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Special Documentation
Bunker Metering System

Commissioning the metering system

Endress+Hauser
People for Process Automation

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1 Document information

1.1 Document function

This Special Documentation is designed to assist the user in commissioning the Bunker Metering System.

The topics it addresses include:
- Structure of a metering system
- Prerequisites for commissioning (mechanical/electrical)
- Commissioning the metering system
- Sealing the metering system against unauthorized access

1.2 Target group

Specialized staff trained in the installation, connection and commissioning of the Endress+Hauser Bunker Metering System.

1.3 Symbols used

1.3.1 Safety symbols

Symbol	Meaning
DANGER	**DANGER!** This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.
WARNING	**WARNING!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.
CAUTION	**CAUTION!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.
NOTICE	**NOTE!** This symbol contains information on procedures and other facts which do not result in personal injury.

1.4 Other documentation

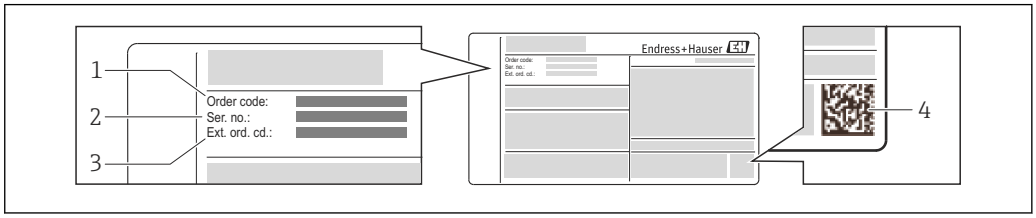
This Special Documentation complements the device documentation for the individual components of the Bunker Metering System. It does **not** replace the Operating Instructions pertaining to the individual components or other device documentation (Technical Information, Brief Operating Instructions, Ex documentation etc.).

1.4.1 Documentation on the Bunker Metering Computer BMC 600

The documentation is supplied with the metering system and comprises:
- Operating Instructions for the Bunker Metering Computer BMC 600
- Wiring diagram of the metering system

1.4.2 Device documentation for the Endress+Hauser devices

The device documentation is supplied with the individual devices. It is, however, always possible to procure the documentation subsequently, for example if you have mislaid the documentation. The information required to retrieve the device documentation for Endress+Hauser devices can be found on the nameplate of the device.



1 *Example of the structure of a nameplate*

1 *Order code*
2 *Serial number (ser. no.)*
3 *Extended order code (Ext. ord. cd.)*
4 *2-D matrix code (QR code)*

Ways to retrieve the device documentation:
- Enter the serial numbers on the nameplates into W@M Device Viewer (www.endress.com → Device Viewer): all the information about the measuring device is displayed.
- Enter the serial numbers on the nameplates into the Endress+Hauser Operations App or scan the 2-D matrix code (QR code) on the nameplate with the Endress+Hauser Operations App: all the information about the measuring device is displayed.

Technical Documentation is also available on the Endress+Hauser website: www.endress.com → Download. However this technical documentation applies to a particular instrument family and is not assigned to a specific device.

1.4.3 Third-party device documentation

Device documentation for third-party components that are supplied by Endress+Hauser are part of the scope of supply of the metering system.

Device documentation for third-party components procured by the client must be ordered from the device manufacturer in question.

1.4.4 Standards and other documents

When commissioning the device, attention must also be paid to Endress+Hauser's internal document entitled "Generic Operating Standard Operating Process for Commissioning of Endress+Hauser Instruments" (SOP-BL-en_A). The document is available on the Endress+Hauser intranet or through the Endress+Hauser service organization.

2 Basic safety instructions

When installing, commissioning, diagnosing and maintaining the individual devices in the Bunker Metering System, it is absolutely essential to observe the safety instructions in the operating manual for the specific device and the associated device documentation → 📄 4.

2.1 Requirements for personnel

The tasks described in this Special Documentation may only be performed by:
- Staff of the Endress+Hauser service organization
- Specialist staff trained by Endress+Hauser

2.1.1 Other general requirements

The personnel for installation, diagnostics and maintenance must meet the following requirements:
- Are qualified specialist staff trained by Endress+Hauser or staff of the Endress+Hauser service organization.
- Are authorized by the plant owner/operator.
- Are familiar with federal/national regulations.
- Before beginning work, the staff must have read and understood the instructions in the manuals and supplementary documentation as well as in the certificates (depending on the application).
- Follow instructions and comply with basic conditions.

The operating personnel must meet the following requirements:
- Are instructed and authorized according to the requirements of the task by the facility's owner-operator.
- Follow the instructions in this manual.

2.2 Workplace safety

When working on or with devices in the Bunker Metering System:
- ▶ Wear the required personal protective equipment according to federal/national regulations.

If working on and with the devices with wet hands:
- ▶ It is recommended to wear gloves on account of the higher risk of electric shock.

2.3 Operational safety

Risk of injury!
- ▶ Operate the device in proper technical condition and fail-safe condition only.
- ▶ The operator is responsible for the trouble-free operation of the metering system and the devices.

Conversions to the device

Unauthorized modifications to the metering system or the devices are not permitted and can lead to unforeseeable dangers:
- ▶ If modifications are nevertheless required, consult with the device manufacturer.

Repair

To ensure continued operational safety and reliability,
- ▶ Carry out repairs only if they are expressly permitted.
- ▶ Observe federal/national regulations pertaining to repair of an electrical device.
- ▶ Use original spare parts and accessories from Endress+Hauser only.

