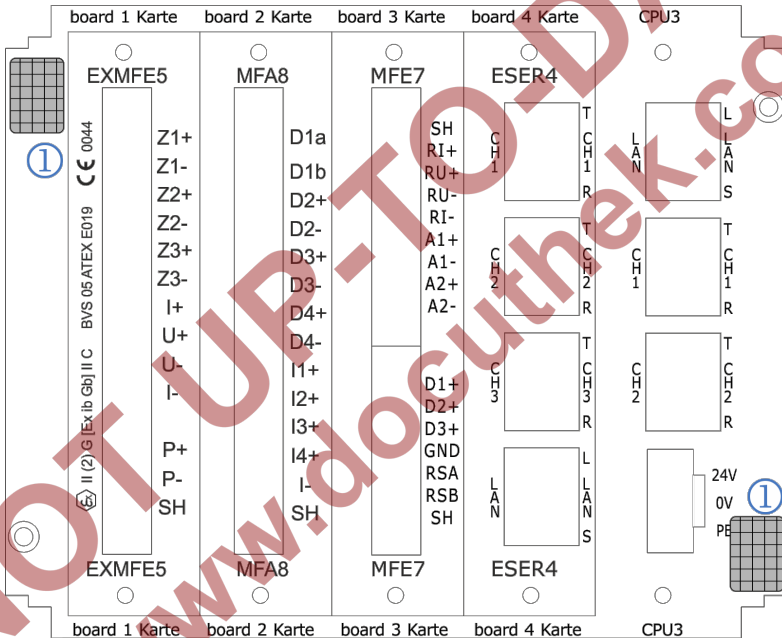


Figure 8: FC1 device sealing, rear view
(1/3 housing width, typical process board configuration)

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



- 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 fiscal use, the connectors of legally relevant process boards have to 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 (please refer to Figure 10).

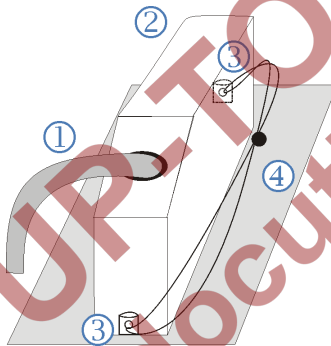


Figure 10 (schematic):
Sealing of ExMFE5 plug-in connectors with wire and seal

- 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 (please refer to Figure 11).

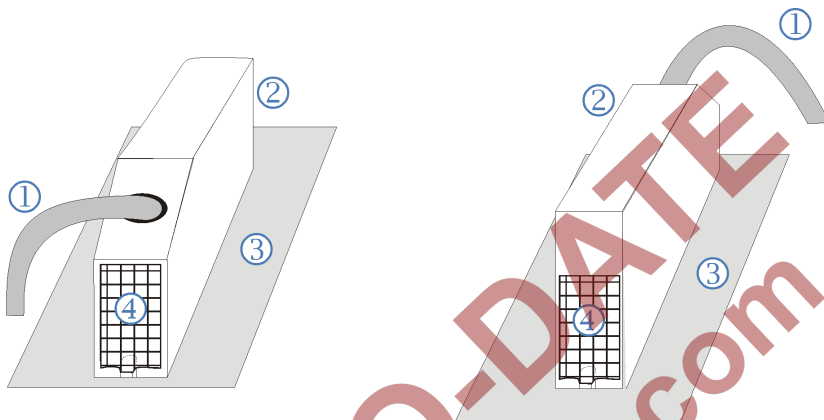


Figure 11 (schematic): Sealing of ExMFE5 plug-in connectors with adhesive labels (view from below and from above, cable feeding from below or from above, depending on installation situation)

- 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 10.

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 11) 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 and the MSER4 board can be secured by securing marks in form of adhesive labels.

NOT UP-TO-DATE
www.docuthek.com