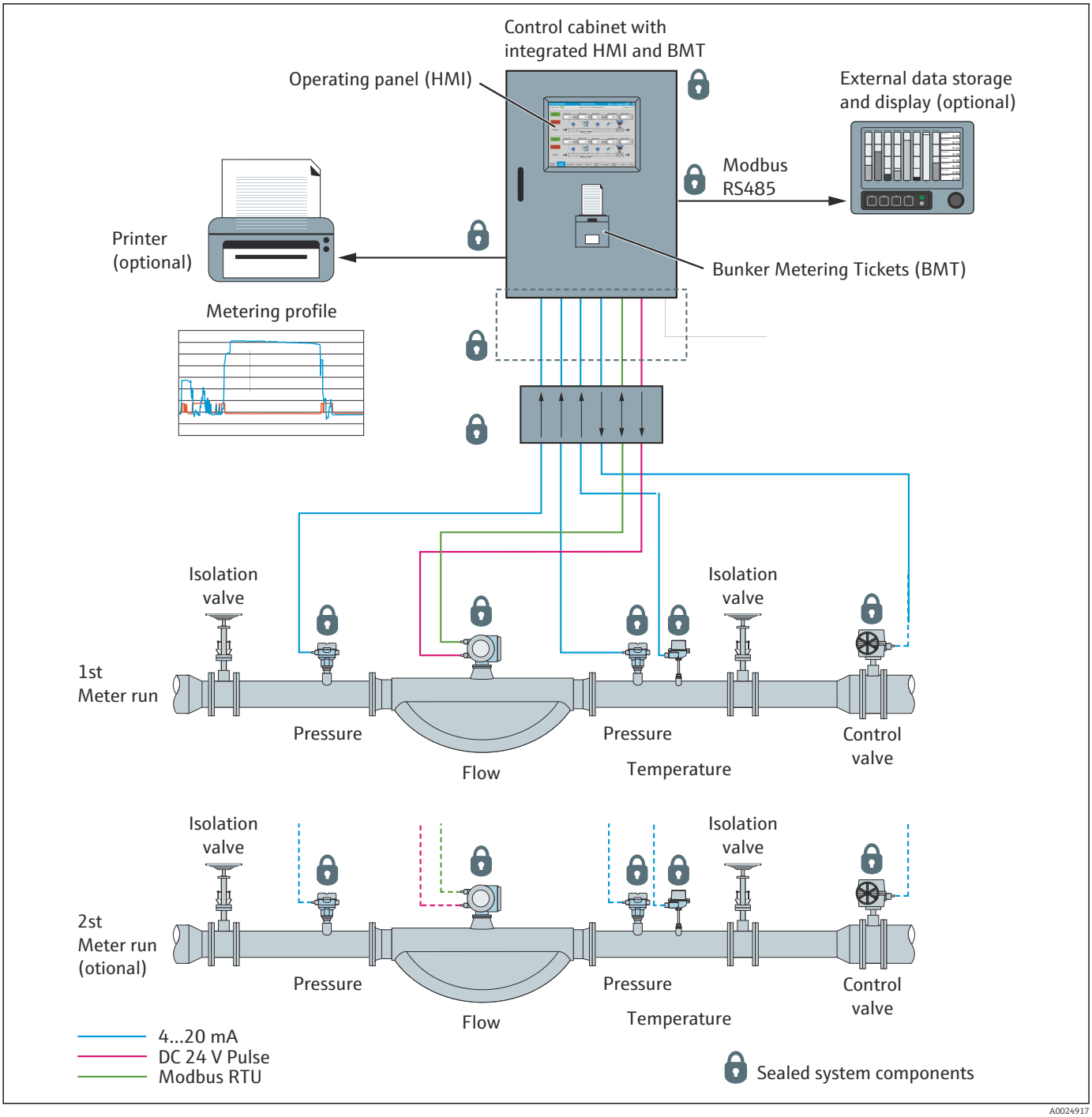
2.4 IT security

We only provide a warranty if the metering system and the devices are installed and used as described in the Operating Instructions. The metering system and the devices are equipped with security mechanisms to protect them against any inadvertent changes to the device settings.

IT security measures in line with operators' security standards and designed to provide additional protection for the metering system, the devices and device data transfer must be implemented by the operators themselves.

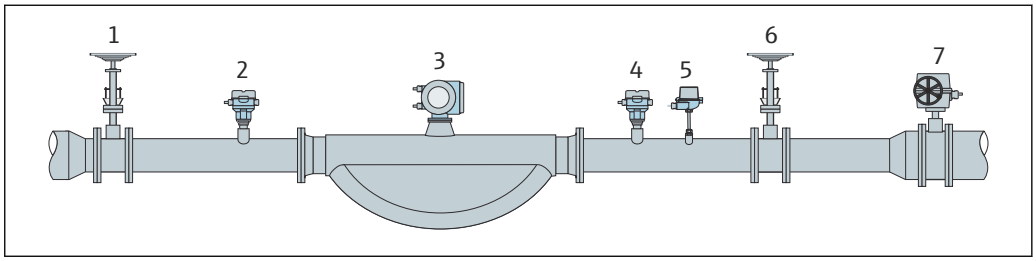
3 Structure of the metering system

3.1 System overview



3.2 System components

3.2.1 Metering section



1 Isolation valve
2 Pressure sensor
3 Coriolis mass flowmeter
4 Pressure sensor
5 RTD assembly
6 Isolation valve
7 Control valve

Coriolis mass flowmeter

The following Endress+Hauser Coriolis mass flowmeters can be employed to determine the flow:

Promass 84 F

Type	Promass 84 F
Nominal diameter	DN 100 (4"), DN 150 (6"), DN 250 (10")
Ambient temperature range	−20 to +60 °C (standard version), optional: −40 to +60 °C
Process temperature range	−50 to +200 °C (standard version)
Process pressure range	Depends on the device version: see nameplate
Maximum permissible measuring ranges in the custody transfer mode	The following is a sample range for the MI-005 Evaluation Certificate (liquids other than water). Mass flow (Q_{min} to Q_{max}): ▪ DN 100 (4"): 200 to 4500 kg/min ▪ DN 150 (6"): 350 to 12 000 kg/min ▪ DN 250 (10"): 1500 to 35 000 kg/min
Additional technical data	See device documentation → 🖹 5

Promass 84 X

Type	Promass 84 X
Nominal diameter	DN 350 (14")
Ambient temperature range	−20 to +60 °C (standard version), optional: −40 to +60 °C
Process temperature range	−50 to +180 °C
Process pressure range	Depends on the device version: see nameplate
Measuring range for liquids (full scale values)	0 to 4100 t/h
Maximum permissible measuring ranges in the custody transfer mode	The following is a sample range for the MI-005 Evaluation Certificate (liquids other than water). Mass flow (Q_{min} to Q_{max}): DN 350 (14"): 137 to 3500 t/h
Additional technical data	See device documentation → 🖹 5

Pressure sensor

Two Endress+Hauser pressure sensors are employed to provide the pressure information for evaluation of the process. The pressure sensors are mounted upstream and downstream from the flowmeter.

Type	Cerabar S PMP 71
Process temperature range	−25 to +125 °C (standard version)
Ambient temperature range	−40 to +85 °C (without LCD display or with LCD display with restrictions as regards visual properties, such as display speed and contrast)
Process pressure range	Depends on the device version: see nameplate
Process pressure range for measured value output: 4 to 20 mA	0 to 10 bara
Additional technical data	See device documentation → 🖹 5

RTD assembly

An Endress+Hauser RTD assembly is employed to determine the temperature.

Type	Omnigrad S TR 66
Process temperature range	−200 to +600 °C
Process temperature range for measured value output: 4 to 20 mA	0 to +100 °C
Ambient temperature range	−40 to +85 °C (without display)
Static process pressure range	Up to 500 bar
Additional technical data	See device documentation → 🖹 5

Control valve

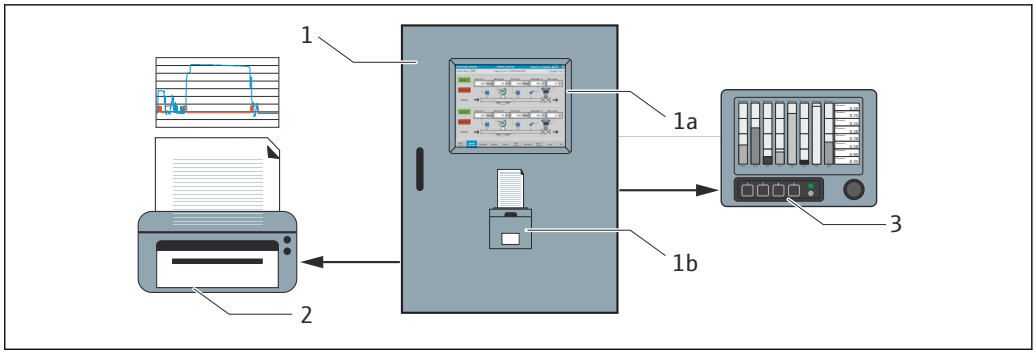
The control valve is employed to ensure that the metering section is filled with fluid. The pressure in the pipe serves as the controlled variable here.

The use of a control valve is specified by Endress+Hauser, but may be supplied by a third party. The valve specification depends on the particular application.

Isolation valves

The isolation valves are mounted upstream and downstream of the metering section and serve to shut off the metering section, e.g. when performing zero setting. They are specified by Endress+Hauser, but may be supplied by a third party. The valve specification depends on the particular application.

3.2.2 Operation, control and logging



1 Control unit and operating terminal of the Bunker Metering Computer (BMC)
1 a Integrated human-machine interface (HMI)
1 b Integrated printers for Bunker Metering Tickets (BMT)
2 Optional: external printer to print out metering profiles
3 Optional: external data storage system with trend indicator for enhanced IT security

Bunker Metering Computer (BMC)

The Bunker Metering Computer (BMC), has an integrated human-machine interface (HMI) and an integrated printer to print a bunker metering ticket (BMT) to document the totalized fuel quantity on completion of the bunkering process. The components of the control unit and operating terminal can be installed in either one or two control cabinets.

Bunker Metering Computer (BMC)	Computer to control all the components of the metering system, and to process the input and output variables.
Integrated human-machine interface (HMI)	For operating the metering system and controlling the bunkering processes.
Integrated Bunker Metering Ticket Printer	For printing a Bunker Metering Ticket (BMT) to document the totalized fuel quantity on completion of the bunkering process.

Optional components

External data storage system with trend indicator

The Memograph M RSG40 is employed to log data and visualize measured values wherever enhanced IT integrity requirements must be met. The data is stored in the internal memory and can be downloaded to an SD card or USB stick for further data processing, e.g. for using it in the Field Data Manager (FDM) software.

Type	Memograph M RSG40

External printer

A commercially available printer can be used. This can also be a printer already in service on site. The metering profiles can be printed out on the printer.

External computer with FDM selection and configuration software

A commercially available computer can be used. This can also be a computer already in service on site. Field Data Manager (FDM), the Endress+Hauser reporting software for data management and visualization of the Memograph M RSG40 data, must be installed on the computer. Metering profiles can be printed out on a printer connected to the computer.

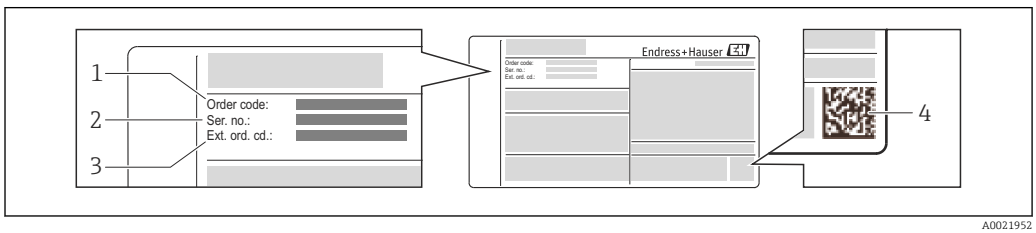
3.3 Product identification

3.3.1 Control Unit and Operating Terminal

The control unit and operating terminal can be identified using the nameplate, which is located on the switch box.

3.3.2 Endress+Hauser measuring devices

The following options are available for identifying the individual measuring devices:
- Nameplate specifications on the measuring device
- Enter the serial numbers on the nameplates into W@M Device Viewer (www.endress.com → Device Viewer): all the information about the measuring device is displayed.
- Enter the serial numbers on the nameplates into the Endress+Hauser Operations App or scan the 2-D matrix code (QR code) on the nameplate with the Endress+Hauser Operations App: all the information about the measuring device is displayed.



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1 *Order code*
2 *Serial number (ser. no.)*
3 *Extended order code (Ext. ord. cd.)*
4 *2-D matrix code (QR code)*

Symbols on measuring device

Symbol	Meaning
	**WARNING!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.
	**Reference to documentation** Refers to the corresponding device documentation.
	**Protective ground connection** A terminal which must be connected to ground prior to establishing any other connections.

3.3.3 Product identification of third-party components

The particular application dictates which specific third-party components are used. Third-party components are identified as described in the manufacturer's documentation for the component in question → 🖹 5.

4 Storage and transport

⚠ CAUTION

Different conditions apply for installing the individual devices/components

This can result in incorrect storage or improper transportation.

- ▶ See the specific device documentation for the storage/transportation procedure → 🖹 4.

5 Installation

⚠ WARNING

Different conditions apply for installing the individual devices/components
This can result in incorrect installation.
▶ See the specific device documentation for the installation procedure → 4.

5.1 Metering section

The measuring devices and valves installed in the pipe form the metering section through which the fluid flows. The metering section can be mounted on deck or below deck (e.g. in the engine room).

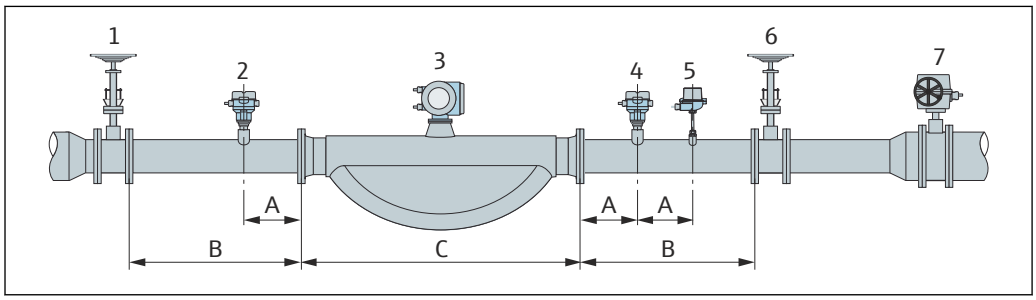
Depending on the mounting location of the metering section, additional installation conditions must be considered and the devices must, for example, meet conditions if used in hazardous areas, in a corrosive environment or other requirements.

The following are typical orientations for the metering section:
- Horizontal: When installed on a barge, for delivering the bunker fuel
- Vertical: When installed on a vessel, for receiving the bunker fuel

The control valve is employed to ensure that the metering section is always filled with fluid. The pressure in the pipe serves as the controlled variable here.

5.1.1 Installing the devices

When installing the devices, they should ideally be spaced apart as follows:



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1 Isolation valve
2 Pressure sensor
3 Coriolis mass flowmeter
4 Pressure sensor
5 RTD assembly
6 Isolation valve
7 Control valve

Spacing	Length [mm]
A	> 1 x DN
B	> 3 x DN
C	Depends on the nominal diameter of the device and the specific process connections

If installation conditions are very confined, pipe runs or dimensions that deviate from the above specifications may be possible. This must be clarified with Endress+Hauser prior to installation.

5.2 Bunker Metering Computer (BMC)

The Bunker Metering Computer (BMC) consists of:
- A control unit
- A human-machine interface (HMI)
- A printer for printing out the Bunker Metering Tickets (BMT)

The components can be installed in either one or two control cabinets.

The control center for loading and delivering of bunker fuel, the cargo control room (CCR), is a suitable place for installing the Bunker Metering Computer (BMC). This location generally does not have an explosive atmosphere or corrosive environment and usually no additional conditions need to be taken into consideration.

Optional components can also be installed in this area:
- External data storage system with display (Memograph M RSG40)
- External computer with reporting software FDM
- External printer

5.3 Third-party devices

The particular application dictates which specific third-party components are used. Third-party components are installed as described in the documentation for the component in question: → 🖹 5

5.4 Special installation conditions

5.4.1 Protection against corrosion

If the devices are exposed to a maritime atmosphere (e.g. saltwater), they require an appropriate protective varnish. This also applies for devices made of stainless steel, depending on the grade of the material.

In some cases, an additional protective coating might not be required on devices with a surface made of stainless steel 1.4404 (316L) or a higher grade material.

5.4.2 Protection against environmental conditions

We recommend installing additional weather protection covers to protect the devices against the influence of climate conditions, such as rain or excessive heating from direct sunlight.

5.4.3 Heating

If heavy fuel oil (HFO) is metered at an ambient/device temperature of < 25°C, there is the risk that the heavy fuel oil could solidify and remain stuck in the measuring tube. To prevent this from happening, the complete metering section (incl. the flowmeter) must be heated.

5.4.4 Thermal insulation

If the metering section is thermally insulated, the insulation must be protected from wet. If insulated material becomes wet it loses its insulating effect.

5.5 Post-installation check

Have all the devices been installed as per the specifications in the device documentation?	❑
Does the arrow on the sensor nameplate of the flowmeter match the direction of fluid flow through the piping?	❑
Has the correct orientation/installation direction been selected for the metering section? ▪ Barge installation: Delivery direction is forward ▪ Vessel installation: Loading direction is forward	❑
Are all identifications and labelings correct?	❑
Is the device adequately protected from rainfall and direct sunlight?	❑
Are the securing screws and securing clamps tightened securely?	❑

6 Electrical connection

⚠ WARNING

Different conditions and procedures apply for the electrical connection of the individual components in the metering system.
This can result in incorrect electrical connection.
▶ See the specific device documentation for the electrical connection procedure → 🖹 4.

⚠ WARNING

As the device is being operated in a maritime environment, the connecting cables and cable entries must meet special requirements.
If the procedure and requirements as specified in the Operating Instructions deviate from, or do not meet, the special requirements for use in a maritime environment, this can result in incorrect electrical connection.
▶ To use the devices in a maritime environment, the requirements set out in this Special Documentation must be met **in addition to** the requirements specified in the Operating Instructions for the specific device.

6.1 Connection conditions

6.1.1 Required tools

- For cable entries: Use corresponding tools
- For securing clamp (aluminum housing): 3 mm Allen screw
- For securing clamp (stainless steel housing): 8 mm wrench
- Wire stripper
- When using stranded cables: crimper for wire end ferrule
- Crimping tool for Keystone Jack Cat. 6A
- Multimeter for cabling test

6.1.2 Connecting cable requirements

⚠ WARNING

As the device is being operated in a maritime environment, the connecting cables and cable entries must meet special requirements.
If the procedure and requirements as specified in the Operating Instructions deviate from, or do not meet, the special requirements for use in a maritime environment, this can result in incorrect electrical connection.
▶ To use the devices in a maritime environment, the requirements set out in this Special Documentation must be met **in addition to** the requirements specified in the Operating Instructions for the specific device.

It is essential to only use power supply and signal cables that are employed in the marine industry according to state-of-the-art technology and sound engineering practice:
- All cables laid must be marine type cables and must meet the requirements concerning the ship class and other requisite approvals where necessary.
- It is advisable to use armored cables that are routed in fixed or flexible conduits so they are protected against mechanical damage.
- All signal cables must be grounded. If multi-core cables are used, the individual signal cables must be grounded individually.
- The Ethernet connecting cable between the control unit and the human machine interface (HMI) must be a cable type S/FTP category 7 (with wire mesh as pair shielding and film as overall shield).
- Required wire cross-sections:
  – Signal cable: 0.75 mm^2
  – Power supply cable for AC: 1.5 mm^2
  – Power supply cable for DC: 2.5 mm^2

6.1.3 Ethernet connector requirements

The RJ-45 Ethernet connectors of the cable, connecting the control unit and the human machine interface (HMI), must meet the following specifications: Keystone Jack Cat. 6A

6.1.4 Cable entry and distribution box requirements

The cable entries and distribution boxes must meet all the safety conditions that are required at the place of installation. This can include:
- Explosion protection
- Protection against climatic conditions
- Corrosion protection

The additional use of sealing compound to seal gaps and joints in the connections is commonplace and has proven effective in practice.

6.2 Powering the devices

The pressure sensors and the RTD assembly are powered directly via the Bunker Metering Computer (BMC).

The Coriolis mass flowmeter and the control valve are powered separately. Appropriate circuit breakers must be provided for these devices.

The circuit breakers should not be installed in the control cabinets of the Bunker Metering Computer (BMC) as these are sealed. If the circuit breakers were installed in a control cabinet, it would only be possible to access them by breaking the seal.

The power supply on vessels is often unstable. Therefore the use of an uninterruptible power supply (UPS) is essential to ensure the continuous operation of the metering system.

The specifications for the uninterruptible power supply (UPS) depend on the individual conditions on site. An uniterruptible power supply capable of bridging a 20-minute power failure is recommended. The power capacity must suffice to supply power to all the components of the metering system including any heating systems installed.

6.3 Terminal assignment

6.3.1 Bunker Metering Computer (BMC)

Control unit		External devices	
Terminal block	**Terminal designation**	**Terminal designation**	**Description**
X1	L	L	Supply voltage 100 to 240 VAC/50 Hz External Protected 4A 3G1.5
X1	N	N	
X1	PE	PE	
X3	1	+	Back pressure Control Valve
X3	2	–	
X3	PE	PE	
X3	3	+	Coriolis Mass Flowmeter Pulse Output
X3	4	–	
X3	5	1	Temperature T1 Line 1
X3	6	3	
X3	PE	PE	
X3	7	1	Pressure P1 upstream Line 1
X3	8	3	
X3	PE	PE	
X3	9	1	Pressure P2 downstream Line 1
X3	10	3	
X3	PE	PE	
X3	11	1	Valve Position Feedback [1] Line 1
X3	12	3	
X3	PE	PE	
X3	13	NA	Warning Signal 24 VDC
X3	14	NA	Warning Signal 24 VDC
X3	15	NA	Alarm Signal 24 VDC
X3	16	NA	Alarm Signal 24 VDC
X3	17	NA	Custom Warning Out 1 Line 1
X3	18	NA	
X3	19	NA	Custom Warning Out 2 Line 1
X3	20	NA	
X4	1	1	Coriolis Mass Flowmeter Modbus Output
X4	2	3	
X4	PE	PE	
X4	3	1	External Logger (optional)
X4	4	3	
X4	PE	PE	

1) Third party control valve active 4 to 20 mA feedback

Version with two control cabinets

Additional terminal assignment (connecting cable)

Control cabinet 1:		Control cabinet 2:	
Terminal block	**Terminal designation**	**Terminal designation**	**Description**
X1	1	1	Supply voltage 100 to 240 VAC/50 Hz
X1	2	2	
X1	PE	PE	
X2	1	+	Supply voltage 24 VDC
X2	2	–	
X2	PE	PE	
Ethernet IP cable	Plug	Plug	Control unit and operating terminal
RS 232 cable	Plug	Plug	Ticket Printer

6.3.2 Endress+Hauser devices

See the specific device documentation for the terminal assignment → 📄 4.

6.3.3 Third-party devices

See the specific device documentation for the terminal assignment → 📄 5.

6.3.4 Bunker Metering Computer (BMC)

See the device documentation for the terminal assignment → 📄 4.

6.4 Connecting the metering system

NOTICE

Incorrect connection can reduce electrical safety!

- Only authorized specialist staff may perform electrical connection work. Requirements for personnel: → 📄 6.
- Observe applicable federal/national installation codes and regulations.
- Comply with local workplace safety regulations.
- Observe grounding concept of the plant.
- In case of the metering system is still connected to the supply voltage: do not perform any installation or wiring work. Use the circuit breakers for disconnecting the metering system from supply voltage.
- For use in potentially explosive atmospheres, observe the information in the device-specific Ex documentation.

6.4.1 Connecting devices and components of the metering system

⚠ WARNING

Different conditions and procedures apply for the electrical connection of the individual components in the metering system.
This can result in incorrect electrical connection.
- ▶ See the specific device documentation for the electrical connection procedure → 🖹 4.

⚠ WARNING

As the device is being operated in a maritime environment, the connecting cables and cable entries must meet special requirements.
If the procedure and requirements as specified in the Operating Instructions deviate from, or do not meet, the special requirements for use in a maritime environment, this can result in incorrect electrical connection.
- ▶ To use the devices in a maritime environment, the requirements set out in this Special Documentation must be met **in addition to** the requirements specified in the Operating Instructions for the specific device.

6.4.2 Basic loop check

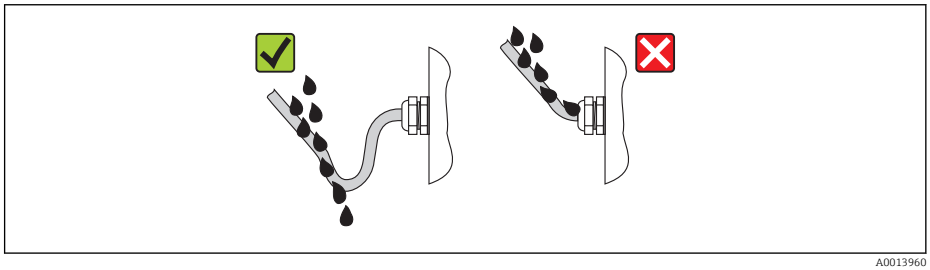
A basic loop check should be performed to check whether all the measuring devices and components in the metering system are correctly interconnected. This loop check can be done using the signal simulating capabilities of the signal transmitter.

6.5 Ensuring the degree of protection

The metering system meets all the requirements for IP66/67 degree of protection, Type 4X enclosure.

To guarantee IP66/67 degree of protection, Type 4X enclosure, carry out the following steps after the electrical connection:

1. Check that the housing seals are clean and fitted correctly. Dry, clean or replace the seals if necessary.
2. Tighten all housing screws and screw covers.
3. Firmly tighten the cable glands.
4. To ensure that moisture does not enter the cable entry, route the cable so that it loops down before the cable entry ("water trap").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5. Insert dummy plugs into unused cable entries.
6. Use sealing compound to additionally protect cable glands installed on deck against moisture.

6.6 Post-connection check

Have all the devices been connected as per the specifications in the device documentation?	❑
Do the cables comply with the requirements ?	❑
Are all the cable glands installed, firmly tightened and leak-tight? Cable run with "water trap"?	❑
Does the supply voltage match the specifications on the transmitter nameplate?	❑
Is the terminal assignment correct ?	❑
Has a basic loop check been performed?	❑
If supply voltage is present, do values appear on the human machine interface?	❑
Are all housing covers installed and securely tightened?	❑
Have gaps and joints in the connections been additionally sealed with sealing compound?	❑

7 Operation options

7.1 Overview of operating options

The metering system is accessed via the touchscreen on the human machine interface (HMI). It is neither necessary nor possible to connect an additional operating options, such as a keyboard or mouse, since the metering system is sealed.

In principle external access to the metering system is possible, but only if there are no reasons not to access the device externally from the point of view of custody transfer or other conditions. A suitable modem and an Ethernet broadband connection are required for external access.

7.2 Structure and function of the operating menu

7.2.1 Devices and components of the metering system

The structure and function of the operating menu is described in the specific device documentation → 4.

7.2.2 Operating the metering system

A variety of menus can be accessed via the touchscreen:
- Totalizer
- Process information
- System configuration

Access to the individual menus is assigned to certain user roles:
- "operator" user role
- "supervisor" user role
- "eh" user role for commissioning

8 System integration

The following methods of system integration are possible:
- External access by modem via Ethernet .
- Integration into a higher control system via Modbus TCP/IP.

National regulations or customer in-company provisions may dictate that external access to the metering system or integration into a higher system is not acceptable.

9 Commissioning

NOTICE

Incorrect commissioning can reduce electrical safety!

- The commissioning procedure described here may only be performed by staff of the Endress+Hauser service organization or by specialist staff trained by Endress+Hauser → 6.
- When commissioning the device, attention must also be paid to Endress+Hauser's internal document entitled "Generic Operating Standard Operating Process for Commissioning of Endress+Hauser Instruments“ (SOP-BL-en_A) → 5 in addition to the documentation for the device in question → 4.

Before commissioning the metering system, some settings must be made on the individual measuring devices and components.

9.1 Function check

Before commissioning, make sure that the post-installation and post-connection checks have been performed:

- "Post-installation check” checklist → 16
- "Post-connection check” checklist → 22

9.2 Configuration of the Coriolis mass flowmeter Promass 84

Measuring devices ordered with the option for use in a Bunker Metering System are pre-configured and normally no additional settings are required. For more in-depth configurations, see the device documentation → 4.

9.3 Configuration of the Cerabar S PMP71 pressure sensor

The pressure sensor must cover a measuring range from 0 to 10 bara (absolute pressure).

The basic settings are pre-configured when the device is delivered and normally only one setting is required.

Necessary settings:
DAMPING VALUE parameter = 0 s (for both pressure sensors)
Procedure: see device documentation → 4

9.4 Configuration of the Omnigrad S TR66 RTD assembly

The RTD assembly must cover a measuring range from 0 to 100 °C.

The basic settings are pre-configured and the measuring device does not require any other settings.

9.5 Configuration of the Bunker Metering Computer (BMC)

NOTICE

If the configuration is modified, this can affect operation in a undesired way.

- Only the parameters described below may be modified.

9.5.1 Basic configuration

Pre-configured when delivered:
- Installation location: use on a barge
- Orientation: horizontal
- Nominal diameter: DN 250 mm (10 in)
- Measuring range: up to 1200 mT

These parameters must be modified if this basic configuration does not match the application.

9.5.2 Process warnings

Parameters under: *Settings*

Alarms for out of range detection (above/below limit threshold) can be defined for the process variables. Different alarm levels can be assigned to the alarms.

NOTICE

Danger if excess pressure not signaled! It ist strongly recommended to alarm high process pressure.

▶ The alarm for excessively high process pressure must always be set **below** the maximum process pressure of the plant.

9.5.3 General configuration

Parameters under: *Settings/System Configuration/General*

- Select the number of metering sections that should appear on the touchscreen.
- Define the ship type.
- Determine the flow direction: forward or reverse flow direction.
  - Installation on a barge: Forward flow direction is delivering.
  - Installation on a vessel: Forward flow direction is loading.
- Customize the information printed on the Bunker Metering Tickets: additional information about the vessel on which the metering system is mounted.
- This information must be agreed with the competent authority or the operator.
- Customize the human-machine interface (HMI): additional information about the flow metering section.

The system ID of the control unit (PLC) is individual to the installed unit and must not be changed.

9.5.4 Process configuration

Parameters under: *Settings/System Configuration/Process*

Batching mode

Coriolis mass flowmeters record the actual mass of the measured medium (mass-in-vacuum). However, a "mass-in-air" reading is often common when handling bunker fuels.

If the competent authorities require a "mass-in-air" reading, this can be selected in the batching mode ("Mass Air" option). If this reading is not required by the authorities, the "mass-in-vacuum" reading should be retained as the batching mode ("Mass" option).

To be able to compare the measurement results of the metering systems on the barge and the vessel, both metering systems must use the same settings and units. If needed, one of the results must be converted for comparing.

Correction factor for buoyancy

The correction factor for buoyancy is used to convert from "mass-in-vacuum" to "mass-in-air". If the competent authorities require a "mass-in-air" reading, the correction factor used in the metering system must be specified or approved by the authority.

The default value for the buoyancy factor used by the metering system is 0.998751. This value has been determined based on the global average atmospheric pressure at sea level. The air density used has been calculated in accordance with the formula defined by the US National Institute of Standards and Technology (NIST).

Meter factors

The meter factors affect the reading and adjust the measurement result. They can be used to offset any deviations based on experience or following repeated calibration.

Normally the meter factors should not be changed! Before applying a correction, check with the competent authority.

9.5.5 Input configuration

Parameters under: *Settings/System Configuration/Input*

Pulse value

The pulse value of the Bunker Metering Computer (BMC) must always match the set pulse value of the Coriolis mass flowmeter.

Default values for the pulse value: Promass F – setting on BMC

DN nominal diameter		Flow rate at 10 000 Hz	Pulse value (to be configured on BMC)
[mm]	[in]	[t/h]	[P/t]
100	4	200	180 000
150	6	450	80 000
250	10	1200	30 000
350	14	2400	15 000

4 to 20 mA values

The set temperature and pressure ranges on the computer (BMC) must match the settings on the measuring device.

Measuring device	Measuring device output	BMC input
	4 to 20 mA	4 to 20 mA
RTD assembly	0 to 100 °C	0 to 100 °C
Pressure sensor 1	0 to 10 bara	0 to 10 bara
Pressure sensor 2	0 to 10 bara	0 to 10 bara

9.5.6 VFR configuration

Parameters under: *Settings/System Configuration/VFR*

VFR coefficient

Air pockets in the fluid can negatively impact the reading and the flowmeter cannot return a reliable flow signal. In such situations, a smart algorithm based on the differential pressure is used to produce the flow measured value (auxiliary method). The flow measured value is calculated based on the VFR coefficients.

The VFR coefficients depend on the nominal diameter of the Coriolis mass flowmeter and the fluid.

Default values for VFR coefficients

DN nominal diameter		HFO (heavy fuel oil)		
[mm]	[in]	K t miu	k	Exp
100	4	–0,035	23	1.3770
150	6	–0,035	21	1.2800
250	10	–0,035	145	1.5377
350	14	–0,035	tbd	tbd

Damping limit value

The limit value is used to switch between the flowmeter and the auxiliary method for determining the flow value.

If the damping exceeds the limit value, it is presumed that the good metering conditions for the flowmeter are no longer met. In this situation, the auxiliary method is used to produce the flow measured value.

Default values for the damping limit value

DN nominal diameter		HFO (heavy fuel oil)
[mm]	[in]	[A/m]
100	4	18000
150	6	25000
250	10	35000
350	14	35000

Differential pressure limit value

The limit value is used to check the validity of the flow value measured by the flowmeter.

If the differential pressure falls below the limit value, it is presumed that the flow value measured by the flowmeter is no longer valid due to specific influences. In this case, the flow value measured by the flowmeter is set to 0.

Default values for the differential pressure limit value

DN nominal diameter		Horizontal installation	Vertical installation
[mm]	[in]	[bar]	[bar]
100	4	0.025	0.015
150	6	0.035	0.020
250	10	0.050	0.025
350	14	0.050	0.025

9.5.7 Installation configuration

Parameters under: *Settings/System Configuration/Installation*

Pressure compensation value for vertical installation

If the flowmeter is installed vertically in a down pipe, the two pressure sensors do not work under the same conditions. The static weight of the fluid between the two pressure sensors additionally acts on the lower pressure sensor. This must be taken into consideration

during device configuration and can be offset by specifying an offset value in the "Static offset" parameter.

The compensation value for pressure when the device is installed horizontally is 0 bar.

Dynamic correction

The value for static offset is correct if the flow metering section is completely filled with fluid.

If the flow metering section is only partly filled, e.g. during intake, at the end of the emptying routine or when draining the pipe, the static offset must be corrected dynamically. This correction is performed using the density of the fluid and an acceleration factor.

Default values for dynamic correction

DN nominal diameter		HFO (heavy fuel oil)	
[mm]	[in]	Reference density [kg/m³]	Acceleration factor
100	4	980	0.100
150	6	980	0.100
250	10	980	0.100
350	14	980	0.100

9.5.8 BMT configuration

Parameters under: *Settings/System Configuration/Bunkering Ticket*

The display format for the printed bunker metering tickets of the batching or loading procedure can vary due to local requirements. The required layout can be selected here.

9.5.9 Data management configuration

Parameters under: *Settings/System Configuration/Metering Profile*

If a Memograph M RSG40 is used as an external data storage system with trend indication, data management and trend display must be disabled on the human-machine interface (HMI).

9.6 Adjustments to the sensors

9.6.1 Flowmeter zero setting

All the flowmeters are calibrated in accordance with state-of-the-art technology. The zero point (parameter for zero offset compensation) obtained in this way is printed on the nameplate. As the first calibration is performed under reference operating conditions, the zero point can deviate from the nameplate value, depending on the actual operation and installation conditions. To adapt the measuring device to local conditions, a zero setting must be performed.

It is mandatory to perform a zero setting if the measuring device is used for custody transfer. Only this can guarantee the maximum possible accuracy of the flowmeter.

For further information on the zero setting, see the separate documentation.

9.6.2 Adjusting the pressure sensor

It is important that both pressure sensors arrive at the same measurement result if they are exposed to the same pressure conditions. If needed, one of them must be adjusted to match the other one.

For further information on the zero setting, see the separate documentation.

10 Operation

The Bunker Metering System is specially designed for delivering and loading processes that start and end with an empty flow metering section. The fluids are pumped through the metering section partly air pockets. The air pockets occur, for example, when tanks are fully drained and air is drawn into the piping system.

In the case of high-viscosity fluids, traditional air/gas separators can often not be used as they do not work correctly under such conditions.

The metering system merely totalizes the fluid flowing through the metering section. It does not control the process, if switched on it is always ready to measure.

To ensure the best possible readings, the control valve ensures that the metering section is filled with fluid as well as possible and for as long as possible.

Such a metering system is typically used to load and deliver bunker fuels from barges to vessels. However, there are also similar applications for such metering system on land or for off-loading from barges.

11 Diagnostics and troubleshooting

11.1 General troubleshooting

The metering system and all other Endress+Hauser measuring devices have a continuous self-monitoring system. Diagnostic messages that occur are output via the outputs and shown on the local display.

For more information on diagnostics and troubleshooting, see the device documentation → 4.

11.1.1 Audit trail

An audit trail is available on the bunker metering computer. It logs all changes to the system.

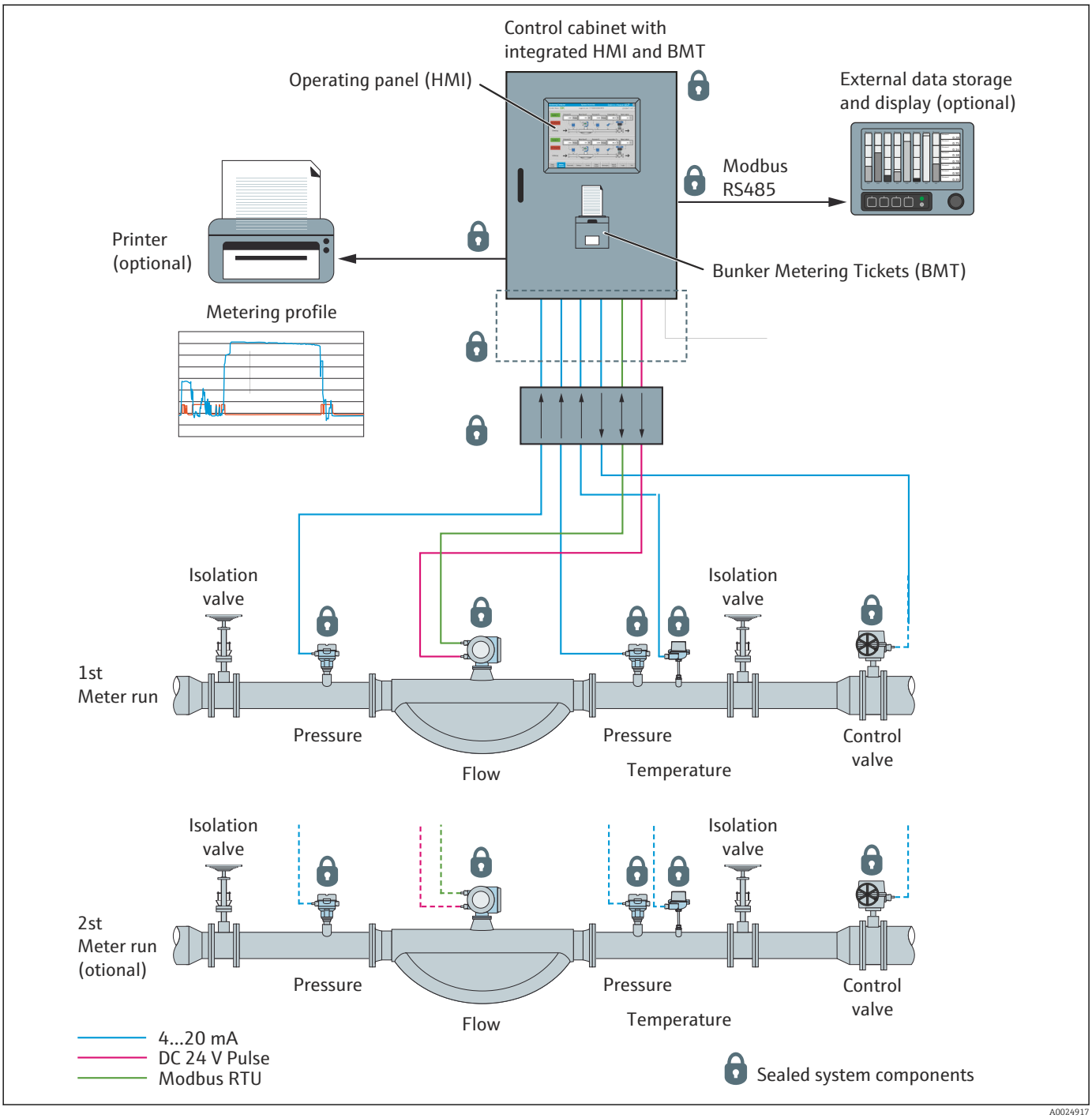
For more information on the audit trail, see the device documentation for BMC 600 → 4.

11.1.2 Firmware history

For more information on the firmware history, see the device documentation → 4.

12 Sealing the metering system

All components of the metering system must protect their settings and functions that are relevant for custody transfer against undesired or unauthorized access. This can be implemented mechanically or via the software.



12.1 Documentation of sealing (Sealing plan)

All the seal points must be documented in a sealing plan. This concerns all the components of the metering system but also the pipe work can be concerned. Spectacle blinds, for example, to isolate pipe connections that could bypass the metering system must be sealed. The sealing plan must be kept available on the vessel or barge.

Each time a seal is affixed or replaced, this must be documented. To this end, the individual seal labeling must be unique and traceable (e.g. through a unique numbering system). Official seal numbers can be traced to the person or organization who affixed the seal.

12.2 Authorized persons

Seals may only be fitted by persons authorized to perform such work. The group of authorized persons depends on local regulations and the time the seal is fitted. For example, seals can be fitted during the test phase by the vessel owner or by individuals appointed by the vessel owner or by authorized Endress+Hauser employees. Official seals may only be fitted in collaboration with an official representative.

12.3 Modifying, replacing or removing the sealing

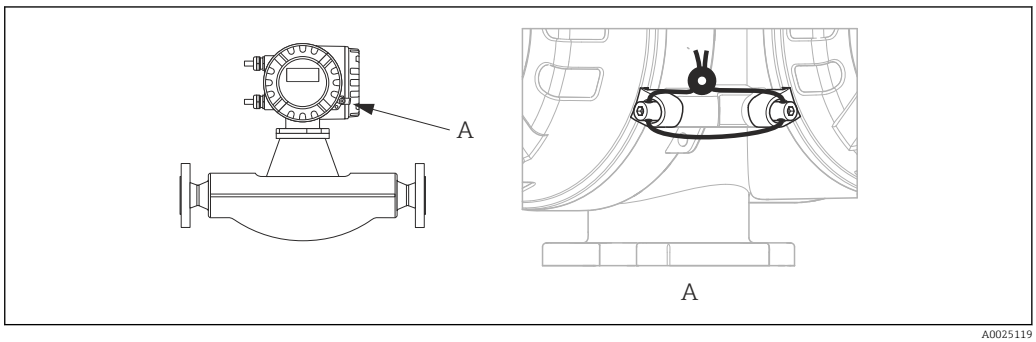
In the case of officially approved systems, the sealing may only be modified, replaced or removed by an official representative or with written official permission.

12.4 Sealing the individual components of the metering system

The sealing material must withstand local conditions. This can be accomplished through the use of stainless materials for example.

Example: The use of galvanized sealing is not recommended in a maritime atmosphere.

12.4.1 Coriolis mass flowmeter



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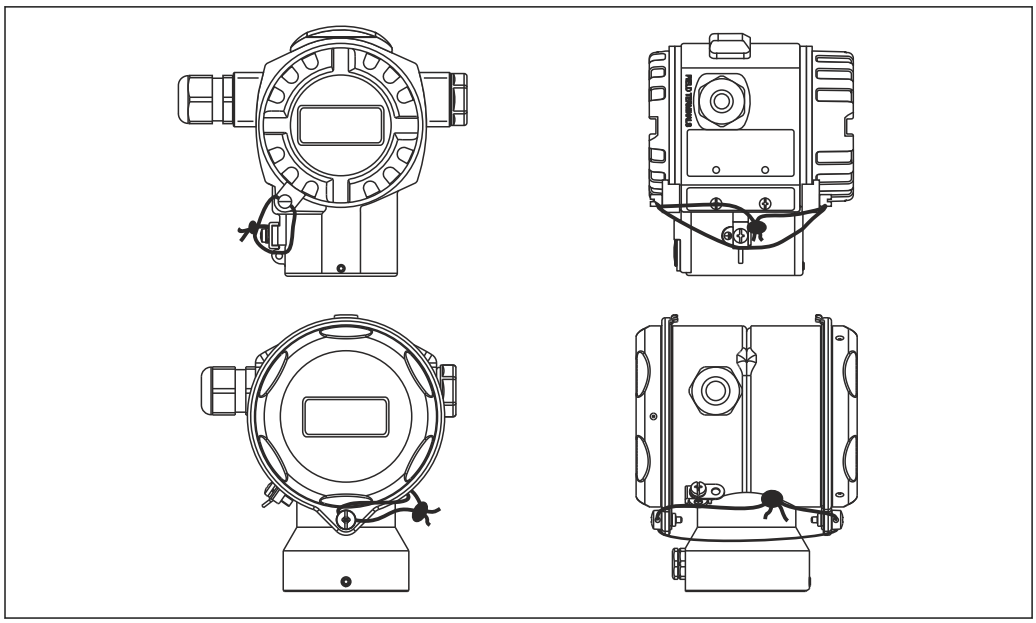
12.4.2 Pressure sensor



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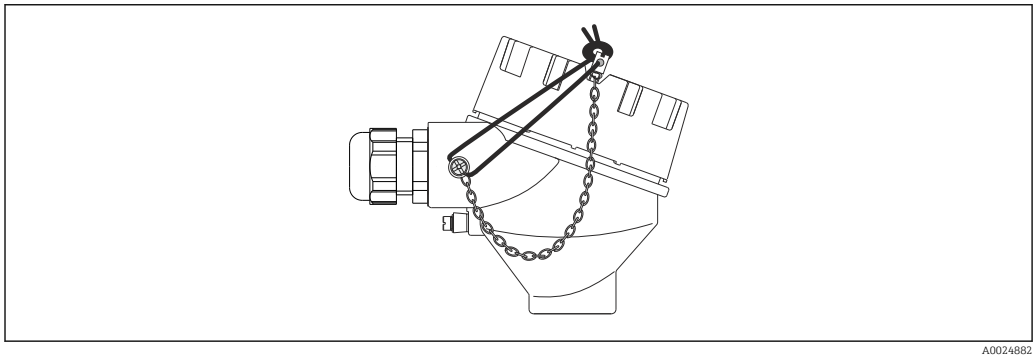
12.4.3 RTD assembly



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12.4.4 Metering system control cabinet

Sealing on the cabinet or cabinets:
- Door lock
- Cable entries
- USB port

For more information on sealing, see the device documentation for the Bunker Metering Computers (BMC) → 🖹 4.

12.4.5 Junction boxes, valves and other components

All components must protect their settings and functions that are relevant for custody transfer against undesired or unauthorized access. This also includes electronic junction boxes and valves that seal pipes which can bypass the metering system.

The application of seals depends on the device version, see the documentation for the particular device → 🖹 4.

13 Maintenance

13.1 Maintenance tasks

No special maintenance work is required.

The metering system should be kept clean and be protected against corrosion wherever necessary.

13.2 Calibration and verification

13.2.1 Coriolis mass flowmeter

It is important to verify the flowmeter regularly to guarantee the correct operation of the metering system. As the metering system is mounted on a vessel or barge, however, it is not always feasible to perform regular calibrations as is common for devices designed for use in custody transfer. Betankungsschiff nicht immer praktikabel. The regular verification of the zero point provides a good way of extending the intervals between calibrations, or of rendering the calibration redundant altogether.

The zero point responds at a very early stage to altered conditions that have an impact on the measured value output by the flowmeter. More serious problems are detected by the flowmeter's integrated self-monitoring system and reported to the higher system. In addition, the sensor and electronics of the flowmeter can be verified and documented.

The procedure for performing zero point verification is described in a separate document. The zero point can also be verified on a metering system (including flowmeter) secured for use in custody transfer without having to break the seal.

The method for performing the inspection and verification must be agreed between the official authorities and the metering system operator and set down in concrete terms.

13.2.2 Pressure sensor and RTD assembly

The pressure sensor and RTD assembly can be calibrated and verified using mobile calibration equipment.

14 Repair

14.1 General notes

Repair concept

Note the following when repairing a measuring device:

- Replace the following entirely in the event of an error:
  - All inexpensive components
  - Electronics boards in the event of hardware errors
- Use only original Endress+Hauser spare parts.
- Carry out the repair according to the Installation Instructions.
- Observe the applicable standards, federal/national regulations, Ex documentation (XA) and certificates.
- Document all repairs and enter them into the W@M life cycle management database.

Notes on repairs

The Endress+Hauser repair strategy comprises the following:

- The measuring devices have a modular design.
- Spare parts are grouped into logical kits with the associated Installation Instructions.
- Repairs are carried out by Endress+Hauser Service or by appropriately trained customers.
- Certified devices can only be converted to other certified devices by Endress+Hauser Service or at the factory.

Components of the metering system	Device	Corrective measure
Coriolis mass flowmeter	Promass 84 F	1. Replace the electronics board 2. Replace the flowmeter
	Promass 84 X	1. Replace the electronics board 2. Replace the flowmeter
Pressure sensor	Cerabar S PMP71	1. Replace the electronics board 2. Replace the flowmeter
RTD assembly	Omnigrad S TR66	1. Replace the electronics board 2. Replace the flowmeter
Control unit and operating terminal SB 600	Computer (Bunker Metering Computer)	1. Replace the I/O modules 2. Replace the CPU
	Human-machine interface (HMI)	Replace the human-machine interface (HMI)
	Printer for printing out the measured values (Bunker Metering Tickets)	Replace the printer
Isolation valves		1. Replace the actuator 2. Replace the valve
Control valve		1. Replace the actuator 2. Replace the valve
Optional components	**Device**	**Corrective measure**
External printer		Replace the printer
External data storage system with trend indicator	Memograph M RSG40	Replace the Memograph M RSG40

14.2 Spare parts and services

Contact your Endress+Hauser Sales Center for information on services and spare parts.

14.3 Returning Endress+Hauser devices

The measuring device must be returned if it is in need of repair or a factory calibration, or if the wrong measuring device has been delivered or ordered. Legal specifications require Endress+Hauser, as an ISO-certified company, to follow certain procedures when handling products that are in contact with the medium.

To ensure safe, swift and professional device returns, please refer to the procedure and conditions for returning devices provided on the Endress+Hauser website at http://www.endress.com/support/return-material

15 Accessories

Various accessories are available for the device, and can be ordered with the device or at a later stage from Endress+Hauser. Detailed information on the order code in question is available from your local Endress+Hauser Sales Center or on the product page of the Endress+Hauser website: www.endress.com.

15.1 Accessories specific to the metering system

15.1.1 Accessories for the metering section

Accessories	Description
Metering section heater	If heavy fuel oil (HFO) is metered at an ambient/device temperature below 25°C, there is the risk of the fluid solidifying. To prevent this from happening, the complete flow metering section (incl. the flowmeter) must be heated. The structure of the heating system is individual and depends on the local conditions. Heating must be planned as part of the overall project.

15.1.2 Accessories for the metering system

Accessories	Description
Memograph M RSG40	External data storage system with trend indicator. The Memograph can be employed for paperless data logging and to display measured values/metering profiles wherever strict system integrity requirements must be met.
Uninterruptible power supply (UPS)	The power supply on vessels is often unstable. Therefore the use of an uninterruptible power supply (UPS) is essential to ensure the continuous operation of the metering system. The specifications for the uninterruptible power supply (UPS) depend on the individual conditions on site. An uniterruptible power supply capable of bridging a 20-minute power failure is recommended. The power capacity must suffice to supply power to all the components of the metering system including any heating systems installed.
Circuit breaker	The following components of the metering system must have their own circuit breaker: ▪ Coriolis mass flowmeter ▪ Bunker Metering Computer (BMC) ▪ Control valve ▪ Heating

16 Technical data

See the specific device documentation for the technical data → 🖹 4.

17 Acronyms and abbreviations

Acronyms and abbreviations	Meaning
BMC 600	Bunker Metering Computer
BMT	Bunker Metering Ticket
HFO	Heavy Fuel Oil
HMI	Human-Machine Interface
MDO	Marine Diesel Oil
MGO	Marine Gas Oil
PLC	Control Unit/Programmable Logic Controller

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